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A SWOT Analysis of Utility-Scale Solar in Myanmar

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Received: 7 January 2020; Accepted: 7 February 2020; Published: 17 February 2020

Abstract: Myanmar remains one of the few exceptions to the rapid diffusion of solar photovoltaics (PV) in power generation mixes. This is surprising considering that Myanmar is one of the countries with the largest technical potential for solar energy among Southeast Asian nations. Solar energy can complement the existing hydropower generation to address endemic energy crisis during the dry season. A continuation of paralysis on investments in solar energy could affect the security and sustainability of the sector in one of the most rapidly growing countries in the region. In this paper, we aimed to identify the barriers preventing solar energy to flourish in Myanmar and to identify policy options to unlock them. We conducted a SWOT (strengths, weaknesses, opportunities, and threats) analysis with inputs from relevant stakeholders from the government, private sector, and civil society organizations. Our analysis suggested a consensus on the merits of solar energy among all factors; however, a policy framework to spur investments that contribute both to the national energy system and local development needs to be developed by considering some particularities of Myanmar, such as securing rightful land ownership and limited experience with market mechanisms (e.g., energy auction), for the promotion of investments in the energy sector.

Keywords: Myanmar; solar energy; capacity expansion

1. Introduction

Myanmar's transition from a closed military regime to an open democracy has attracted a lot of interest and brought opportunities for rapid economic growth in the country. In order to accommodate this, Myanmar is on the verge of a massive power capacity expansion. The growth in energy demand calls for a 3-fold increase in the system in the next 10 years. The investment needs in the near- and medium-term future are commensurable. The World Bank has recently announced that USD 2 billion/year will be needed [1].

The current generation mix is dominated by hydropower, with an increasing role of natural gas. The power generation capacity of the current mix is tight, and it is not able to grant a robust supply during the dry season months. The country relies mostly on hydropower that is generated in the North and transferred over long distances to the demand centers in the South, particularly Yangon in the Ayeyarwady Delta. This has created a vulnerability of the supply to seasonal changes. As a result, the country endures frequent power shortages during the dry season [2].

The use of solar energy could increase the security of supply in Myanmar [3–5] and 60% of the country is suitable for solar photovoltaic (PV) generation [6]. The highest solar radiation levels (over 20 MJ m^{-2} day^{-1}) are found in the Central Dry Zone of the country [7], which coincides with the most densely populated areas [8]. In addition to the existing potential, the use of solar energy can further increase the security of supply and address the short-term needs during the dry season due to the complementarity with hydropower generation [9].

The use of utility-scale solar in Myanmar is almost nonexistent, with only a few rooftop facilities in factories and large buildings. The first phase of a utility-scale project was connected in the summer

of 2019, after being delayed for several years. Indeed, the development of projects in Myanmar is constantly delayed and there are no signs for a sudden change anytime soon. There is also a pressing need for the development of a policy framework to mobilize investments in utility-scale solar power generation.

Despite the urgency of a policy framework to secure a stable and sustainable supply for areas in the national grid, the number of studies is still very limited. Most of the literature on solar at utility-scale in Myanmar are techno-economic studies on its potential, all indicating a large unexploited potential, but with little insights on the policy framework. Siala et al. found that Myanmar is one of the countries with the largest estimated technical potential of solar energy in Southeast Asia [10]. Lee et al. estimated the levelized cost of electricity (LCOE) of utility-scale solar in the Association of Southeast Asian Nations (ASEAN) [11]. They calculated an LCOE for utility-scale solar in Myanmar between 79.8 and 80.3 USD/MWh, the lowest in the region. Furthermore, Depierreux et al. estimated that 19% penetration of variable renewable should not be an issue for the stability of the national grid [12].

The majority of existing literature in Myanmar has mostly focused on the use of renewable energy for rural electrification (the other main energy challenge in the country). A large portion of the rural population still lacks access to electricity or has very low levels [6,13]. The use of sustainable energy has been studied both for increasing the energy access and for promoting economic development and social well-being through an analysis of existing resources [14,15] and the proposal of socially inclusive business models [16–18]. Myanmar's agriculture-based economy has fostered an extensive analysis of the potential of biomass for use in rural areas [19–22]. Solar Home Systems (SHSs) have also been highlighted in the literature and well-studied [23]. More recently, global technological costs and the realization that a long time might be needed before the national grid can reach all parts of the country has led to an increase in techno-economic studies for solar, battery, and solar hybrid systems [24–27].

This study aims to fill the gap in academic literature on the drivers and barriers for the development of utility-scale solar in Myanmar. We focused our analysis on those elements affecting the attraction of international private investment. This will serve as an initial step toward the development of a policy framework for renewables in the country, which still does not exist [28]. For that, we conducted a strengths, weaknesses, opportunities, and threats (SWOT) analysis based on an extensive review of the literature and semi-structured interviews.

The paper is structured as follows. The next section introduces the status of solar energy development in Myanmar. Then, we describe the methodology and data collection approach. After that, we present the SWOT analysis with a detailed explanation for each of the factors identified, followed by a discussion of the results. Finally, policy recommendations, particularly for updating the National Electricity Master Plan (NEMP), and suggestions for future research directions are discussed.

2. Solar in Myanmar

Despite the large estimated existing potential [10] and the expected lower LCOE [11], as described in the introduction section, the use of grid-connected solar energy is still in its infancy in Myanmar. There is an increasing attention from private investors, both national and international, who are interested in investing in the development of new projects [29]. The realization of utility-scale solar PV power stations could help the government of Myanmar to address the urgency of frequent blackouts during the dry season. At the same time, this would help to build a sustainable energy mix in the long-run, avoiding a costly carbon lock-in.

The government plans send contradictory signals regarding further developments. On one side, the Ministry of Electricity and Energy (MOEE) is emphasizing its interest in exploring renewable energy opportunities. Reports and presentations show a pipeline of 1.5 GW [29,30]. There is still no certainty on the development status of these projects. Among them, only the Minbu project has connected the first phase of 50 MW to the national grid [31]. On the other hand, the National Electricity Master Plan (NEMP), which will increase the generation capacity, has only a marginal role for renewables. In the first version, all renewables (except for hydro of any kind) were externally limited in the model

to represent no more than 10% of the total capacity by 2030. A revised version, delivered to the government in 2019, did not show big modifications (33% coal, 38% hydropower, 20% natural gas, 9% other renewables) [32]. This would represent a massive increase in coal-fired generation, from a single power plant today to a third of the total capacity.

From a regional perspective, ASEAN has been slower than other regions in the adoption and diffusion of solar PV generation [33,34]. In recent years, several of them are shifting toward the development of regulatory frameworks to spur investments in solar generation. Many of them have also included more ambitious targets in their power development plans. Thailand has been an important driver of solar investment in the region through its feed-in tariff and setting more ambitious goals for solar penetration in its power development plan [35,36]. Countries that are increasing coal-fired capacity, such as Vietnam, are also promoting investments in solar energy [37]. These are also related to the achievement of the ASEAN goal of 21% renewable energy and the development of regional power trade in Southeast Asia [38,39]. In general, solar energy is "graduating" from the pilot project level in ASEAN, while Myanmar is still at a very initial stage, similar to countries that have much lower estimated potentials, such as Lao People's Democratic Republic (PDR). Figure 1 shows the PV potential estimated in the country, with the highest levels located in the Central Dry Zone.

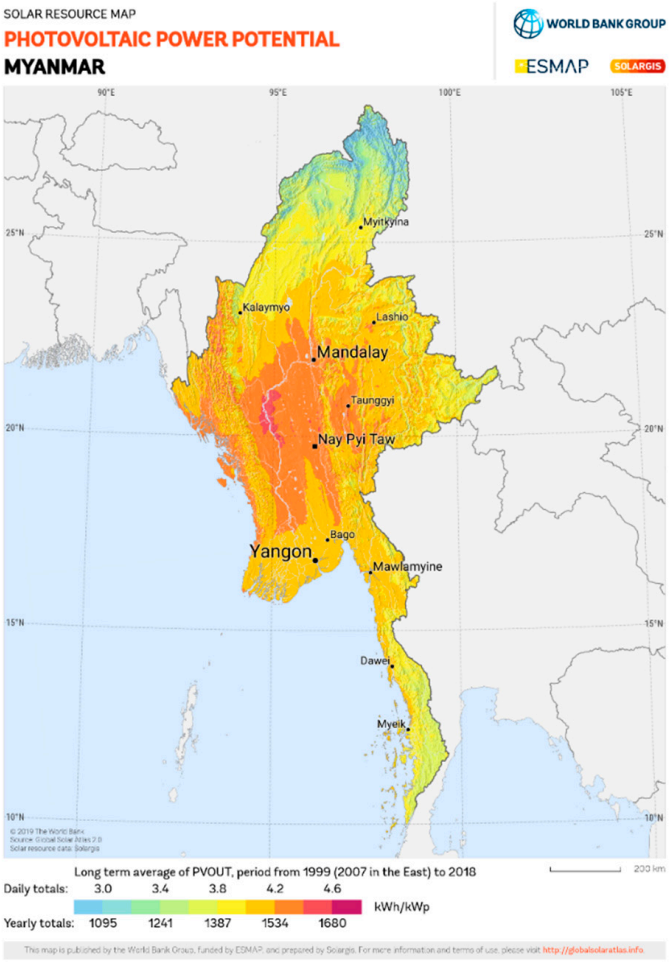

Figure 1. Photovoltaic Power Potential in Myanmar. Source: Global Solar Atlas 2.0, Solar resource data: Solargis. © 2019 The World Bank.

3. Materials and Methods

A key advantage of SWOT analysis is to "yield useful information about the future viability of the considered system" [40]. Although originally from the business field [41], the use of SWOT has

expanded to several other areas, particularly, energy [42–46]. A number of SWOT studies have been conducted in Southeast Asia, both for individual countries [47] and for ASEAN as a whole [48].

This SWOT analysis was conducted over two phases. First, a list of factors was identified throughout an extensive review of the existing academic and grey literature. These factors were classified accordingly within the four categories of the SWOT analysis. After that, semi-structured interviews were conducted to (i) assess the completeness of this list and (ii) discuss each factor in more detail. Interviews were conducted face to face, and, when not possible, through telephone or videoconference. Interviewees were chosen from the government, private sector, and civil society organizations so as to have a diverse and balanced set of stakeholders' perspectives. In total, nine experts were interviewed, respectively two, three, and four from each of the groups previously mentioned. During the interviews, the initial list of factors was presented and interviewees were asked to provide their assessment of the relevance of each of them. Only those factors indicated as relevant or very important were included in the final SWOT. The final conclusions were also reviewed through informal discussions with policymakers and academia at the workshops held jointly by the University of Tokyo, Economic Research Institute for ASEAN and East Asia, and Association for Overseas Technical Scholarship (AOTS) in Nay Pyi Taw throughout 2019.

4. Results: SWOT Analysis of Utility-Scale Solar Energy in Myanmar

The research process led to the identification of a total of 19 factors to be included in the SWOT analysis. Table 1 summarizes the identified factors.

Table 1. Factors identified for SWOT (strengths, weaknesses, opportunities, and threats) analysis.

Category	Factor	Issue
Strengths (S)	S1	Vast untapped solar potential resource
	S2	Areas with higher solar potential near to existing national grid
	S3	Public support for solar (in contrast to coal and large hydro)
	S4	Shorter lead times for the construction of solar power plants
	S5	Increasing experience in solar PV through off-grid projects
Weaknesses (W)	W1	Regulatory uncertainty in Myanmar's power sector
	W2	Highly subsidized electricity tariffs to final consumers
	W3	Lack of policies to support the development of renewables
Opportunities (O)	O1	Possibility of export generation surpluses to neighboring countries
	O2	Seasonal complementarity between solar and hydro resources
	O3	Decreasing global prices of solar energy
	O4	International investment interest in Myanmar
	O5	Growing investment in solar energy in Myanmar
	O6	Support from various international donors to Myanmar
Threats (T)	T1	Potential disputes to secure land through due process
	T2	Difficulties to improve business environment due to high levels of perceived corruption
	T3	Unwillingness to propose new projects due to delays in the implementation of currently approved projects
	T4	Reluctance to invest due to possible security and reputation concerns
	T5	Reduced investment interest due to the very low level of solar energy in government's capacity expansion plans

4.1. Strengths

4.1.1. Vast Untapped Solar Potential Resource (S1)

Myanmar is one of the countries with the largest solar potential in continental Southeast Asia [49]. The Asian Development Bank (ADB) has estimated a technical potential of 40 TWh/year [50]. More recent studies have increased the potential to up to 118.2 TWh [10]. Furthermore, other studies have indicated that about 60% of the country is suitable for solar PV generation [51].

A modeling exercise sponsored by the World Wildlife Fund (WWF) found that solar energy could be the main source of electricity by 2050, with 4800 MW of concentrated solar power and 27,459 MW of PV power [52].

In contrast, there is a nearly total absence of grid-connected solar PV generation. There are merely a couple of rooftop solar PV installations in the Junction commercial complex in Yangon and in a garment factory [53,54], and only the first phase (50 MW) of the Minbu project has been recently connected to the national grid.

4.1.2. Areas with Higher Solar Potential near the Existing National Grid (S2)

The Central Dry Zone is an area catching the attention for new solar projects. Indeed, the highest levels of solar irradiance are located in that area. In addition, land availability issues would be a lesser concern because it is a flat plain [55] composed of infertile soil [56].

In addition, the investments of additional transmission lines would be relatively low considering that the, still limited, national grid reaches the Central Dry Zone. In contrast to this, other alternatives such as new hydropower dams in the northern mountains or the import of electricity from its neighbors, China and Lao PDR, will require building new long-distance transmission lines.

4.1.3. Public Support for Solar (in Contrast to Coal and Large Hydro) (S3)

Solar energy has a broad, strong public support. In contrast, coal-fired generation has been severely criticized. By 2019, the 120 MW Tigyit power plant is the only operating coal-fired generation facility in Myanmar. This could dramatically change if the National Electricity Master Plan (NEMP) would be implemented without modification from its 2014 version. The NEMP foresees a large deployment of coal-fired generation from a minimal contribution in 2019 to about a third by 2030. The construction of additional coal-fired generation is unclear due to public opposition. Environmental organizations, as well as other local and regional non-governmental organizations (NGOs), have mobilized in order to prevent further developments [57].

The government is yet to make a final decision over the role of coal in the future energy mix. In 2017, all the coal-fired projects were cancelled [58]. Since 2018, some regional governments have been advocating for the construction of new coal-fired plants, even against the official position of the national government, both are led by members of the National League for Democracy (NLD). This reached higher levels of confrontation for the 1280 MW coal-fired power plant in Hpa township in Kayin, when the regional government intentions were blocked by the national government [59–62].

Solar energy projects are subject to similar levels of opposition in Myanmar. This would facilitate a more rapid development of new generation capacity, avoiding also the negative environmental and social impacts from air pollution and CO_2 emissions.

4.1.4. Shorter Lead Times for the Construction of Solar Power Plants (S4)

Myanmar is clearly in a hurry to increase power generation, particularly to avoid the blackouts during the dry season. The electricity demand is expected to continue to grow rapidly, increasing the need for emergency dispatch. At the same time, the increase in electricity tariffs and the cost of diesel for back-up systems can trigger higher expectations from consumers, who will be less likely to accept frequent blackouts.

The public opposition to coal-fired and large-scale hydro projects should also be considered in the total time required for construction. Coal projects are particularly sensitive and public and governmental support for these projects is doubtful. For hydropower projects, the need to increase the transmission capacity from the mountains in the North to demand centers in the central and southern regions is also a factor to be counted.

The import of liquified natural gas (LNG) recently became a major option for the government, with the signing of power purchase agreements (PPAs) for the construction of five plants. These plants are expected to enter operation not before 2020, and the final cost has raised concerns [63,64].

In contrast, solar energy projects have the comparative advantage of having shorter lead times and lower construction risks [65]. Furthermore, the general public position is very favorable for solar energy. In the past, this has been mostly associated with off-grid areas, but this is also applicable to grid-connected projects.

4.1.5. Increasing Experience in Solar PV through off-Grid Projects (S5)

The use of renewable energy for energy access projects in rural areas has made these technologies more common in Myanmar. In the past, pilot projects have been implemented by different organizations with support from development partners. More recently, extensive programs are looking at the use of renewables for rural electrification. In particular, a large number of Solar Home Systems (SHSs) have been implemented [23]. The Department of Rural Development (DRD), with support from the World Bank through the National Electrification Plan, has initiated a program to support the development of solar-based mini-grids through what has been called the 60/20/20 project. A grant from the national government funds 60% of the project, while the remaining 40% is divided equally between the community and the developer. The program also supports the establishment of Village Electrification Committees (VECs) in each community.

4.2. Weaknesses

4.2.1. Regulatory Uncertainty in Myanmar's Power Sector (W1)

Investments into the electricity sector are affected by the certainty of regulations. Myanmar's power sector is still a vertically integrated monopoly with the state-owned Electric Power Generation Enterprise (EPGE). The Ministry of Electricity and Energy (MOEE) has also signed several Power Purchase Agreements (PPAs) with private generators [6,66].

A new electricity law was approved in 2014, incorporating several changes to the previous law from 1954. A certain degree of decentralization in decision making has been implemented through granting state governments the possibility of approving off-grid projects smaller than 30 MW [67]. The new electricity law also includes the creation of a regulatory commission. Nevertheless, this has not been implemented, and the prospects for that are unclear.

4.2.2. Highly Subsidized Electricity Tariffs to Final Consumers (W2)

Electricity tariffs in Myanmar have consistently been highly subsidized, making electricity in Myanmar the cheapest among neighboring countries. The amount of the total cost to the national budget has reached worrisome levels. In the fiscal year of 2017–2018, this was 378 billion kyats (about USD 280 million) [68,69], and it increased in the following year (2018–2019) to 450 billion kyats (USD 330 million) [70].

A new tariff increase has been implemented in July 2019, after several signs of the necessity of such action [71–73]. This increase in tariff has changed the situation dramatically. In the fiscal year of 2019–2020, the new tariff is expected to reduce or erase the financial losses of the sector [74]. Households have been roughly paying 3–4 USD cents/kWh, while industrial consumers pay 5–10 cents/kWh after the tariff increase in 2014 [75]. Tables 2 and 3 summarize the electricity tariffs before and after the tariff hike. In the past, the losses due to subsidies have been a burden for the government to raise the

funding needed for new generation. Nevertheless, it is expected that the MOEE will continue favoring the lowest cost projects.

Table 2. Rates for electrical power consumption for domestic (domestic consumption, power meter at homes, religious building) consumers in 2014 and after the tariff hike in 2019.

Consumer Range (kWh/month)	2014		2019	
	Kyats/kWh	USD Cents (2014) (1 USD = 972.00 kyats (as of 17 July 2014); Central Bank of Myanmar https://forex.cbm.gov.mm/index.php/fxrate)/kWh	Kyats/kWh	USD Cents (2019) (1 USD = 1514.5 kyats (as of 17 July 2019) Central Bank of Myanmar https://forex.cbm.gov.mm/index.php/fxrate)/kWh
1–30	35	3.6	35	2.31
31–50	35	3.6	50	3.30
51–75	35	3.6	70	4.62
76–100	35	3.6	90	5.94
101–150	40	4.1	110	7.26
151–200	40	4.1	120	7.92
Over 201	50	5.1	125	8.25

Source: Authors based on Htwe, Htet, & Chau (2019).

Table 3. Rates for electrical power consumption for non-domestic (industries, businesses, temporary, lamp posts, governmental buildings, state-owned industries, state-owned businesses, river water pumping stations, municipal departments, work, non-governmental organizations, embassies, international organizations) consumers in 2014 and after the tariff hike in 2019.

Consumer Range (kWh/Month)	2014		2019	
	Kyats/kWh	USD Cents (2014)/kWh	Kyats/kWh	USD Cents (2019)/kWh
1–500	75	7.7	125	8.25
501–5000	100	10.3	135	8.91
5001–10,000	100	10.3	145	9.57
10,001–20,000	125	12.9	155	10.23
20,001–50,000	125	12.9	165	10.89
50,001–100,000	150	15.4	175	11.55
50,001–100,000	150	15.4	175	11.55
100,001–200,000	150	15.4	180	11.89
201,000–300,000	125	12.9	180	11.89
Over 300,001	100	10.3	180	11.89

Source: Authors based on Htwe et al. (2019).

4.2.3. Lack of Policies to Support the Development of Renewables (W3)

There is an absence of policies to streamline renewable energy investments in Myanmar. The World Bank's Regulatory Indicators for Sustainable Energy (RISE) provides a global comparison of the situation for each country [76]. Myanmar only has fiscal incentives on tax reduction for imports and sales [77]. This is in contrast with the situation of other neighboring countries, such as Thailand, that are implementing more ambitious targets through feed-in tariffs and renewable energy auctions [78].

4.3. Opportunities

4.3.1. Possibility of Export Generation Surpluses to Neighboring Countries (O1)

Myanmar's neighboring countries can be an alternative source of electricity as well as a destination for surplus generation. Indeed, interconnections that are currently under discussion might be developed in the short term for Myanmar to import electricity from its neighbors, Lao PDR [79] and Yunnan (China), for power imports. India has also proposed some schemes for export. Currently, the interconnection with Yunnan appears to be the most advanced [80]. Negotiations are also being held to interconnect with Bangladesh, which would also be an importer of electricity from Yunnan.

In the long term, Myanmar would be able to utilize these interconnections to export electricity from surplus generation. The WWF's alternative scenarios show a rapid and large increase in power generation exported to neighboring countries in the Greater Mekong Subregion. In particular, 40,000 GWh is forecasted to be exported to Thailand by 2040 [52]. The large variation of the power output from the dams between dry and rainy seasons will require a large increase in generation capacity, which might lead to seasonal surpluses.

The possibility for these exchanges will depend on the progress of several ongoing regional initiatives of regional electricity cooperation. In Southeast Asia, both the Greater Mekong Subregion (GMS) and ASEAN power grids are being actively promoted by the countries. While in South Asia, the South Asian Association for Regional Cooperation (SAARC) has already conducted some studies including the interconnections with Myanmar, which holds the status of observer at SAARC.

4.3.2. Seasonal Complementarity between Solar and Hydro Resources (O2)

Hydropower makes roughly 60% of the power supply of Myanmar, with an increasing contribution from natural gas. This has created a situation in which there is plenty of electricity generation during the rainy season and shortages in the dry season months, leading to the current frequent blackouts [67].

Solar energy generation would provide the highest output in the months when it is more needed. Myanmar's Energy Master Plan found good seasonal complementarity between hydro and solar resources [9]. From January to May, solar irradiation is at its top, while it is the minimum hydropower output; and the opposite occurs from July to November.

4.3.3. Decreasing Global Prices of Solar Energy (O3)

Solar technology prices have plummeted in the last decade with a decrease of 70% in new solar PV since 2010 [81]. This rapid price decrease has no comparison in any other energy technology [82]. Solar PV prices in developing countries are already at the level of USD 0.06–0.08/kWh [83].

Nevertheless, the actual price for solar varies from country to country. With little prior experience, there would be an initial consideration of the actual costs in Myanmar. For example, the price levels achieved through energy auctions can vary depending on their design elements [84–89].

4.3.4. International Investment Interest in Myanmar (O4)

Myanmar's democratic transition has opened the country to the world and attracted the interest of international donors and investors. The lifting of the economic sanctions by the United States and the European Union has opened the door to new investments in Myanmar [90,91].

The development of Special Economic Zones (SEZs) is a good example of this renewed international investment appetite. Since their authorization in 2014, four SEZs have been proposed in Thilawa, Fawei, Kyauk Phyu, and Sittwe [92]. Among these, only Thilawa SEZ, supported by Japan, is currently in operation and has successfully attracted over 70 companies and USD 700 million in investments [93]. Figure 2 shows the yearly approved foreign direct investment to the country.

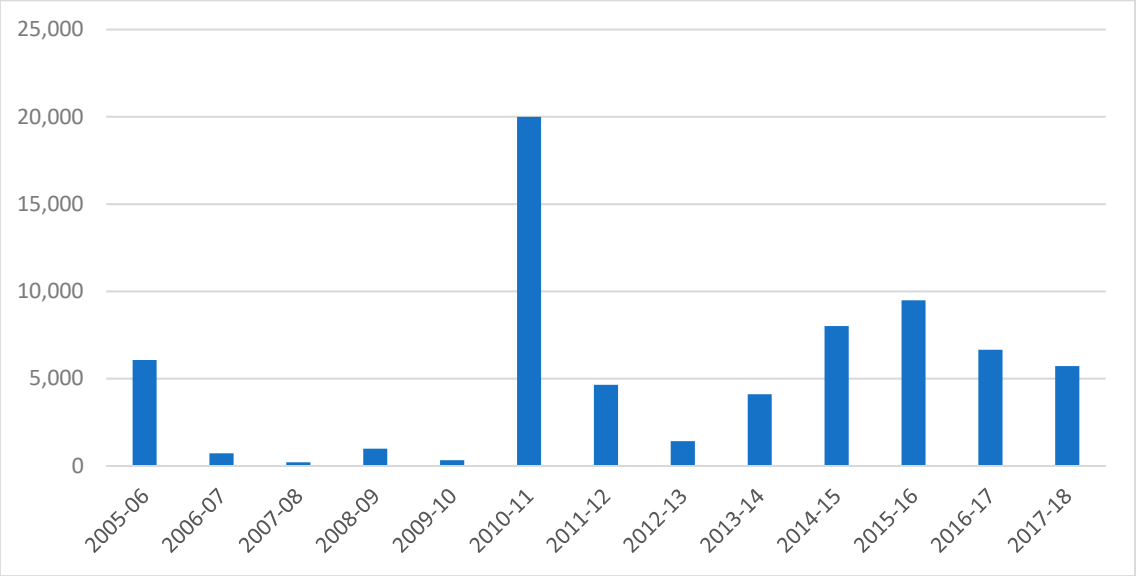

Figure 2. Yearly approved amount of foreign investment in Myanmar (USD million) (Source: Myanmar Directorate of Investment and Company Administration (DICA)).

The power sector is becoming one of the more attractive investment sectors, considering the expected large investments needed in the short, medium, and long term [94].

4.3.5. Growing Investment in Solar Energy in Myanmar (O5)

Myanmar still has the opportunity to become an emerging market for solar PV investments. Globally, investments in solar energy are flourishing with a 50% increase in 2017 [95]. So far, solar energy in Myanmar has been mostly limited to mini-grids and solar home systems. If adequate policy measures are put in place, solar energy in Myanmar can be an attractive area for investment, considering the country's need to increase generation for the national grid.

4.3.6. Support from Various International Donors to Myanmar (O6)

The democratization process lifted international sanctions. President Obama signed an executive order to lift the USA economic sanctions in 2016. The European Union also lifted the sanctions. This allowed a re-engagement of the international community. International organizations re-started their operations in the country, and international private investors are looking at it as a new market opportunity. All this support can help Myanmar to overcome its current limitations.

Myanmar is currently the recipient of support from multiple countries and multilateral institutions. The World Bank and the Asian Development Bank re-started their programs with the democratic transition. There are also numerous programs from bilateral donors, such as the Japan International Cooperation Agency (JICA), the German Development Agency (GIZ), and the Norwegian Agency for Development Cooperation (NORAD).

China is also increasingly becoming an important donor. In addition to investments and aid to the country, Myanmar is an important country in the One-Belt-One-Road Initiative through the Myanmar–China Economic Corridor. The initial projects include the Kyauk Pyu Port and gas and oil pipelines connecting the port to Yunnan Province in China [96]. The Asian Infrastructure Investment Bank (AIIB), supported by China, has also joined the World Bank and ADB in the Myingyan gas-fired power plant.

4.4. Threats

4.4.1. Potential Disputes to Secure Land through Due Process (T1)

The development of utility-scale solar plants will require vast areas of available land, which in Myanmar might not be as simple as was initially thought and might not be easy to obtain rightfully. The availability of suitable empty (or non-highly productive) areas might not be a big burden. Nevertheless, securing the rights of that land may involve more complex challenges. After decades of military dictatorship, a large number of farmers are now claiming back their land ownership that was forcibly expropriated [97]. This comes with an increasing awareness of possible land conflicts arising from renewable energy development [98].

The government of Myanmar has included the achievement of a solution to the land grabbing crisis as one of its main objectives; however, big progress is yet to be seen [99,100]. Thein Sein's government also took some actions, but they were perceived to have had some negative consequences [101]. The national government promoted a consultation process that has resulted in the National Land Use Policy in Myanmar [102]; however, full resolution is still not near, with conflicts also arising between neighboring towns [103].

4.4.2. Difficulties to Improve Business Environment Due to High Levels of Perceived Corruption (T2)

Fighting corruption is one of the priorities for Myanmar [104,105]. The country still ranks at the bottom according to Transparency International. The country ranks poorly at 130/180 in the Corruption Perception Index (CPI) [106]. This is recognized as an obstacle to the business climate [107]. The government approved an anti-corruption law in 2013 and created an anti-corruption commission in 2014, but with limited impact so far [108]. Nonetheless, this has become a key goal for the NLD-led government and some improvements have been seen [109–111].

4.4.3. Unwillingness to Propose New Projects Due to Delays in the Implementation of Currently Approved Projects (T3)

The limited actual progress of the projects already approved can have a negative impact on the attractiveness of Myanmar for future investors. As discussed previously, several projects are in the pipeline, more particularly, three projects have already signed memorandum of understandings (MOUs) as well as PPAs with the government. Nevertheless, none of these projects have been finalized yet. Even the Minbu project, the most advanced among them, continues to accumulate long delays. The project, approved in 2014, was expected to deliver the first phase of electricity generation by the first semester of 2016, but the first phase was connected to the national grid finally in the summer of 2019.

4.4.4. Reluctance to Invest Due to Possible Security and Reputation Concerns (T4)

The national reconciliation process between the central government and areas with large presence of ethnic minorities groups is at the top of the agenda for the success of democratization. Myanmar has been under this internal conflict for several decades. A Nationwide Ceasefire Agreement (NCA) was proposed by Thein Sein's government, which only a few ethnic, armed groups finally signed [112]. After democratization, the NLD government initiated new peace talks under the framework of the 21st Century Panglong Union Peace Conference. The conference, initiated in late August, early September in 2016, was expected to hold sessions every half-year. Only two sessions were held, with the third having been delayed on several occasions [113–116].

These peace negotiations has not included the clashes between the Muslim Rohingya and Myanmar's military, the Tatmadaw, in the Rakhine state. However, it has been the conflicts in Rakhine state that has received the strongest attention in the international community, especially Western countries, such as Europe and the United States [99]. An involvement in the weak democratic transition in Myanmar has been perceived by some to have a reputational risk [117]. The increasing international

skepticism increases that risk. The re-instalment of international sanctions by the US, EU, or United Nations is not likely. Investors might be concerned with possible reputational issues, and that would not only include Europeans and Americans, but also important neighboring countries in South and Southeast Asia [118,119], particularly in Muslim-majority countries [120].

4.4.5. Reduced Investment Interest Due to the Very Low Level of Solar Energy in Government's Capacity Expansion Plans (T5)

The National Electricity Master Plan (NEMP) outlines the government's capacity expansion plans. The first version of the NEMP was published in 2015, considering three different scenarios: (i) domestic energy consumption (large hydro and gas-fired plants are maximized), (ii) least-cost scenario (coal-fired plants replace gas-fired plants), and (iii) power resources balance (only feasible large hydro and gas-fired plants with secured resources will be developed) [121]. Renewables (solar, wind, and biomass) were externally limited to 10% of the total capacity mix. This has resulted in an underestimation of the potential role of renewables in Myanmar in the government plans [4]. A revised version was announced in the first quarter of 2019 with only minor modifications. According to this, the power generation capacity mix by 2030 will be 33% coal, 38% hydropower, 20% natural gas, and 9% renewables [32].

5. Discussion

The SWOT analysis revealed several promoting and limiting factors with broad consensus among different stakeholders. There was a general agreement on the merits of solar energy, particularly important were the existing resources to be developed (S1) as well as the possible rapid commissioning of the projects (S5). Among the barriers, surprisingly, the technical limitations due to the ageing of the infrastructure were initially included, but later excluded from the weaknesses. Expected higher costs of solar and low electricity tariffs (W2) were the most apparent barriers for more ambitious plans. Another surprising finding throughout the interviews was the relatively low significance for energy independence with which solar energy was perceived. At present, it seems that hydropower is mostly considered as the only "national" resource; however, as there is more presence of solar energy in the country, the relevance of this factor could also increase. This could have important implications for protecting Myanmar from the economic shocks that a sudden increase in the price of fossil fuels could have on its economy.

The attraction of private investment at the lowest possible cost is the main goal to foster utility-scale solar. Nevertheless, the SWOT analysis identified several threats that may prevent this from occurring. The highly subsidized electricity tariffs (W2) have been a traditional burden for the government to invest in new generation capacity. The increase of tariffs in 2019 can actually foster investments on rooftop solar for those companies and industries looking to reduce their electricity expenditures. Currently, more relevant factors are the lack of policies to spur investments (W3) and the slow pace in developing projects that have already been approved (T5). The lack of experience can explain the reluctance to move forward with more ambitious projects [122].

The SWOT analysis also identified several other factors that are not commonly highlighted. The development of solar energy projects in rural areas with low levels of agricultural productivity (S2) can bring several additional benefits in terms of jobs creation, attraction of investments, and economic revitalization in general. On the other hand, potential disputes arising from land-intensive projects in areas where land rights and legal property are still under discussion (T1) are not to be discarded. Similarly, reputational concerns (T4) considering the current political climate can reduce investment appetite from international investors.

6. Conclusions and Policy Implications

There are important policy implications that can be derived from the results of the SWOT analysis. Here, we highlight three relevant implications for policymakers, which would provide valuable areas

for future research. First, this research has confirmed the broad support for the diffusion of utility-scale solar "if right conditions" are met. For this to happen, an adequate policy framework needs to be put in place. The framework has to take into consideration the particularities of Myanmar. Land-right issues and concerns with political developments are a concern for investors without experience in the country and/or the region.

Second, the results highlight the need for strengthening the capacity to manage market-based support programs to streamline investments in solar energy. Development partners can bring support and value to this beyond economic aid. Until today, most of the new power generation plants are built based on a power purchase agreement (PPA) directly negotiated between the government and the private investor. Only the contract for the 225 MW Myingyan combined-cycle gas turbine power plant has been the result of competitive bidding. For that, the project has counted support from multiple development partners, such as the International Finance Corporation, the Asian Development Bank, the Asian Infrastructure Investment Bank (AIIB), and the Multilateral Investment Guarantee Agency (MIGA).

Third, there is a need to explore new policy instruments to foster competition and to secure the efficiency of required investments, especially considering the number of solar projects that would have to be implemented simultaneously. The success of the energy auctions in Zambia through the Scaling Solar Program by the World Bank [89,123] provides a good example of a promising alternative for development partners to engage with Myanmar.

This paper is a first attempt on the development of a policy framework for renewables in Myanmar. The factors identified provide a common ground of issues with consensus among the perspectives of different stakeholders. Nevertheless, an evaluation of relative weight or prioritization would require a further study, possibly using quantitative methods such as the analytical hierarchy process (AHP), which could be the next step to better understand the motivations of private investors. A political economy comparison of the merits and drawbacks of utility-scale solar against other alternatives being implemented (e.g., imports of liquified natural gas) or considered (e.g., large-scale hydro and coal-fired imports of electricity from China or Laos) would also contribute to the clarification of options in front of the government, and therefore, to design a long-term energy strategy for Myanmar.

Author Contributions: Both the authors contributed equally to the design and planning of this work. D.d.B.A. conducted most of the interviews, with M.S. also joining for some of them. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Economic Research Institute for ASEAN and East Asia (ERIA).

Acknowledgments: The authors would like to thank all the interviewees and the participants in the workshops for their insights and their overall contribution to this research.

Conflicts of Interest: The authors declare no conflicts of interest.

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