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Community-based energy projects in Myanmar

Study on rural renewable energy projects and the potential contribution of cooperatives to a sustainable electrification

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Abbreviations

ADB	Asian Development Bank
ATP	Ability to Pay
BMZ	Federal Ministry for Economic Copoeration and Development
CAPEX	Capital Expenditures
CBO	Community-Based Organisation
CHP	Combined Heat and Power
DGRV	German Cooperative and Raiffeisen Confederation
DP	Development Partner
DRD	Department for Rural Development
ERLIP	WB Project
ESE	Electric Supply Enterprise
FIT	Fixed Feed-In Tariff
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoM	Government of Myanmar
GW	Gigawatt

HPNET	Hydro Empowerment Network
HyCEM	Hydropower for Community Empowerment in Myanmar
ICA	International Cooperative Alliance
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
MEPE	Myanmar Electric Power Enterprise
MES	Myanmar Engineering Society
MMK	Myanmar Kyat (currency)
MOALI	Ministry of Agriculture, Livestock, and Irrigation
MOBA	Ministry of Border Affairs
MOE	Ministry of Education
MOEE	Ministry of Energy and Electricity
MOI	Ministry of Industry
MONREC	Ministry of Natural Resources and Environmental Conservation
MW	Megawatt
NEMC	National Electrification Management Committee
NEP	National Electrification Plan
NGO	Non-Government Organisation
NREC	National Renewable Energy Committee
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
REAM	Renewable Energy Association of Myanmar
REC	Renewable Energy Cooperatives
SAD	Self-Administered Division
SAZ	Self-Administered Zone
SDG	Sustainable Development Goal
SHS	Solar Home System
SME	Small and Medium Sized Enterprise
SPP	Small Power Producers
TW	Terrawatt
UMFCCI	Union of Myanmar Federation of Chambers of Commerce and Industry
VEC	Village Electrification Committee
VEC	Village Electrification Committee
WB	World Bank
WI	Wuppertal Institute
WTP	Willingness to Pay
YESB	Yangon Electric City Supply Board

Executive summary

Given that over 50% of Myanmar's urban inhabitants and nearly 75% of the rural population lack access to adequate electricity, the country's development agenda includes electrification as a key policy goal. The government's National Electrification Project (NEP) aims to reach 100% household electrification by 2030. To achieve this ambitious target, the government of Myanmar has established a set of strategic electrification priorities. The primary focus is to electrify the country through extension of the national grid and construction of large power plants based on fossil fuels and renewable energy.

For decades, decentralised energy solutions have played a niche role in Myanmar's electrification journey. Local developers have constructed thousands of nominal "mini-grids", powered by a range of sources, including water, diesel, and solar. With the support of local communities, these initiatives provide positive stimuli for the social and economic development of villages across the country. To achieve its electrification goals, the NEP includes a segment to promote the development of new mini-grids through a set of subsidies and private sector cooperation initiatives. These target remote regions, which are difficult to electrify through extension of the main grid.

This report takes an in-depth look at decentralised electrification through community-based mini-grids with a focus on renewable energy. The aim is to provide insights into the potential role of sustainable electrification and to identify both enabling and limiting factors related to the institutional and policy landscape (macro), as well as the local conditions (micro). It also aims to explore whether the cooperative model is a suitable organisational framework for the operation of mini-grids in Myanmar. The results of the study will help to inform policymakers and supporters of decentralised electrification about the potential role for cooperatives and provide ways to improve the operating environment for sustainable, community-based mini-grids.

The first sections of the report (chapters 3 and 4) analyse the national framework. These chapters map out policies, stakeholders, and other relevant institutions, then identify enabling and limiting factors for decentralised and community-based electrification. The second part (chapters 5 to 7) includes a field study based on information from interviews and visits to ten mini-grids in different regions of the country. The analysis uses the seven internationally recognised cooperative principles as a framework to summarise the various organisational and ownership models. The last part of the report presents the findings and makes recommendations for the support of community-based mini-grids and recommendations for further study.

Community-based mini-grids, i.e. mini-grids, developed and operated with significant participation from the affected community, serve local populations in at least two ways. First, community-based mini-grids provide affordable clean energy and thus increase standards of living and, in some cases, create opportunities for income generation. Local mini-grids also help build communities. When local stakeholders are involved in the preparation, construction and operation of local mini-grids, the experience brings people together and creates a strong sense of ownership.

The report highlights how local communities have successfully established numerous community-based mini-grid projects in Myanmar, despite limited institutional support. Development constraints include the following:

- Decentralised electrification plays only a minor role in the patchwork of various electrification policies. In the policy framework, the primary purpose of mini-grids is to fill the time-gap for many communities until they connect to the national grid. There is no clear plan for what happens to the existing infrastructure when villages connect to the national grid.
- Technical standards are not consistently applied to ensure safety and compatibility with the national infrastructure. Mini-grids, promoted by the NEP, are in theory built to be “grid ready”, but implementation of technical standards is project-specific and not universally applied.
- Myanmar’s subsidised energy prices put mini-grid electricity fees at a competitive disadvantage.
- Various governmental funding mechanisms at the local level lack coordination and direction

Due to the fact that these limitations create significant uncertainty for communities and developers when planning and operating mini-grids, it is unclear whether decentralised energy infrastructure has a lasting future in Myanmar or whether the national grid will eventually replace mini-grids in the medium to long term.

At the local level, the lack of capital and lack of access to technical expertise and services turn each project into a monumental challenge for the community, especially for projects implemented without external funding. In response to these challenges, local developers have, for decades, worked as facilitators, enablers and financiers. These developers now offer a repository of technical knowledge and can provide access to low-cost technologies and local expertise. Additionally, they have provided pre-funding arrangements for communities in some cases and play a critical role in connecting communities with government entities that provide funding.

The cost element is critical because unelectrified communities are generally less affluent than the average population. The lack of capital has forced communities to adopt low-cost solutions. Local developers have shown an impressive level of creativity and innovation in designing solutions that are cost-effective. Most observed structures use locally developed technology with components parts often sourced from neighbouring countries. The communities contribute labour and resources. Nevertheless, these local structures are not compatible with the national grid, which makes future integration with the national infrastructure difficult. The NEP’s subsidy scheme, funded by the World Bank and supported by GIZ, seeks to offset these challenges by helping mini-grids to become grid-ready.

The second part of the study identifies three funding and ownership models currently in use locally: self-funded and self-managed projects; subsidised projects operated by the communities; and two cases in which a registered cooperative serves as a legal entity for a joint venture between local developers and local investors. The cases represent diverse operational approaches to electrify the communities. But each example shows strong local ownership due to the high level of local participation.

The report contends that community-based mini-grid models based on cooperative principles can be successful. However, effective implementation depends on support for and capacity-building within communities. In each of the analysed cases, local institutions provided this kind of support. Given the government’s stated commitment to include mini-grids in the national energy infrastructure and to better define the role of off-grid solutions, a standardised and coordinated approach could make the support and development of community-based mini-grids more effective. However, a massive scale-up of the support scheme is needed, and the report concludes with a set of recommendations for realising such a scenario.

1 Background, objective and approach of the study

Civic engagement to promote renewable energy / BMZ

DGRV – German Cooperative and Raiffeisen Confederation is implementing a global project, commissioned by the German Federal Ministry of Economic Cooperation and Development (BMZ), on civic engagement to promote renewable energy. The project aims to create a national and regional exchange to support cooperatives and other related enterprises to encourage the use of renewable energy on three continents – Africa, Latin America, and Asia.

Access to affordable clean energy is a *sustainable development goal* (SDG 7). In Myanmar, around 60% of the population does not have access to reliable electricity, especially in rural areas where the national grid does not extend. Electricity allows for lighting, cooking, communication, productive uses, irrigation and leisure activities. Electricity access also has proven benefits for living standards and health conditions. The Myanmar government has thus set an ambitious target to electrify the entire country by 2030. Several national and international programmes are actively expanding the national grid while also promoting the development of micro- and mini-grids in rural communities.

C*limate change mitigation* is also a key global challenge and calls for a transition away from fossil fuel-based electricity generation towards sustainable sources. The Intergovernmental Panel on Climate Change and the Paris Agreement show that in the long term, there are no viable alternatives to renewable energies that can support a reasonable level of energy consumption. Here, the involvement of citizens as both electricity consumers and producers play an important role. After the deregulation and privatisation of national energy markets in many Western countries, people set up locally-owned solar and wind power facilities. The *direct participation of hundreds of thousands of individuals* in the electricity sector has accelerated the energy transition (Devine-Wright 2007). In many cases, facilities were organised individually but were often owned by cooperatives and community-based organisations (CBOs). These legal forms present an exciting and meaningful tool for self-driven, yet solidary action, which allows for carbon-neutral electricity production, increased economic participation and democratic co-determination, while also strengthening civic society, local economies and municipalities.

In Myanmar, decentralised actors and community-based organisations are already important for rural electrification. Through Village Electrification Committees (VECs), villagers organise and manage the construction and operation of decentralised energy solutions in cooperation with local developers, local authorities, and national and international NGOs. In some cases, communities have formed cooperatives to operate local energy infrastructure; in other cases, they work in line with cooperative principles but without a legal structure. Despite evidence of strong organisation, there is still limited knowledge about the institutional environment, organisation and business models, and the framework conditions that lead to successful local initiatives.

Objective of the study

The study focuses on rural electrification in Myanmar through renewable energy cooperatives and other community-based organisations. It evaluates the expanded role energy cooperatives could play by providing an overview of the current situation, and opportunities and challenges for energy cooperatives and other community-based organisations in Myanmar.

The target groups of the study are national policymakers and international and national organisations working in Myanmar. The study hopes to inform key stakeholders in the energy sector in Myanmar on how cooperatives and community structures using renewable energy can contribute to economically viable and environmentally sustainable rural electrification. The report provides recommendations for how such structures can be further promoted.

Approach of the study

This report presents the results of a 5-month study based on three pillars of research. Under the first pillar, the Wuppertal Institut (WI) conducted desk-based research on the legal context of energy cooperatives and community-based projects in Myanmar. Researchers analysed studies, documents and presentations available in English provided by DGRV, complemented by additional literature. Findings from this research provide the basis for the sections on Myanmar's electricity sector and the framework conditions in the country for energy cooperatives.

The second pillar comprised a field study to 10 rural mini-grid electrification projects in Myanmar to explore their governance, operational and financial structures. For this micro-analysis, DGRV and WI developed the questionnaires, and local DGRV and REAM researchers conducted the study visits. WI then processed and analysed the resulting information. Section 6.1 includes a detailed methodology for the field study and results.

The third pillar of research included stakeholder interviews, conducted by all authors of the study to confirm, discuss and add additional information to the preliminary findings. Interviewed stakeholders included officials from relevant ministries and government agencies, development cooperation partners, local developers and associations, and financing institutions. WI researchers also visited two project sites to gain insight into the local situation. The reference section includes a list of the stakeholders interviewed for the report.

2 Community-based mini grids

2.1 Renewable energy cooperatives and Community-based organisations

This study looks at energy projects, which are started, financed, planned, implemented or otherwise operated by rural communities in Myanmar. The specific intent is to analyse whether initiatives through cooperatives and community-based organisations have the potential to contribute to rural electrification.

Renewable energy cooperatives

The International Co-operative Alliance refers to a *cooperative* as an "autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise". A cooperative complies with defined cooperative principles built on the general values of self-help, solidarity, social responsibility, democracy and equality, but also to independence and basic economic viability (ICA, 2019 see box).

Renewable energy cooperatives (REC) specifically take joint action to realise sustainable energy generation to meet their member's economic and social needs. These needs might include increasing consumption, income generation through the sale of excess electricity, or idealistic motives such as support for the energy transition. It is thus helpful to differentiate between consumer cooperatives and producer cooperatives, although the literature refers to both organisational forms as renewable energy cooperatives (Tarhan, 2015). In consumer cooperatives, consumers are willing and financially able to establish a cooperative business for electricity or heat generation to meet their own energy demands (Birchall, Ketilson, & International Labour Office, 2009; Tarhan, 2015). In contrast, cooperative members in producer cooperatives, come together as financial investors who jointly organise the technical setup, business, distribution and sale of the produced energy. In Western countries, most recent cooperatives focus on the energy transition and produce economic revenues for their members based on feed-in tariffs.

Energy cooperatives in Myanmar are clearly motivated to provide electricity to previously unelectrified rural villages. In this case, the degree of autonomy and the distinction between consumer and producer cooperatives is an interesting area for further exploration.

In Myanmar, legally registered cooperatives must comply with the official state-governed cooperative system, which provides a clear framework and hierarchical institutional structure for cooperatives. In this report, the term "cooperative" in the Myanmar context refers to "official cooperatives" and "cooperative principles" refers to internationally accepted definitions listed below (BOX, ICA 2019).

BOX: Definition of cooperatives by International Co-operative Alliance (ICA)

- **Definition**: A cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise.
- **Values**: Cooperatives are based on the values of self-help, self-responsibility, democracy, equality, equity, and solidarity. In the tradition of their founders, cooperative members believe in the ethical values of honesty, openness, social responsibility and caring for others.
- **Cooperative Principles**: The cooperative principles are guidelines by which cooperatives put their values into practice.
  1. **Voluntary and Open Membership**: Cooperatives are voluntary organisations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.
  2. **Democratic Member Control**: Cooperatives are democratic organisations controlled by their members, who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the membership. In primary cooperatives members have equal voting rights (one member, one vote) and cooperatives at other levels are also organised in a democratic manner.
  3. **Member Economic Participation**: Members contribute equitably to, and democratically control, the capital of their cooperative. At least part of that capital is usually the common property of the cooperative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing their cooperative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the cooperative; and supporting other activities approved by the membership.
  4. **Autonomy and Independence**: Cooperatives are autonomous, self-help organisations controlled by their members. If they enter into agreements with other organisations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their cooperative autonomy.
  5. **Education, Training, and Information**: Cooperatives provide education and training for their members, elected representatives, managers, and employees so they can contribute effectively to the development of their co-operatives. They inform the general public - particularly young people and opinion leaders - about the nature and benefits of co-operation.
  6. **Cooperation among Cooperatives**: Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional and international structures.
  7. **Concern for Community**: Cooperatives work for the sustainable development of their communities through policies approved by their members.

Community-based organisations

Although the concept of energy cooperatives exists in Myanmar, few entities are officially registered energy cooperatives. However, in practice, many energy initiatives exist in the country that follow cooperative principles and values to some degree.

Against this background, this study looks at what Tarhan calls the broader field of ‘community energy’ (Tarhan, 2015, p. 106). This includes projects that are “developed under various legal structures such as community trusts, not-for-profit organisations, charities, and renewable energy co-ops”. Using Tarhan, Walker and Devine-Wright’s (2008) definition of community-owned initiatives, we focus on renewable energy projects, which are “developed and run through an open and participatory *process* and that entail local and collective *outcomes”* (Tarhan, 2015, p. 106).

We use this definition to qualify the various kinds of “**community-based organisations**” analysed in this study. Village communities can operate, own and/or initiate these organisations or projects. If any of these conditions hold true, we categorise the organisation as “community-based”.

2.2 Potential benefits of energy cooperatives: economic, social and environmental impacts

The cooperative values defined above (see BOX, ICA 2019) outline how cooperatives have many potential benefits and empower their members. The following sections describe the economic, social and environmental benefits that renewable energy cooperatives can achieve.

Energy cooperatives provide **economic impacts** by sharing the costs, risks and responsibilities of capital-intensive renewable energy projects, which are often impossible for an individual citizen to undertake. Cooperative members also share the economic rewards of generated electricity, as well as the local economic benefits through regional added value (Tarhan 2015).

Economic benefits can generally be realised through:

- *Self-consumption* of generated energy through combined heat and power (CHP) plants installed by renewable energy cooperatives.
- *Energy sales to the grid*, which are typical in jurisdictions with FITs or long-term electricity sales contracts for renewable energy, such as Germany, UK, Denmark, Canada
- A combination of energy sales revenues and consumption cost savings
- *Generation of additional economic opportunities* for members by increasing electricity for local productive use and generating additional income.
- *Local economic impacts and regional added value* such as employment creation by renewable energy projects owned by communities of place with higher local impact than projects implemented by out-of-area organisations.

For the **social impacts**, Tarhan (2015) states that democratic decision-making and management structures can enhance the social cohesion, confidence, interest and capacity of communities to take positive collective action. Democratic management structures also increase a “sense of community” among coop members, change member attitudes and link to various types of learning. Joint ownership and professional service contracts can even create new linkages within communities and stakeholders.

However, Tarhan also points to the conditions that enable these changes, namely that positive social impact depends on the process and outcomes of energy projects. If not implemented well, diminished trust and increased social friction may occur between shareholders and other community members who feel they are bearing the costs without benefiting from the project.

Finally, renewable energy cooperatives have substantial **environmental impacts** (Tarhan, 2015, p. 112):

- *Minimising greenhouse gas emissions* and acceleration of the transition towards a sustainable energy sector
- Cultivating a culture of conservation
- *Enhancing public acceptance of renewable energy* through education and inclusion in the deliberation process (Rogers, Simmons, Convery, & Weatherall, 2008)
- *Alleviating the depletion of forests and water resources*

In rural areas in Myanmar, the use of renewable energy technology in community projects could promote environmental conservation through the substitution of firewood, charcoal, gasoline and candles, which mitigates the depletion of forests and water sources.

2.3 The role of energy cooperatives in rural electrification in Germany

Energy cooperatives have received increasing attention as their numbers in some European countries, especially Germany and Denmark, have risen over the past 15 years (Huybrechts & Mertens, 2014; REScoop.eu, 2019; Tarhan, 2015). In 2014, there were about 3,000 renewable energy cooperatives in Europe (REScoop.eu, 2019). In Germany, the number of newly founded renewable energy cooperatives per year increased from 8 in 2006 to 812 in 2015 (DGRV 2016). After the deregulation and privatisation of national energy markets in European countries in the 1990s, corporate actors could become involved in what was formerly a centralised and state-owned system (Tarhan, 2015; van der Horst, 2008). Environmental movements have also encouraged the introduction of policies that promote renewable energy technologies, such as feed-in-tariffs (FIT) and technology subsidies. Specifically, the introduction of state-guaranteed feed-in tariffs for renewable energy, specified in the Renewable Energies Act (EEG) in 2000, and the amendment of the Cooperatives Act in 2006 set new enabling conditions. These acts helped facilitate the process by which most energy cooperatives set up projects as grid-connected generation communities. [1]

In parallel, societal and behavioural changes emerged that promoted the shift from conventional fossil fuel-based and centralised energy production towards the sustainable energy sector. Private individuals began to participate directly in the electricity sector as producing actors (Devine-Wright, 2007; Tarhan, 2015). Some private actors, such as individual homeowners or farmers, installed PV modules on their roofs, while other actors gathered in groups and cooperatives to finance and install small to medium-sized systems, for example, community solar power on larger buildings, like schools or communal facilities.

In Germany, while each project may have been small, the total share of private citizen ownership in all newly installed renewable energy power plants rose to 47% by 2013 (Trend:research & Leuphana Universität Lüneburg, 2013). The share of private ownership exceeded the percentage of conventional energy suppliers and contributed to the expansion of renewable energy within the German electricity generation mix.

The history of energy cooperatives in Germany dates back even further than these recent developments. Around 1930, about 6,000 energy cooperatives existed in the country (Holstenkamp & Müller, 2013). When rural communities in remote areas had no access to the electricity grid, villagers formed cooperatives to finance and install wind and hydropower facilities, battery storage facilities and distribution lines (Holstenkamp & Müller, 2013; Meyer, 2016). The motives for rural communities to set up their own mini-grids included: (1) faster access to electricity than waiting for the national grid, (2) desire to improve living conditions, (3) creation of local economic opportunities, (4) keep local decision-making power.

[1] After several changes to the complex and technology-differentiated tariff structure, the subsidy scheme changed in 2016 to the following: for installations below 100kWp, fixed feed-in tariffs persist with a differentiated tariff according to size (7.2-9.5 ct/kWh). For installations above 100kWp, tariffs are tendered. Tenders with lowest offers win the support. As tendering procedures are complex and need full planning and project calculation for investments, this sets difficult conditions for energy cooperatives today.

Working in cooperative structures was not new for many communities, which had familiarity with cooperatives in the agricultural sector. Those villagers also accepted negative issues such as the noise level or the degraded supply quality from wind power plants because they had proportional ownership of the energy infrastructure and were involved in operations.

On the whole, decentralised projects in Germany enable project leaders to plan and build based on demand, while many profit-oriented and centralised activities tend to build bigger infrastructure than is needed to buffer potential demand increase. For small-scale projects, developers can conduct household surveys to gauge expected electricity use. However, after some years, demand may rise in these project areas and exceed the supply, leading to re-powering needs.

Although the time, cultural and geographical context are different, experiences from Germany may serve as an example for Myanmar. At a time when many remote rural areas in Germany had underdeveloped infrastructure, there were still over 6,000 of energy cooperatives present in the country. This experience shows that an energy system based on local production and consumption can be an attractive and viable way to improve local livelihoods.

2.4 Cooperatives in Myanmar

In Myanmar, cooperatives have a long history. Many cooperatives were first introduced in 1904 by the colonial authorities. In the beginning, British authorities used the model to counter usury lending practices of informal moneylenders. Initially, the number of cooperative societies grew quickly, but due to mismanagement and a lack of transparency, the system failed in the 1920s. Out of the 4000 credit cooperatives that existed in 1929, only 57 credit coops remained in 1932 (FAO and MOALI, 2016). One reason for the failure is that many local communities viewed cooperatives as "externally imposed and controlled organisations". [2]

After independence, the government re-instituted cooperatives with the primary aim to promote rural development and increase access to finance for the rural population. In 1951, the government formed the Ministry of Cooperatives to guide the development of cooperatives. During the socialist era, the central government used the Ministry and cooperatives as an instrument to implement its development policies. While the ruling junta remained in place during the 1990s, the government enacted several key laws such as the 1992 Cooperatives Societies Act and the 1998 Cooperatives Rules. The rules were later updated in 2013 and remain in place today.

As part of a restructuring process, the new NLD government dissolved the Ministry of Cooperatives in 2016 and created a new Cooperatives Department under the Ministry of Agriculture, Livestock, and Irrigation (MoALI).

Myanmar's cooperative system has four tiers - primary cooperatives, township-level cooperative syndicates, union and state-level cooperative syndicates and, a national apex-body called the Central Cooperative Society (CCS). As of December 2017, there are 40,085

[2] For an analysis on the rise and fall of cooperative credit during the colonial time, see: Turnell, Sean, 2005, Cooperative Credit in British Burma, Sydney, Australia: Economics Department, Macquarie Universit, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.199.9123&rep=rep1&type=pdf

registered primary-level cooperatives with 4.2 million members across the country. Primary-level cooperatives must be part of a township or union-level cooperative syndicate. Theoretically, the higher levels of the cooperative system provide demand-based services to their member institutions based on the principle of subsidiarity. In practice, however, these linkages are often weak and provide little support besides access to credit schemes.

Table 1 Cooperative societies in Myanmar

Tier	No. of societies	No. of members
Central Cooperative Society (CCS)	1	469
Union Cooperative Syndicates	22	515
Township Cooperative Syndicates	463	20,792
Primary Cooperatives	40,085	4,248,149

Source: MoALI, as of 31 December 2017

Cooperatives are usually independent bodies governed by a General Assembly of their members and work according to the principle “one member one vote”. In Myanmar, there is a high level of government control. The reason for this lies in the structure of the cooperative system, which historically relied on government intervention, which has led to the weak performance of many cooperatives that are unable to operate without close supervision and support. After decades of government influence and inefficient management structures, the cooperative brand has been severely damaged and does not have a good public image in Myanmar. With the restructuring of many cooperatives in recent years, attitudes towards cooperatives have slowly begun shifted towards a more positive view (Ferguson 2013, The Global New Light of Myanmar, 2018). International donors have set up a number of cooperatives with sound business concepts with the aim to nurture a brighter future for this form of community enterprise.

There is a lack of public data on cooperatives in Myanmar. The Cooperative Department maintains that by the end of 2019 there were a total of 14 registered cooperatives, which list energy as a main sector of focus. This handful of cooperatives reportedly cover a total of 2,077 people. Compared to the number of mini-grids and the total number of cooperatives as low figure.[3]

Against this background, the next chapters present an overview of the Myanmar electricity sector and the current regulatory environment, to provide an overview of the framework condition in which rural mini-grids must be established and function.

[3] The inquiry was conducted early 2020 by Email with cooperatives in Chin State (7), Ma Gway Region (2), Mandalay Region (3), Shan State Region (2).

3 The Myanmar electricity sector

Myanmar is the second largest country in Southeast Asia and contains over 676,000 km² of land and a total population of about 53.4 million (2018). The country's average per-capita electricity consumption is 110 kWh/a, among the lowest in the world. In terms of energy intensity, Myanmar is ranked 191 globally. Access to electricity and other conventional energy sources in the urban centres is around 50%. In contrast, between 68% (WWF, REAM, Spectrum, & IES, n.d.) and 76% (ADB, 2016, p. 2) of the population in rural areas does not have access to conventional energy sources. Widespread use of traditional biomass, particularly for cooking, and candles for lighting is common.

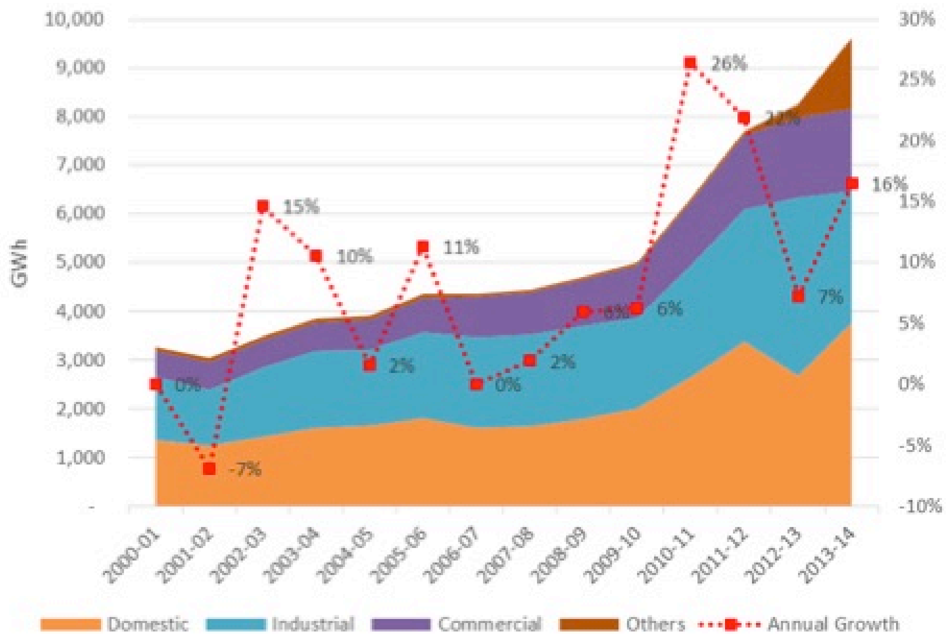
In several Myanmar regions, there are on-going disputes about the construction of new energy projects and overall public perception is sceptical about foreign investment in coal and dam developments.[4]

3.1 Electricity generation

Electricity demand

Since 2009, total electricity demand has steadily increased at an average annual growth rate of around 15% (WWF et al., n.d., p. 79).

Figure 1 Total electricity demand by sectors and annual growth rates



Source: WWF (p. 79)

The energy system does not operate on a firm financial basis due to government subsidies at below-market rates (see section 4.3.2). In the past, investments in power plants and the transmission and distribution system were undertaken almost exclusively by state-owned enterprises. However, as electricity demand increases, massive investment in generation

[4] Tokyo university Chp 2; Khine Kyaw/Myanmar Eleven: Myanmar "must review energy policies" (2016)

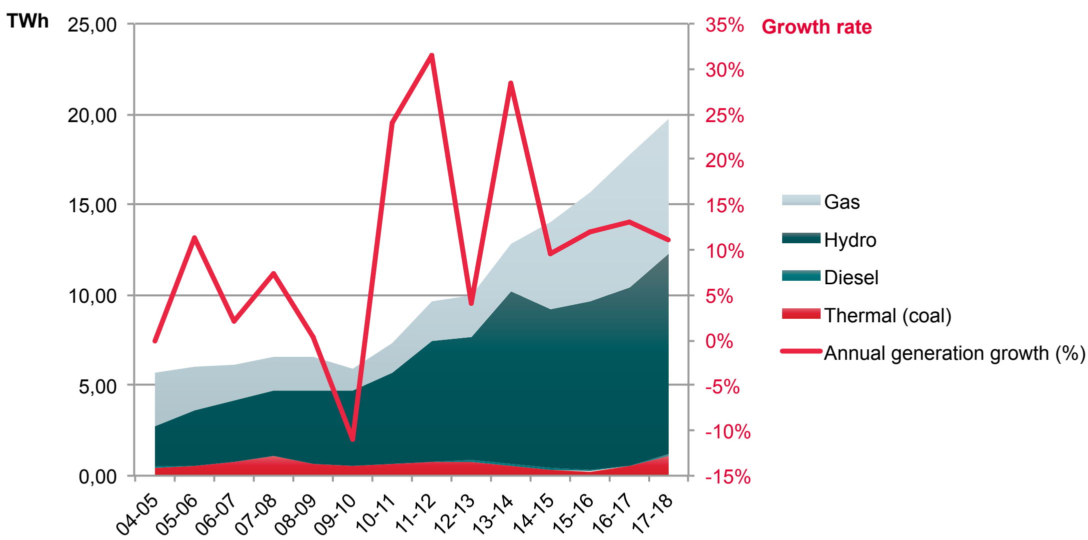
capacities and distribution infrastructure are needed. As a consequence, the Myanmar government plans to open the sector to foreign investors and public private partnerships.

The focus for future generation capacities lies on large-scale power plants, especially hydropower and gas, and potentially coal. The following sections discuss the current state and potential for various generation technologies in Myanmar.

Electricity generation sources and potential

Since 2015, when the NLD came to power, electricity generation growth has remained around 10%, falling well short of expectations. Data lists from 2018 indicate an installed capacity of 3.2 GW hydro (59%), 2.1 GW gas (39%), 0.1 GW coal (2.2%) (MOEE, 2018) (see Figure 2).

Figure 2 Myanmar electricity generation by source (TWh/a and % growth)



Source: Based on MEPE data retrieved from MMSIS (2019)

Planned capacity builds on the same energy sources. National strategies have typically focussed on large dams and fossil fuel-based projects, which have severe environmental and social impacts and have thus led to protests. The National Electrification Management Committee (NEMC) estimates that the total hydropower potential is 100 GW, of which 46 GW potential projects have been identified (NEMC 2015, 596; ADB 2016, 1). For the 36 projects under development, 14 with capacities between 6–1050 MW are under construction and are due to come online between 2014 and 2020. This would add a total of 2.1 GW capacity (NEMC 2015, 595-596).

Installed gas-fired plant capacity amounts to 2 GW (MOEE 2018, 4). If all currently planned projects are completed, this amount will increase to 4,148 GW, and if rehabilitation plans are successfully implemented, the total available capacity of gas fired plants will increase to 4,514 GW (NEMC, 2015, p. 589).

Myanmar coal deposits and open-cast mines are located in remote regions and are of low calorific value (ADB, 2016, p. 5). The 120-MW coal-fired power plant in Tigyit uses about 50% of mined coal and the remainder is used by cement and steel companies. While the ADB (2016) is sceptical about the economic potential of Myanmar coal, the National Electrification Management Committee (NEMC) lists 11 announced projects for which

MoUs have been signed. This list is based on a JICA (2014) study identifying projects for the private sector development and amounts to a total additional capacity of 11 GW (2015, 591).

In contrast, *renewable energy sources (Solar PV, Wind)* currently play a marginal role in the Myanmar energy mix but have significant potential. Around 60% of the country is suitable for solar PV installation (ADB 2016, 6), which has the potential to generate over 973.8 TWh per year (MOEE, 2018). Around 470 MW is planned under on-going projects and future projects, and 990 MW is under investigation (MOEE 2018, 6). Only four pilot wind turbines are operational, but the potential for wind power is significant. ADB (2016) lists 4GW of foreign investment proposed for wind projects, while MOEE reports 30 MW planned and on-going in this area and another 830 MW under investigation (MOEE 2018, 7).

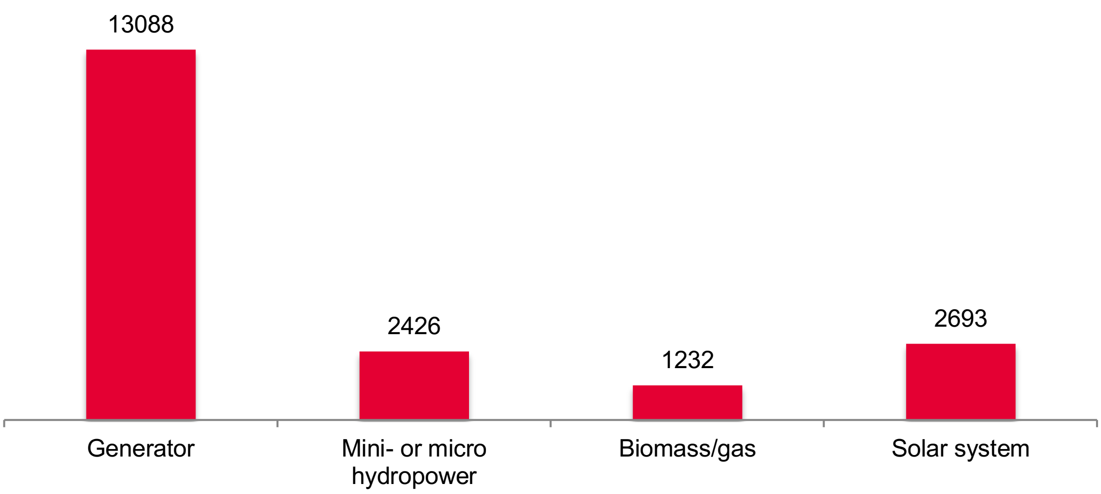
The appendix includes further details on the Myanmar electricity generation.

3.2 Off-grid electrification

In rural off-grid areas, the primary sources of electricity are small and mini-hydro, diesel generators, and solar PV, often through solar home systems (SHS). Many mini-hydro projects are set up, run and managed by community organisations (see chapter 4). Because these systems are often located in remote areas and run by communities without government support and involvement, there is no systematic registration process for these projects (Myint, 2014). Additional potential is difficult to estimate without further ground investigation.

The best available estimate is provided by village-level data published by the Department for Rural Development (DRD) in 2015. Out of 64,000 villages, over 19,000 villages are considered by the DRD to be electrified by off-grid systems (Figure 4) (Greacen, 2016). "Solar systems" primarily refers to individual solar home systems (SHS) and only in very few cases signifies larger PV generations connected to mini-grids (Greacen, 2016; interviews). The other generation sources are nearer to village-scale mini-grids.

Figure 3 Off-grid electrification by generation type (number of villages)

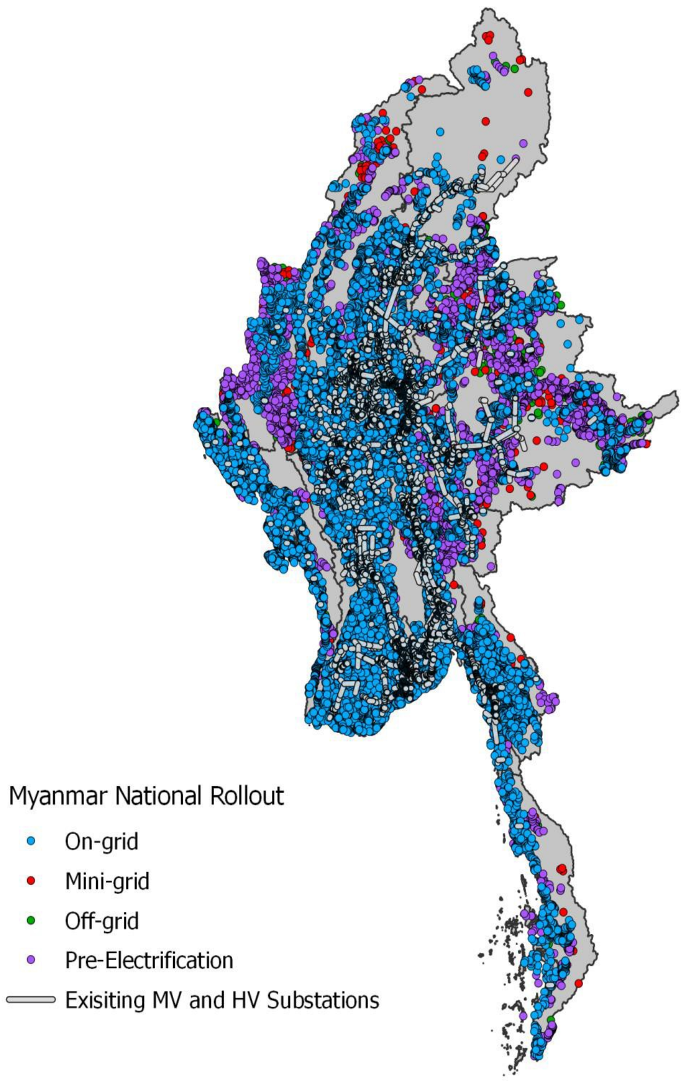


Data source: Department of Rural Development, cited in Greacen 2016

In over 13,000 villages, the most common generation source for mini-grids is diesel, which requires low levels of investment, but has high operating costs. Typical tariffs are 800 to over 1100 MMK/kWh (0.73 to 1 US$/kWh in 2016[5]) (Greacen 2016). The second most common generation source is small-scale hydropower plants, which are concentrated in regions with sufficient water, i.e. Shan, Mandalay and Sagaing states. Around 2,400 small-scale hydropower plants exist with tariffs around 200-800 MMK/kWh (0.18-0.78 US$/kWh) (Data from study field visits and Greacen 2016). Around 1200 biomass gasifiers are also used, although these are mostly concentrated in the Ayeyarwaddy delta and have with a reference tariff of 400 MMK/kWh (0.36 US$/kWh).

Solar systems are now prevalent in rural Myanmar, but solar-powered mini-grids are much less common. Greacen (2016) estimates there are dozens of PV mini grids, while the DRD confirmed that of the 65 or so mini-grids implemented under the National Electrification Plan (NEP) until early 2019, almost all were PV systems (interview DRD 2019).

Figure 4 On- and off-grid electrification projects



[5] Note these US$ figures were calculated by the original source with 2015/16 exchange rates. MMK have devaluated significantly since then.

Source: MoEE (2018, 3, 2019b)

According to Greacen (2016) and interviews with project team (Sai Htun Hla, Vaghela, 2019) small hydropower projects are typically planned and implemented with the help of local developers who know the region and have decades of experience implementing projects in remote areas. These developers assist communities with the set-up and production of the necessary technical equipment. To keep costs low, turbines and transformers are mainly produced in local workshops, and second-hand generators are often imported from countries such as Germany, Japan, and China.

3.3 Electricity distribution – national grid

Although the national electricity grid[6] connects to the country's major power plants, it only covers the central parts of the country. Electrification rates in cities have improved (Yangon: 78%, , Mandalay: 40%, Nay Pyi Taw: 39% according to ADB 2016, 8). In contrast, rural areas often have electrification rates below 10%. Under the NEP, the main goal of the MOEE is to expand the national grid (see below). The goal is to connect 500,000 households per year from 2020 onwards and achieve 100% electrification by 2030 (MOEE, 2019).

MOEE and its subsidiaries do not plan to finance all of the work and associated investment costs to connect unelectrified villages to the national grid. The operator plans only to extend the national grid and construct sub-stations next to villages but does not cover household connection to the grid. Instead, villages must form "village electrification committees" (VECs)[7], which are responsible for funding and managing the construction of 230/400V distribution grids within their villages. Funds for this are typically collected from villagers for a "village fund" and complemented with support from various government agencies (MOEE, DRD) or international development agencies. Distribution grids usually run alongside village roads, and once they connect to the national grid, the national operator takes over the maintenance and operation of these systems.

Individual households must cover expenses for connecting their own houses to the distribution grid, meter installation and in-house wiring. See the box below for an example.

[6] This includes lines with powers of 230kV, 132 kV, 66 kV and 33 kV. System losses decreased from 35% in 2000 to 25% in 2013 (NEMC 2015, 127).

[7] Attention: same terminology as VECs for mini-grids.

Table 2 Costs for village connection to the national grid, example for village with 230 households

Cost item	
Transmission grid to the village	Covered by grid operator
Distribution grid	Total MMK 24 million covered by the village. Recovery: MMK 300,000 per household for approximately 200 households. The other expenses were covered by village funds, and ERLIP (World Bank), JICA, DRD, ADB
Dwelling connection and in-house wiring	Paid for by individual households, depending on distance of the dwelling to next grid pole (estimated MMK 200,000 per household on average but figures vary widely between different locations)

Source: Stakeholder interview with VEC members operating a distribution grid to be connected with the national grid

According to JICA in 2003, "even on the optimistic assumption that rural electrification level is improved by 2% per year, it would take more than 40 years for the transmission and distribution networks to reach the majority of the local towns and villages" (JICA 2003). REAM general secretary Aung Myint echoed this view during an interview in 2019. Given his past experience and the current assessments of future planned connections, it will be impossible to electrify the entire country by 2030 at current grid expansion rates. Moreover, simply extending the grid will not provide a short to medium-term solution due the inadequate generation capacity, which falls well short of demand. MOEE estimates an increase in load demand through grid expansion of 300 MW until 2022 (MOEE, 2019), in addition to annual demand increase rates of 10-30%.

The expansion of the national grid together with a focus on projects with large generation capacity is in the core focus of the MOEE, its agencies and utilities. So far, MOEE has prioritised expanding generation through centralised large-scale plants. However, utilities could benefit from connecting generation capacities that help to boost voltage at the end of the line (Greacen, 2015, p. 16). Equally, this would support small and medium-sized generators. Although MOEE is drafting a renewable energy regulation that will include standardised power purchase agreements (PPA) (MOEE 2019), currently, there are no general connection and tariff provisions in Myanmar and local generation capacities are connected to the grid through bilateral agreements with MOEE.

3.4 Energy strategies and policy framework

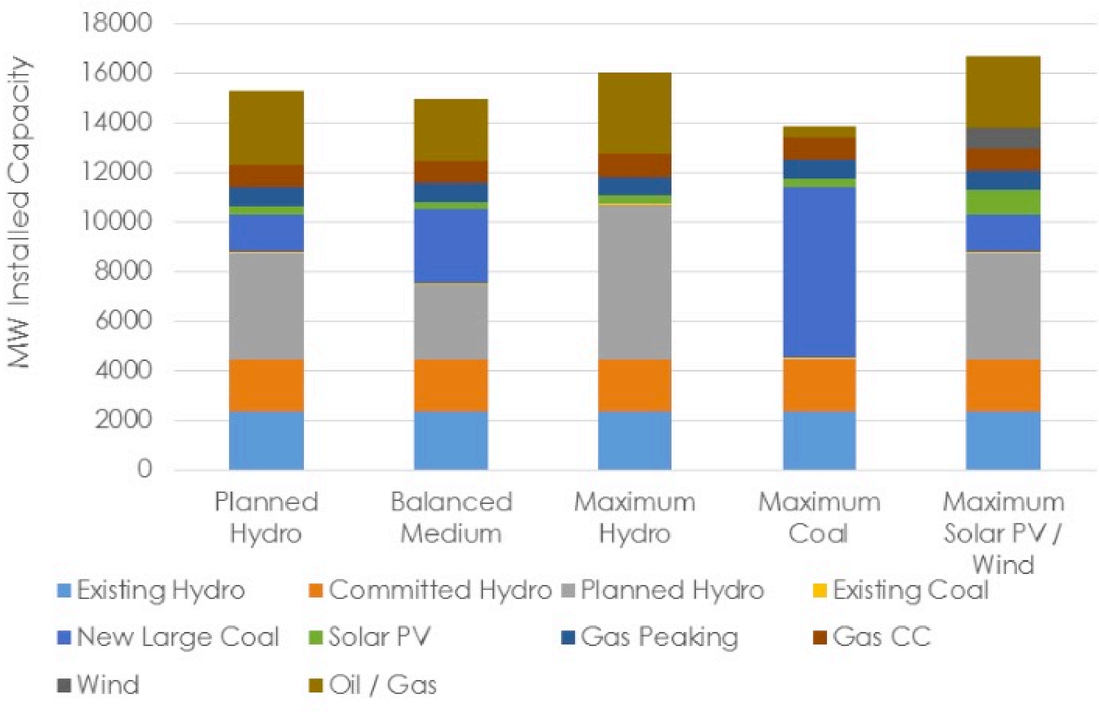
The outlook for Myanmar's electricity sector is embedded in a number of plans, roadmaps and core projects, that range from broad national strategic plans to concrete energy implementation masterplans. The core documents are:

- Myanmar Sustainable Development Plan 2018-2030 (Ministry of Planning and Finance, 2018)
- National Energy Policy launched in January 2015 (NEMC)
- Myanmar Energy Masterplan prepared by ADB, 2015
- National Electricity Masterplan prepared by JICA
- National Electrification Plan (NEP)/ World Bank Project, 2015

The **Myanmar Sustainable Development Plan (2018 – 2030)** establishes a framework for the country's development agenda and identifies five main pillars with action plans for the selected priority areas. One of these strategic areas focusses on the provision of affordable and reliable energy for both the public and businesses via a suitable energy mix. The government aims to expand access to affordable low-carbon energy to all classes of consumers, especially those in rural areas, through measures promoting energy efficiency and competition in the energy market. The MSDP is not detailed and instead leaves sector specific policies to be developed by the respective line ministries and working groups.

The **National Energy Policy,** published by NEMC, was approved by the president in 2014. It outlines a comprehensive plan for how to develop the energy sector to reach full national electrification and also emphasises the importance of renewable energies. The policy includes plans to promote government-driven "community-based renewable energy projects" as a means to poverty reduction. Although it highlights the importance of the private sector to provide suitable technology, it does not mention local developers of mini-grids which have been existing for many years. It outlines an institutional arrangement how the plans should be realised and coordinated between different government stakeholders.

Figure 5 NEMC Electricity generation capacity scenarios for 2030

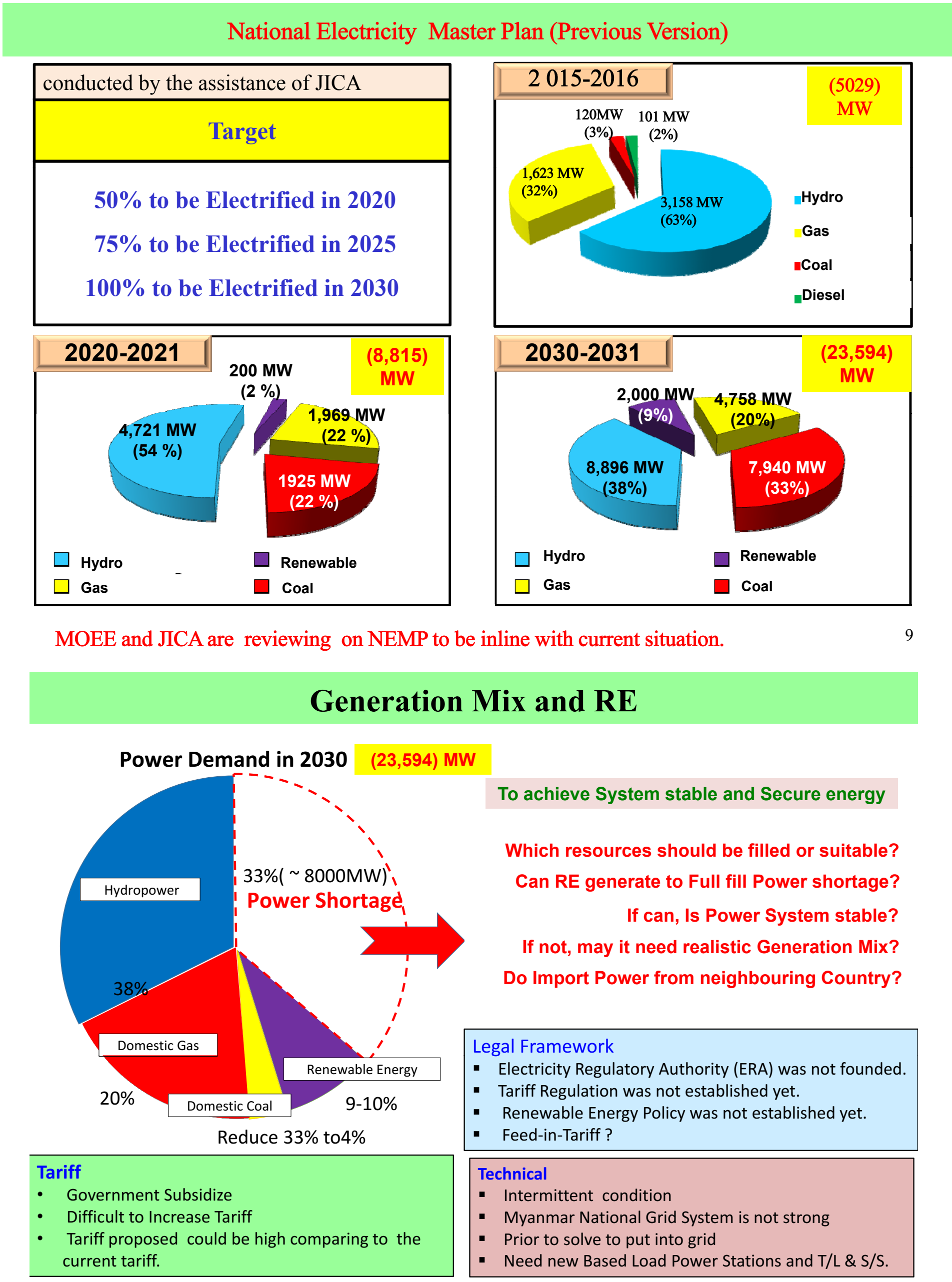


Source: NEMC 2015, 676

There are three main national plans for extending electrification in the country supported by three different donor institutions. **The Myanmar Energy Master Plan**, developed jointly by NEMC and ADB, provides a detailed energy demand forecast and develops scenarios for a suitable energy mix. It focusses on grid extension and centralised power generation from renewable and fossil sources. The plan points to the fact that 100% electrification by 2035 is unrealistic and estimates 5% of communities, which will not be connected to the main grid, should be electrified by off-grid solutions.

The **National Electricity Master Plan** was developed jointly by MoEE and JICA. It also focusses on grid extension and the construction of large-scale generation facilities. Off-grid electrification is not featured in this plan. The main targets of the master plan, according to the latest version, are that the whole country should be electrified, with 38% generation from large hydro, 33% from coal, 20% gas plants and 9% renewable energy. Under the plan total capacity would increase from 5 GW in 2015 to 23 GW in 2030.

Figure 6 National Electricity Master Plan (2015)



Source: MOEE (2018, 9-10)

The **National Electrification Plan** was developed by the World Bank in collaboration with MOEE and MOALI. It targets 100% electrification by 2030 through a mixture of grid extension and off-grid electrification, particularly in areas that will not be connected to the grid by the target date. In order to realise the plan, the World Bank provided USD$400 million loan to the government of Myanmar of which USD$80 million is designated for off-grid electrification (see below, National Electrification Project).

It is not entirely clear how the MOEE selected the current generation capacity expansion pathway. During a stakeholder interview (MOEE 2019), MOEE said it is guided by "national interest" and "affordable generation", which indicates that the ministry plans to pursue a least-cost generation mix. It is unclear whether considerations of the external effects on local ecology, economy and communities are evaluated in such cost-assessments. The 2015 studies (NEMC) forecast a massive need for generation capacity expansion by a factor 3-4x within the next 15 years. However, the plans entirely disregard small-scale renewable energy options from hydro, solar and wind. MOEE is conscious that renewable energies are missing from the 2015 NEMC study and plans to estimate future potentials for renewables and update the scenarios accordingly (MOEE 2019).

The gaps in the NEMC have been criticised. According to the general secretary of REAM (Kyaw 2016, Aung Myint 2019), a strategic assessment shows renewable energy is a reliable and practical option with sufficient potential. The coordinator of Karen Environmental & Social Action Network estimates that large coal and hydro projects threaten to uproot communities, damage ecosystems, livelihoods, food security and ethnic culture, cause pollution, fuel climate change and aggravate conflicts across the country (Kyaw 2016).

National Electrification Project (NEP)

In 2015, the World Bank financed the National Electrification Project. While national grid expansion is coordinated by MOEE, the off-grid component is administered by the Department of Rural Development (DRD) within the Ministry of Agriculture, Livestock and Irrigation (MOALI), with assistance from GIZ.

World Bank financing supports three main components (World Bank, 2015):

- **National grid rollout**, supported by USD$200million, for financing medium/low voltage distribution grid expansion to villages closest to the existing grid infrastructure. This component is managed by YESB and ESE.
- **Off-grid component,** supported by USD$80million, targeting households in areas where the national grid is not expected to reach in the next 10 years. In these areas, mini-grids and household energy systems including solar PV, mini-hydro, wind diesel and hybrid systems are supported. This component is managed by DRD.
- **Capacity building and technical assistance**, supported by USD$20 million. This includes support and technical assistance to GoM agencies responsible for the planning, implementation, monitoring and evaluation of the NEP.

Under the NEP scheme, project developers apply for funding for 60% of total investment costs (CAPEX), then operate the facilities for a period between six and up to 15 years and conduct capacity building activities, before they hand projects over to communities. As the scheme began in 2015 it is relatively new and has not yet conducted handovers to community organisations after developer-management periods. Moreover, DRD has not yet defined what kind of community organisations will take over projects and how they can best prepare for management (interview DRD 2019). Prerequisites for funding are:

- <1 MW
- 40% funding from developer and/or community (typically: shared)
- project site outside national grid extension area within the next 10 years

There are a number of additional actors active in rural electrification projects, within and outside the framework of the NEP. An overview by the network of Development Cooperation partners includes (Development Partner Support, 2017):

- Italian AICS with a € 30 million soft loan contribution and a €1. 05 million grant to the NEP,
- Japanese JICA with a total of 85 million US$ for on-grid and US$ 5 million for off-grid projects
- EU with a € 10 million grant for rural electrification from the Asian Investment Facility
- German Development Cooperation GIZ and KfW with a €4.87 million grant for both technical measures and project implementation (DRD/MoALI)

It is not entirely clear which ministry/department is implementing the respective programmes.

3.5 Institutional landscape and stakeholders in the electricity sector

Ministries related to the energy sector

In 2016, the government restructured its organisational structure and reduced the number of ministries (ADB 2016). Of the 25 ministries, six are involved in energy and electrification

Table 3. The Ministry of Electricity and Energy (MOEE) is responsible for oil, gas and electricity operations. The Ministry of Natural Resources and Environmental Conservation oversees coal mining, and the Ministry of Industry supervises energy efficiency. Two ministries are involved in the development and electrification of rural areas: The Ministry of Agriculture, Livestock, and Irrigation is in charge of off-grid rural electrification, biofuels and micro-hydro for irrigation use, and the Ministry of Border Affairs is responsible for the development of border areas. Finally, the Ministry of Education is responsible for research, vocational and technical training regarding the energy subject. The ministries also maintain regional/state and township offices.

Table 3 Ministries related to Energy, 2019

Abbr.	Ministry
MOEE	Ministry of Electricity and Energy
MONREC	Ministry of Natural Resources and Environmental Conservation
MOI	Ministry of Industry
MOALI	Ministry of Agriculture, Livestock and Irrigation
MOBA	Ministry of Border Affairs
MOE	Ministry of Education

Source: MIMU (2019) and Tokyo University (2013)

The primary ministries involved in electrification are MOEE and MOALI. MOEE is responsible for overall energy policy and for extending the main grid and power generation. Within MOALI, DRD is responsible for rural electrification through decentralised solutions (mini-grids, SHS).

The National Electrification Management Committee (NEMC) coordinates efforts between the ministries. NEMC has published a number of policy papers. Government interviews indicate that exchange takes place between DRD and MOEE through inter-ministerial working groups.

The President Office founded the National Renewable Energy Committee (NREC) on 6 February 2019 with the Notification number 24/2019. The committee consists of the Ministries, stakeholders of private sector organisations and NGOs, such as Union Chamber of Union of Myanmar Federation of Chambers of Commerce and Industry (UMFCCI), Myanmar Engineering Society (MES) and Renewable Energy Association Myanmar (REAM). The tasks of NREC include

- developing renewable energy policy; law, rule and procedure
- wind and solar mapping
- investigation of feasible mini-hydro resources; review of other renewable energy technology development (Geothermal, Biomass, Waste-to-Energy, Tidal Power),
- inter-ministerial coordination on renewable energy mini-grids in off-grid area
- collaboration with international organisations for development aid for renewable energy and
- providing domestic and international technical assistance for HR development

The committee is organised in working groups, some of which are technical, such as Mini Grid and Off Grid, Law Formulation, Legal and Commercial.

Village Electrification Committees (VECs)

These organisations exist in many villages and are predominately led by voluntary staff. VECs operate mini-hydro, biomass and solar-powered schemes. Although, there is no standard structure or standard rules and regulations, the concept and VECs' strong commitment towards the community and their ability to establish equitable tariffs (JICA 2003) represent a significant opportunity for potential rural electrification projects.

Figure 7 VEC meeting

Photograph: Khin Akari Tar

VECs mainly support electrification through the national grid. The MOEE and MEPE do not implement or fund village distribution grids, which must be financed and set up by the communities themselves and then handed over to MEPE. In these cases, VECs consist of village representatives who arrange and manage implementation of village distribution grids (see above Table 2) In our field study, we encountered several villages with two parallel VECs, one for the local mini-grid and one for the national grid (chapter 6). There are no reliable statistics on the relative frequency of two committees operating in a village, but according to DRD this is only the case in a few villages. The department suggests that villages organise one VEC to manage both grids together.

Non-Governmental Organisations and development organisations supporting off-grid electrification projects

NGOs: There are many national and international NGOs in Myanmar that carry out a range of development activities in rural areas. Their objectives include humanitarian aid, promotion of health, education, social matters, food security and environmental conservation. The energy component is considered essential by many of these NGOs, as energy for cooking, water supply and light are considered prominent basic needs and also relate to health, forest conservation and income generation.

NGO activities serve as an important and complementary support to nationwide strategic programmes in rural development with energy integration. Aside from energy generation and distribution, NGOs address issues of conservation (e.g. forest depletion due to overharvesting firewood and charcoal), alternative fuel utilisation, energy saving and energy efficiency, and knowledge gaps. They are also trying to promote innovation and commercial-scale production of renewable energy in cooperation with private developers.

Although many NGOs in Myanmar are engaged in rural development activities that integrate aspects of energy provision and production, for a long time the Renewable Energy Association Myanmar (REAM) was the most active organisation in this area. REAM emphasises renewable energy promotion as a tool for rural development, environmental conservation and increasing energy access in Myanmar. It seeks to alleviate the energy shortage issue by helping to promote private sector activities in solar and supporting education about renewable energy for the public.

With the support of REAM, the network of mini-hydropower developers and other stakeholders “Hydropower for Community Empowerment in Myanmar” (HyCEM) was established. It is now a member of the regional network “Hydro Empowerment Network” (HPNET).

Development organisations: In cooperation with the Myanmar government and national NGOs, development organisations are heavily involved in off-grid electrification efforts in Myanmar. The various international institutions and support programs which are listed in table 5 of Annex 3.

Since 2013, the World Bank has assisted the National Electrification Plan (NEP) to support the expansion of electricity services in Myanmar through both on- and off-grid solutions to achieve universal access to electricity in Myanmar by 2030 and to strengthen the institutional capacity of the Government of Myanmar.

The joint WBG energy team works closely with all development partners (DPs) active in the power sector (ADB, JICA, KfW, DFID, Norway, Australia, etc.) in addition to working with the public and private sector investors. The NEP is designed as an open platform which DPs can use to guide their support for electrification in Myanmar.

As a “lead development partner”, the Asian Development Bank, also provides loans for distribution, rehabilitation of the transmission grid, and risk guarantees for power plants. The German development agency focuses on supporting “rural electrification through mini-grids” (GIZ & MFAT, 2018) in off-grid areas. GIZ, in cooperation with New Zealand’s MFAT, supports the DRD with the development of the new mini-grid regulations (see section 4.3.4). It also does capacity building work for state and private actors and is supporting the introduction of a quality insurance framework for mini-grids.

Since 2013, the Japan International Cooperation Agency (JICA) has assisted with preparations for the National Electricity Master Plan, which focuses on power sector generation and transmission planning. According to ADB, on-going and planned loans and grants totalling more than USD$1 billion across all power subsectors, including power generation, transmission and distribution and electrification (ADB, 2016, p. 16).

Smart Power Myanmar facility: In 2018, a consortium comprising the Rockefeller Foundation, World Bank, USAID, and YOMA founded the SPM facility “to align and coordinate existing and potential future investments in decentralised renewable energy mini-grid systems”. The facility focuses on three priorities: A) project development support and demand (household and productive loads) facilitation for energy service companies (ESCOs) and developers, B) investment facilitation and business modelling for last-mile electrification models; and C) policy support and industry coordination. (Rockefeller Foundation, 2018).

3.6 Summary

Electrifying the country is a major national development goal enshrined in the Myanmar Sustainable Development Plan 2018 -2030. The goal is to reach universal electrification by 2030. The target is ambitious. Numerous state actors are directly or indirectly involved in all aspects of energy generation and distribution ranging from on- and off-grid electrification to environmental issues and diversity. Coordination between the actors exists, but there are several policy documents and studies which stress different priorities. It is not clear which strategy actually guides electrification plans. The most decisive government actors are MOEE and DRD, which respectively oversee extension of the national grid and off-grid electrification.

The current electrification plans focus on national grid extension and projects with large generation capacity. With the exception of the National Electrification Plan, off-grid electrification is only a side goal. In most plans, off-grid electrification serves only to fill the electrification gap temporarily until the main grid arrives, or to help electrify small communities where the main grid is unlikely ever to reach. Several sources indicate that adequate extension of the national grid will not be achieved by 2030 due to the high investment requirements and insufficient generation capacity available to meet demand.

4 Framework conditions for energy cooperatives in Myanmar

4.1 Financing

The case studies conducted for this paper show that few projects can be implemented without any external funding. Especially in remote communities with low incomes, there is a strong need for complementary external financing. Excluding the projects funded under the NEP program, the external funding ratio for local projects averaged around 83%, ranging between 73% and 100%. This section provides an overview of different funding options available for small decentralised energy projects.

4.1.1 Governmental funding schemes

For rural unelectrified communities, investment in electricity generation and distribution projects is often difficult due to low income levels and the high investment costs required, while access to finance is near impossible. Although we found examples of electrification projects that were entirely self-financed[8], projects typically receive partial funding from the government. This sub-section lists the most common public funding sources.

DRD: National Electrification Project (off-grid electrification)

As mentioned in section 3.4, DRD operates a USD$ 80 million off-grid funding facility under the NEP. DRD pre-identified 95 possible project sites for development in the financial year 2018/ 2019. The department publishes "calls for proposal" [9] for which developers can submit competing tenders (interview DRD). The sites are outside the national grid expansion area (phase 4/5). In theory, MOEE takes sites off the list for off-grid development once extension of the national grid is planned in those regions.

Additionally, developers can propose developer-identified sites. For the third tendering round, there is no fixed deadline (a "*first-come-first-serve system*"), but proposals can be submitted at any time (interviews DRD and GIZ).

Projects implemented under the NEP generally must fulfil technical and safety requirements and are typically of good quality and ready for grid integration in case the grid expands to the project site. In the pilot phase, eight projects across ten villages received funding. In the second phase, 25 projects in 35 villages were funded and completed. In the coming years, DRD aims to complete 100 projects annually (interview DRD 2019).

For many hydropower developers with decades of experience implementing remote mini-grids, the NEP scheme is not a viable option. The technical standards required increase costs, often by a factor 10. This increase is not offset by government subsidies and leads to a higher cost burden on investors. In remote areas with low income levels, ability and willingness to pay is a problem. Villagers in these regions are often reluctant to contribute when there are government subsidies available. Also, investments in small hydropower

[8] Interview with HP developer: out of the 70 projects he implemented, 50 were entirely financed and owned by the community, ten were financed by company, eight by CDD/DRD and two through the cooperative department.

[9] The DRD was set up a website, which contains all background information, registration forms and supporting documents. These include e.g. technical specifications and guidelines, templates for MoU between developer and village electrification committees (VEC), tripartite agreement etc. – in total two information documents, one registration documents, 19 supporting and nine reference documents (DRD, 2019).

often only pays off after a longer time period than the maximum ten years required by the NEP (interview 7). Additionally, developers report that there are problems with the application. The process is very complex and involves submitting numerous forms and conducting many pre-studies. According to DRD, there is only one set of guidelines between the DRD, WB and GIZ for mini-grids. However, in at least one reported case, various actors (WB, DRD, GIZ) gave diverging advice to the developer about whether to proceed with their application; eventually the developer's application was denied (interview 7).

Ministry of Border Affairs

MOEE and DRD programmes often do not reach remote regions or conflict zones. We found in project site visits that the Ministry of Border Affairs co-finances community mini-grids, partially or even 100% of CAPEX (interview 7). These projects usually aim at a least-cost possible generation, often based on small hydropower with turbines and penstock fabricated in local workshops. On-site installations are implemented by villagers who are supervised by the developer. Due to the limited funds available, technical and safety standards usually do not comply with NEP provisions. It was not possible to identify the number of projects support by border affairs.

DRD Community Driven Development (CDD)

Several of the projects we visited for this study had also received funds from the DRD under the Community Driven Development (CDD) programme (also mentioned in interview 7)[10]. In these cases, the contact was mostly established by DRD township offices who gave access to CDD funds for local villages. According to their website, 2,594 villages received support for electrification[11].

Cooperative Department (CD)

Organisations that are legally registered as cooperatives and are part of the official cooperative system can apply for credits managed by the central cooperative society (CCS). The cases covered in the second part of this study include one project, which received funding from the CD.

4.1.2 Market-based financing

In Myanmar, access to commercial funding for SMEs is a large obstacle for development, especially for rural enterprises. As recent surveys (GIZ, 2018) have shown, less than 0.2% of banks' loan portfolios are to SMEs. Accordingly, most entrepreneurs borrow from their own family or informal money lenders. The current financial ecosystem does not support lending to mini-grid projects due to a variety of issues, these include:

- Collateral requirements: Banks traditionally rely on land-titles to collateralize loans. The mini-grid projects surveyed often lacked a legal land ownership document.

[10] The CDD project aims to provide grants to poor rural communities for small-scale development projects which are selected by the communities themselves.

[11] https://cdd.drdmyanmar.org/en, last access, 21.07.2020

- Lack of experience and lending techniques: financial institutions are unfamiliar with small-scale energy projects, which makes it difficult for loan officers to access the lending risks and conduct loan appraisals. (Sanyal & Eisinger, 2016)
- Costs for banks: Small-scale projects in rural areas are relatively expensive to appraise and smaller loans provide less return for the bank. The mix of high costs (and high risk) and lower return disincentivises banks from lending.
- Cost of borrowing: Interest rates of often more than 10% p.a. increase the investment costs of projects significantly.
- Loan duration: Loan duration for local banks range normally between 1 and 3 years (less for microfinance) (GIZ, 2018). In contrast, surveyed mini-grid sites, as well as the interviews with local developers, indicate that investment cycles must range, depending on size and technical standards, between 8 and 15 years.
- Lack of financial skills of the borrower: Sanyal & Eisinger (2016) state that most SMEs do not have adequate knowledge of the different funding options and lack the skills needed to prepare documents such as business plans or financial statements. Our surveyed sites in most cases only rudimentary forms of bookkeeping.

Box: Thar Bar Wa project

The EU funded project Thar Bar Wa, jointly implemented by WWF, the Savings Bank Foundation for International Cooperation as well as the Myanmar Food Processors and Exporters Association, aims to build the capacities of selected banks in assessing and lending to projects with a "green label". The project helps improve bank internal loan appraisal processes and thus help financial institutions lend to more local renewable energy projects.

4.1.3 Developers and Community funding

There are two alternative sources of funding used by communities: pre-financing by the developers and community funding.

In the two cases where the mini-grid was registered as a cooperative, the developer provided between 72% and 85% of the capital as up-front financing and in return received 50% in equity shares and thus a right on cash flow from connection fees and tariff payments. According to the developers it took approximately eight years to recover the invested funds. It is interesting to note that the developer took over the function of a financial intermediary.

Figure 8 Workshop of local developer

Photograph: Khin Akari Tar

The communities mobilised operations and maintenance costs for all projects either in the form of connection fees and tariffs, or through the collection of special contributions through a village fund. Besides government lending, there was no case in which commercial funding was utilised either through a bank or through a microfinance institution.

4.2 Renewable energy support

As sustainable rural electrification projects involve setting up small renewable electricity generation capacities (mostly solar or small hydro power), any renewable energy support scheme would be beneficial for their implementation. Looking at the international energy policy landscape, a number of support schemes are possible (see Table 4).

Table 4 Types of renewable support schemes

Institutional Instruments	Monetary/Price instruments	Quantity Controls	Other
Regulations direct: energy laws indirect: competition law, environmental regulations	**Fiscal** revenue side (taxes, duties) expense side (subsidies, support schemes)	**Quantitative targets** Quota tenders/auctions trading schemes	**Support schemes** limited in time and target **Support of voluntary measures**
Organisational support (ministries, agencies)	**Non-fiscal** Price oversight, investment control Feed-in tariffs		

Source: based on Espey (2001)

At present, there is no general renewable support scheme in place that could be used by off-grid projects apart from the funding schemes mentioned above.

For grid-connected renewable energy generation, there is no fixed feed-in tariff (FIT). Instead, generation facilities have to negotiate with MOEE on individual power purchase agreements (PPA). These are typically in the range of USD$12-13 ct. MOEE is currently preparing a renewable energy law that will also contain standardised PPA procedures (interview with MOEE 2019).

PPAs with MOEE are not relevant for off-grid projects. However, they can become relevant, if the national grid arrives in the future, once mini grids are connected, and generation capacities intended to be integrated (see section 4.3.3). In these cases, a PPA rate of 65 MMK would be too low to keep operating existing generation facilities. PPA rates rather in the range of 300 MMK would be needed, according to developers (interview with HP developer).

4.3 Regulation and technical standards

4.3.1 Regulation of small power producers (SPP)[12]

According to the electricity law from 2014 (Electricity Law, 2014), the MOEE is responsible for the oversight and licencing of any electricity generation and distribution capacities. The law defines “small-scale electrical projects” as generation capacities up to 10 megawatts.

In principle, licenses can be issued by the ministry, region/state governments and Self-Administered Divisions/ Zones (SAD/SAZ) (Chapter 4.7, Electricity Law,). Licenses for

[12] There is no clear definition of what a SPP is even though the Energy Policy describes different categories (FDI-IPP/ SPP/ VSPP) to be regulated (Energy Policy (2015), 2nd key point).

"projects separate from the grid" and which are "small and medium sized" are issued by the "relevant regional or state government" (Chapter 4.9a, Electricity Law) or heads of SAD/SAZ (Ch. 4.9b, Electricity Law).

The electricity law also mentions quality and norm specifications that have to be followed (Chapter 6, Electricity Law) The duty of "the relevant ministry" is to "inspect electricity activities and electrical appliances" (Chapter 7, 9, Electricity Law).

Chapter 8 of the law assigns the task of identifying "suitable places for the systematic management of the country's electric power needs". Chapter 12 contains a number of prohibitions including (summarised, references to chapters):

- 44: to engage in electricity activities without having obtained a license
- 45: to engage in other activities not contained in the licence
- 46: to install or repair electrical installation without an electrical competence certificate
- 47: to engage in any electrical activity without a safety certificate
- 48: to produce or trade any electrical appliance that does not conform to the norms
- 49: to engage in electricity activities with third parties without permission from the relevant department
- 50: to trade licences
- 51: to engage in any activities in power line areas
- 52: to illegally connect to a power line or waste power
- 53: to divert power, cut lines or destroy apparatus

Violations are fined with up to MMK 1 million (Chapter 13, electricity law). The electricity law clarifies the state rules and regulations for the electricity sector. There is little legal room for private and community engagement, and this is only under strict supervision of MOEE.

The provisions to issue licences for small-scale power generations are not entirely clear and the formal proceedings are not laid out explicitly. DRD jointly with the MOEE has been developing since 2018 separate mini grid regulations that will also cover the licensing process. GIZ is also consulting DRD on this regulation development and proposed first draft regulations for isolated small-scale electrical power enterprises (Schmidt-Reindahl, 2018). This included the following steps for a licencing process for rural mini grids

- optional certificate of exclusivity (local monopoly)
- permission for engaging in electricity related business (Electricity law, chapter 12, section 44), for <10MW (easier process for <100kW)
- tariffs should allow for "reasonable return on investment" and may be adjusted for inflation and changing fuel prices (note: electricity law, chapter 10, section 41: authorities may prescribe tariffs)
- application for compensation certificate: regulation of compensations in case of large distribution network arrival

Literature and the field visits conducted for this study found, that in remote rural areas far from the national grid, the reality of electrification projects on the ground over the last few decades is often different from the conditions described in the electricity law. Villagers have often initiated projects or, due to the absence of the national grid and MOEE, township offices and other ministries, have started projects. In border regions and insurgent areas, the DRD and Ministry of Border Affairs are especially active in setting up, supporting and financing projects.

A number of projects are able to obtain official licences from local/state/region governments or MOEE, but in very remote regions or areas with ongoing armed conflicts, village heads cannot or do not follow the legal procedures. It is often necessary to obtain the consent for projects from other local actors, such as local army command or local ethnic militia leaders. As a consequence, mini-grids are operational in a number of villages that have not been counted in national statistics. There are often very difficult socio-economic, technical and safety conditions. Nevertheless, these mini-grids are the only source of power for the residents in these areas and thus provide important services.

The inclusion of these systems into the official legal system and updating them to meet existing technical and safety standards (see section 4.3.5) should be high on the agenda.

4.3.2 Electricity tariff regulations

Grid-connected areas

As of 1 of July 2019, the MoEE introduced new electricity rates (see tables below).

Table 5 Residential electricity tariffs

Demand band (kWh)	Tariff/kWh (MMK)
<30	35
31 – 50	50
51 – 75	70
76 – 100	90
101 – 150	110
151 – 200	120
> 200	125

Table 6 Industrial electricity tariffs

Demand band (kWh)	Tariff/kWh (MMK)
< 500	125
501 – 5,000	135
5001 – 10,000	145
10,001– 20,000	155
20,001 – 50,000	165
50,001 – 100,000	175
> 100,000	180

Source: MOEE (http://moee.gov.mm/en/ignite/page/593)

The minimum household rate of 35 MMK/kWh corresponds to USD$ 2.3 ct or €2 ct, one of the lowest tariffs in the world. According to MOEE, generation costs are currently at 89 MMK/kWh (USD$5.9 ct) for hydropower and 178 MMK/kWh (USD$12 ct) for gas-powered generation[13]. The government heavily subsidises electricity. Subsidy figures range per average kWh from MMK 23–74 and this rate is expected to increase as new plants come online with necessarily higher costs than old dams (MMT, 2018a, 2018b). The MMT states total electricity subsidies to be MMK 406 billion (300 mn US$) for the fiscal year 2017/18 and estimates USD$ 500 million for FY 2018/19, which was confirmed by MOEE (interview MOEE 2019). Today's rates still do not entirely cover generation costs.

Consequently, the government is losing large amounts of money. The energy sector is the single-largest expenditure in the union budget and accounted for 30% of total government expenses in 2016 and 2018 (CSO, 2019). Tariffs below market price result in insufficient investment in proper maintenance and the infrastructure expansion required for universal national electrification. At the same time, tariffs encourage waste.[14][15] Funds currently spent on subsidising electricity tariffs might instead be spent on social support programmes.

Off-grid areas

In areas not covered by the national grid, local electricity providers are also regulated according to the electricity law (chapter 10.41), "The governments of the regions and states and the heads ("oozi") of the self- administered divisions and self-administered zones shall have the right to fix, after consultation with the relevant ministry, suitable electric power rates that are to be charged for electric power under their own management in the electric power system of their area. The electric power rates may be changed from time to time."

This means that any mini-grid project needs to have its electricity tariffs approved by region/state governments or by heads of SAD/SAZ. In the case of NEP-supported mini grids, the developer has to supply detailed calculations of financing, costs for organisation and management, a cash flow statement, (supporting document 8/19), a bilateral service agreement for the sale of electricity that includes tariffs (reference document 5) and the overall evaluation of proposals, which includes tariffs as one important criterion (support document 17). This means that for NEP projects, the DRD Project Management Office effectively controls the tariff and not state/region governments or SAD/SAZ heads.

Many of the mini grids that are not part of the NEP off-grid component but financed and set up by villages and developers, at times with funding from MOBA or DRD, reportedly set tariffs through a joint decision-making process. This process includes the owners and in most cases involve the VEC as a village representative whose members call village gatherings if tariffs need to be revised to cover costs. Tariffs are often on a per-appliance or light bulb basis or per kWh.

[13] According to the approximate exchange rate as of 01.07.2019 of 1,500 MMK to 1 USD.

[14] The Myanmar government has recognised that revising the tariffs towards cost-recovery will have many benefits:

- Subsidised levels for small consumption allow for socially fair low-consumption levels while discouraging waste of electricity
- cost-recovering tariffs allow for a financially sustainable operations and expansion of the electricity system
- current funds used for subsidies can be used for other urgent public expenses such as social, health or education system

[15] From 1st of July 2019 the Government of Myanmar increased electricity tariffs: https://www.mmtimes.com/news/myanmar-electricity-rates-soar-next-month.html

In these cases, we did not encounter effective tariff oversight by region/state governments or SAD/SAZ heads as mandated by the electricity law, but rather it is left to the organisation of the communities and their VECs as representatives. As a consequence, tariff structures vary widely. For community-managed mini grids, electricity rates should not be decided by the regional or central government, but by the community which is most familiar with the investment needs and local payment abilities.

4.3.3 Grid expansion and grid connection

One crucial determinant for viability of local mini-grids is accurately gauging whether the area will be electrified by the national grid in the short term. If the grid is expected to arrive in the medium term, how the established mini-grid can be converted into a distribution grid for the national grid needs to be determined.

National grid expansion

Expanding the national grid as fast as possible is one of the priorities for the Myanmar government and the MOEE as the responsible ministry. Expanding the national grid is also the focus of World Bank-funded NEP (see section 3.4). MOEE sets five year-plans for grid connection and defines priority phases. Areas that are in planning phase 4/5 can reportedly expect to be electrified with the national grid within the next 5 years. Therefore, a prerequisite for mini grid project assistance from the NEP is that the identified site is located in phase 4/5 national grid expansion area (interview DRD 2019).

The NEP itself recognises that with the limited funds and capacity of the respective government agencies the national grid will not cover the entire country by 2030. Experts familiar with off-grid regions estimate that all national and international funds currently assigned to national grid expansion are not sufficient to meet the 2030 electrification targets (interviews with HP developer and REAM, Aung Myint 2019).

National grid connection

When the national grid reaches a site with a mini-grid in place, there are a number of different scenarios for what can happen with the mini-grid (see Table 7).

Table 7 Options for previously isolated mini grids

Option	Detail
Small power producer (SPP)	The mini-grid converts to a main grid–connected SPP and no longer sells at retail to villagers
Small power distributor (SPD)	The mini-grid converts to an SPD that buys its full supply at wholesale from the main grid and sells purchased electricity to villagers at retail (with or without backup generation)
SPP + SPD	The mini-grid continues to sell electricity to its retail customers with its own generated electricity or wholesale purchases from the main grid operator and also sells electricity to the main grid operator when a surplus is available
Compensation and exit	The mini-grid goes out of business, and the developer receives some compensation for assets taken over by the main grid operator (typically a government-owned national utility)
Side-by-side but not interconnected	The mini-grid continues to serve customers even when the grid arrives, with no electrical interconnection between it and the main grid, even though both operate in the same village
Abandonment	The mini-grid and generation facilities are abandoned

Source: Tenenbaum et al. (2018) (without abandonment option)

The first four options are grid connection options with different business models. The fifth option is a coexistence option with a maintenance of parallel infrastructures. The sixth option, in which mini-grid and generation facilities are abandoned has been often observed but is not recommended because of high lost investments.

According to the electricity law (chapter 4.9), "... the relevant region or state government and the head ("oozi") of the relevant self-administered division or self-administered zone must coordinate with the ministry with regard to how the project is connected with Union projects for the generation and distribution of electric power". This vague formulation means that in the field interconnection can only happen under MOEE standards and conditions.

For implementing one of the first four options, it is thus crucial to figure out whether local grid installations can be converted to national grid distribution lines and whether small generation capacities can be turned into small power producers connected to the grid. This means it is necessary to fulfil technical standards (be "grid ready", see section 4.3.5).

If local mini grids do not fulfil the technical requirements and are not "grid ready", the only options available are

- reinvesting in upgrades to be grid-ready
- maintaining parallel infrastructures (side-by-side/not interconnected)
- abandonment

This is of high importance for mini-grid operators within the expansion area of the national grid, because at some point in time the grid will arrive. The abandonment of projects due to substantial loss of money and effort should be avoided.

When a village that already has a mini grid with small generation capacities, consumers consider a number of factors when opting for or against the national grid (source: interviews):

- larger load possiblilities (e.g. for washing, cooking, productive uses)
- potentially more stable voltage
- blackouts (in remote areas sometimes for days, mini-grids are often more stable)
- low tariffs
- high grid connection costs (individual connection to the main grid + village distribution grid contribution), prohibitive for some households
- costs of upgrading an existing grid in comparison to the economic benefits (depending on the business model)

4.3.4 Mini grid regulation

Currently, the relevant legal and operational framework for rural and community-based mini grids consists of various laws and rules and governs the following:

- registration with regional government (according to electricity law). However, no detailed process is set, no registry in place, and no compensation for existing grids foreseen
- tariff supervision by region/state governments or SAD/SAZ heads (according to electricity law)
- technical standards for grid connection set by MOEE
- (co-) funding schemes from different ministries

DRD is the department in charge of rural development. It has prepared (2019) a mini grid regulation in cooperation with GIZ that encompasses most of the above issues in one legal framework. It is currently being negotiated with MoEE.

4.3.5 Technical standards for grid and interconnection

Technical standards for mini-grids are a central aspect of grid connection and electrical safety. Low technical standards can be dangerous for individuals, involve high maintenance costs in the mid- to long-term and thus impact the economic viability.

Myanmar has a number of regulations and technical guidelines which are relevant for developing mini-grids. The key legal and regulatory documents are set out in the Annex (section 10).

The MoEE is the main actor who sets the technical standards for both national grid and mini-grids. DRD is currently drafting mini-grid regulations including technical standards together with MoEE and according to national standards and norms. The VECs commitments also include some technical guidelines on how interconnected mini-grids should be set up. Respective detailed rules are also included in the Annex (section 10).

The Electricity legal procedure, Notification no. 63/85, issued on 1 July 1985 contain guidelines for electrical works, including low, medium and high voltage works, their grounding works, lightning protection, safety practices, application procedures for electrician certificates and even some meteorological data (temperature and lightning map), though these data are outdated. Further information is included in the annex. This is the procedure referred to by the Electrical Inspection department (EI) and electricians practicing in Myanmar. The regulations were also accepted by MoEE before it updated technical regulations and standards development.

According to DRD, the MoEE develops low voltage standards and other standards such as grid codes. Mini-grids developed under the NEP scheme are generally grid-ready. According to field observations and interviews, other mini-grids often do not comply with set standards. The main reasons for this are the budget constraints of communities and funding entities, limited availability of technical know-how, as well as geographical constraints and in some cases political issues. Under these conditions, official standards are not always met.

4.4 Legal cooperative context and registration options

As mentioned previously, Myanmar has an extensive and historic cooperative system. As this study examines energy cooperatives, the registration of mini-grids as cooperatives needs to be considered.

Currently, most mini-grids have vague legal ownership. The structures often belong to the "community" and are operated and maintained by a VEC. This also applies to the mini-grids under the NEP scheme, which often have unclear legal ownership, but are supposed to eventually be handed over to the national grid operator after a designated period of time.

This institutional arrangement has so far met community needs. However, it is worth noting the advantages of being a registered entity, such as:

- Access to commercial funding. Funding from international sources is usually only available for registered entities with proper structures and financial statements;
- Registered entities can establish contractual relationships;
- Clarity of ownership and formal responsibility;
- Formal requirements such as bookkeeping and accounting for proper operation of business and transparency.

One clear advantage of registering a mini-grid as a cooperative is that long-term community ownership is ensured. Members of a community who purchase one share are equal members (one-member-one vote)[16]. Furthermore, cooperatives are audited at least once a year, which helps maintain proper bookkeeping. Cooperatives also have access to small loans through the cooperative system. In the surveyed cases one registered cooperative even received a larger loan to build extra generation capacity.

It must be noted that registration as a cooperative in Myanmar poses a number of challenges. Due to cooperative system's socialist history, government involvement in cooperatives is still relatively strong. Many cooperatives view themselves as part of a governmental system. This is in conflict with the cooperative principle of independence (see section 2.4.).

[16] It needs to be noted that there are several ways to set up a cooperative. A group of individuals could pool capital, build a mini-grid, and register it as a cooperative, which supplies energy to third parties. Two mini-grids in the sample in section 5 of this study have ben set up according to this model. Another model is that consumers are the members of the cooperative. This model seems to be suitable when handing over a project that has been funded or subsidised by public funds.

In many countries, cooperatives are part of a multi-tier system, which provides support services to primary level cooperatives based on the principle of subsidiarity. These services can be very helpful as they are usually priced on a cost-covering basis, meaning there is no profit mark-up, and are tailored to the needs of the member cooperatives. In Myanmar, each cooperative needs to be member of a cooperative syndicate by purchasing one share (MMK 10,000 – 50,000 per group). However, the syndicates are not currently able to provide technical services needed by energy cooperatives besides offering micro loans.

4.5 Socio-economic preconditions in rural areas

Ability to Pay (ATP) and Willingness to Pay (WTP)

Myanmar geography and conditions offer abundant renewable energy potential, but the high unit costs of small-scale power plants pose a significant problem for self-financing by villagers (JICA, 2003). The economic situation of communities is crucial to consider.

Out of the total 53.4 million Myanmar population, 70% lived in rural areas. A JICA (2003) three-year study on renewable energies in rural areas in Myanmar found among communities that agreed to participate in scheme implementation, willingness and ability to pay for decentralised services does exist. This was confirmed in the field study as elaborated in section 5 of this study.

The Willingness to Pay (WTP) must be considered to pay for the initial connection fees and monthly payments. It depends on the current spending on light and fuels that would be replaced by electric power. The Ability to Pay (ATP), on the other hand, depends on the net household income level. The JICA study estimated ATP by the amount of savings. The research showed that the ATP was significantly greater than the WTP. Moreover, ATP was at a level that would support electrification projects. The survey showed that a majority (58%) of villagers out of 1,348 households had a positive attitude towards participation in village electrification projects, while only 9% had a negative attitude. Out of the positive replies, 32% were willing to become a VEC member, 15% a money collector, 14% a maintenance team member.

4.6 Summary: Enabling and limiting factors in the framework for community based mini-grids

In addition to substantial efforts to extend the national grid and build additional generation capacities, there are several initiatives to promote the development of mini-grids. Decentralised energy mainly plays a role in off-setting the time gap some communities face until they can connect to the national grid. The impressive self-initiated electrification efforts of local communities and developers is hardly considered at the national level. Nevertheless, the mini-grid regulations which are now being developed by DRD and MoEE might signal a longer-term commitment to support mini-grids.

The first part of the study has provided an overview of the current electrification landscape and the framework condition for rural mini-grids. Here we summarise the key enabling and limiting factors for energy cooperatives in Myanmar:

- **Enabling factors:**
  - Strong local need for decentralised mini-grids in areas of the country that are not expected to be electrified soon;

  - Communities show a high level of willingness to invest their own financial, labour and other resources;
  - Main stakeholders including MoEE recognise that 100% grid extension by 2030 is not realistic and that decentralised energy can be part of the solution;
  - Strong solidarity and sense of community in villages
  - Public resources are available to fund mini-grids through the NEP and other governmental schemes
  - Existing eco-system of stakeholders (e.g. local developers)
  - Existing technical potential(water sources for hydro, good solar irradiation)

- **Limiting factors:**
  - Low access to commercial funding (especially remote areas)
  - Fragmented government funds from various ministries
  - No existing renewable energy support schemes
  - National grid tariffs below market price lead to the danger of the national grid crowding out existing mini grids
  - High subsidies for national grid electricity have a negative impact on the financial viability of decentralised energy solutions
  - No clear strategy about the role of mini-grids for national electrification (i.e. eventual integration with the main grid)
  - No clear grid connection options for existing mini-grids (integration of mini grid and generation facilities), high technical standards needed for grid-readiness
  - Uncertainty related to changes in the grid extension plan make it difficult to plan mini-grids
  - No technical support facility for mini-grids; the cooperative system does not currently have the capacity to fully support energy cooperatives
  - Little hands-on technical and safety support for mini grids is available; there is no financial support to shift projects to national grid standards
  - Difficult investment environment, including the security situation in remote areas, loan conditions, and inflation

5 Field study on rural electrification

The field team conducted a qualitative micro-analysis of select energy cooperatives and other community-based energy projects. The aim was to find out whether community-based rural energy projects have typical cooperative characteristics and whether they are suitable vehicles for sustainable rural electrification. The analysis focusses on financing, operations, capacity-building, governance and ownership, and seeks to understand how the cooperatives function, and how they might contribute to the community's benefit. The analysis also sought to identify potential challenges or limitations of these projects. Research questions covered are as follows:

- How are the projects governed, operated and financed? Who owns the structures and how are the benefits shared within the community?
- What are the limitations and enabling factors for the different models?
- What are recommendations of how these models can be used to promote renewable energy?
- What are key organisational, structural and framework factors that make cooperative-like organisations successful?

5.1 Methodology

Sampling

By following a qualitative research approach, the study aimed not to make generalisable statements beyond the examined cases, but rather to describe and investigate a complex environment and explore questions of interaction. To minimise the likelihood of missing meaningful information during the investigation, it was necessary to 1) analyse heterogeneous cases, 2) include contrasting examples of the relevant characteristics and 3) represent the most informative projects (Patton, 2002).

A database of all potential rural electrification projects suitable for case selection does not exist yet in Myanmar. Instead, the study team applied a mixture of deductive sampling procedures and sampling by gatekeepers. The team used their knowledge of the projects to select cases and local experts, such as developers, gave input on cases to consider.

Key selection criteria to explore were ownership of the rural electrification project, issues of finance, the project's legal form, organisational structure, the origin of initiative (top-down/bottom-up) and the duration of the project

Focus group interviews, questionnaire with pre-test

The team ensured that it interviewed committee stakeholders, who were familiar with the technical information and were involved in the project from inception. Considering the critical role of governance and community participation, the study team also sought to include the perspective of villagers. The team conducted separate focus group interviews with both the Board Members of energy projects and with energy clients and community members for deeper insight.

The interview topics are listed in the table below. In addition to questions about the project background and the management and operations, project board members were also asked to share positive and challenging experiences, as well as their recommendations for other projects. A datasheet documented all technical and financial information.

The client questionnaire focused on the impact of the provided electricity on livelihoods, the quality of services, local involvement in the project, as well as communication and the relationship with the project management. The interviews with this target group included questions on difficulties that may have occurred and an overall evaluation of the project.

First drafts of the questionnaires were pre-tested in two communities and adjusted accordingly. Final questionnaires are included in the appendix.

Table 8 Separate questionnaires for board members and clients/customers

Interviewees	Focus of interview
Board Members	▪ History of the initiative ▪ Information on funding, business, other financial issues ▪ Project´s governance (organisational structure, operational business, clients) ▪ Positive and difficult experiences ▪ Personal evaluation, outlook, recommendation ▪ Technical and financial data
Clients/Customers	▪ Customer´s livelihood ▪ Impact of the provided electricity ▪ Quality of services ▪ Communication and relationship with organisation ▪ Any difficulties or problems ▪ Outlook, overall evaluation

A local DGRV and REAM research team organised interview dates with project representatives and clients, travelled to the selected project sites and led the interviews. Interviews were recorded for transcription. Response rates were generally high.

Transcription, translation, plausibility check

The recorded interviews were transcribed into Burmese language (externally contracted), checked by the local research team from DGRV and REAM and then summarised and translated into English to allow for further analysis by Wuppertal Institute researchers. Inconsistencies between answers or vague answers were clarified or removed with the help of the interviewers.

Methodological limitations

As the leading bodies selected members for interviews, it should be noted that they tended to choose members who would answer favourably about the project and the role of the management. A random selection of interviewees would have better ensured against biased responses but could not be achieved due to practical reasons. In some cases, time conflicts occurred for the villagers and restricted the interview times. Transcription was challenging, as people in remote villages spoke strong local dialects that were difficult to understand. Summarising and translating answers into English may have led to some nuance or meaning being lost or altered.

In one case, members went to the insurgent area in Karen State. To avoid any potential conflicts with the locals and according to the guidance from the officers from township Department of Rural Development, the interviews and discussions during the field visits were not audio-recorded.

5.2 Overview of selected villages

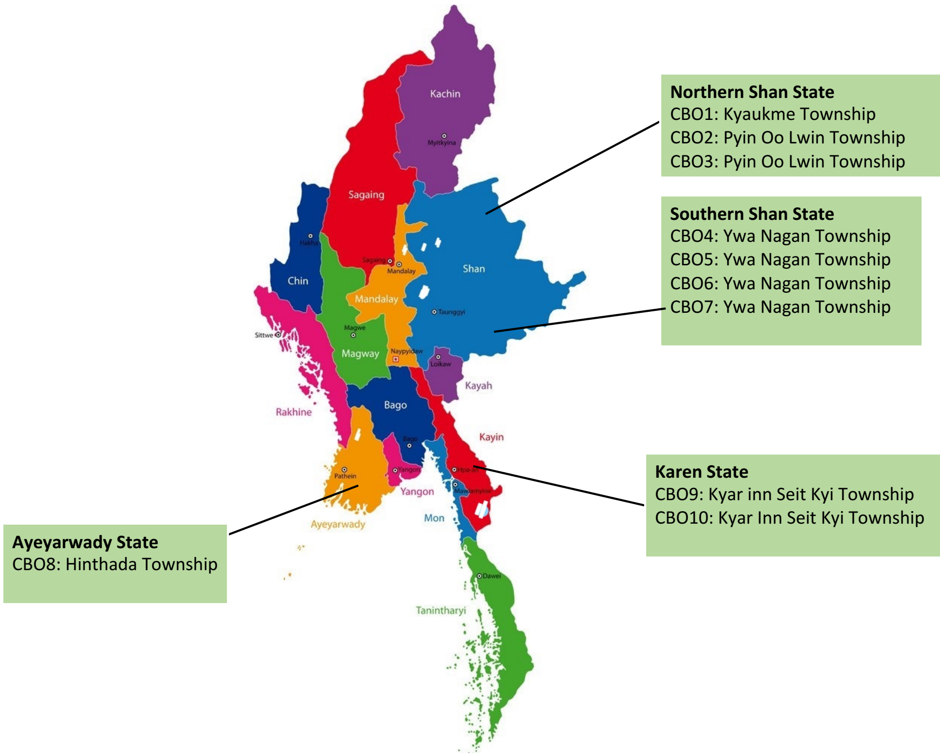
Fehler! Ungültiger Eigenverweis auf Textmarke. and Figure 9 provide an overview of the selected project sites and their locations.[17] The selection process aimed to choose a heterogeneous sample that included different generation sources. During the identification process, it became clear that the majority of community-owned projects are hydropower projects. The study team only visited one project funded under the NEP scheme because the aim was to study sites with at least two years of operations.

Table 9 Field study site overview

Nr.	Site	Location of site	Type of Generation	Installed Capacity	Ownership/ registration
1	CBO1	Shan State Kyauk Me Tsp	Hydro power	420 kW	Registered cooperative
2	CBO2	Shan State Pyin Oo Lwin Tsp.	Hydro power	100 kW	Subsidised, community managed
3	CBO3	Shan State Pyin Oo Lwin Tsp.,	Hydro power	500 kW	Registered cooperative
4	CBO4	Shan State Ywa nagan Tsp.	Hydro power	30 kW	Community owned
5	CBO5	Shan State Ywa nagan Tsp.	Hydro power	50 kW	Community owned
6	CBO6	Shan State Ywa nagan Tsp.	Hydro power	90 kW	Community owned
7	CBO7	Shan State Ywa nagan Tsp.	Hydro power	10 kW	Community owned
8	CBO8	Ayeyarwady State Hinthada Tsp.	PV solar	25 kW	Subsidised, community managed (NEP)
9	CBO9	Karen State Kyar Inn Seit Kyi Tsp.	Hydro power	10 kW	Subsidised, community managed (CDD)
10	CBO10	Karen State Kyar Inn Seit Kyi Tsp.	Hydro power	100 kW	Subsidised, community managed

[17] A summary of descriptive observations from all sites is included in Appendix 3.

Figure 9 Map of field study projects locations



5.3 Analytical framework

5.3.1 Three types of projects

Wuppertal Institute systematically gathered information from the questionnaires in a spreadsheet matrix according to the question-items. Between the community projects, large variance was observed in ownership and financing models, operations and management, physical infrastructure and cooperation with external and state actors.

The goal was to assess whether projects actually function as cooperatives and if those projects can sustainably contribute to rural electrification. The projects were first clustered according to key organisational features, and then an analysis framework was applied to cases within clusters to yield cluster-specific outcomes.

The Institute identified three organisational models among the surveyed projects for further analysis (see table 10).

Table 10 Categorisation of ownership and management models

(A) Legally registered energy cooperatives	(B) Subsidised community energy projects	(C) Community funded energy projects
Electrification enterprises registered as cooperatives represent a local investor-driven model where affluent individuals and the developer provide the funding and organise the mini-grid as a cooperative business.	Government subsidised projects, where the population mainly provides funding for running costs and maintenance, but not for the investment. The NEP project has a special funding and operating model.	Locally funded and operated projects. These projects do not consider themselves to be enterprises, but as projects established and run by local people for the community.
CBO1, CBO3	CBO2, CBO8, CBO9, CBO10	CBO4, CBO5, CBO6, CBO7

WI considered subsidised and community-funded energy projects as potential counterparts for cooperatives. However, it was expected that these three categories would differ in how they correspond to typical cooperative characteristics. For comparison, items considered in the interviews were sorted by the cooperative principles. A matrix provided in the appendix served as an analysis tool (see appendix).

5.3.2 Cooperative Principles

The analytical framework builds on the cooperative principles outlined in section 2.1. Each of these internationally-recognised cooperative principles was represented by an empirical indicator that could be coded for each of the projects under analysis (see table below). The purpose of the framework was to assess the degree to which projects are working in a cooperative manner.

Table 11 Cooperative principles and operationalisation

Cooperative principle	Variable
1. Autonomy and independence	Initiative (Bottom-up / not)
	Investment and financing scheme
	Subsidies, donations
	Ownership
	Government / other institutions involvement
	Operation & maintenance
2. Member economic participation	Benefit
	Market position (identity principle)
3. Voluntary and open membership	Membership requirements
4. Concern for community	Productive end-use
	Employment
	Local value added (regional principle)
	Social Responsibility
5. Education, training, and information	Capacity building
6. Democratic decision-making, control by members	Decision-making
	One-man one-vote principle
	Transparency / accountability
	Annual meeting with members
	Free election of Board Members
	Number of women in the BoD
7. Cooperation among cooperatives	Exchange with other mini-grid projects

5.3.3 Developmental framework conditions

Based on the interview findings, Wuppertal Institute identified the relevant factors and preconditions for the success the community energy projects and provided recommendations to other mini-grid initiatives. The factors are listed below:

- Environment, natural conditions
- Access to finance
- Technology
- Education
- Community
- Economic conditions
- Management (strategies)

Table 12 Overview: Identified factors in the analysed community-based electrification projects

Developmental framework	Aspects identified in the projects (examples)
Environment	▪ Water supply, seasonal effects ▪ Water quality ▪ Facility distance to village ▪ Weather conditions
Access to finance	▪ Initial investment capital ▪ Repairs, maintenance, upgrade ▪ Connection fee ▪ Tariff ▪ Ability to pay / Willingness to pay
Technology	▪ Applied technology ▪ Technical design ▪ Capacity, voltage stability
Education	▪ Technical and administrative know-how ▪ External support, capacity building ▪ Correct implementation of instructions
Community	▪ Trust, solidarity, motivation, interest, support ▪ Existing know-how, skills ▪ Dealing with mistakes / failure ▪ Superstition ▪ Task and cost allocation
Economic conditions	▪ Sustainable business model ▪ Market ▪ Payment requirements ▪ Customer commitment ▪ Possibility to build up reserves
Management (strategies)	▪ Assignments, work division, other concepts ▪ Communication

The following section presents the empirical findings of the assessment and applies the cooperative principles to examine developmental framework conditions that are enabling and limiting for each project category.

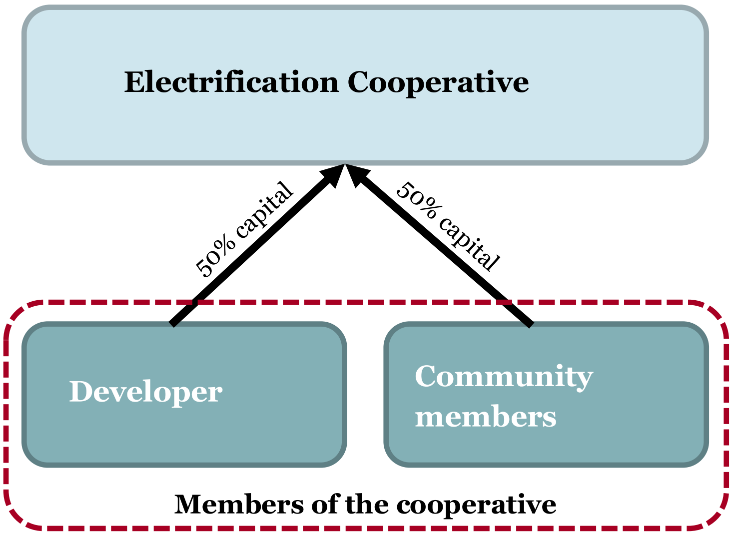
6 Field study findings by project category

6.1 Registered Energy Cooperatives

6.1.1 Overview

Two of the surveyed projects (CBO1 and CBO3) are registered cooperatives. In both cases, the developer provided the initial idea to set up and register the mini-grid. In contrast to the other surveyed projects, the mini-grids in these cases were registered to establish a legal investment vehicle. The developer and individuals in the community raised funds through contributions. In favour of the cooperative conceptual approach, they chose not to register the project as a limited company. It should be noted that not every person in the community is a member of the cooperative; only the ones that provided investment are members. During the interview, developers said they were familiar with cooperative organisational principles.

Figure 10 Governance structure of electrification cooperatives



Local developers and individuals in the two communities funded both projects. The developers paid by providing the hardware and labour. Community members contributed with an initial payment of MMK 1.5 Million and MMK 2.5 Million per share and made contributions in the form of labour and local materials. The ownership split of the entity in both cases is 50% developer and 50% community members. The initial investment value for the two projects is estimated at approximately MMK 500 Million and MMK 1 Billion.

In one case, after it became clear that there was high electricity demand, the cooperative invested in additional generation capacity. The Cooperative Department provided a loan with regular instalment terms.

Electricity fees are the primary income source for both cooperatives. Other income sources included connection fees and in one case selling and renting meter boxes to households. Fees for a mobile post that connects to the mini-gird also contribute to the cooperative's regular income. Clients are households and small business owners which, with access to electricity, were able to venture into new business fields such as brick making and welding. Each cooperative charged electricity fees ranging between MMK 125 and 800 per unit.

The two communities electrified by the cooperatives ended up connecting to the national grid earlier than anticipated. This led to a decline in the number of cooperative clients and thus, income. Still, around 300 of 500 households remained connected to the mini-grid Some households were not able to pay connection fees to the national grid and remained clients of the cooperative, and others kept both connections for their household or business.

The clients had a generally positive opinion about the cooperative mini-grids and wished for it to remain even after the village had connected to the national grid.

6.1.2 Organisational Structure and Governance

The highest governing body of the cooperative is the Annual General Assembly (AGM). One of the cooperatives reported that it conducted biannual meetings as well as ad hoc meetings. The other cooperative was not able to pay the costs for regular meetings once the village connected to the national grid.

Regular operations of both entities are managed by a Board of Directors, consisting of a chairperson, a secretary, and a deputy secretary. The cooperatives employ staff (6 and 3, respectively) including an accountant, a guard and a line worker.

As required by the Cooperative Act, the cooperatives both have by-laws which outline the rules and regulations. A general ledger is kept as well as a cash book, which records fee collection and the cooperative's basic financial statements. Once a year both cooperatives are audited by Township Cooperative Department staff, which ensure that the books are properly kept. The Cooperative Department provided training in and support for general booking to the account and board members.

6.1.3 Analysis according to the cooperative principles

Autonomy and Independence

Both projects were initiated by the developer with strong support from the respective communities. For setting up the initial structure, the cooperative mostly provided financing by equity and one cooperative received loans from the Cooperative Department. The members raised the funds themselves and the developer as a member contributed to about half of the costs in exchange for a future return. The members own the structures.

In the initial phase, there were no subsidies and government involvement was low. The Cooperative Department only functioned in a supervisor role and provide capacity support for bookkeeping. Both cooperatives are operated and managed by a Board of Directors.

Member economic participation

The members of both projects are the investors. The self-driven nature of the cooperative allows members of the analysed cooperatives to produce and also to use electricity. Thus, the two **market positions work together (cooperative identity principle).** Members contribute shares, connection fees and tariffs to construct and operate the power generating facilities and network. They also receive electricity for lighting, cooking, water pump, ironing, washing machine, TV, as well as productive use in restaurants, brick making, oil grinding and corn threshing. The electricity is cheaper than using a generator or candles, and increases living standards, supports development small local industry and helps the community earn more income. Most locals also receive a dividend when profits are made. Consequently, the cooperative identity principle is met.

Voluntary and open membership

Membership in both cooperatives is **open and voluntary**. Acquiring a share and paying connection fees and tariffs are the only conditions that must be met. Villagers are not forced to become a member and can exit at any time. However, a share value must be paid by members (MMK 1.5 million, MMK 2.5 million) and this acts as a **barrier** to open membership as most villagers are not able to pay this amount.

Concern for community

Both projects focused on income generation to cover expenses. The main aim for the community was to receive electricity rather than profit maximisation. Additionally, both cooperatives created regional value and employment opportunities. They hired 3- 6 employees and enabled productive end-uses (e.g. oil grinding machines, fridge (stores)/ restaurant, workshops, welding, corn threshing).

Both cooperatives were **socially responsible**. They showed respect for members who had lower incomes and for institutions, which provide important services to the community. Households that cannot pay the connection fees can start with a smaller amount and pay the remainder at a later date. One cooperative said that connection fees are adjusted to the ability to pay and shareholders paid higher connection fees per unit than normal users (MMK 1.5 million vs. normal clients MMK 600,000). When customers cannot pay the full amount or pay on time, the board of directors (BoD) waited and negotiated with the client but did not immediately cut electricity. In one case, the school, hospital and monastery have a beneficial tariff (200 MMK/unit flat rate). The telecommunications provider which operates a mobile post in the area was one of the project's main clients. Providing electricity to the communication structures improved communication channels for the community.

Education, training, and information

Both cooperatives are members of a cooperative syndicate. This institutional membership is helpful for capacity-building. For instance, the Cooperative Department provides training in bookkeeping.

For technical issues, the developers provide technical training to the members and staff of the cooperatives to properly maintain the structures. When there is a problem, the developer comes to the community to give support. This support might have a time lag, as the developers are usually busy with other projects. Members of both cooperatives underlined the strong motivation and commitment that was necessary for such capacity building activities.

Democratic decision-making / control by members

The Annual General Meeting is the highest governing body in a cooperative. This meeting elects the Board of Directors. Both cooperatives have a chairman, secretary and deputy secretary, which comprise the board, as well as staff (guard, line worker, accountant). The developer is the chairman. Only one of the two cases examined mentioned that the board is elected. Nevertheless, for important decisions such as a change in the fee structure, all members come together to discuss the change and agree on the solution. The process did not necessarily follow the principle of "one person one vote". Although the process of decision-making did not exactly comply with the cooperative principle, it can still be described as participatory.

As both cooperatives have financial statements which are regularly audited. They also record meeting minutes and fee collection, so the cooperative has the means to establish the necessary transparency for decision-making. Furthermore, the by-laws of both cooperatives describe roles and responsibilities of members and lay out a basic set of rules. Members of one cooperative meet every six months and ad hoc when necessary. The other cooperative was unable to fund the regular meetings once its income base deteriorated after arrival of the national grid.

Cooperation Among Cooperatives

There is strong communication between the two cooperatives surveyed for this study. However, cooperation through networks or other means was not observed due to the institutional constraints of the cooperative system in Myanmar.

Figure 11 NEP-project solar plant

Photograph: Johannes Thema

Table 13 Registered cooperatives and cooperative principles

Principle	CBO1	CBO3
1. Autonomy and independence	Investment: Equity + borrowed capital (loans from Cooperative Department + Lashio Union Syndicate) No subsidies. Ownership: Coop Operation: Coop	Investment: 100% Equity No subsidies. Ownership: Coop Operation: Coop Township cooperative draws the financial statement.
2. Member´s economic participation	Identity of market positions	Identity of market positions
3. Voluntary open membership	Voluntary open membership Face value share: 250,000 MMK	Voluntary open membership Face value share: 150,000 MMK
4. Concern for community	Productive end-use Employment (3 persons) Local value added Extra tariff (flat rate) for School, hospital, monastery	Productive end-use Employment (6 persons) Local value added Less income people tariff
5. Education	Self-studies, Developers training Cooperative Department provides assistance for financial statements	Self-studies, Developers training Cooperative Department provides trainings for bookkeeping and accounting
6. Democratic decision-making	Engaged persons lead the coop No regular assembly, meeting upon issues Bookkeeping system (transparency) Audits by Coop Department (transparency) Existing by-law Strong position of developer One-man one vote principle?	Election of Board Regular meetings with shareholders at first, not anymore now. Bookkeeping system (transparency), Financial statement. Audits by Coop Department (transparency) Existing by-law Strong position of developer One-man one vote principle?
7. Cooperation among cooperatives	CBO 1 stated that they took the example of CBO 3 and tried to practice in that way.	CBO 1 and CBO 3 have a very close relationship and communicated very closely.

Note: green = coop. principle met; yellow = coop. principle partially met/ n.a.; orange = coop. principle not met

6.1.4 Developmental framework conditions

The **enabling factors** that aided the development of the two surveyed cooperatives are summarised below:

- The Cooperative Department provided **training in bookkeeping and accounting** and a **loan** to one of the entities. Regular audits ensured that books were maintained.

- The villagers stated an annual income of 50-300 Lakh (MMK 5-30 million) and quantified the costs for electricity as "not over 10% of income". The **economic situation** made it possible to raise funds from the community and for the community to pay fees.
- Some line workers in the cooperative had worked for the Electric Power Corporation[18] and thus brought a certain level of **technical know-how**. Villagers primarily received technical instructions through the developer.
- **Local businesses** were created or expanded due to the new access to electricity, which lead to a growth in demand and thus a positive financial return for the cooperative.
- **Mutual trust** between the developer, the community and the members of the cooperative was prerequisite for the success of the projects. The members said during interviews that the community was supportive, and that "there was a spirit that allowed them to learn from failure".
- **Low cost technology** was used, and it was relatively easy to maintain

Limiting factors were:

- Despite suitable pre-conditions, a major problem for both cooperatives was the **lack of capital.** While financing of the necessary construction and material for turbines, generator, penstock, distribution lines, connection, buildings etc. could be carried out, once the facilities were set up, expenses were still be high. Maintenance, major repairs, replacement of damaged poles and general facility upgrades required further capital.
- Both cooperatives initially experienced a lack of **trust and knowledge from the villagers due to past experiences** with unsuccessful projects. Implementing a community-based electrification project requires substantial effort and a high level of coordination and commitment, which can be an issue, especially at the beginning. In one case, mini grid connection passed by a neighbouring village, and the developers had to negotiate with the neighbour villagers, who wanted to connect for free.
- Developers mentioned the **distance between the site of power plant** and the village was an issue and required additional effort to build the structure
- Finally, a major problem was the unexpected arrival of the national grid in some of the villages, which made it difficult to maintain their community mini-grids. Due to the high technical standards, extended power supply and smaller electricity tariff charged by the national grid, the mini-grid became a less economical option for villagers. They migrated to the national grid and the community projects operated in parallel or became a transitional option in danger of being abandoned.
- While also an enabling factor, low cost technologies have limitations and are often less safe and not able to connect to the national grid in the future.

[18] The Electronic Power Corporation is the predecessor of the Myanmar Electric Power Enterprise (MEPE).

Table 14 Cooperatives – Enabling and limiting factors

Factors	+ Enabling +	- Limiting -
Environment, natural conditions	Existing river	Difficult construction due to remote location
Access to finance	Financial capacity of community Financing through developer Loan from Cooperative Department	General lack of financial services
Economic conditions	Sufficient income among members, commercial and technical skills / experience (EPC) existing; Local productive end-use Local technology	Revenue generation did not turn out as planned (for one cooperative); Unexpected national grid arrival upended business model and customer migrated
Technology	-Low cost technologies-	Need for upgrading the structures
Capacity building	Strong support from Cooperative system and developers: training for book-keeping and accountancy; support for drawing financial statements	--
Attitudes within Community	Spirit that “allows to learn from failure”	Lack of trust and knowledge among clients; Willingness to pay (WTP), missing “respect” towards tariff collectors
Operation and Management (strategies)	Existing Board of Directors; Strong support by developer; Book-keeping system, regular audits by the Coop Department	No regular assemblies, no democratic decision-making

6.2 Subsidised community energy projects

6.2.1 Overview

Different government departments fund the four subsidised projects (CBO 2, CBO 8, CBO 9 and CBO 10) considered in this study. In each case, the respective department contacted a local developer to begin the project. After an initial assessment and cost estimation, the government contracted the developer to construct the mini-grid.

Each project was funded under a different subsidy scheme, which included various kinds of support and required different levels of involvement from the communities as summarised in the table below.

Table 15 Subsidy scheme support

Support provided to the communities through the subsidy schemes				
	MoALI Irrigation Dept. (CBO 2)	**DRD** NEP project (CBO 8)	**DRD** CDD Project (CBO 9)	**MoBA** (CBO 10)
Capacity building provided to the VEC	**X**	**X**		
Financial contribution of community	**About 3%***	**20%**	**None**	**None**
Management by VEC	**X**	**X**	**X**	**X**
Involvement of developer in managing the structure		**X**		

** Financial contribution by the community raise funds to repair/ alter the original structures*

The power generation facility of CBO2 did not function after completion because of flaws in its design. The community, led by the VEC, raised approximately MMK 30 million to hire a developer to make the project operational. The structure was upgraded and now provides the connected communities with reliable electricity.

In comparison to the other subsidised projects, CBO2 is the most commercially successful of the subsidised project in terms of estimated net income. It is the only project in the group where there is productive end use, which partially explains the positive financial return.

Table 16 Monthly income of projects

Estimated monthly gross income			
CBO 2	CBO 8	CBO 9	CBO 10
1,500,000	400,000	40,000	400,000

** As reliable data was not available, the estimations are based on the information the VEC and developer provided during the interviews on estimated monthly cost and income. The information is therefore only an estimation.*

The NEP-supported project (CBO 8) was funded with a 20% community contribution towards overall project costs. Because the structure is built to a standard that will allow it to connect to the national grid, the total community contribution is comparable to the unsubsidised project costs included in this survey.[19] Most villagers expected donor-led projects to be free and members in the community did not entirely understand why they had to contribute.

The NEP project and the CDD project (CBO 9) included support for the communities during the project duration. Electrification was just one element included in the CDD project, which also provided training for VECs through the DRD on administrative and managerial skills such as bookkeeping and leadership. In the NEP project, developers had to provide capacity building for technical and administrative skills before the project hand-over.

Funds collect for all of the projects were mainly used to cover future maintenance costs.. If maintenance costs surpassed the available funds, more money was collected from the community. Without the maintenance costs, all of the projects would generate a positive net return. However, net income varied between the different projects.

None of the projects are legally registered. Developers have handed over one of the projects to the community, while two other projects still have a vague ownership structure. The NEP-funded project will be handed over to the communities in the future, according to the agreement between developer, community, and MoALI.

Irrespective of the technical legal ownership, the study team found that there is a strong sense of ownership in the communities. This observed feeling of ownership was especially apparent for CBO2, where the community had raised MMK 30 million to repair the project structure. It was also present in the cases where the ministry had completely funded the mini-grid due to the fact that community members usually contributed by supplying local materials and donating their labour to build the structures.

[19] As the technologies differ, the actual costs aren't comparable. While 9 of the 10 surveyed projects are mini-hydro power projects, the NEP funded project is a solar power project.

6.2.2 Organisational structure and governance

All projects are operated by the VEC, which manages of all activities related to electrification. Usually, there is a chairman and an accountant or treasurer who take care of the collected funds. Regular meetings with the community are not conducted. When decisions need to be made, such as raising funds for maintenance, the VEC organises a community meeting.

The book and recordkeeping procedures at all projects is rudimentary. All records are held in one comprehensive folder. There are no meeting minutes and there is no separate cash book. Except in one case (CBO2), there are no regular cash counts. As the projects collect money, and in some cases significant amounts of cash, there is a risk of misappropriation or theft of funds.

In general, the organisational structures can be characterised as weak in all cases, although CBO2 shows slightly stronger organisational capacity. CBO2 employs an accountant and their VEC includes two treasurers and internal auditors from different villages, which manage the funds including regular cash checks. Their comparatively strong structure likely developed due to the significant investment made by the community as described above.

In the NEP project, fees are paid through a card system provided by the developer.

Figure 12 Pre-paid meter

The NEP project is barely comparable to the other subsidised cases. In the other project examples, the communities are generally left to themselves to manage the mini-grid. In contrast, the developer of the NEP-supported project is involved in management and provides technical support to the communities, after construction has been completed up until the official project handover (between 6-15 years). In this case, the VEC functions as a bridge between the developer and the community. Electricity fees are fixed by a contractual agreement. In summary, the VEC has less management responsibility compared to the other surveyed cases.

6.2.3 Analysis according to the cooperative principles

Autonomy and independence

Government departments initiated the projects and provided full or significant funding. Without government support, the projects would not have been constructed. In two cases, the community made significant financial contributions.

The structures, however, are managed by VEC. There seems to be little government involvement in operational aspects after project completion, even in cases where there was no official handover. Handover to the communities for the NEP-funded projects will happen in the future.

The interviews with clients of the mini-grids reveal that there is a strong sense of community ownership even in the subsidised projects. For the NEP project, it is still too early to judge given that the project has been operational for less than three years and the developer is still heavily involved.

In summary, while the communities depend on donor funding for the initial start-up costs, the communities independently administer and manage the structures.

Member economic participation

Similar to the cooperatives, the subsidised projects have a lot of benefits. Villagers gain access to electricity, they can substitute candle/kerosene lights and save money, they can focus on business, use electricity for farming (e.g. irrigation), and do not have to collect fire wood and have greater access to information and communication (TV, radio, mobile phones).

However, in the subsidised project cases, the principle of self-help and identity of market positions is more difficult to assess. On one hand, members do not usually finance facilities set-up. The projects are subsidised. Respondents mentioned that for further expenses, such as upgrades, the Ministry of Boarder Affairs (CBO 10) and the developer of the NEP project, hold responsibility. On the other hand, villagers contributed to the investment through connection fees (CBO 2 and CBO 8), and by donating labour and local materials.

The local population can be viewed as “members” because the whole community is typically connected and there is sense of community ownership of the structures. It can also be said that the market positions come together: members generate electricity through their community mini-grid and are also users who pay for the services.

Voluntary and open membership

To be involved as a member of the project, villagers do not need to fulfil any special conditions. However, in CBO2, villagers had to contribute to the village’s share of investment. It was possible in all cases to opt out of the project.

Concern for community

In this aspect, the projects differ. All projects except one employ 1 – 2 people in the community. Some degree of productive end-use can be observed in the villages. The projects all provide clean energy to the local population and thus contribute to a cleaner environment.

Because they are non-for-profit enterprises, the subsidised projects consider social aspects when it comes to fee payment. When a household cannot pay, usually they negotiate with the VEC. The NEP-funded project is an exception. It is structured as a business model and the developer is involved.[20]

[20] In the interviews, recipients said, “we cannot really force them because they are the people that we knew since we were born. Some of them are even relatives”.

Education, training and information

Educational and training issues were hardly mentioned in the interviews. This is possibly due to the fact that the value of a systematic and professional specialised training for the tasks of operating the mini-grids is not well understood.

In general, external parties, including developers and government entities, provide **technical expertise** on handling the electric devices and managing and recording the payment processes. In the NEP-funded project case, there is a close cooperation with the developer who provides ad hoc and on-going support. Nevertheless, none of the projects had people with technical knowledge in the communities and no attempts were made to build basic expertise in the communities. No support for bookkeeping and accounting or management issues could be observed.

Democratic decision-making/control by members

None of the project has written rules and regulations or by-laws. In all four cases, BoD members said that decisions are made in committee and village meetings. There are **no regular village meetings**, mostly they are held as issues arise. Villagers state that they are informed in these meetings about decisions, but have **never been asked for their opinion** in any pending decision. The decision-making process, though participatory, cannot be considered close to the principle of "one-man, one vote". This may also be because rural communities in Myanmar are not very familiar with voting practices.

Accountants or treasurers are responsible in theory for keeping the books; however, **no bookkeeping system, ledger, cash book or financial statements** are kept. An external auditor was mentioned in only one case. Management at another project (CBO10) said they assess the financial situation each year with the village.

Cooperation Among Cooperatives

There is **no cooperation** with cooperatives or other initiatives.

6.2.4 Developmental framework conditions

The **enabling factors** for the subsidised projects identified by the survey team are summarised below:

- Finance is one of the key issues. The state-supported mini-grid projects had the advantage of receiving **subsidies from governmental institutions** (MOBA, MOALI, DRD) to partially or fully finance the initial investment costs for power generating facilities. This naturally removed the main burden from the communities.
- The subsidised projects also benefited from **institutional support** given by government and in case of the NEP-funded project, support provided by the developer.[21] In one case the community members said there was a knowledge "gap" left by the governmental representatives and the community was unable to proceed as recommended (CBO9).

[21] The developer`s role was underlined by the villagers "The commitment of the company and flexibility of the company made them very comfortable and better off in getting access to electricity."

- **Strong interest and solidarity** among the villagers could be observed. “Except for a handful of people, the village is united and tried to support with everything (labour, material etc.)”. Some communities also tried to learn from the failure of past projects (CBO9, CBO10).
- **Governmental support** during the initial phase helped to build trust in the community and being part of an official government project validated the electrification efforts in the eyes of many people.
- The **capacity of the VEC** was of vital importance to generate. In one case, due to electricity shortage, the VEC successfully negotiated with the villagers to reduce their electricity usage at certain times to help free up capacity for the children to study in the evening.
- Although most of the villagers are farmers, **some productive end use activities** such as furniture business and seasonal wood processing factories could be found in the state-supported communities.

Limiting factors identified were,

- **Technical difficulties** as a result of utilising **low-cost technologies** and **limited technical support** were the most severe limiting factors. The team observed several shortcomings including plant failure due to mistakes in construction planning, voltage fluctuation, and stronger than expected changes in water flow between rainy and dry season.
- Community members said they worry about not being able to fund future maintenance costs and that the existing technical structures are too weak to withstand adverse weather.
- In one case, a problem with **water quality** occurred due to lime residue in the penstock as well as sediments of sand and small gravel.[22]
- For the communities, **funding** the construction, maintenance, and facility upgrades is a big challenge. Wooden posts need to be repaired or substituted with concrete posts, but villagers need to finance this themselves.
- Some communities were sceptical of the electrification project in the beginning, mainly due to **lack of awareness** (“we just want to live with the candle light”) or past **negative experience** after failed projects or reports of hydropower projects being implemented despite of the resistance of local communities. In all cases the initial resistance was overcome through communication between the communities the government department and the developer.
- The **managerial and technical capacities** of the people in the community are another major challenge. In one community, the VEC representatives mentioned that government representatives tried to help and provide recommendations, but the communities were unable to follow the guidelines. VEC members also highlighted it is was a huge challenge to **organise and coordinate** the contributions of community members especially in terms of task allocation.

[22] As potential future problems the project management said that the water level might be reduced and maintenance costs could go up. Technical issues may occur and machines could break down. They think that the cables are too weak and need to be upgraded and wooden posts should be changed to concrete poles.

Table 17 Subsidised community energy projects and cooperative principles

Principles	CBO2	CBO8	CBO9	CBO10
1. Autonomy and independence	100% subsidised, but after facility failed, village fund	(80% subsidised)Tariff collection	(100% subsidised) No share; Tariff collection	(100% subsidised) No share; Village fund for repairs
2. Member´s economic participation	Village contributed	20% village share; no involvement in any activity	Labour, local material, and maintenance	Labour, local material, and maintenance
3. Voluntary open membership	Open membership. Connection fee	Open membership. Connection fee	Open membership. No condition.	Open membership. No condition.
4. Concern for community	Productive end-use. Employment (1 staff).	Some productive end-use. Employment (cash keeping and line men). Customers not paying, cut electricity supply	No productive end-use. Cost reduction (lighting instead of candles). Children shall study.	Productive end-use, Employment (2 staff) VEC pays smaller tariff; wait for villagers who cannot fully pay.
5. Education	Not stated.	The company provides on job training to the staff.	Department gives recommendations.	Gov.: Technical support / O&M + adm./ fin. skills ; link to skilled technicians
6. Democratic decision-making	No regular meetings. Leaders let clients know; Cash controls by auditor.	Election of Board members, fixed duration. Accountant and cash keeper, but no book-keeping system. Leaders let clients know.	No election. Leaders let clients know. One book keeps all records. No audit. Technical issues will be discussed first with operating staff, then comittee, then whole village	Discuss with villagers No book-keeping system. No election. No audit.
7. Cooperation among cooperatives	Not stated	Not stated	Not stated	Not stated

Note: green = coop. principle met; yellow = coop. principle partially met/ n.a.; orange = coop. principle not met

Table 18 Subsidised community energy projects – Enabling and limiting factors

Framework	+ Enabling +	- Limiting -
Environment	Existing river	Mega dam threatens water resources; decreasing water level expected; No constant water level during summertime High amounts of lime in the water, threatening facilities Lots of work due to far distance to the powerplant. Some households cannot be connected due to distance.
Access to finance	80-100% subsidies from Government for initial investment; Low tariff (ATP)	Lack of capital investment for set-up on the villagers' side (20%), repair of faulty construction, upgrading facilities. Connection only provided to nearest connection place, users need to pay themselves for connection. Lack of financial capacity to invest in machines and make full use of the mini-grid for productive end-use
Economic condition		Failure led to increasing expenses; Fear that future maintenance costs could go up and machines could break due to decreasing water level;
Technology		Failure of plant due to mistakes in construction planning, leading to complete cut of power generation. High voltage fluctuation, devices break down; Electricity shortage; Peak usage of electricity leads to problems. Increasing amount of lime Thin cables; Wooden poles
Education	Support from governmental institutions and developers	Knowledge-gap; not all instructions lead to expected outcome. No resource persons available aside from developer.
Attitudes within Community	Interest, trust, solidarity and support; Openness to learn from failure; Cooperation when problems occur	Knowledge gap within the community. At initial stage, lack of trust, confidence and motivation due to previous experiences; Superstition; Management problems regarding cost and task allocation between villages (some do more, some less). Willingness to pay (WTP)
Operation and Management (strategies)	Commitment and flexibility of the developer; VEC responsible to administer the collected funds and cover operational costs, staff, reserves; Community management of power usage.	

6.3 Community funded energy projects

6.3.1 Overview

Communities completely self-funded four of the observed projects. In all cases people in the communities heard about the advantages of electricity from neighbouring communities and contacted a developer in their region to assess the possibility of constructing a hydropower project. Funds were collected among the people in the respective villages. Whenever possible, everyone paid the same share, but poorer households were allowed to contribute less. The communities generally contributed through labour and the provision of local material.

In comparison with the other surveyed sites, the costs of construction per connected household of the self-funded projects was on average the lowest. As financial resources in the communities are scarce, they had to purchase a low-cost solution.

Connection fees and tariffs are the main income source for all four projects. Because the main aim of the enterprise is not to earn money, but to cover costs of maintenance, the structures of all four projects are relatively simple, and tariffs are comparably low. The main expenses are staff and maintenance costs. When maintenance costs go beyond the available funds, community members are asked to contribute financially. In one case the village created a savings and credit fund from the surplus from the mini-grid. People in the community can then take small loans from this fund.

Figure 13 Water pipe of a mini-hydro powerplant

Photograph: Khin Akari Tar

6.3.2 Governance and Organisation

All projects employ an operator. Accounting is conducted by the designated voluntary accountant from the VEC). In one case, a VEC member was also member of the board of the township cooperative syndicate and thus had experience in bookkeeping and accounting.

The bookkeeping system in all project cases is rudimentary. Generally, one book is kept which includes all relevant records. It is not possible to control and reconcile the monetary transactions with the current system. Nevertheless, the communities seem to trust the management of the VEC. There was no internal or external control in any of the cases.

The VEC manages all relevant operations. In two cases there are regular community meetings. In all the other cases there are ad hoc meetings for important decisions. According to the interviews, the people in the villages are usually consulted when important decisions are being made.

Table 19 Investment costs and connected households

Type	CBO	Total investment cost (estimated)	Households connected*	Investment costs per connected household
Registered cooperative	CBO 1	500,000,000	300	1,666,666
	CBO 3	1,030,000,000	653	1,577,335
Subsidised project	CBO 2	1,030,000,000	280	3,678,571
	CBO 8	170,000,000	138	1,231,884
	CBO 9	25,000,000	57	438,596
	CBO 10	89,000,000	290	306,897
Self-funded project	CBO 4	29,300,000	208	140,865
	CBO 6	120,000,000	470	255,319
	CBO 5	18,900,000	158	119,620
	CBO 7	6,200,000	55	112,727

** Number of households connected at time of interview*

6.3.3 Analysis according to Cooperative Principles

Autonomy and independence

In all four cases, initiative for implementing the project came from the villagers. They were inspired by small hydropower plants in neighbouring villages, and by conversations with officials or TV programs.

No government entity was involved in the initiation process. The funds were raised completely by the villages. There were no subsidies. In one case a loan was taken from the military.

The VEC oversees operation and maintenance. Three projects employed a powerhouse operator. Operating costs are covered through connection and electricity fees as well as through community contributions if more funds are needed.

In all cases the mini-grid is not registered as a legal entity. Nevertheless, there is a strong feeling of ownership within the communities. During the interviews, respondents in all four cases responded that they wanted to maintain the structures even after connecting to the national grid.

Member economic participation

The **identity principle** is clearly met in all cases. The villagers finance and operate the power generation and electricity business (producers), and also use the electricity (consumers). The main end use is lighting, with few other productive end-uses due to limited generation capacities. Benefits include better living conditions, cost savings (candle, kerosene) and increased working hours with more lighting.

Voluntary and open membership

The aim of the projects is to provide electricity to the community. Each person in the village has **equal access**. In some cases, connection fees are levied from households with very few financial resources. Funds are collected primarily to build reserves for maintenance and upgrades and to be used for various community activities.

Generally, anyone in the community can join the project. Members need to pay connection fees (in most cases around MMK 50,000 per light bulb – MMK 100,000 per TV) and engage in construction labour. An exit is possible at any time, although few exits were observed.

Concern for community

Strong **social responsibility and solidarity** was observed in the communities. Financial contributions were made according to the capacity of the individual. Electricity was used with consideration for the whole community. One remark by a respondent during the interviews exemplifies the solidarity principle: "At that time, [the villagers] contributed labour. They didn't use the electricity for cooking secretly. They used it with discipline because it is like their property and they also know that they need to use it carefully and wisely" (CBO6).

In two cases, there is a **rotation system**. At CBO 7, every household is alternately responsible for operating the water valve of the power house. This work is done voluntarily, thus, tariff collection is not needed and understanding and respect for the work is fostered. In CBO5, everyone in the village is assigned to collect the tariff for one month. The person gets a book and writes everything down and gives the collected money to the accountant/treasurer. This way, they say, everyone knows how difficult it is to do the collection work. This form also leads to transparency

In all cases, **regional added value** is created. In three of the projects, a power house operator was engaged as permanent staff.

Education, training and information

The learning process was described vividly by the interviewees. Mostly, the villagers acquired knowledge through self-study, learning by doing, and through training from the developers. They are aware that they need to learn and identify which technician is capable to successfully implement the project: "If the technician that we use is not be good, our work, effort and money is wasted".[23]

Interestingly, they also let the young generation in the committee learn the technical skills from the developer (peer learning), to more easily solve technical issues independently.

Democratic decision-making/control by members

The VEC manages all operations. It consists of individuals who volunteer for the position and are deemed suitable by the communities. There is no explicit election mechanism, but the selection process seems to be in consensus with the effected people. This is reflected by the high acceptance of the VEC. In one interview, for instance, community members mention that "VEC really needs to invest their time and mind into the project. We are still very far away from that." Apparently, there is a widespread consent that current VEC

[23] In one interview, the VEC members stated that ""sometimes we did things in a way that made things go faster, but in terms of the quality it was not good. The developer always checked such kind of things and made us change again according to his standard. He was strict in regards to the technical standard!" (CBO 7)

members are doing the job they themselves are not capable to do or do not have the time to do.

According to the interviews, whenever decisions need to be made, VEC members call a **village meeting**. The people in the communities confirm that they are informed through village meetings, but that they never have been asked for their opinion on any pending decision. They have **never voted on any issues,** which – as above – may be also because of many people in rural communities are not familiar with voting practices.

Cooperation among cooperatives

There is a good communication between them (CBO 5, 6 and 7). They are not registered as cooperatives, but genuine cooperation can be seen in their daily work.

Table 20 Community energy projects without governmental support according to the cooperative principles

Principles	CBO4	CBO5	CBO6	CBO7
1. Autonomy and independence	Bottom-up Equity Ownership Operation	Bottom-up Equity Ownership Operation	Bottom-up Equity Loan Ownership Operation	Bottom-up Equity Ownership Operation
2. Member´s economic participation	Identity principle	Identity principle;	Identity principle	Identity principle;
3. Voluntary open membership	Connection fee per lamp (50.000)	Connection fee per lamp (50.000)	Connection fee per lamp (65.000)	Connection fee per lamp (50.000)
4. Concern for community	Prod. End-use Employment (1 staff) VEC contribute more to finance.	Prod. End-use Employment (1 staff) Rotation of responsibilities (tariff collection)	Prod. End-use Employment (1 staff)	No tariff. Rotation of responsibilities (power house)
5. Education	Developer Self-studies Learning by doing	Developer, Self-studies, Learning by doing	Developer. Peer-learning (young VEC members).	Self-studies, Learning by doing
6. Democratic decision-making	No election Record book Regular communication of fund balance to community No audit. 1 woman in BoD	Free Election No book-keeping system. No audit.	No election. Book-keeping system (transparency) Internal control (transparency)	No election. No records as no tariff collection.
7. Cooperation among cooperatives	No cooperation	Cooperation between CBO 5, 6 and 7	Cooperation between CBO 5, 6 and 7	Cooperation between CBO 5, 6 and 7

Note: green = coop. principle met; yellow = coop. principle partially met/ n.a.; orange = coop. principle not met

6.3.4 Enabling and limiting factors

Enabling factors stated in the projects

- In contrast to the other two types of projects, the **awareness of renewable energy technology and the local potential** was truly an enabling factor that marked the beginning of the electrification efforts. Programs on television, conversations with officials, activities in neighbouring communities or other encounters inspired VEC chairmen or members to initiate RET projects.
- The **villager's unity** was advantageous, also **technical interest** and strong **willingness to learn** was helpful. They attended workshops, made site visits and joined discussions to gain technical understanding. They were open to learn from previous mistakes or build on their existing experience with pico-hydro power. The local developer provided further support.
- **Second-hand material** (generators from Germany, Japan) helped to reduce costs.
- The realised hydro power facilities seem not to have suffered from any seasonal generation fluctuation and are located at rivers with constant flow all year round. The community's awareness of the importance of a functioning eco-system and maintaining the forest with regard to the water sources underpinned their electrification efforts.
- All projects were self-funded. Nevertheless, the communities were able to receive **pre-financing** from orange- and tea brokers as well as the military. The developers were willing to accept payments in instalments for a significant time after completion of the projects which shows a strong bond of trust between the different stakeholders.
- Existing **village funds** served as an important financial source for maintenance costs.
- Their way of **rotating assignments among villagers** (system powerhouse, tariff collection) saved on costs for staff and encouraged commitment for the project and the willingness to pay within the community.
- Local economy (tea leaves, farmers), handicrafts (bamboo baskets) deliver productive end-use that benefits from electricity.

Limiting factors stated in the projects

- Due to an overall **lack of access to finance**, the ability for communities to raise funds for maintenance or extension of capacity was limited to their own financial means. Collecting funds from within the community is a cumbersome and difficult.

- The future connection of the village to the **national grid** is a threat to the project structures. In the interviews, communities expressed their wish to maintain their hydropower-based mini grids and even wanted to upgrade the facilities achieving voltage stability because they have invested significant own resources.[24]
- Due to geological challenges (hard rock), construction was significantly delayed in one case which nearly caused in the community to abandon the project before completion.
- Convincing community members to join the project in the initial phase was challenging due to superstition towards electricity in some cases and because some households were already using their own pico-hydropower facilities.

Figure 14 Water basin for a mini-hydro powerplant

Photograph: Khin Akari Tar

[24] Currently, one CBO looks for more help from the government and NGOs for proper environmental program and trainings (CBO5). They wish to maintain their mini hydropower and upgrade it, even using the facilities in parallel with the national grid power, by maintaining their environment.

Table 21 Other Community Energy projects – Enabling and limiting factors

Framework	+ Enabling +	- Limiting -
Environment, natural conditions	Awareness of RET and local knowledge on RET potential among VEC chairmen (Media, neighbourhood activities); Facilities placed at river sites with constant flow all year Awareness of the importance of a functioning eco-system and forest with regard to water source	Hard rock (difficult to carve)
Access to finance	100% Equity; village fund; Loans and pre-finance by orange/tea brokers or contact in the military;	No access to further external finance.
Economy	Productive end-use through local economy, handicrafts deliver	Grid arrival
Technology	Having a good technician and technical planning	Not having a good technician and technical planning
Capacity building	Self-driven workshop attendance, site visits and experts discussions. Partly existing knowledge from pico hydro power. Further support by developers. Peer learning: sending young generation in the committee for practical training with the developer	Insufficient capacity-building
Attitudes within Community	Strong unity, technical interest and willingness to learn, also from failure. Commitment to sound work and developer´s standard. Willingness to pay.	
Operation and Management (requirements / strategies)	Reducing costs through second-hand material; Rotating assignments for maintenance and tariff collection to save costs for staff and raise the understanding, transparency and commitment to the project.	

7 Summary of field study findings

Myanmar has many historic mini-grids that exhibit cooperative characteristics. These mini-facilities supply off-grid communities with electricity. Most of the cases considered in this study are not officially registered cooperatives. The interviews, however, have shown that they do reflect cooperative principles and values to some extent. The projects are mostly based on self-help and cooperation. Even if the initiative for some projects came from the developer or a government entity, local communities in all cases provided financial, material and labour resources to help in the electrification process.

The projects in the sample are not profit-oriented but generate revenue to cover expenses. The motivation is to provide electricity to benefit the community. Projects also contribute to the overall development of the community. All interviewees who had help realise an electrification project showed strong pride and commitment to the project. Participation, self-responsibility and self-organisation for technical and administrative work, had contributed to a shared experience of community resourcefulness and self-sufficiency.

Experiencing the success after extended construction efforts, overcoming project challenges, and joint operation through self-developed instruments (e.g. rotating tasks), strengthened solidarity, trust and unity among villagers. Social cohesion was both an enabling factor and an outcome. This is expected to be of great value for a community as a foundation for coping with future problems and challenges.

The cases considered in the qualitative analysis have been segmented into three categories,

1 | Electrification enterprises registered as cooperatives, which represent a local investor driven model where affluent individuals and the developer provide the funding and organise the mini-grid as a cooperative business.
2 | Government-subsidised projects, where the population has to provide funding for operational costs and maintenance, but not for the investment. The NEP project has a special funding and operating model, which has been already described above.
3 | Locally funded and operated projects. These projects do not consider themselves enterprises, but instead act as projects established and run by the communities for the communities.

The first category represents an actual business case. Developers and affluent individuals act as investors in mini-grid projects and share the profits generated by electricity fees. However, the main motivation for investing was not to be financial returns but rather the desire to bring electricity to the community – a social investment. Both entities are producer cooperatives, which generate electricity and selling it to non-members. Strictly speaking, the 50% shareholding of one major investor compromises the cooperative nature of the enterprise. Nevertheless, considering the immense funding challenges, it is a reasonable compromise. Also, during the field visits, members and the developer showed to collaborate well.

One major benefit of this model is the close collaboration between community and developer. Because the developer has a stake in the project, there is a high level of technical support which the members and the communities rely on.

Improved access to loans and technical support for administration are the main benefits of registering as a cooperative. Compared to other projects, the registered cooperatives have a systematic bookkeeping system as well as codified internal rules and regulations. The annual audit by the cooperative department ensures that the funds are managed reasonably well and provides a certain level of financial protection for the members. Also, staff of the cooperative received trainings on bookkeeping and accounting.

The other subsidised and non-subsidised projects, generally do not perceive themselves as enterprises. There is a strong sense of community ownership even for projects that have yet been officially handed over to the communities. People are generally content to receive electricity. Compared to the registered cooperatives, administration and management seems to be less systematic.

The main difference between subsidised and non-subsidised projects is the funding source. In the first case, a government entity typically provided full funding for the mini-grid and community members contributed by providing their labour and local resources. Maintenance costs and costs of upgrading need to be funded by the communities through electricity and connection fees and by special contributions if financial reserves are no sufficient.

Technical capacity in the communities is a major bottleneck when it comes to regular maintenance. In the subsidised projects, often the government sponsor provided support to link up with technicians whereas the communities in the self-funded projects had to find suitable and timely support themselves.

All projects with the exception of the project under the NEP-scheme, were developed using low-cost technology, the main reason for this being the financial capacity of the communities and the limited subsidies available. None of the observed cases can be expected to connect to the national grid. Grid-ready projects are unlikely to be funded by communities alone, considering the mismatch between the high costs needed to reach the required technical standards and restricted local financial resources. The NEP project logically fills this gap by off-setting high upfront technical costs.

8 Conclusions and recommendations

8.1 Recommendations for community-based energy projects and supportive policy framework

The Government of Myanmar is promoting electrification as a key part of the social and economic development of the country. Although it is focused on expansion of the national grid, supporting off-grid projects in rural areas is also an important part of the government's national electrification strategy. Through different ministerial programs, the government provides subsidies to solar and hydropower projects in off-grid areas not covered by the national grid. Often, developers and in some cases development aid agencies are involved in technical and operational support for electrification in remote villages. The subsidised projects are usually handed over to management committees organised by rural communities. Between 2015 and 2019, around 38 NEP-supported projects were initiated. Figures are not available for the other projects established by the government.

Forecasts show that extension the national grid will not achieve full electrification of rural areas by 2030 as planned. Community-managed renewable energy projects are one viable and sustainable way to meet the acute electricity needs of remote communities.

To actualise new projects, research shows that the technical and engineering considerations (capacity, technical standards, safety aspects) are essential. However, providing technology and access to sustainable energy alone is not sufficient to achieve successful projects.

Terrapon et al (2018) argue that energy projects need to be embedded in a set of actions that address social, cultural, economic and environmental factors. Capacity building and complementary activities should aim to deliver a people-centred approach to training that focuses on the needs, skills and interests of the potential beneficiaries.

This study found example projects where no significant social or economic development effects could be observed after communities gained access to sustainable energy. Although further research is needed, we expect that cooperatives and rural energy projects which operate under cooperative principles may be more conducive to community development. A cooperative approach goes beyond the technical issue of the power plant, to promote individual agency and autonomy, democratic norms, economic participation, education and concern for the community.

It can be noted that numerous rural mini grid projects in Myanmar are constructed by villages without official government support. These communities are driven to realise their electrification goals and act faster than the government. The study showed how successful self-initiated projects can be in contributing to the electrification of rural communities, improving living standards and expanding employment opportunities. With a broader, community-driven approach, the projects benefit from local knowledge on low-cost technological solutions that fit the local conditions. Developers choose appropriately sized power generation facilities and benefit from strong interest and commitment of the community. Moreover, community-managed projects are able to find and fix issues much faster than in a national grid system due their presence in the local community. This proximity and reliability are an important advantage and, in some cases, mini-grids can be a better alternative than the national grid to meet community needs.

It is essential to create a supportive political environment to promote the successful development of citizen-based electrification projects. As we have clearly illustrated throughout the report, these projects have the potential to not only provide electricity, but also to empower local people to promote democratic development and to conserve the environment.

As a conclusion, it seems worth creating a supportive political landscape to promote the successful development of citizen-based electrification projects in areas where villagers do have a certain economic power to invest, in co-existence with governmentally subsidised projects for communities and areas where people clearly have not investment capital. Referring to the identified challenges and limiting factors that community projects outside the NEP program face (see chapter 4), this political support should address the following: finance, business models, capacity building, technological standards and regulations.

8.1.1 Promotion of renewable energy in rural areas

As shown in (chapter 0), there is huge potential for Myanmar to harness renewable energy for development aims. Further research and development should be conducted on how to best promote and execute these projects.

News and information sharing (TV programmes, talks, activities in villages) with community leaders is one avenue to encourage the adoption and use of renewable technologies in remote areas. Systematically promoting success cases and encouraging leaders to evaluate the local potential for off-grid projects could help encourage community to initiate self-driven electrification projects.

Promotion of renewable energy in line with and reflected in the national energy policy, would be conducive to further uptake of renewable alternatives. The recently instituted National Renewable Energy Committee (NREC) is not only responsible for policy matters but also for PR and announcements on renewable energy developments. NREC's activities could include developing a public awareness program about renewable energy and teaching basic knowledge about renewable energy in school curriculum.

Mini-grid regulations will set the guiding principles as well as rules and procedures for stakeholders involved in mini-grid projects. This will link to Myanmar Sustainable Development Plan (MSDP), national energy policy, national electrification plan and national renewable energy policy. The NREC could play an active role in setting legal and regulatory frameworks also for grid connection with renewable energy generations and setting up PPAs and FITs. Possible components could be policy measures like priority feed-in for renewable energies.

International development agencies should collaborate with NREC to realise the targets and activities, which can lead to a systematic development of renewable energy projects.

8.1.2 Coordination between involved institutions, standardisation and transparency through data collection

Fortunately, the government already conducts a number of rural renewable energy projects and programs of ministries. Departments promote the development of RET-based mini-grids in Myanmar. To ensure a strategic course of action, intensified coordination and collaboration between the respective ministries is crucial. Also, a reconciliation of technical standards within the government-supported projects would facilitate project development.

The newly introduced National Renewable Energy Committee, set up by MOEE in February, 2019 is fulfilling this role by coordinating inter-ministerial programmes, encouraging R&D, as well as collaboration between entrepreneurs and international actors. The NREC is expected to develop a procedure which includes data survey, collection, analysis, and dissemination of information related to renewable energy development in Myanmar.

Systematic data collection on realised energy projects, and surveys for RET potential sights could provide transparency and an important planning and monitoring function. It should include governmental and citizen projects, and regularly updated plans of the national grid expansion.

8.1.3 Professional planning and technical standards

Site analysis and reliable feasibility studies should evaluate the potential and suitable renewable energy technology for a given location. The technical design and components (turbines, posts, etc.) need to have a certain quality to be considered sustainable use. Almost all of the interviewed energy projects underlined the importance of sound technical planning and the importance of finding a capable technician to provide and develop a suitable technical design. The technician should, at the outset, consider the local conditions, potential risks, and reasonable expected electricity use.

The technical associations, such as Myanmar Engineering Society, Myanmar Engineering Council, Myanmar Associate of Government Technical Institutes Society and various government technical bodies have rich expertise. The MoI's Electrical Inspection Department (EI), MoEE's Renewable and Hydropower Department, Department of Research and Innovation, can work together for standardisation, planning and procedure implementation. For example, MOEE now allows external electricians with first class certificate issued by the EI Department of MoI to work for VECs, this is a good step in the right direction.

Additionally, the VECs should allow residents, who are interested in technology and are willing to work on mini-grids O&M activities, to join electrical trainings given by MoI. Mobile trainings are conducted by the government and can lead to local people earning government-approved electrician certificates. The trainings should work with middle-aged individuals, and women, who are settled in the community, to keep the know-how in the village. Interviews alluded to the fact that trained young villagers often leave for cities to seek further employment.

Figure 15 Wiring for a mini-grid

Photograph: Khin Akari Tar

8.1.4 Financial schemes and business models for non-subsidised energy projects

The analysis revealed a need for a broader access to external finance for communities and rural electrification projects. Most of the villagers collect money from households or village funds or loans from local agricultural brokers to finance their projects. High investment and maintenance costs in energy generation projects complicates financing by equity and local brokers. A business case for monthly income is feasible under certain conditions and loans can be taken and paid back based on regular revenues.

The analysis found that some villages seek to upgrade their system through self-financing arrangements. Almost all of the villages or their VECs are willing to upgrade their existing system to a safe and sustainable mini-grid. A local system has many advantages. If there is a black-out, residents can monitor and steer repair works with their local repair team at the mini-grid located near the village. In the case of a national-grid black-out, however, the repairs are conducted only by the grid operator and outside the villagers' control. Recovery time is not easily estimated and the faulty location is often far away from the village.

A major barrier to upgrade the existing systems is the lack of financial support and local funds. If grid and generation facilities are upgraded to MOEE technical standards and connected to the national grid, they could help reduce the power deficit through decentralised power generation.

There is a gap in existing financial instruments. According to the WISION for Sustainability Initiative,[25] challenges for financial access are often linked to the lack of flexibility of traditional financiers and the limited suitability of products offered. The main barriers to providing finance also include the "lack of financial literacy" and a "misalignment of risk and return expectations". Communities may have a limited understanding of existing financial options.

Thus, successful and innovative financing schemes should be analysed and, if appropriate, promoted to serve as models to be replicated. More banks and other traditional financiers should be encouraged to develop products tailored for renewable energy projects.

The model should allow sufficient revenue generation to cover expenses, serve as a small return of invest for potential shareholders and ideally ensure a constant revenue flow to build up reserves. In the analysed energy projects, monthly revenues often only covered the operational expenses, which made it necessary to raise additional funds for bigger repairs or necessary upgrades.

Professional consultancies can help develop these business models, but a certain base of financial skills among the villager is needed. Book-keeping can support for monitoring activities to measure monthly income, generation, and electricity use.

Of course, potential business models, suitable tariffs and connection fees need to meet the customer's ability and willingness to pay. Customers at all of projects interview said that they saw cost savings after the project installation. They reported additional income due to candle and diesel substitution, charging their phones and batteries at home, and more

[25] Financing Renewable Energy in South East Asia : Insights from Practitioners.

http://www.wisions.net/files/uploads/Financing_Renewable_Energy_in_South_East_Asia.pdf (last access: 10.04.2019) efficient work due to extended work hours at night-time. Bringing these trade-off calculations might create a broader scope for tariff design.

8.1.5 Capacity building for community members and stakeholder networks

Villagers showed tremendous willingness to learn. Community members were motivated to acquire technical and administrative skills. They visited sites and workshops, tried to learn from mistakes and apply the knowledge received in operational trainings delivered by the developer. Over time, however, the projects needed technical upgrades and additional financing for repairs and other unexpected expenses. Many initiatives struggled both technically and financially due to these pressures. In many cases the problems have not yet be solved.

Only a few cooperatives and non-subsidised community energy projects mentioned that they had access to professional capacity building and consultancy support. There is a need to fill this gap and the demand should be addressed through further institutional efforts and vocational training programs at the township and regional level.

To this end, an institutionalised program for community energy projects including respective modules, guidelines, templates and recommendations could be very useful. It could be offered as a part-time course to VEC members. It could rotate geographically, perhaps even lead to a network platform where energy community projects can exchange and learn from each other. These training programs should include education on safety measures, customer communication, health education and environmental conservation. Institutions should invite and encourage women to join these programs.

One possibility could be to build and equip a unit to provide technical support through the government to connect mini-grids to networks, such as the cooperative department and to create guidelines on how to build standardised business models.

8.1.6 Common good, instead of profit maximisation – promoting democratic values and participation in rural communities

In order to support a community-oriented practice of self-help initiatives, transparency and democratic decision-making could be further developed. Firstly, book-keeping and accounting audits performed by external entities could be more consistently implemented for villagers. Participation contributes to member well-being. Thus, important decisions should be explicitly put to vote in the plenary of village/member meetings. Forming individual opinions for voting requires a certain knowledge basis, and this procedure thus promotes further education and strengthen village capacities. Even though energy generation as a technical subject seems to have a bigger attraction to men, the training and awareness-building activities should encourage of women’s participation to address priorities and needs which might otherwise be neglected. Guidelines and recommendations for VECs for how to follow such principles could be developed.

There are also interlinkages between community building and the acceptance of energy infrastructure. While large-scale dam projects often are met with protest from local population, citizen involvement in other countries seems to have a positive effect regarding local-level acceptance of power generating facilities.

8.1.7 Advancement of grid connection strategies

To avoid lost investment or paying for additional connection fees, a strategy for the integration of mini-grids with the national grid should be further developed. Risk mitigation is an extremely important aspect of community projects. Distributing reliable information regarding the national grid, its current state and expected completion and geographies could help villagers to calculate and decide, whether it is reasonable to start a self-driven mini-grid project. Aside from that, the possibility of integrating mini-grids into the national grid should be promoted and substantiated through regulations. This would include:

1 | Defining of technical standards to make mini-grids grid-ready
2 | Addressing regulatory issues surrounding power purchase by small power producers Currently, the role of local power producers is not yet reflected in the national energy laws and there are no specific guidelines for grid-interconnectivity between isolated mini-grids and the national grid. Power purchase agreements and tariff regulations are unclear.
3 | GIZ (Greacen 2018/ Schmidth-Reindahl 2018) discusses "grid-connected small-scale electrical power enterprise regulations" and "Isolated Small Scale Electrical Power Enterprise Regulations" with regulatory authorities and regulatory functions as necessary legal framework.
4 | A country focal independent electricity regulatory commission should be established.
5 | Feed-in tariff or standardised power purchase agreements for mini grid connection.
6 | Tariff regulation: Adapting the electricity tariff in the national grid to the real generation costs would help to create a framework that allows fair competition ("level playing field") between mini-grid operators and national grids.
7 | Institutional cooperation: Public-private partnerships and other cooperation

Becoming a small power producing institution increases the responsibilities and requirements for the management committees of community projects. They need to achieve higher technical standards, ensure compliance with legal and regulatory requirements, and do strategic planning as the electricity usage and numbers of clients will increase over time. Consequently, the involved persons will face highly professionalised conditions and requirements.

In order to cope with that, cooperation with governmental utilities as public-private partnerships or promoting cooperation between several mini-grid operators in order to scale effects and distribute the generated electricity, could be of future importance.

Another form of organisation to consider that is an enterprise owned by the legal representative of the community i.e. local authority. This form of enterprise is common in Western countries and often known as public or municipal utility. In liberalised markets such as Germany, local utilities are increasingly being set up to provide clean, secure and affordable energy to local communities (Wagner & Berlo, 2017). In the Myanmar context, this is not yet an issue as large utilities are state-owned (union level). However, in the future, this may be an interesting option for existing informal projects to convert into a community business.

8.2 The cooperative model as contribution to sustainable rural electrification

This study also analysed whether the cooperative sector in Myanmar could provide a substantial support for mini grid projects, as is observed in other countries. Besides having access to loan programs and support in setting up the administration, forming a legal entity can help with obtaining loans from other financial institutions as well as international donors.

The nation-wide cooperative system with regional and local divisions, and the strong support by the government, seem to provide benefits. As the cooperative system is also assigned to provide services for registered cooperatives, they could play an important role in giving financial support and capacity building in the future.[26]

The current system of cooperative syndicates does not have the capacity to provide the technical services that energy cooperatives require. Building these capacities in the existing cooperative network or setting up new network organisations might be an option to maintain on-going support. Such efforts would require joint collaboration between the DRD and the Cooperative Department. If implemented correctly, a cooperative set-up could strengthen the sense of community ownership and the commercial drive of small power producers. In that way, village communities can contribute to rural electrification.

[26] FAO/MOALI: Formulation and Operationalization of National Action Plan for Poverty Alleviation and Rural Development through Agriculture (NAPA) – Rural Cooperative (2016)?

9 References

ADB. (2016). *Myanmar: energy assessment, strategy, and road map.* Place of publication not identified: Asian Development Bank.

ADB. (2018, April 20). *DP Off-grid support*. Document provided by DGRV.

Birchall, J., Ketilson, L. H., & International Labour Office. (2009). *Resilience of the cooperative business model in times of crisis*. Geneva: ILO.

British Council. (2013). *Social Enterprise Landscape in Myanmar*. Retrieved from https://www.britishcouncil.org.mm/sites/default/files/social_enterprise_landscape_in_myanmar_-_september_2013.pdf

CSO. (2019). *Expenditures of the Union Government by sector*. Retrieved from http://mmsis.gov.mm/statHtml/statHtml.do

Devine-Wright, P. (2007). Energy Citizenship: Psychological Aspects of Evolution in Sustainable Energy Technologies. In *Governing Technology for Sustainability* (pp. 63–86). London: Earthscan.

DRD. (2019). Call for Proposals for Engineering, Procurement, Construction and Operation of Mini-Grid Projects in Rural Villages [Department of Rural Development]. Retrieved 1 April 2019, from http://drdmyanmar.org/index.php?page=bmV3ZGV0YWlsJmlkPTE3Nw==#

Electricity Law. , (2014).

FAO, & MOALI. (2016). *Formulation and Operationalization of National Action Plan for Poverty Alleviation and Rural Development through Agriculture (NAPA)*. (Working Paper 7).

Ferguson, J.-A. (2013). *Consultancy on Co-Operative Systems in Myanmar*. Retrieved from https://www.lift-fund.org/sites/lift-fund.org/files/publication/Consultancy-on-Cooperative-Systems_English%20(Sept%202013).pdf

GIZ. (2018). *Myanmar's Banking Sector in Transition. Current Status and Challenges Ahead*. Retrieved from http://www.giz-banking-report-myanmar-2018.com/#2

GIZ, & MFAT. (2018). *Rural Electrification through Mini-Grids. Accelerating development of decentralised renewable energy in Myanmar.*

Greacen, C. (2015, June). *Presentation at workshop INTEGRATED RESOURCE PLANNING FOR MYANMAR'S ELECTRICITY SECTOR*.

Greacen, C. (2016). *Role of Mini-grids for Electrification in Myanmar. SWOT analysis and a roadmap for scale-up.* Retrieved from https://energypedia.info/images/e/ed/20160530_Minigrids_in_Myanmar_-_SWOT_and_roadmap_for_scaleup.pdf

Holstenkamp, L., & Müller, J. R. (2013). *Zum Stand von Energiegenossenschaften in Deutschland. Ein statistischer Überblick zum 31.12.2012*. 7.

Huybrechts, B., & Mertens, S. (2014). The relevance of the cooperative model in the field of renewable energy. *Annals of Public and Cooperative Economics*, *85*(2), 193–212. https://doi.org/10.1111/apce.12038

ICA. (2019). Cooperative identity, values & principles | ICA [International Cooperative Association]. Retrieved 1 April 2019, from https://www.ica.coop/en/cooperatives/cooperative-identity

JICA. (2003). *The Study on Introduction of Renewable Energies in Rural Areas in Myanmar*. Japan International Cooperation Agency.

KfW. (2017). *Project Information. Rural Electrification Programme – Myanmar*.

Kyaw, K. (2016). *Myanmar must review energy policies*. Myanmar Eleven, Yangon.

Meyer, A.-M. (2016). *Dezentrale erneuerbare Energien damals und heute: genossenschaftliche Elektrifizierung in den 1920er Jahren am Beispiel von Großbardorf*. Hamburg: Diplomica Verlag GmbH.

MIMU/UNDP. (2019, February). *Myanmar Government ministries and department list*. Retrieved from http://themimu.info/sites/themimu.info/files/documents/Infographic_Myanmar_Government_Ministries_and_Departments_MIMU_IG006v01_28Feb2019.pdf

Ministry of Planning and Finance. (2018, August). *Myanmar Sustainable Development Plan (2018 – 2030)*.

MMSIS. (2019). *Electric power generation by type of energy*. Retrieved from http://mmsis.gov.mm/statHtml/statHtml.do?orgId=195&tblId=DT_MAB_0002&conn_path=I3

MMT. (2018a, January 25). New electricity rates set to be announced this year (Myanmar Times). Retrieved 1 April 2019, from The Myanmar Times website: https://www.mmtimes.com/news/new-electricity-rates-set-be-announced-year.html

MMT. (2018b, May 31). The real cost of Myanmar's electricity. Retrieved 1 April 2019, from The Myanmar Times website: https://www.mmtimes.com/news/real-cost-myanmars-electricity.html

MOALI. (2019). Cooperative Department | MOALI - Ministry of Agriculture , Livestock and Irrigation. Retrieved 11 April 2019, from https://www.moali.gov.mm/en/content/cooperative-department

MODINS.net. (2019). MODiNS [Myanmar Online Information], Government & Policy. Retrieved 11 April 2019, from http://www.modins.net/myanmarinfo/ministry/cooperative.htm

MOEE. (2018, June). *Current Energy Situation and Development*. Presented at the Aung Zaw Hein, Nay Pyi Taw. Aung Zaw Hein, Nay Pyi Taw.

MOEE. (2019). NEP Plan [Ministry of Electricity and Energy]. Retrieved 1 April 2019, from http://www.moee.gov.mm/en/ignite/contentView/

MOEE, & MoA. (n.d.). *Off-Grid Electrification and Programmes*. Presentation by Pyae Sone Oo.

Myint, A. (2014, November). *Decentralised Hydro Energy and Private/Public involvement perspective.* Presented at the Yangon & Inn Lay. Yangon & Inn Lay.

NEMC. (2015). *Myanmar Energy Master Plan*. ADB, IES, MMiC.

Pasqualetti, M. J. (2010). Morality, Space, and the Power of Wind-Energy Landscapes. *Geographical Review*, *90*(3), 381–394. https://doi.org/10.1111/j.1931-0846.2000.tb00343.x

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3 ed). Thousand Oaks, Calif: Sage Publications.

REScoop.eu. (2019). REScoop.eu. Retrieved 10 April 2019, from REScoop.eu website: http://www.rescoop.eu/

Rockefeller Foundation. (2018, April 30). Accelerating Rural Electrification in Myanmar. Retrieved 15 April 2019, from The Rockefeller Foundation website: https://www.rockefellerfoundation.org/blog/accelerating-rural-electrification-myanmar/

Rogers, J. C., Simmons, E. A., Convery, I., & Weatherall, A. (2008). Public perceptions of opportunities for community-based renewable energy projects. *Energy Policy*, *36*(11), 4217–4226. https://doi.org/10.1016/j.enpol.2008.07.028

Sanyal, S., & Eisinger, F. (2016, March). *Enabling SME access to finance for sustainable consumption and production in Asia. An overview of finance trends and barriers in Myanmar*.

Retrieved from https://www.switch-asia.eu/fileadmin/user_upload/Publications/2016/Green_Finance_Study_-_2016_-_Myanmar.pdf

Schmidt-Reindahl, J. (2018, March). *Discussion of isolated small scale electrical power enterprise regulations*. GIZ presented at the Nay Pyi Taw. Nay Pyi Taw.

Tarhan, M. D. (2015). Renewable Energy Cooperatives: A Review of Demonstrated Impacts and Limitations. *The Journal of Entrepreneurial and Organisational Diversity*, *4*(1), 104–120. https://doi.org/10.5947/jeod.2015.006

Tenenbaum, B., Greacen, C., & Vaghela, D. (2018). *Mini Grids and the Arrival of the Main Grid: Lessons from Cambodia, Sri Lanka and Indonesia*. Washington DC: ESMAP, World Bank.

Terrapon-Pfaff, Julia et al. (2018). *Impacts pathways of small-scale energy projects in the global south - Findings from a systematic evaluation.* Renewable and Sustainable Energy Reviews 95 (2018) 84-94. (https://doi.org/10.1016/j.rser.2018.06.045).

The Co-operative Society Law. (1992).

The Global New Light of Myanmar. (2018, October 28). *The Cooperative Movement in Myanmar*. Retrieved from http://www.globalnewlightofmyanmar.com/the-cooperative-movement-in-myanmar/

Tokyo University. (2013, 2014). *Improving Energy access in Myanmar*. Provided by DGRV.

Trend:research, & Leuphana Universität Lüneburg. (2013). *Definition und Marktanalyse von Bürgerenergie in Deutschland*. Retrieved from https://www.buendnis-buergerenergie.de/fileadmin/user_upload/downloads/Studien/Studie_Definition_und_Marktanalyse_von_Buergerenergie_in_Deutschland_BBEn.pdf

van der Horst, D. (2008). Social enterprise and renewable energy: emerging initiatives and communities of practice. *Social Enterprise Journal*, *4*(3), 171–185. https://doi.org/10.1108/17508610810922686

Wagner, O., & Berlo, K. (2017). Remunicipalisation and Foundation of Municipal Utilities in the German Energy Sector: Details about Newly Established Enterprises. *Journal of Sustainable Development of Energy, Water and Environment Systems*, *5*(3), 396–407. https://doi.org/10.13044/j.sdewes.d5.0152

Warren, C. R., & McFadyen, M. (2010). Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. *Land Use Policy*, *27*(2), 204–213. https://doi.org/10.1016/j.landusepol.2008.12.010

World Bank. (2015). *National Electrification Project. Project information document (PID). Concept stage.* Retrieved from http://projects.worldbank.org/P152936/?lang=en&tab=documents&subTab=projectDocuments

WWF, REAM, Spectrum, & IES. (n.d.). *Myanmar's Electricity Vision. Updating National Master Electrification Plan*.

10 Annex Technical standards for grid and interconnection

Technical standards for mini-grids are a central aspect for grid connection and for electrical safety. Low technical standards are dangerous and lead to high maintenance costs in the medium to long-term. Myanmar has a number of regulations and technical guidelines which are relevant for developing mini-grids. The following list summarises the key legal and regulatory documents:

- The Electricity (Control of Undertakings) Act, [BURMA ACT NO. LXIII OF 1947.] , 17. October 1947

- Electricity Law, 1984
- Electricity legal procedure (လြြပျစရျဆိုငျရာလုပျပိုငျခ္ျမြး), Notification no. 63/85, 01. July 1985
- The Board of Yangon City Electric Power Supply Law, (The State Peace and Development Council Law No. 6/ 2005), 22. November, 2005
- Electricity law 2014, enacted by Pyidaungsu Hluttaw, 27 October 2014
- Electricity Rules, Notification 198/2015, 27. October, 2015
- Myanmar National Building Code-Building Services (Lighting, Electrical and Allied Installation), (draft), Ministry of Construction, 2017, part 5B
- Commitments of VEC directed by Ministry of Electricity and Energy (MOEE)- မီးလင်းရေးကော်မတီများ အား ဝန်ခံကတိပြု၍ လိုက်နာဆောင်ရွက်ရန် အချက် (၁၂) ချက်

MoEE sets the technical standards for both, national grid and mini-grids. DRD currently drafts the mini-grid regulations including technical standards together with MoEE and in line with MoEE standards and norms. VEC commitment also include some technical guidelines on how interconnected mini-grids should be set up. Rules include:

- The height of concrete pole for different distribution line voltages (400V, 11kV and 33kV)
- The sizes of cross-sectional area (CSA) of cables and wires which prevent from line loss and electric hazard
- To use local-made transformers recommended by MoEE; if imported ones, need to have inspection by MoEE
- Colouring code must be Red, Yellow and Blue
- Small substation must be two-pole erected, with 5' fence and concreted floor.
- Pole footing must be dimension of L2'xW2'xH2.5' with 6" above natural ground and 2' underneath
- VEC must take responsibility and undertake the maintenance of self-procured transformers and distribution lines of 400V
- If substations and lines are constructed by external electricians, they must be at least first-class electrician certificate holders, given by the Electrical Inspection department of Ministry of Industry. Equipment list, line diagrams and drawings of substation are needed to have approval
- 33kv and 11kV lines which have been constructed by VEC and private are to be transferred to the MoEE at the time of energizing (national grid connection). The maintenance cost of these lines must be borne by the MoEE. MoEE can permit connections from these lines after examining technically.

The Electricity legal procedure (လျှပ်စစ်ဥပဒေဆိုင်ရာ လုပ်ထုံးလုပ်နည်းများ), Notification no.63/85, 01. July 1985 contains guidelines for electrical works, including low, medium and high voltage works, their grounding works, lightning protection, safety practices, application procedure of electrician certificates and even some meteorological data (temperature and lightning map), though these data are outdated, as annexed. This is the procedure referred by the Electrical Inspection department (EI) and electricians practicing in Myanmar as well as somewhat accepted by MoEE before its updated technical regulations and standards development.

According to DRD, low voltage standards and other standards like grid code are developed by MoEE. As mentioned above, the mini-grids developed under the NEP scheme are generally grid-ready. According to field observations and interviews conducted, other mini-grids mostly do not comply with set standards. The main reason are budget constraints of communities and funding entities, availability of technical know-how, as well as geographical constraints and in some cases political turbulences. Under these conditions, official standards could not always be fully met.

Table 22 List of interviews within the research

No	Stakeholders	Name	Stakeholder/other participants	Date, place and Time
1	Project site visit	VEC Htanhlapin	Project site visit VEC of Htanhlapin village, Ywangan Township	22-02-2019 Htanhlapin village, Ywangan Township, Shan State One whole day
2	Developer	Zaw Zaw Aung	Developer of Htanhlapin village, visit to workshop in Ayetharyar, Taunggyi	23-02-2019 Ayetharyar, Taunggyi, Southern Shan State 7:30 to 8:15 AM
3	DRD	Maung Win	DRD Deputy Director General (Mr. Maung Win), one project manager (Dr. Soe Soe Ohn) one director (Mr. Myo Myo) from NEP project attended	25-02-2019 DRD office, Nay Pyi Taw 1 pm to 2pm
4	MOEE	Hein Htet	MOEE Deputy Director General (Mr. Hein Htet), and Senior Engineer (Mr. Thant Lwin Oo), Assistant engineer (Mr. Aung Zaw Hein) attended	26-02-2019 MOEE office, Nay Pyi Taw 10 AM to 11 AM
5	GIZ	Regine Dietz	GIZ, team attended	27-02-2019 GIZ office, Yangon 10 AM to 11:30 AM
6	A-Bank	Saw Dino Ku	Interview with A Bank	27-02-2019 A Bank HQ office, Yangon 3 PM to 4 PM
7	Developer	Sai Htun Hla	Developer of cooperative project sites- hydro power	27-02-2019 Yangon 6 PM to 8 PM
8	Project site visit	VEC Hinthada	Project site visit to NEP site in Ye-le-thaung-kyung-su village in Hinthada Township, Ayeyarwady Region	28-02-2019 One whole day
9	REAM HYCEM	Aung Myint Dipti Vaghela	REAM HYCEM	01-03-2019 REAM office, Yangon 10:30AM to 1:00 PM
10	Developer (NEP)	Zaw Min	Developer (NEP) Mega Global Green Company	05-03-2019 Yangon 3 PM to 4 PM