

DECENTRALIZING POWER

The Role of State and Region Governments
in Myanmar's Energy Sector

April 2019





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Any faults in the substance or analysis of the report rest with the author.

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PREFACE

Myanmar's state and region governments matter, and their importance has only continued to grow since their creation. They increasingly shape the role and the public's perceptions of the Myanmar state in their jurisdictions as they broaden their range of activities and manage a significant proportion of government expenditure. As the peace process continues, decentralization to the state/region governments can help subnational actors gain the experience and capacity to govern.

In September 2013, The Asia Foundation published its first report on Myanmar, ***State and Region Governments in Myanmar***. The report elicited a great deal of interest in subnational governance from government, civil society, donors, and development partners. Since then, 39 reports from the Foundation have looked in greater detail at issues of subnational governance, peace, and conflict.

In October 2018, The Asia Foundation issued a new edition of ***State and Region Governments in Myanmar***. The new edition provides a much-needed update on the structures and functions of subnational governance in Myanmar, identifying the key political, administrative, and fiscal opportunities and challenges presented by decentralization. The report supports a better informed, more technically grounded debate on the issues of subnational governance that are critical to strengthening ongoing policy and reform processes here in Myanmar, including the all-important peace process.

This report is a companion report, covering the subnational aspects of Myanmar's energy sector. The Asia Foundation has been providing support and technical assistance to seven states and regions, and has been conducting training with all 14 of the states and regions, with the aim of building technical capacity and better articulating the need for government reforms. Increasingly, we have found that the states and regions recognize energy as an emerging issue on which they would like guidance, assistance, and greater clarity on the overlap between the Union and state/region governments in terms of policy, investment, and legal frameworks.

There is a particular need to clarify the rights and roles of states and regions in the power sector, and to understand how investments in the electricity generation, transmission, and distribution system are decided. The World Bank, with its USD 400 million of loans and technical assistance to the National Electrification Project, is focusing almost entirely on the national government and national ministries, but there is a lot of political willpower (and foreign funding) supporting investments in Myanmar's energy sector, and this creates a significant opportunity for state/region governments.

In principle, the government has been decentralizing administrative and legal power to the states and regions since 2011. The process has been slow, however. Even after tripling its contribution, state and region government budgets were only 12 percent of total government spending in 2017–18. Yet, while constitutional and legislative changes have created options for increased state/region autonomy, the old, centralized government hierarchy remains. There is clearly room for the states and regions to assert more control over permitting and investments in power-sector infrastructure.

But where should the state/region chief ministers and energy ministers start? When energy issues arise, are they and their staff equipped to address detailed technical issues and related policymaking? What are states allowed to do on their own, and when do they need Union approval or concurrence? As Myanmar faces the

immense challenge of building out its national electricity system, there is a great opportunity to build capacity at the state/region level—in the areas of planning, project evaluation and negotiation, project management and oversight, and public consultation and communication—to meet these challenges. The national expansion of the transmission and distribution system, the development of mini-grids, and the planning and siting of power plants in consultation with communities need significant, informed input and support from state/region governments. Legally, under the constitution and the Electricity Law, the state/region governments have significant authority and responsibility for energy development, and a more decentralized approach to energy planning and development will help Myanmar attract investment to the energy sector and build a strong national energy system that supports economic development.

We hope that ***Decentralizing Power: The Role of State and Region Governments in Myanmar's Energy Sector*** will serve as a useful knowledge base on the ways that all stakeholders in subnational governance reform can support decentralization in Myanmar's energy sector. This would have great benefits, including unlocking entrepreneurial activity and investment that will help local economic development and growth across the country.

Dr. Matthew B. Arnold

Country Representative
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Yangon, April 2019



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ACRONYMS

| | |
|---------------|--|
| ADB | Asian Development Bank |
| CSO | Civil society organization |
| DDA | Dawei Development Association |
| DEPP | Department of Electric Power Planning (DEPP) (under MOEE) |
| DPTSC | Department of Electric Power Transmission and System Control |
| DRD | Department of Rural Development (of MOALI) |
| ECD | Environmental Conservation Department (of MONREC) |
| EGAT | Electricity Generating Authority of Thailand |
| EIA | Environmental impact assessment |
| EMP | Environmental Management Plan |
| EPGE | Electricity Power Generating Enterprise (under MOEE) |
| ESCO | Energy service company |
| ESC | Electricity supply corporation |
| ESE | Electricity Supply Enterprise (under MOEE) |
| FDI | Foreign direct investment |
| FY | Fiscal year |
| GAD | General Administration Department |
| GAO | General Administration Offices |
| GIZ | Gesellschaft für Internationale Zusammenarbeit, a German development agency |
| HyCEM | Hydro for Community Empowerment and Myanmar |
| IEE | Initial environmental examination |
| IGC | International Growth Center |
| IPP | Independent power producer |
| JICA | Japan International Cooperation Agency |
| KOICA | Korea International Cooperation Agency |
| MESC | Mandalay Electricity Supply Corporation |
| MIC | Myanmar Investment Commission |
| MIMU | Myanmar Information Management Unit |
| MMK | Myanmar kyat (national currency) |
| MOALI | Ministry of Agriculture, Livestock, and Irrigation |
| MOEE | Ministry of Electricity and Energy |
| MONREC | Ministry of Natural Resources and Environmental Conservation |
| MOPF | Ministry of Planning and Finance |
| MoU | Memorandum of Understanding |
| MP | Member of parliament |
| MW | Megawatts |
| NGO | Nongovernmental organization |
| NEP | National Electrification Project |
| NLD | National League for Democracy |
| NPC | National Planning Commission |
| NVE | Norwegian Water Resources and Energy Directorate |
| PAP | Project-affected persons (with reference to an EIA) |

| | |
|--------------|---|
| PFM | Public financial management |
| PPA | Power purchase agreement |
| PTC | Pho Thee Cho Co., Ltd. |
| REAM | Renewable Energy Association of Myanmar |
| SAD | Self-administrated division |
| SAZ | Self-administrated zone |
| SCADA | Supervisory control and data acquisition (system for controlling the power grid) |
| SEA | Strategic environmental assessment |
| SES | Socio-economic survey |
| SHS | Solar home system |
| SPP | Small Power Producer Program |
| VSPP | Very Small Power Producer Program |
| YESC | Yangon Electricity Supply Corporation |

EXECUTIVE SUMMARY

BACKGROUND

This report explores the role of Myanmar's state and region governments in the development of the country's energy sector, and how they can increase their agency in shaping their own and the nation's energy future. It is a companion to the Asia Foundation's October 2018 report, ***State and Region Governments in Myanmar***, which examines the structure and execution of subnational governance and articulates needed reforms. Like that earlier effort, this report incorporates the views of state and region governments themselves on the challenges and opportunities presented by Myanmar's evolving energy sector.

Myanmar's Union government has been gradually devolving legal and administrative powers to the states and regions since 2011, but these new powers often exist in an uncertain and untested relationship to the traditional powers and prerogatives of the central government. In the energy sector, the states and regions clearly have room to be more assertive in the areas of policy and planning; public consultation and permitting; management of the local (11 kV) electrical grid; off-grid energy, especially renewable energy mini-grids; and the promotion of private investment.

This report describes how state and region governments are discharging their energy-sector responsibilities, and the extent to which existing policies and guidelines empower state/region officials to act to meet regional energy needs.

OBJECTIVES

This report addresses four key research questions:

- What is the constitutional, legal, and institutional framework of state/region energy authority, and is there a trend toward decentralization of the energy sector?
- Where can the states and regions act autonomously in the energy sector?
- What are the challenges, opportunities, and strategies for improving subnational energy policy, management, and decision-making?
- How can states and regions attract the private-sector energy investments needed for economic development?

METHODOLOGY

This report draws on six months of interviews with a range of stakeholders across Myanmar, supported by desk research, to understand the forces shaping the energy sector. The project team conducted field research from May to October 2018 in Shan State; Yangon, Tanintharyi, and Bago Regions; and the capital, Nay Pyi Taw. These choices permit the comparison of regions with states and encompass a range of population, poverty levels, geography, governance issues, and conflict histories. During this period, the research team conducted semi-structured interviews with 78 stakeholders in subnational energy governance, including state/region MPs and ministers, Union energy officials within MOEE and a number of its sub-departments, bilateral and multilateral donors, private sector investors and project developers, energy consultants and experts, and members of civil society organizations working on energy issues at the Union and state/region levels.



...this report incorporates the views of state and region governments themselves on the challenges and opportunities presented by Myanmar's evolving energy sector.



MYANMAR'S ENERGY SECTOR

The electrification of Myanmar is a tale of inequality. The Yangon metropolitan area alone consumes half of the country's electricity. State/region electrification is also starkly unequal, and nine of the 14 states and regions have household electrification rates below 40 percent (see figure below).

The government is tackling this challenge through its National Electrification Project (NEP), which calls for 100 percent household electrification by 2030. Myanmar had 2.3 million household connections in 2014. If successful, the NEP will add more than 7.2 million more by 2030, at a cost of USD 5.8 billion, roughly USD 800 per household connection (World Bank 2016).

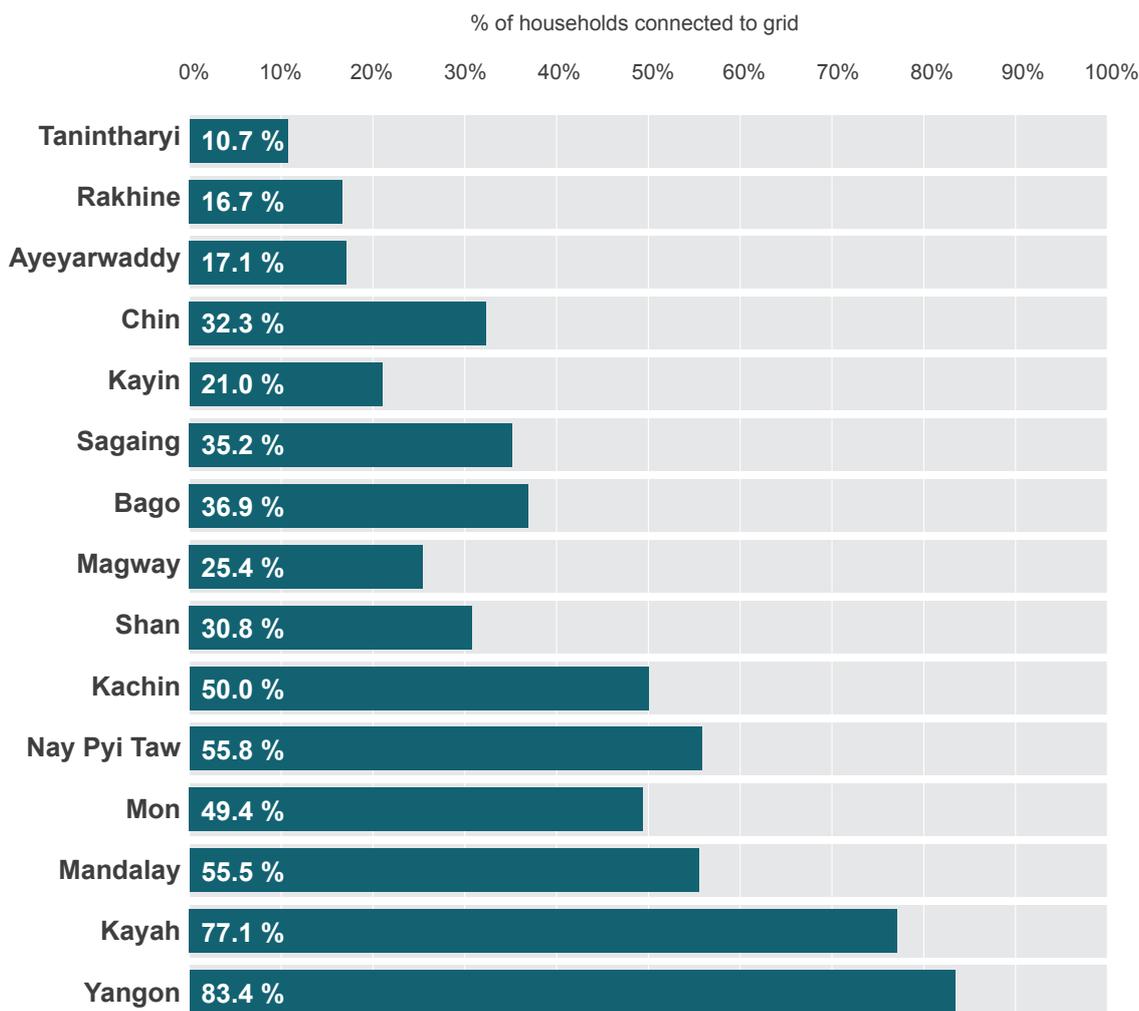
The energy sector attracted 58 percent of all foreign direct investment (FDI) in Myanmar from 1988 to 2017. Nearly half of this energy sector investment went

into the power sector—USD 20.1 billion across 14 investments, most of them large hydropower projects. More than 60 percent of this power-sector FDI took place in 2010–12, shortly after the reopening of the Myanmar economy. After power, the next-largest subcategory of energy-sector investment was oil and gas. It appears that the predominant fuel for future planned electrification will be natural gas: some 80 percent of the power-plant projects currently in the pipeline of the Ministry of Energy and Electricity (MOEE) are gas fired, 15 percent are hydropower, and five percent are solar (MOEE 2018A).

THE PROBLEM OF THE ENERGY SUBSIDY

The national commitment to 100 percent electrification by 2030 has placed MOEE in a difficult situation, because electricity is heavily subsidized. Myanmar has among the lowest electricity prices in ASEAN.

FIGURE 1. Official electrification rates of Myanmar states and regions.



Source: MOEE web site: <http://www.moee.gov.mm/en/ignite/page/80>

The residential rate is less than half the production cost of roughly MMK 109 (7.2 U.S. cents) per kWh, and the government loses MMK 59–74 (3.9–4.9 U.S. cents) on every unit sold to residential customers (de Langre 2018). Because it loses money on each unit of electricity, the MOEE’s deficit increases as the number of connected households grows.

Financial losses from electricity service in FY 2017–18 exceeded projections by more than a factor of three, reaching MMK 406.52 billion (USD 300 million). This number is expected to reach USD 400–500 million in 2018–19, and as high as USD 1 billion—1 percent of GDP—in the next few years (Thant 2017; de Langre 2018; Thant 2018A). This subsidy cannot be sustained over the long term. The World Bank estimates that achieving the target of 100 percent household electrification by 2030 will require a total investment of more than USD 30 billion. To give a sense of scale, Myanmar’s total tax revenue for 2017–18 is estimated at just under USD 5 billion, so the electrification effort could absorb about half of total tax revenues over a 10-year period (de Langre 2018).

LEGAL MANDATE AND STRUCTURE OF SUBNATIONAL ENERGY GOVERNANCE

The 2008 Constitution lays out the respective powers of the Union and state/region governments with regard to energy. It gives the Union government the right to manage all generation and distribution of electricity connected to the national grid, and authorizes the state/region governments to manage unconnected, medium- and small-scale power systems.

The 2014 Electricity Law limits the licensing authority of state/region governments to grid-unconnected systems smaller than 30 MW. If the owner of such a system wishes to connect to the national grid, the license holder may apply to the state or region for a connection, but the MOEE “may allow or refuse” the connection. It is up to MOEE to set the terms of licenses and connections. Currently, there are no legal provisions for the connection of mini-grids to the main grid.

The tables below show the division of responsibility between state/region governments and the Union government. Table 1 covers power generation, and table 2 covers transmission and distribution.

Each state or region has a chief minister and a minister whose portfolio includes energy. It is a singular feature of Myanmar’s system of government, however, that most of the departments over which state/region energy ministers preside are actually part of Union ministries. These Union departments have offices in each state or region, staffed by engineers who work for the Union ministry. Limited state/region energy budgets further compound the reliance of state/region governments on Union energy personnel for everything from technical operations to management.

Yet despite these constraints, state/region energy ministers are exercising growing authority over their departments and playing an increasing role in policymaking, planning and budgeting, and even human resource decision-making.

TABLE 1. Responsibility for generation of electricity in Myanmar

| ACTIVITY | RESPONSIBLE PARTY |
|--|--|
| Electricity generation ≥ 30 MW or connected to the national grid | Union level: Electricity Power Generation Enterprise, under MOEE |
| Electricity generation < 30 MW and isolated from the national grid | State/region governments |

TABLE 2. Responsibility for transmission and distribution of electricity in Myanmar

| ACTIVITY | RESPONSIBLE PARTY |
|---|---|
| Electricity transmission, 33 KV and above | Union level: Department of Electric Power Transmission and System Control, under MOEE |
| Electricity distribution, 11 KV | State/region governments (or the relevant leading body of an SAD/SAZ) |
| Electricity distribution, 400V | Community (or the relevant leading body of an SAD/SAZ) |

Note: SAD is a self-administrated division, SAZ is a self-administrated zone.

STATE/REGION ENERGY PRIORITIES AND OPPORTUNITIES

State/region energy ministers have three main objectives: increase access to electricity, improve the affordability of electricity, and ensure adequate generation capacity. These priorities are nested within the development priorities of the National League for Democracy (NLD)—namely roads, water, power, and education. To achieve these outcomes, energy ministers must work within Myanmar’s legal, institutional, and budgetary frameworks. This report highlights some key priorities and concerns that emerge within this context, drawn from personal interviews, including:

- Ensuring adequate power generation
- Ensuring comprehensive and effective electricity distribution
- Coping with inadequate budgets and the low tariff
- The state/region role in project approval
- New state/region energy laws

The report also identifies several significant *opportunities* for state/region action in the energy sector, including:

- 1. Championing large-scale power development.** Kayin State recently promoted the development of a large coal-fired power plant within its borders. Although local opposition scuttled the plan, the precedent suggests that state/region governments can play a proactive role in power projects larger than 30 MW, even though they are legally a Union responsibility.
- 2. Increasing state/region autonomy over regional grids.** Tanintharyi Region is unconnected to the national grid. It relies instead on a number of “regional grids,” which deliver electricity from local generators over distribution lines originally built by the Union government. A case study of electricity concessions in Tanintharyi shows how a state/region can effectively manage and improve electricity service within its borders through a process of competitive tendering and rebidding. A regional energy law passed by the Tanintharyi legislative assembly (or “Hluttaw”) in 2013 formed the basis for the region’s active engagement in regional grid development and oversight.
- 3. Promoting mini-hydropower.** Roughly one-quarter of Myanmar’s 64,000 villages have diesel-generator, micro-hydropower, or biomass/biogas mini-grids. Only about 6 percent of villages are substantially electrified, however (Greacen 2017). At the same time, there is vast, relatively untapped, potential to expand investment in mini-hydropower. Shan State, for example, has built more than 5,000

hydro mini-grids smaller than 1 MW, and regional grids, developed under state oversight, could turn these into an important source of power (Min 2018). State regulations could play an important role in supporting mini-hydro development.

- 4. State/region action in decentralized energy and projects smaller than 30 MW.** A number of states and regions have built village-level mini-grids, but there has been very little investment in slightly larger-scale decentralized power production in Myanmar. Such small-scale generation projects of 1–30 MW are technically feasible and can be commercially viable and cost-effective. However, investors in Myanmar, whether domestic or foreign, consider these projects “unbankable”—impossible to finance—because state/region governments lack the budget authority to enter into power purchase agreements for the electricity they produce. This report looks at Thailand’s efforts to decentralize power production over the past two decades through its Small Power Producer Program. Of the 24,750 MW of new generation capacity in Thailand since 2009, 20 percent has been from power plants smaller than 50 MW. This could be an interesting model for Myanmar (Greacen and Greacen 2004; Tongsopit 2014).
- 5. State/region action on off-grid electrification and village-scale mini-grids.** One area that is clearly within the domain of the states and regions is small-scale, off-grid electrification. The NEP is developing electricity mini-grids in thousands of villages across the country as part of its “preelectrification” strategy, and the states and regions will play an important role in authorizing and overseeing these systems. The Department of Rural Development has already developed draft regulations with guidelines, for consideration by both the Union and state/region governments.

KEY FINDINGS AND RECOMMENDATIONS

The state/region role in the energy sector will grow in prominence as energy production becomes more decentralized, following regional and global trends. Given this likelihood, this report focuses on areas where states and regions have a mandate, where they will need to develop skills and capacity, and where they have opportunities for greater agency in energy planning and development within their borders. The findings and recommendations fall into three broad areas:

- Energy legislation, policy, and planning
- Energy project review and grid management
- Off-grid, decentralized energy and mini-grid development

Recommendations for energy legislation, policy, and planning

1. A greater state/region role in energy laws and regulations
2. Improved capacity for energy data collection and planning by state/region governments
3. Training to increase the knowledge base of state/region energy ministers
4. Gradual state/region budget increases for energy-sector development
5. Assistance to the poorest households to cover the cost of grid connection

Recommendations for energy project review and grid management

1. A more formal role for states/regions in reviewing grid-connected projects
2. A more formal role for states/regions in championing selected large-scale power projects
3. State/region approval of projects smaller than 30 MW
4. Active promotion of decentralized, grid-connected energy projects
5. Training for ministers and senior officials in energy-related technical and financial literacy
6. Training for state/region engineers

Recommendations for off-grid, village-scale energy and mini-grids

1. Adoption of Union and state/region regulations for development of off-grid energy
2. Risk protection for mini-grid developers
3. Support for development of mini-hydropower in Shan State, and other states/regions as applicable
4. A comprehensive framework for scaling up village-scale mini-grids in Myanmar
5. Technical training in mini-grids for state/region governments

THE OPPORTUNITY OF DECENTRALIZED ENERGY

The energy sector is vital to Myanmar's economic development. Myanmar's household electrification rate of 42 percent is one of the lowest in Southeast Asia, and as noted earlier, nine of its 14 states and regions have electrification rates of less than 40 percent. Significant investment is needed to electrify these areas of the country, and that investment, when it materializes, will bring major economic benefits. But energy generation and distribution cannot be directed and controlled solely by the Union government. Decentralized, smaller-scale energy resources offer several advantages. They can be deployed much more quickly than large-scale megaprojects. They are also scalable, and they improve the reliability and resilience of the electric grid. Many of the largest energy companies are shifting their investments to distributed, decentralized, low-carbon resources—the global energy behemoth Engie being the most prominent example. Decentralizing decision-making on energy infrastructure can help states/regions to attract direct investment in this sector (ACORE 2018). Such investment will not only bring electricity service to millions of Myanmar citizens; it will also create jobs, livelihoods, and new economic opportunities (ILO 2011).

Chapter 1

INTRODUCTION

1. WHY IS DECENTRALIZATION IMPORTANT IN MYANMAR'S ENERGY SECTOR?

Subnational governance is critical to the future of Myanmar and, like so much in the country, is undergoing rapid and significant change. The 2008 Constitution introduced new institutions and actors, most notably creating state and region governments, and began a process of decentralization that could significantly change the lives of people across Myanmar.

Decentralization has the potential to strengthen the peace process, improve governance, and support effective human and social development (Batcheler 2018). Governments at the subnational level that are accountable, participatory, and transparent can give people more power and influence in the formulation and implementation of laws and policies. Beyond its effect on the peace process, subnational governance can make a meaningful contribution to Myanmar's development and improve standards of living. Myanmar's state/region governments have the potential to provide more efficient and responsive public services in a country where economic growth has been slow and the quality of public service delivery has typically been poor.

The energy sector is a keystone of Myanmar's economic growth and development. Myanmar's electrification rates are among the lowest in Southeast Asia, with 42 percent of households electrified nationwide and less than 40 percent in nine of its 14 states and regions. Significant investment will be needed to electrify these areas of the country, and that investment, when it materializes, will bring major economic benefits, but it cannot be centrally directed and controlled solely by the Union government, for several reasons. First, local government involvement is needed to identify and accommodate local priorities. Second, distributed, smaller-scale energy sources, many of them renewable, have been falling in cost dramatically,¹ and several of the largest energy companies are shifting their investments to these decentralized, low-carbon sources, most prominently the energy behemoth Engie.² Decentralized, smaller-scale energy resources can also be deployed much more quickly than large-scale megaprojects; they are scalable; and they improve the reliability and resilience of the electric grid.

To summarize, the decentralization of decision-making on energy resources can attract investment to energy infrastructure at the state/region level (ACORE 2018). This will not only bring electrical service to millions of Myanmar citizens, but create jobs, livelihoods, and new economic opportunities (Jarvis et al. 2011).

1.2. HOW DOES DECENTRALIZATION APPLY TO THE ENERGY SECTOR?

The key issues and challenges of political, administrative, and fiscal decentralization are dealt with in depth in a companion to this report, *State and Region Governments in Myanmar*, which was issued by The Asia Foundation in October 2018.

This report applies the same logic to the energy sector, which is a key sector for development and currently absorbs more than half (58 percent) of Myanmar's foreign direct investment (FDI) (Eurocham 2017). The report addresses a series of energy-related questions and issues, including:

- What are the remits of state/region governments with regard to energy systems and the electricity system in particular?
- How do their remits and mandates relate to those of the Union government?
- What is the level of political, administrative, and fiscal decentralization of the energy sector?
- Where are the state/region governments able to act, and where are their options limited?
- What is their role in choosing energy-sector investments in their state or region?
- What is their role in regulating off-grid systems such as solar home systems and mini-grids?³

1.3. BACKGROUND AND OBJECTIVES

This report draws on six months of interviews with various of stakeholders across Myanmar, supported by desk research, to understand the forces shaping the energy sector. It describes how these forces affect local communities and groups, how states and regions are dealing with their decision-making responsibilities in the energy sector, and the extent to which state/region governments have the power to act to improve the energy future of their area.

A significant peculiarity of Myanmar's current system of governance is that state/region bureaucrats, who work with state/region governments, are actually officials of the Union government and report to Union ministries. A related feature of the political landscape is that anything big—projects, programs, initiatives, investments—tends to be regarded as a Union government matter.

This research is addressed to a broad audience of policymakers, government officials, experts, and international organizations who wish to support the development of Myanmar's energy sector by providing effective policy advice to the states and regions.

BOX 1. Key research questions

- What is the constitutional, legal, and institutional framework of state/region energy authority, and is there a trend toward decentralization of the energy sector?
- Where can the states and regions act autonomously in the energy sector?
- What are the challenges, opportunities, and strategies for improving subnational energy policy, management, and decision-making?
- How can states and regions attract the private-sector energy investments needed for economic development?

1.4 RESEARCH METHODOLOGY

The research team conducted field research over a period of six months (May–October 2018) in Shan State; in Yangon, Tanintharyi, and Bago Regions; and in the capital, Nay Pyi Taw. These areas were chosen to permit a comparison of regions with states and to encompass a variety of governance issues, populations, poverty levels, geographies, and conflict histories.

The author conducted semi-structured interviews with a total of 78 stakeholders in subnational energy governance, including state/region MPs and ministers, Union energy officials within MOEE and a number of its sub-departments, bilateral and multilateral donors, private sector investors and project developers, energy consultants and experts, and members of civil society organizations working on energy issues at the Union and state/region levels. Interviews centered on the mandate and role of state/region governments in energy sector decision-making and how things are working in practice. A table of interviews is presented in annex A.

The interviews were supplemented by desk research covering key reports in the energy sector, newspaper articles, and documentation relevant to the central research questions.

1.5 STRUCTURE OF THE REPORT

Following this introduction, chapter 2 provides an overview of Myanmar’s energy sector, including energy resources and supply, state/region electrification rates, the National Electrification Project, national power-expansion plans, the problem of the energy subsidy, and the role of donors in the energy sector. Chapter 3 covers the legal framework and mandate of state/region governments under the 2008 Constitution and the 2014 Electricity Law. It also explains some of the Union-level departments that work at the state/region level in the energy sector and describes the structure of subnational energy governance. Chapter 4 considers the energy-sector roles played by state/region governments in practice, based on interviews and desk research covering state/region priorities and opportunities for agency in the sector. Finally, chapter 5 presents key findings and offers recommendations to improve the ability of state/region governments to manage the energy issues that affect them.

“

Interviews [for this report] centered on the mandate and role of state/region governments in energy sector decision-making and how things are working in practice.

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Chapter 2

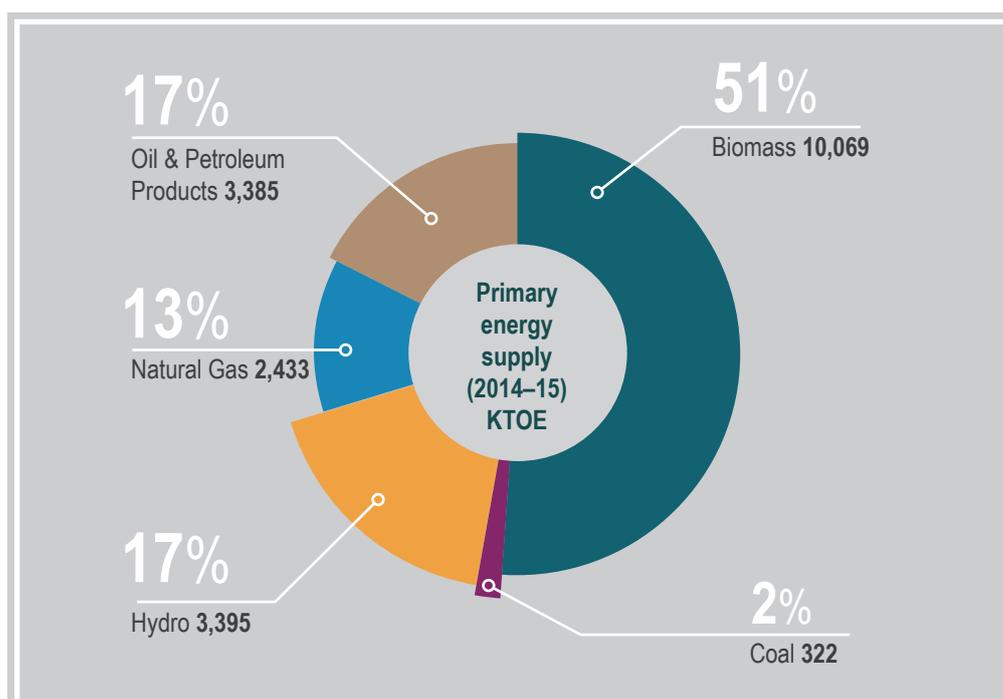
OVERVIEW OF MYANMAR'S ENERGY SECTOR

2.1. ENERGY RESOURCES AND SUPPLY

While energy is not a direct service per se, it is required for services that people need, such as lighting, refrigeration, cooking, air conditioning, and transportation. Energy is a fundamental element of economic development, and this report argues that investment in the energy sector at the state/region level is a precondition for economic development (see text box, “What Is the energy sector?”)

About half of the energy used in Myanmar comes from biomass—principally firewood, used mainly for cooking—in what is called the traditional energy sector. The main forms of “modern” energy are hydropower and natural gas, which are used to produce electricity, and oil and gas, which are used for transportation and, in some cases—e.g., diesel generators in mini-grids—to produce electricity (2).

FIGURE 2. Primary energy sources in Myanmar.



Source: MOEE 2018A.

BOX 2. What is the energy sector, and why is energy planning necessary?

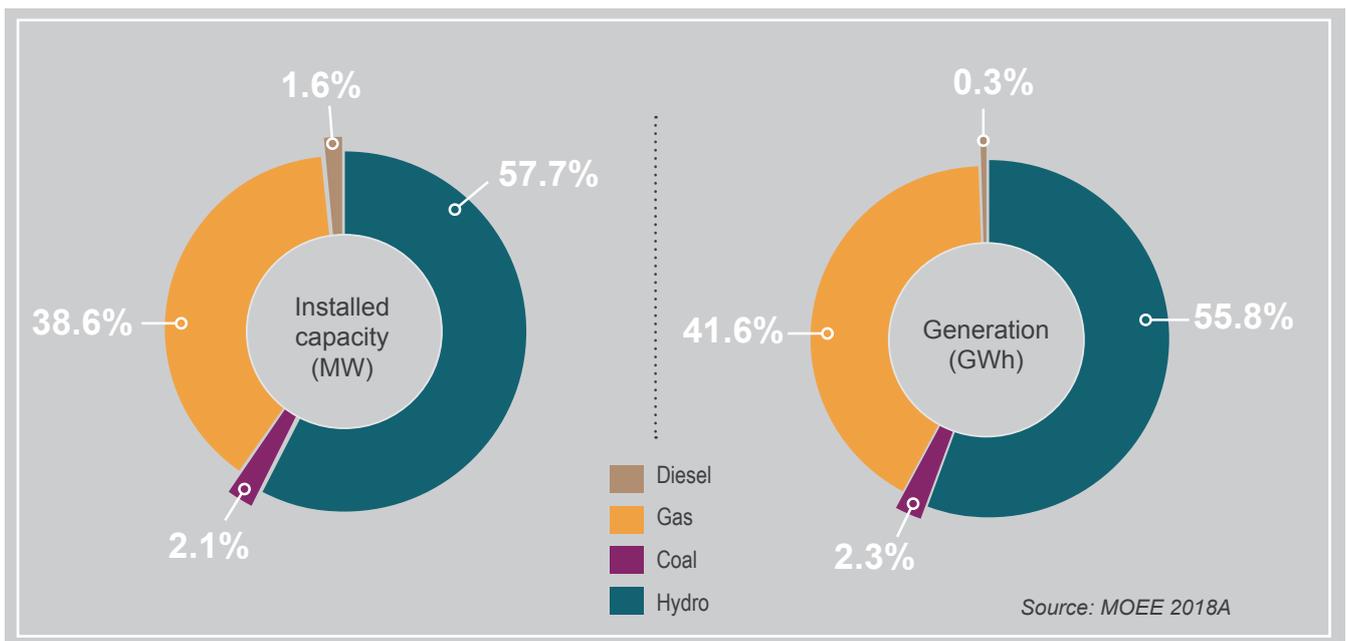
Energy plays an important role in daily lives and society. Energy is needed to provide services such as lighting, cooking, moving machines and vehicles, and powering phones and appliances. The availability of energy is an important driver and facilitator of local economic development.

While essential for a well-functioning economy and society, energy is a means and not an end in itself. Extraction, production, and consumption of energy can have environmental and social impacts. The more productively energy is used, the better for the economy, and the more we can save on costs, conserve limited energy resources, and reduce deleterious impacts.

Energy has many forms, from firewood to solar, coal, petroleum, and electricity. Primary energy, or natural forms of energy, such as sun, wind, coal, and petroleum, have to be harnessed or mined and converted to final energy, like electricity or gasoline, suitable for end users. Some energy is inevitably lost when primary energy is converted to final energy. Efficiency is therefore an important consideration in the conversion and delivery of final energy.

As the economy grows, energy planning is essential to make sure that supply can meet growing demand. Developing energy resources requires careful consideration of options, costs, impacts, and policy objectives, such as equitable access and sustainability. The planning process requires effective public engagement to arrive at solutions that are acceptable to the community and that will be robust over the long term.

FIGURE 3. The power sector: primary sources of fuel used for electricity production.



| | |  HYDRO |  GAS |  COAL |  DIESEL | TOTAL |
|-------------------------|------------------|---|---|---|--|--------|
| Installed Capacity (MW) | National Grid | 3,221 | 2,163 | 120 | | 5,504 |
| | Off Grid | 34 | 12 | | 92 | 138 |
| | Total | 3,255 | 2,175 | 120 | 92 | 5,642 |
| Generation (GWh) | Generation (GWh) | 11,190 | 8,344 | 451 | 69 | 20,055 |

Source: MOEE 2018A

This report focuses primarily on one form of energy, electricity—from production to delivery to households, buildings, and factories—because of the importance of electricity to communities across Myanmar, the low rate of electrification, and the wide disparity in electrification and electricity use.

According to MOEE power-sector data for October 2018, hydroelectric power plants account for 58 percent of Myanmar’s electrical generating capacity, and gas-fired power plants account for 39 percent (figure 3).

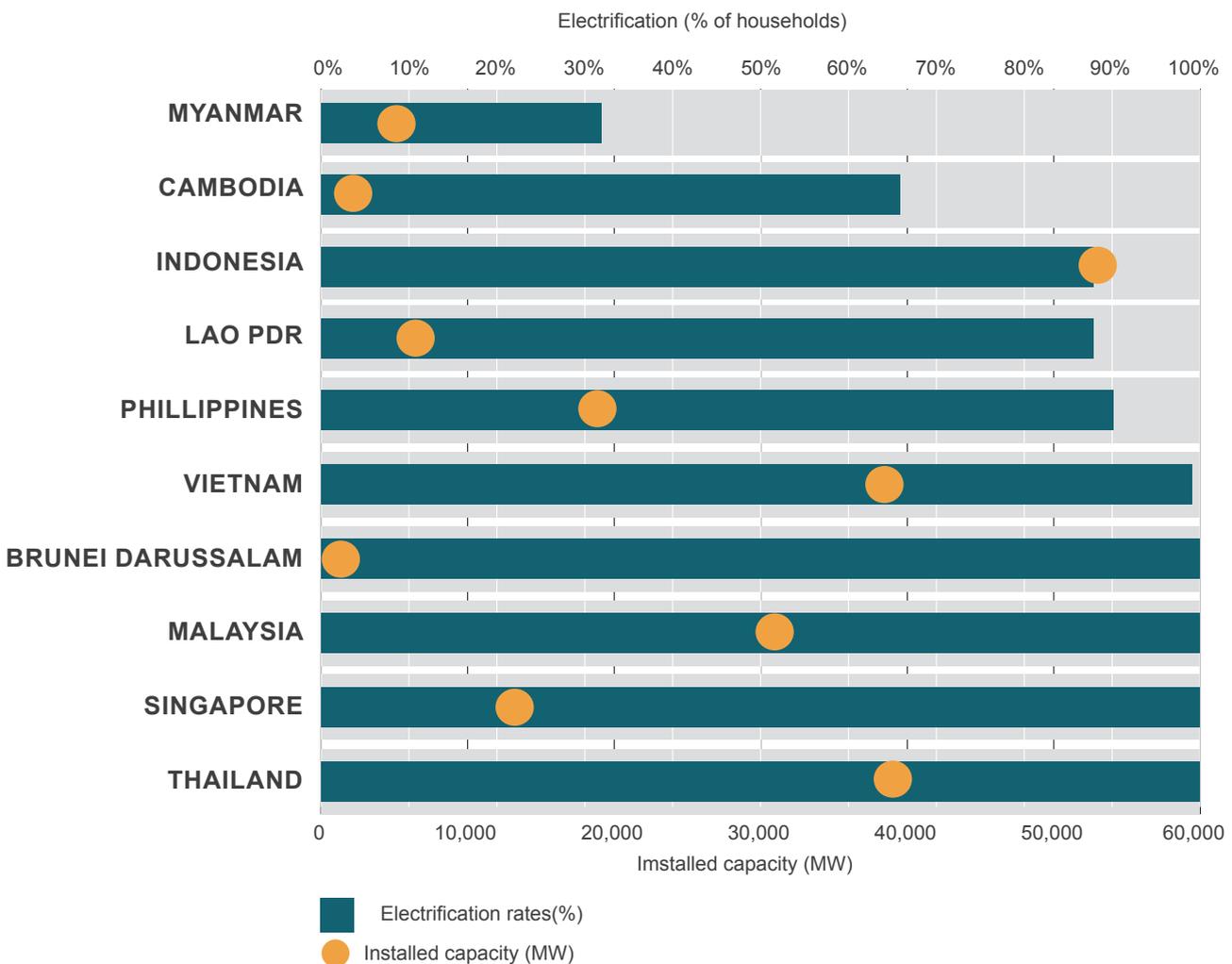
The breakdown of electricity actually generated is similar, with 56 percent from hydropower and 41 percent from natural gas. Coal currently accounts for just 2.2 percent of electricity generation, and diesel, which is used for mini-grids in remote areas, accounts for less than 1 percent.

Much of Myanmar’s natural gas is exported via pipelines, and it accounts for more than three-quarters of energy exports.⁴

2.2 THE CHALLENGE OF ELECTRIFICATION

In eight of 10 ASEAN countries, according to ASEAN data for 2016, more than 85 percent of households are connected to a power grid. The remaining two countries are Cambodia, with 66 percent, and Myanmar, with just one-third (see figure 4)). Note that the dots showing generating capacity are intended only as a point of reference to allow easy comparison of the relative size of the power grids. For example, Myanmar has much more generating capacity than Cambodia (4,800 MW vs. 1,900 MW, respectively, in 2016), but it has half the rate of electrified households, because Myanmar’s population is so much larger than Cambodia’s—54.1 million in Myanmar vs. 16.4 million in Cambodia.⁵

FIGURE 4. Electrification rates and installed generating capacity in ASEAN countries.

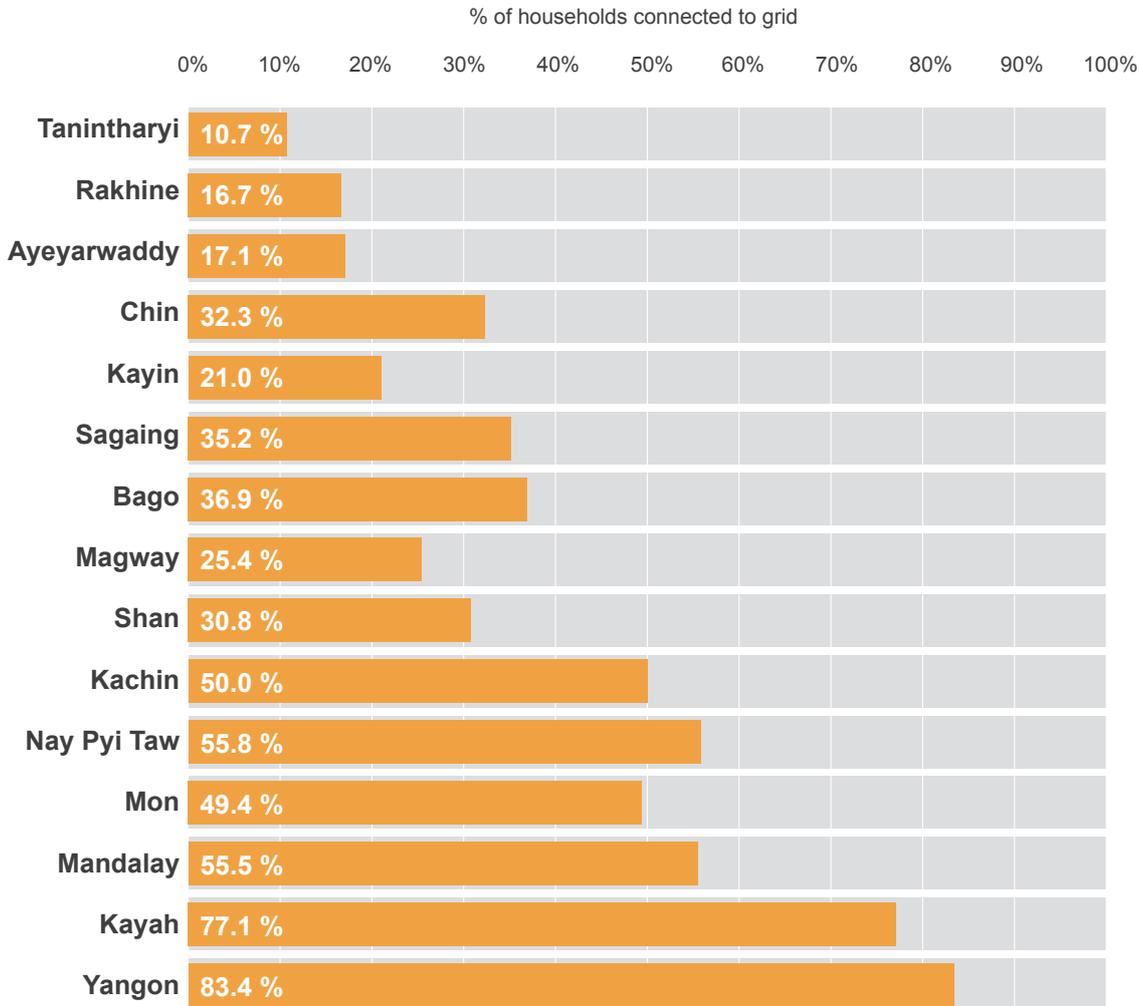


Source: HAPUA Directory 2016 and ASEAN Centre for Energy. Downloaded from: <http://www.aseanenergy.org/blog/what-is-the-status-of-energy-infrastructure-in-asean-power-sector/>

The electrification of Myanmar is a tale of inequality. Figure 5 compares the electrification rate of states and regions across Myanmar and highlights the stark inequality in access to electricity. For example, the single

urban area of Yangon consumes half of the country's electricity, while nine of the 15 states and regions have fewer than 40 percent of their households connected to the electrical grid.

FIGURE 5. Official electrification rates of Myanmar states and regions.



Source: MOEE web site: <http://www.moee.gov.mm/en/ignite/page/80>

2.3 THE NATIONAL ELECTRIFICATION PROJECT

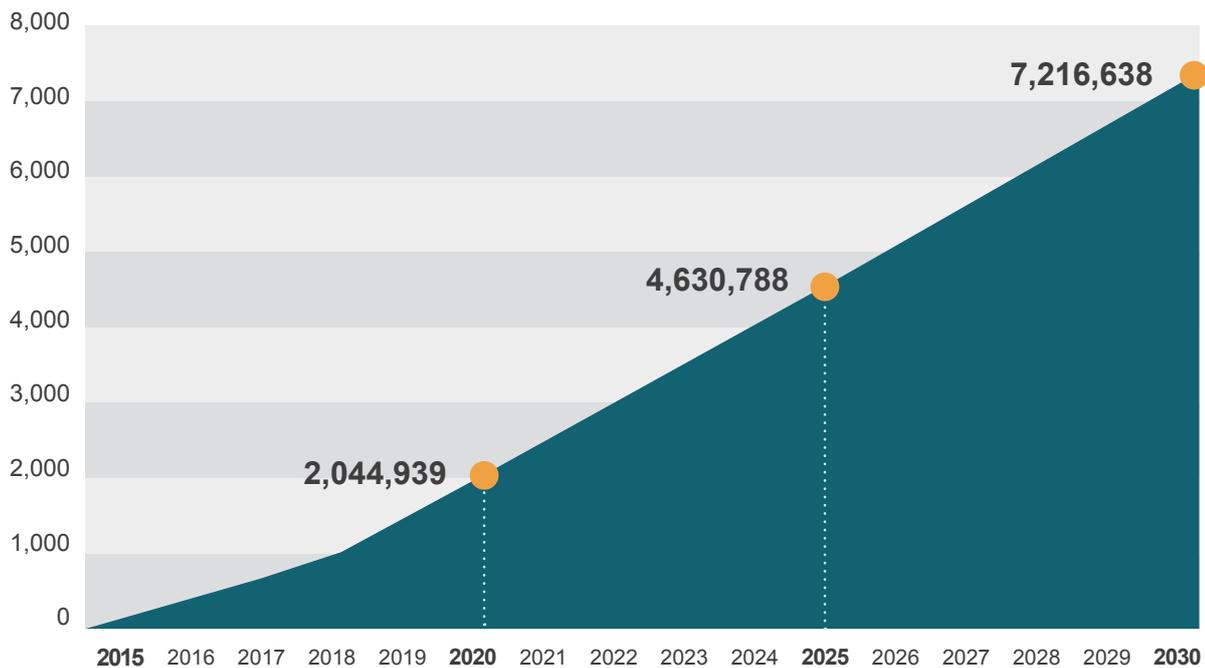
Myanmar's National Electrification Project (NEP) aims to achieve 100 percent electrification of Myanmar households by 2030 (see text box, "Myanmar's National Electrification Project"). In 2014, Myanmar had 2.3 million connected households, and the NEP goal is to connect more than 7.2 million more households over a 16-year period. The total cost of the NEP has been estimated at USD 5.8 billion, or an average of USD 800 per household connection (World Bank 2016).

Geospatial planning to prioritize grid extension

With support from The World Bank, Columbia University's Earth Institute developed a geospatial electrification plan and estimated that more than 90 percent of new connections would be grid-based. The balance would need to be off-grid connections, to be provided by solar home systems and mini-grid systems (Castalia 2014).

To achieve the target, new household connections would need to nearly triple, from a yearly rate of 189,000 in 2014 to 520,000 annually over the coming decade (see figure 6).

FIGURE 6. Projected number of household connections under the National Electrification Project roadmap.



Source: Castalia 2014

The NEP roadmap notes that the 2014 electricity tariff (average USD 0.037/kWh) would leave a funding gap of USD 2.1 billion in the electrification program. The roadmap indicates that the government would need to increase the average residential tariff over the period to USD 0.05/kWh, a 35 percent increase (Castalia 2014).

The NEP roadmap also envisions that 99 percent of households will be electrified by 2030 through expansion of the main power grid. Interviews carried out for this research cast doubt on this target for both economic and technical reasons. A number of respondents believed that the government could not afford the grid extension. One senior energy official thought the grid would reach around 94 percent of households at best, and called for a strategy to connect the main grid to proliferating mini-grids. Another respondent, an international energy expert, said simply, “Let’s be honest, the incremental cost of extending the grid to every nook and cranny of Myanmar doesn’t make sense, and you can’t pay for it.”

The original geospatial analysis for the NEP was done by Columbia University and used 2012 data. Since then, the government has obtained better geospatial location data for villages. At the time, there was geospatial data for about 65–70 percent of the villages; now that figure has risen to about 85 percent of villages because of data from MIMU and the OneMap initiative.⁶ There is also SES data for each village, and MOEE is adding geospatial data on small and medium substations to give a better real-time picture of where the grid has been extended. The ongoing data updates

will be done by MOEE and the International Growth Center (IGC).

2.4 ENERGY DEVELOPMENT IN THE CONTEXT OF OVERALL INVESTMENT

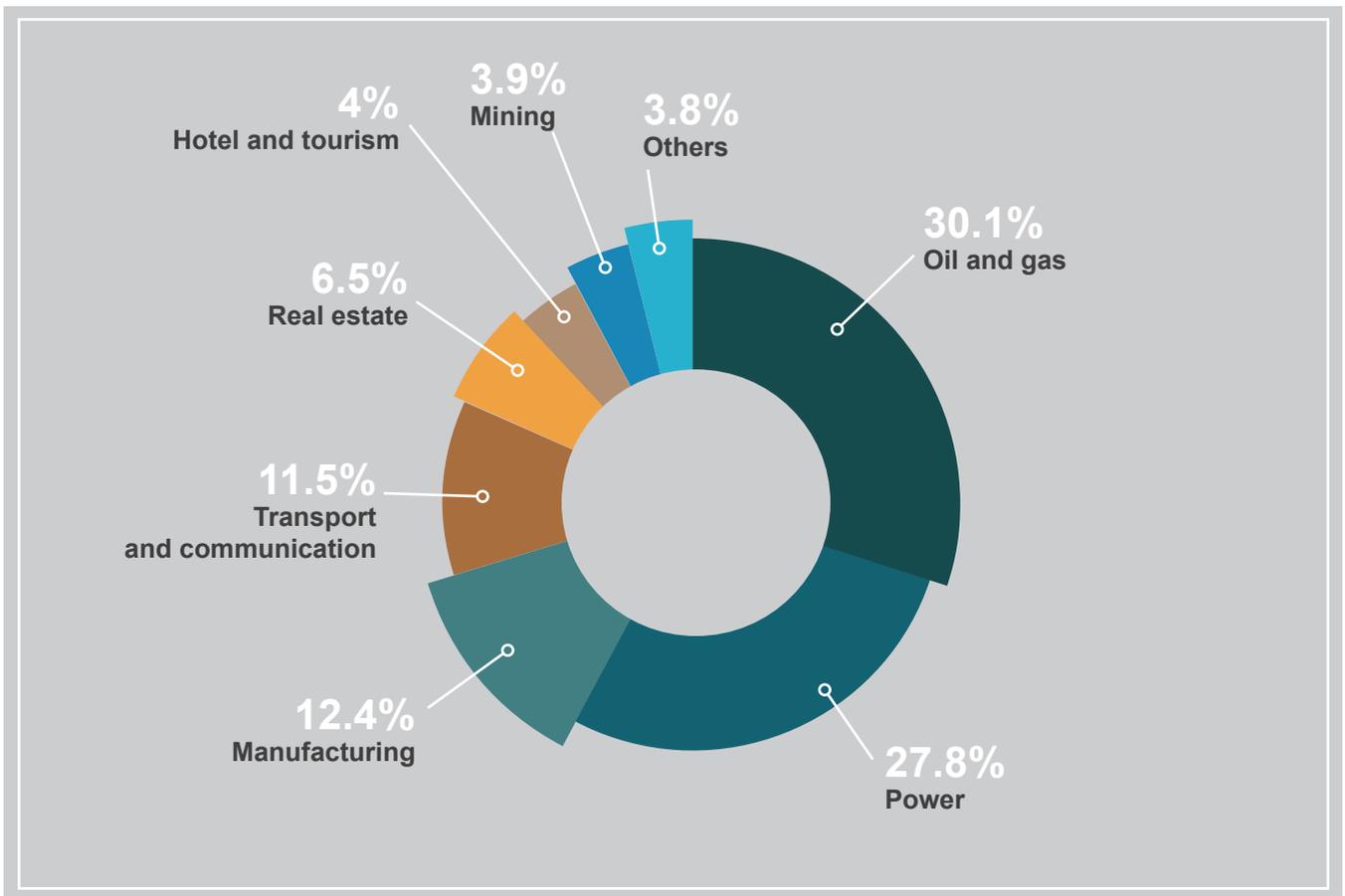
Energy is the largest area of foreign direct investment (FDI) in Myanmar, attracting more than half (58 percent) of all FDI over the period 1988–2017 (see figure 7). Nearly half of this energy sector investment went into the power sector—USD 20.1 billion across 14 investments, most of which were large hydropower projects, and more than 60 percent of this occurring in the period 2010–12 after the reopening of the Myanmar economy. Figure 8 shows the spurts of foreign investment in 2005–06 and again in 2010–12.

Given the levels of investment, current and planned, in the energy sector, it is clear this sector will enjoy the largest share of infrastructure spending by far, but this spending may differ from other countries in Southeast Asia. For example, because Myanmar is a highly agrarian society and the population is quite dispersed, energy-sector investment in heavy industrialization is probably not the future. At the same time, there is a need to attract investment in the energy sector at the state/region level to spur economic development and, as part of this process, to build the capacity of state/region governments to manage energy-sector planning and decision-making within their borders.

Off-grid: A “preelectrification” plan

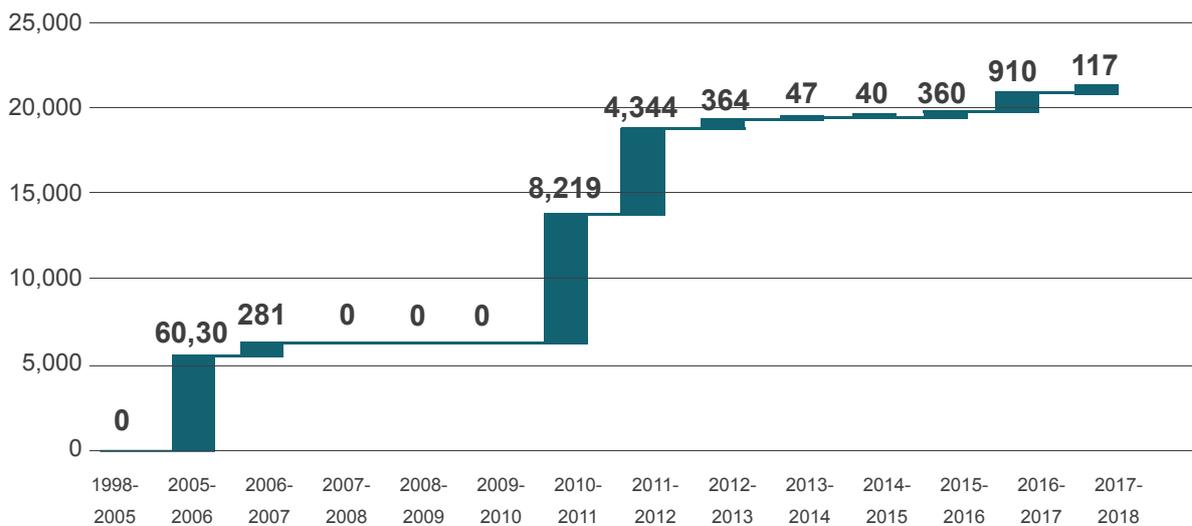
There is not an unlimited budget for grid extension.

FIGURE 7. Foreign direct investment in Myanmar, 1998–2017.



Source: DICA data and statistics cited in Eurocham 2017

FIGURE 8. Foreign direct investment in the Myanmar power sector, 1998–2018.



Source: DICA data and statistics cited in Eurocham 2017

The NEP designates about 3–4 percent of settlements for what it calls “preelectrification,” which means the provision of electricity through non-grid approaches such as solar home systems, solar battery charging, and mini-grid systems. This preelectrification is planned to cover about 491,500 households across

Myanmar by 2021 (World Bank 2015). It has already spurred intense interest in the development of mini-grids powered by photovoltaic systems, and it appears this will be a significant source of energy development in rural Myanmar in the coming years (see section 4.3 for more discussion of off-grid programs).

BOX 3. Myanmar’s National Electrification Project

Under the National Electrification Project, the Myanmar government took a loan of USD 400 million from the World Bank. The loan has two main elements:

- Grid extension (USD 300 million). This amount is for procurement of goods and services to extend the national grid
- Off-grid component (USD 80 million). This amount is for off-grid electrification through solar home systems, village-level mini-grids, electrification of health clinics, and public street lights.

The balance of the loan (USD 20 million) is for technical assistance and project management. The loan period extends through 2021, and the overall targets are as follows:

- People provided with new or improved electricity service = 5.7 million
 - Grid connected = 3.2 million
 - Off-grid/mini-grid, renewable sources = 2.3 million
 - Off-grid/mini-grid, nonrenewable sources = 0.2 million
- Community electricity connections
 - Grid-connected = 10,000
 - Off-grid/mini-grid, renewable sources = 11,400
- Public lighting
 - Grid-connected = 113,000 systems
 - Off-grid = 19,000 systems
 - Distribution lines constructed = 20,700 km
 - Transformers installed = 735,000

Source: World Bank 2015

2.5 POWER-EXPANSION PLAN

BUILDING POWER-GENERATING CAPACITY

As of late 2018, Myanmar had about 5,500 MW of installed capacity (figure 9) and only about 3,300 MW of peak demand. The reason for this disparity is that much of Myanmar’s generating capacity is hydropower, which has a low “capacity factor” because for much of the year, power output is limited by low water levels.

Under the previous government, many independent power producers (IPPs) proposed construction of coal-fired power plants to meet growing energy demand. Eventually, a total of 11 coal-fired plants were approved. The projects have since stalled due to significant public opposition—e.g., 60–70 communities signed petitions against the plants. To date, only one of the 11 coal-fired power plants has become operational.⁷

Given the pipeline of current projects announced by MOEE in 2018, it appears unlikely that coal will play

such a large role in the mix. Table 11 in Annex C shows the MOEE pipeline, which indicates whether projects are approved or likely to proceed. There are about 12,700 MW of power-plant projects, with roughly half the projects “approved” (generally meaning the government has signed a Notice to Proceed) and half undergoing feasibility assessments.

Figure 10 shows the breakdown of projects in the MOEE pipeline by fuel type:

- Eighty percent of the power-plant projects in the MOEE pipeline will use natural gas.
- Fifteen percent are hydropower.
- Five percent are solar projects.

The government is banking on natural gas to meet the rising demand. In January 2018, it announced a high-priority, intensive program to build 3,000 MW of gas-fired power plants within the next three years using LNG (Shin 2018). Domestic natural gas, which will be cheaper than LNG, should enter the domestic market starting in 2023 (Htwe 2018B).

FIGURE 9. Energy Master Plan demand forecast through 2030 and actual generating capacity.

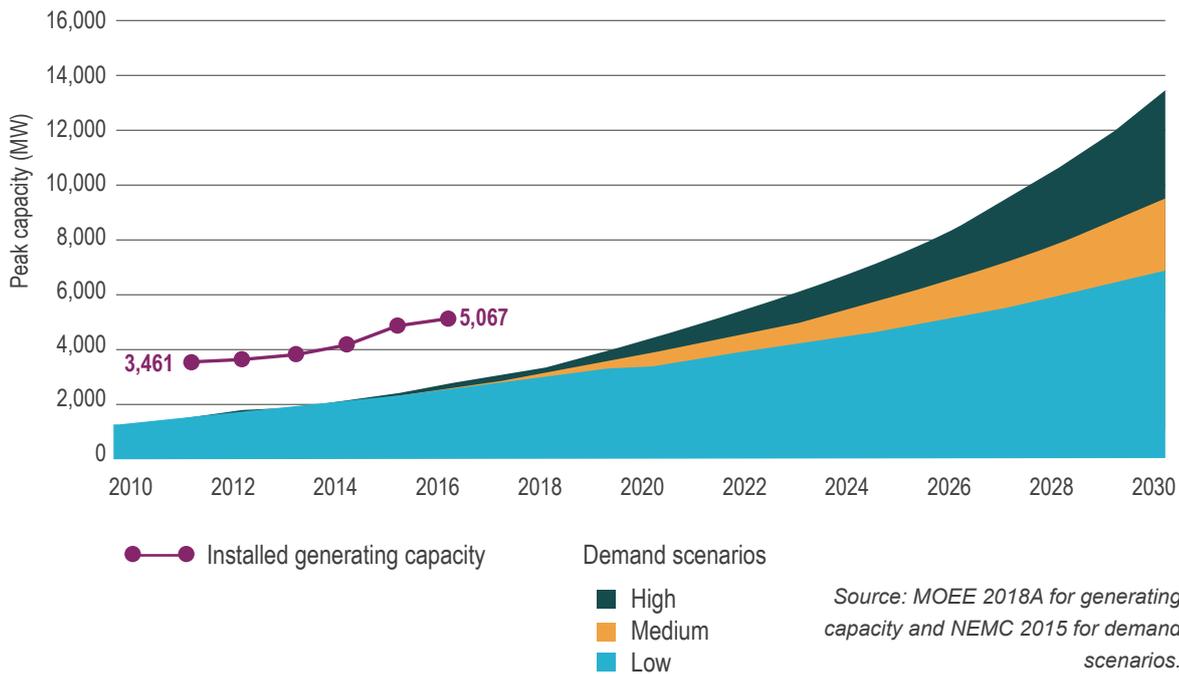
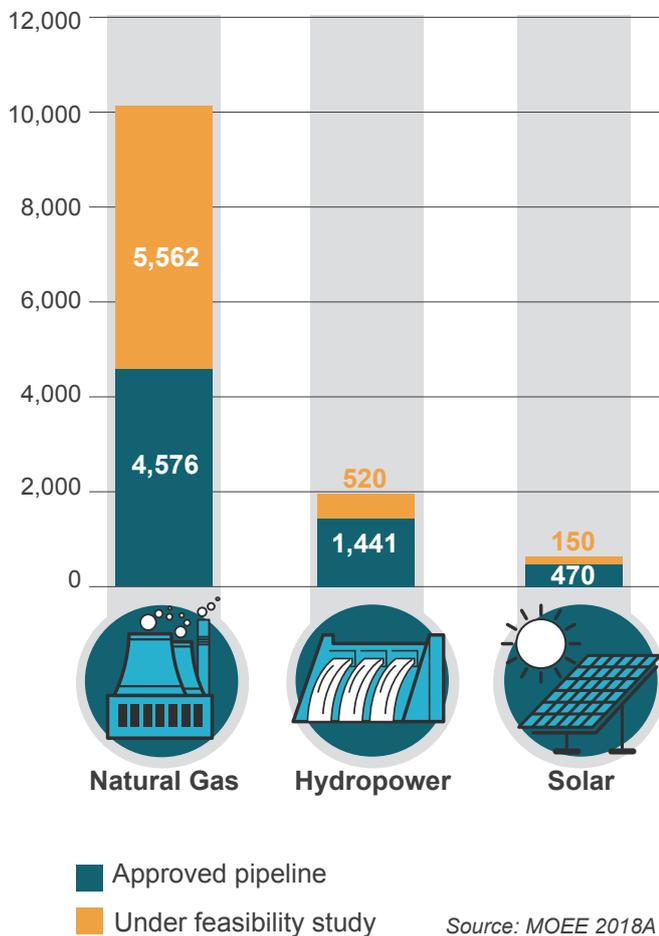


FIGURE 10. Breakdown by fuel type of pending MOEE power projects.¹⁰



On January 30, 2018, MOEE approved four large gas/LNG power projects through a Notice to Proceed (NTP) instrument.⁸ Some interviewees expressed concern about this “emergency 3 GW gas plan,” questioning the way it was developed, its financial viability, and the long-term impacts of these projects on the national budget.⁹

For more information on power generation plans, see annex C.

POWER TRANSMISSION AND DISTRIBUTION PLANS

Under the Electricity Law, transmission lines are the responsibility of the Union government, which interviewees viewed as a constraint on investment because it excludes the private sector. MOEE officials at the Union level indicated that, even with large donor loans, investment in 500 kV and 230 kV transmission lines is urgently needed to strengthen the grid to meet future demand. One respondent said that discussions had occurred in late 2018 with the Union of Myanmar Foreign Chambers of Commerce (UMFCCI) to change the law to permit private-sector investment in power transmission.¹¹

For more information on transmission and distribution plans, see annex C.

2.6 THE ROLE OF DONORS IN THE ENERGY SECTOR

International donors and financial institutions are providing valuable support to the Myanmar government to help finance power sector investments, particularly by strengthening and expanding the transmission and distribution infrastructure. Nearly all of the policy advice, technical assistance, and investment is organized at the national level and channeled through Union ministries, particularly MOEE and, in the case of off-grid energy, the Department of Rural Development (DRD) of the Ministry of Agriculture, Livestock, and Irrigation (MOALI).

This substantial donor input is shaping institutions. MOEE, for example, absorbs USD 300 million of the World Bank loan to expand the power grid under the National Electrification Project, and DRD absorbs much of the USD 80 million of World Bank funding to support off-grid development through the expansion of solar home systems and mini-grids.

MOEE holds a regular meeting of its Electricity and Energy Sector Coordination Group, and in August 2018, MOEE and donors agreed on the following strategic priorities for the energy sector:

- Improve the financial viability of the sector.
- Accelerate the pace of electrification.
- Ensure efficient and sufficient investment.

Note that all of these are Union-level priorities, and none of them address the role of states and regions in energy policy, investment, implementation, and oversight.

See annex D for an overview of international donor support in Myanmar's energy sector.

2.7 THE PROBLEM OF THE ENERGY SUBSIDY

The Ministry of Energy and Electricity is in a difficult situation, created by the conflict between its own commitment to achieve 100 percent electrification by 2030 and the fact that the electricity tariff subsidy will steadily increase as it continues to add new households to the national grid. Since it is losing money on each unit of electricity sold, the MOEE's debt increases as it expands the number of connected households (Thant 2018A).

Myanmar has among the lowest electricity prices in ASEAN. The residential rate is MMK 35 (2.3 U.S. cents) per kWh for the first 100 units, MMK 40 (3 U.S. cents) for the next 100 units, and MMK 50 (3.3 U.S. cents) per kWh after that. Unfortunately, this is not nearly enough to cover the cost of production. The average cost of supplying a kWh in early 2018

was MMK 109 (7.2 U.S. cents), which means that the government loses MMK 59–74 (3.9–4.9 U.S. cents) on every unit sold to residential customers (de Langre 2018).

During fiscal year 2017–18, projected financial losses from electricity generation were MMK 133 billion, but according to MOEE, the actual losses were more than three times that—MMK 406.52 billion (USD 300 million). The subsidy is expected to increase to as much as USD 400–500 million during 2018–19, and then to more than USD 1 billion—1 percent of GDP—in the next few years (Thant 2017, 2018A; de Langre 2018).

The subsidy cannot be sustained over the long term. The World Bank estimates that achieving 100 percent household electrification by 2030 will require a total investment of more than USD 30 billion. To give a sense of scale, Myanmar's total tax revenue for 2017–2018 is estimated at just under USD 5 billion, so the electrification effort could absorb about half of total tax revenues over a 10-year period (de Langre 2018).



The [electricity] subsidy is expected to increase to as much as USD 400–500 million during 2018–19, and then to more than USD 1 billion—1 percent of GDP—in the next few years.



One senior adviser to the government described the evolution of the Ministry of Planning and Finance (MOPF) into a more proactive watchdog on energy budgets. Previously, he said, MOPF was “staffed mainly by accountants who were checking the books ... they did not have much planning or forecasting ability,” but now the agency is pressing MOEE to seriously grapple with the implications of the growing electricity subsidy. According to the adviser, MOPF is concerned that the subsidy primarily benefits large, urban, residential customers while consuming funds that could be used for grid expansion and other, non-revenue-generating activities like education and health care.

On the other hand, he noted that rising tariffs have historically been associated with periods of social and political upheaval, as in 1962, 1988, and 2006, just before the Saffron Revolution, a correlation that still haunts policymakers.

2.8 THE “EFFECTIVE TARIFF” IS HIGHER FOR COMMERCIAL AND INDUSTRIAL CUSTOMERS

Another point that came up in our interviews is that many commercial and industrial customers effectively pay much higher rates for electricity than the nominal tariff, because businesses have to keep an extra generator on hand for power outages, resulting in a blended rate that can easily be two or three times the basic MOEE tariff of around MMK 50 (3.3 U.S. cents) per kWh. An executive of a solar company that is developing several large, grid-scale solar-power projects that will sell power to the government through EPGE said that his company is also in discussions with business owners to install rooftop solar-power systems for factories and buildings. While the cost of power from solar rooftop systems is higher than the average published tariff, he explained, it is actually less than what factory and building owners now typically pay.

At first, the customer thinks that what we are charging for solar power, which is around MMK 150–180 [10–11.2 U.S. cents] per kWh, is more expensive than their subsidized power. But they often don’t realize what their blended rate is. What we find is that commercial and industrial customers are typically paying in the range of MMK 230–300 [12–15 U.S. cents] per kWh when they add up the total cost of backup generators and diesel fuel.

Chapter 3

STATES AND REGIONS— THE FRAMEWORK AND STRUCTURE OF THEIR ROLE IN ENERGY

3.1 WHAT IS THE LEGAL FRAMEWORK FOR ENERGY DEVELOPMENT?

CONSTITUTION

The 2008 Constitution of the Republic of the Union of Myanmar is the fundamental law in the framework for decentralization. It establishes the administrative structure of the state and creates 14 new state/region governments, which consist of a unicameral, partially elected state/region hluttaw (legislature), an executive led by a chief minister and a cabinet of state/region ministers, and state/region judicial institutions. The formation of state/region legislatures and executives represents a significant devolution of authority from the Union government (Batcheler 2018).

The 2008 Constitution also defines the powers of the Union and state/region governments with respect to energy. It states that the Union government has the right to manage all generation and distribution of electricity connected to the national grid. The state/region governments have the right to manage medium- and small-scale power generation and distribution systems unconnected to the national grid.

A key element of the 2008 Constitution is its definition of the Schedule 1 and Schedule 2 roles of government:¹²

- Schedule 1 of the Constitution defines the roles and responsibilities of the Union government.
- Schedule 2 defines the roles and responsibilities of the state/region governments.

ELECTRICITY LAW

Replacing the 1984 version, the 2014 Electricity Law (Pyidaungsu Hluttaw Law No. 44) sets the legal framework for the electricity sector in Myanmar.¹³ The law calls for the formation of a five- or seven-person Electricity Regulatory Commission (ERC) headed by a chairman from the Union level, but the ERC has never been established. Even if established, the ERC would have no staff and weak regulatory authority, limited mostly to advising, studying, reviewing, and consulting with the governments and the private sector on various energy issues (Electricity Law, sections 4 and 5).

The real power of the law is exercised through a licensing regime. No one, regardless of system size, is allowed to engage in activities in the electricity sector without a license (section 44). Only the Union-level MOEE and state/region governments (including self-administered divisions and zones) are authorized to grant licenses (section 7). Licenses can be granted to local or foreign investors in accordance with existing laws. There are no specific restrictions on foreign investments.

National Energy Policy. The Union government launched a nine-point National Energy Policy in 2015.¹⁴ It established MOEE as the lead agency for energy activities in Myanmar, and newly assigned the DRD to oversee off-grid electrification. The 2015 National Energy Policy replaced the earlier National Energy Committee, which had included representatives from 11 ministries. A challenge for the new National Energy Policy was that three of the major donor plans—the Asian Development Bank’s National Energy Master Plan (ADB 2016), the World Bank’s National Electrification Project (World Bank 2016), and the Japan International Cooperation Agency’s National Electrification Master Plan¹⁵—were not really aligned with each other. According to a number of private, NGO, and public-sector stakeholders, there was no master plan for Myanmar’s power sector apart from the general goal of 100 percent household electrification by 2030. And even though the government is following the five-phase plan of the National Electrification Project (NEP), the roll-out of the NEP does not reflect the actual situation on the ground, so it is not an accurate planning tool.¹⁶

Role of state/region governments. The licensing authority of state/region governments is limited to generation and distribution systems smaller than 30 MW unconnected to the grid. If the owner of an unconnected system wishes to connect to the national grid, the license holder of the system may apply to MOEE for a connection, but the MOEE “may allow or refuse” the application (section 14). It is up to MOEE to set the terms of licenses and connections. Currently, there are no regulations governing the connection of mini-grids to the main grid. The default response to date has been to refuse interconnection.

The Electricity Law also grants the MOEE, subject to Union government consent, the right to carry out large-scale projects (> 30 MW) including generation, transmission, and distribution of electricity and trading electricity across national borders. MOEE is also authorized to transfer its capital, assets, and property to an electrical power corporation to implement large-scale projects, and to arrange financing in such a way that the corporation can manage its finances autonomously (section 8d).

The law also grants MOEE and state/region governments the right to obtain permission to use the land required for electricity generation, transmission or distribution for grid-connected projects and isolated generation and distribution of less than 30 MW. The law requires, however, that the MOEE, state/region governments, and private entities engaged in electricity activities conduct an environmental impact assessment (EIA) in accordance with the Environmental Conservation Law. They are also required to pay compensation for such impact and contribute to the Environmental Conservation Fund (section 10).

Other relevant laws are:

- **The Myanmar Companies Act of 1914.** This act regulates the formation of companies in Myanmar and covers any company in the energy sector. During 2017 and 2018, discussions were under way to approve the first amendment of the Act since 1940. Reportedly, amendments were to include an increase in the permissible share of foreign ownership in a Myanmar company and the establishment of an electronic company registry (Thiha 2018).
- **The State-Owned Economic Enterprises Law of 1989** (SLORC 1989). This law describes the categories of business reserved exclusively for the government. With regard to energy and electricity, these are:
 - exploration, extraction and sale of petroleum and natural gas and production of products of the same (item 3 on list);
 - electricity generating services other than those permitted by law to private and cooperative electricity generating services (item 11 on list).

Myanmar Investment Law of 2016. The Myanmar Investment Law 2016 provides a more comprehensive and streamlined framework for foreign investment in Myanmar, including in the energy sector. The law consolidates and replaces the previous Foreign Investment Law 2012 and the Citizens Investment Law 2013. The Government will now treat foreign and local investment projects equally in terms of expansion, management, operation and sale of direct investments. The law provides new, streamlined procedures for investment approval, and there are now two types of processes to obtain approval from the Myanmar Investment Commission (MIC)—the permit application process and the endorsement application process.

Lack of a Rural Electrification Law. In 2014 and 2015, The Asian Development Bank (ADB) consulted with MOEE and the Myanmar government on the Electricity Law and its associated rules and regulations. One of the objectives of the ADB project was to develop a rural electrification law that would promote rural electrification by identifying a government agency

to lead the effort, increasing the operational efficiency of the power grid, allowing private-sector participation, supporting mini-grids, and designing sustainable household electrification programs (ADB 2016).

The intent was to establish a clear institutional structure and a mechanism for government funding, to specify how the funding would be used, and to enable debt financing of off-grid electrification projects. Although a draft of the rural electrification law was prepared, it was never formally considered. ADB's final report recommends two types of electrification programs to expedite electrification in Myanmar:

- a small power-producer and -distributor program, which would relax regulatory requirements for mini-grids and off-grid generation to spur private sector investment
- a distribution program of subfranchises and subcontractors, which would provide incentives to increase the rate of electrification by “using sub-franchises and subcontracts to attract private investments in new or upgraded distribution networks” (ADB 2016).

Like the Electricity Law, the Foreign Investment Law has few restrictions on foreign investments in the power sector. Electricity generation under 10 MW is generally reserved for local investors, but with MOEE approval, foreign investors can have up to 80 percent equity in a joint venture for projects under 10 MW. Foreign investors are also allowed to operate as IPPs in Myanmar and receive concessions for natural gas turbines, hydropower, solar power, waste-to-energy, and wind power (DFDL 2016).

ENVIRONMENTAL CONSERVATION LAW OF 2012

Any individual or entity that plans to conduct an activity with the potential to harm the environment is required to seek prior permission from the Ministry of Natural Resources, Environment, and Conservation (MONREC) and comply with the Environmental Conservation Law and regulations, including conducting an EIA or an initial environmental examination (IEE) (DFDL 2016). The text box below, “Building the capacity to oversee the environmental impact process for power projects”, describes the role of the Environmental Conservation Department within MONREC.

Projects required to conduct an EIA under this law are:

1. *Project-based categories*—hydropower and other heavy electricity production and construction of the national grid for electric power
2. *Location based categories*—projects with operations in fragile ecological sites, in areas of

endangered flora or fauna, in the vicinity of main resources or public drinking water, lakes, and reservoirs, and in areas prone to natural disasters

Projects fall into one of the following three categories, depending on type and scale:

1. *IEE projects*

Project proponent informs MONREC of the name of the company performing the IEE and submits the the IEE in the Myanmar and English languages. The IEE report is to be disclosed to civil society, project-affected persons (PAPs), local communities, and other stakeholders through local media and at public meetings. The Ministry of Environmental Conservation and Forestry (MECF) is also required to disclose the IEE report to the public, arrange public consultations, and collect and review public comments and recommendations before making a final decision (DFDL 2016).

2. *EIA projects*

Project proponent must submit an EIA report to MECF. MECF will then invite comments from all relevant parties and arrange public consultations, where the project proponent will present the EIA report. MECF collects and reviews public comments and recommendations before making a final decision. Project proponent must comply with an Environmental Management Plan (EMP) that has received an Environmental Compliance Certificate from the MECF, and is responsible for all MECF's costs related to monitoring and evaluation (DFDL 2016).

3. *Projects requiring no environmental review*

For energy projects, the cut-off sizes for IEEs and EIAs for the primary plant types are shown in table 3 (see annex E for more detail).

BOX 4. Building the capacity to oversee the environmental impact process for power projects

In the power sector, the environmental impacts of planned coal power plants are a major issue, and there are often community protests against planned coal power plants and large hydropower projects (see related text box, “Strategic environmental assessment of hydropower in Myanmar”).

The Environmental Conservation Department (ECD) of MONREC, established in 2012, is responsible for overseeing the EIA process in Myanmar. The procedures governing EIAs cover the energy and mining sectors, among others (see annex 2).¹⁷

At its formation, ECD had 26 people. It has since opened offices in most states and regions, and as of late 2018 it had more than 1,000 people and 20 district offices. Recently, MONREC received new organizational authority to have up to 20,000 employees. It is expected that these staff will be added during the next 10 years, and their incorporation will require a significant amount of training and capacity building at the state/region level and in district offices.¹⁸

While the EIA process is managed by the Union government (MONREC and the line ministry), the states play an important role:

- Once the EIA is approved, MONREC sends the EIA report and Environmental Compliance Certificates to the state/region offices, which are responsible for monitoring.
- Under the new Myanmar investment law, state/region governments have authority to review and approve all investments less than USD 5 million.
- Note that even for projects under USD 5 million, the EIA reports have to be approved by the Union government (MONREC).

Officials from ECD at the state/region level are part of the IEE and EIA project-assessment teams, and they have the responsibility to oversee the initial review of the project at the local level during the IEE and AIE process, as well as to help lead public consultations.¹⁹ These ECD officials also report to the ECD in Nay Pyi Taw as part of project monitoring and compliance (e.g., with regard to the Environmental Management Plan approved as part of the Environmental Compliance Certificate for a project).

In short, with the need to increase MONREC’s ECD staff twentyfold over the next decade to handle environmental compliance, with the need to learn and implement a systematic public participation process, and with the need for state/region staff working for ECD and the state/region ministries, a huge amount of training and skill development will be needed at the state/region level.

TABLE 3. Environmental review requirements for different types of power plants

| TYPE OF POWER PLANT | IEE REQUIRED | EIA REQUIRED |
|---|--------------|---------------------------|
| Hydropower plants | if ≥ 1MW | if ≥ 15 MW |
| Natural gas or biogas power plants | if ≥ 15MW | if ≥ 50 MW |
| Waste-to-energy power plants | if ≥ 50MW | at discretion of Ministry |
| Geothermal power plants | if ≥ 5MW | if ≥ 50 MW |
| Combined cycle power plants (gas & thermal) | if ≥ 5MW | if ≥ 50 MW |
| Other thermal power plants | if ≥ 5MW | if ≥ 50 MW |
| Wind power plants | if ≥ 1MW | if ≥ 15 MW |
| Solar power plants | if ≥ 50MW | at discretion of Ministry |

BOX 5. Strategic environmental assessment of hydropower in Myanmar

One of Myanmar's largest power resources is hydropower. Unfortunately, while some power-project developers follow international standards, many cut corners and fail to provide adequate information and transparency on power projects.²⁰ To provide a positive framework and vision for hydropower development in Myanmar, the International Finance Corporation (IFC), with support from the Australian government, led a strategic environmental assessment (SEA) of the hydropower sector, in partnership with MOEE and MONREC, from 2016 to 2018.²¹

The SEA was not intended to assess any particular hydropower projects in Myanmar, but rather to promote an approach that looks at basin-side planning, trends, and risks. The SEA vision is an integrated approach to water, land, and ecosystem planning, balancing a range of natural resource uses and priorities to achieve economic development, environmental sustainability, and social equity. The SEA recommends that five of its mainstem rivers, including the Ayeyarwady and Thanlwin (Salween), be preserved from hydropower development. The scope of the SEA was hydro projects of 10 MW capacity or greater in Myanmar.

The SEA foresees that hydropower development in Myanmar will be 13,000 MW or more. This estimate is based on existing projects (3,300 MW) plus new generation from projects under construction (1,600 MW), currently proposed projects in medium and low zones (7,300 MW), some capacity from low-impact hydropower projects in high-zone subbasins, refurbishment of existing power stations, installation of turbines on irrigation projects, and small hydropower projects of less than 10 MW capacity. As hydropower investigations proceed in priority subbasins, however, additional capacity may well be developed.

As of February 2019, the future of the SEA was unclear. During 2018, MOEE began working on a new hydropower policy with technical assistance from China's National Energy Administration. This has cast some uncertainty on the Myanmar government's commitment to the key recommendation in the SEA that five of its mainstem rivers, including the Ayeyarwady and Thanlwin (Salween), be preserved from hydropower development (Kean 2018).

3.2 UNION-LEVEL ORGANIZATIONS IN THE ENERGY SECTOR DEALING WITH STATES AND REGIONS

This section describes some of the main departments and subunits under MOEE that provide staffing at the state/region level to support the work of state/region energy ministers. It also describes two other related departments with significant energy-related activities at the state/region level: the Department of Mines within MONREC, and the Department of Rural Development within MOALI.

MINISTRY OF ELECTRICITY AND ENERGY (MOEE)

In the energy sector, the key ministry is MOEE. Figure 11 below shows how MOEE is organized, showing all of its various departments and subunits. Three primary MOEE departments working at the state/region level Electric Power Generation Enterprise (EPGE), the Department of Electric Power Transmission and System Control (DPTSC), and the Electricity Supply Enterprise (ESE).

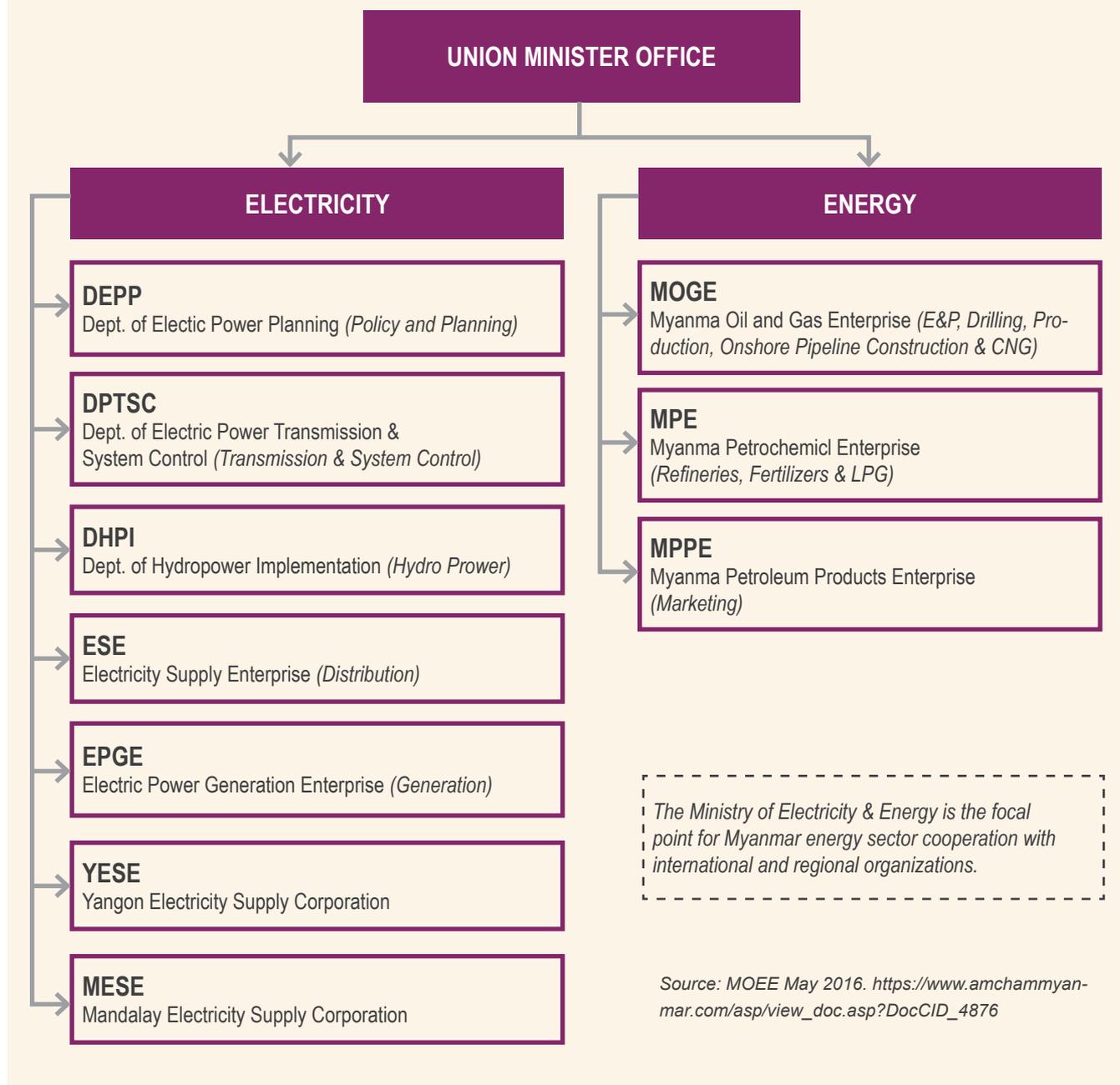
Electric Power Generation Enterprise

EPGE is the department within MOEE responsible for building and operating power plants. It also enters into agreements to buy power from IPPs and sell to electricity distributors—namely the Electricity Supply Enterprise (ESE) and the two state/region electricity supply organizations, the Yangon Electricity Supply Corporation (YESC) and the Mandalay Electricity Supply Corporation (MESOC).

Entering into power-purchase agreements is somewhat complicated. First, a project developer will come to EPGE with a proposed project and get approval in principle from the Union cabinet. EPGE reviews project information from the developer, including the feasibility study, EIA, and related documentation. EPGE then develops a power purchase agreement (PPA) with the project developer. Finally, the project gets cabinet approval, and the PPA is signed and becomes legally binding.

As to PPAs with small power producers, EPGE indicated that the states and region governments manage all power projects smaller than 30 MW unless

FIGURE 11. Organizational chart of MOEE, showing its various departments and subunits.



they connect to the grid—in which case they fall under the jurisdiction of MOEE. In practice, there are very few projects smaller than 30 MW that connect to the grid. EPGE officials said they would not be able to manage small-scale power projects—in part due to their lack of time to adequately review and vet project proposals, and in part because “the grid is weak and cannot accommodate many small-to-medium inputs on the 230 kV line.”

EPGE officials were interested in learning more about Thailand’s Small Power Producer (SPP) program, as a possible example for Myanmar, but they were skeptical

about the ability of the grid to handle inputs from many SPPs (see text box in section 4.3 “Thailand’s Small Power Producer Program”).²²

Department of Electric Power Transmission and System Control (DPTSC)

DPTSC is the department within MOEE responsible for constructing and operating the electricity transmission system. The transmission system consists of high voltage lines that carry power from power generating plants to substations. The high-voltage lines are 230 kV, 132 kV, and 66 kV, and they have substations

between them to “step down” the power to a lower voltage. The transmission lines end at substations where high voltage (66 kV) power is stepped down to medium voltage (33 kV) distribution lines.

Since transmission is a relatively centralized operation, DPTSC has less interaction with state/region governments that does ESE, which manages the distribution lines (see below). Nonetheless, the transmission lines and related substations are sited within state/region boundaries, and it is necessary for DPTSC engineers to coordinate with state/region governments on the siting and construction of the transmission infrastructure.

Electricity Supply Enterprise

ESE is the department within MOEE responsible for constructing and managing the electricity distribution system, and then selling electricity to customers. It therefore acts as a distribution utility and is responsible for the distribution and sale of electricity in all areas of Myanmar where the national grid operates, with the exception of Yangon, which is served by YESC, and Mandalay, which is served by MESC.

The distribution grid is comprised of medium voltage lines that are rated at 33 kV and 11 kV. It implements the World Bank–supported, USD 320 million NEP to extend the national grid and electrify the entire country by 2030. As the key electrification unit within MOEE, ESE receives NEP funding to expand the national grid, which it works to do in each state/region in cooperation with the state/region government.

ESE officials explained that their mandate is to extend the grid down to the level of the 11 kV distribution lines, which is the last level before power enters a village or community. They indicated that sometimes the extension is funded from the Union budget, sometimes from donor grants, and sometimes from the state/region budgets. Myanmar has 63,000 villages, and ESE’s budget has funding to electrify 5,000 villages per year for the next several years.

An ESE official explained that, drawing on the NEP budget, ESE is putting in a SCADA control system for the distribution grid:

We’re trying to upgrade the distribution management system for the future ... in every region, so that we can control it effectively. With the [SCADA] system, we can receive information in real time to monitor and control the substations. It’s basically a two-way interface all the way down to the end of the 11 kV line.

In terms of staffing, as already mentioned, the technical capacity for electricity supply and distribution resides

with Union engineers, who provide expertise to the offices of the state/region governments responsible for the local aspects of electricity distribution.

ESE has an office in each state/region except for Mandalay and Yangon, which have the Mandalay and Yangon Electricity Supply Corporations instead. The head of the ESE office manages relations with the state or region government to implement the construction and management of the 11 kV system. There is very close cooperation between the ESE office, the chief minister of the state or region, and the minister responsible for electricity. “[The arrangement of] ESE engineers working with state and region governments ... generally works well,” the ESE official said, but he added that the ESE engineers working with the state/region governments need training.

We don’t know anything about international competitive bidding. We don’t know the international standards. For example, we have separate tenders for materials and for construction, and we have to hire the company for the 11 kV line, so we have to invite bidding for the installation.

He added that the ESE staff at the state/region level, who are supporting the state/region governments, need training on the SCADA control system as well.

Departments with energy-related functions in other ministries

Department of Mines

Traditionally, all mining has been under the authority of the Department of Mines, which sits within MONREC and is the primary Union agency responsible for mining.

There are four categories of mines under Myanmar law:

- large-scale mining (> 1 sq km)
- medium-scale mining (20 acres to 1 sq km)
- small-scale mining (< 20 acres)
- artisanal mining, which does not require heavy machinery and applies to individuals and households and covers gemstones and gold mining.

Staffing. The Department has 133 staff, including those at the state/region level, and about three-quarters of these are based in Nay Pyi Taw. As with the MOEE, the Department of Mines has technical staff who are engineers and geologists. These technically trained officials work in offices around the country and provide technical assistance to the minister in the state or region where their office is located.²³

Oversight of coal mines. The Department of Mining oversees more than 100 companies doing business in the coal-mining sector, with an annual combined production in the range of 500,000 tons. About one-third of these mines are large, and the rest are very small. The coal is used primarily in the cement and steel industries. At the Union level, there is currently only one coal-fired power plant, with 120 MW capacity. The big challenge in the coal sector is safety and the risk of accidents, especially explosions.

Mining licenses. Companies that wish to apply for a mining license must first inquire of the Department of Mines whether there is another claim on the intended site, another company is active at the site, or the site is a restricted area. This process includes checking with the Department of Forestry. Once this review is done, the Department of Mines will forward the application to the state or region government for approval. Once the review has determined that the mining site is clear of restrictions, and the state or region government has approved the application, the Department of Mines can issue the mining license.

Environmental requirements. Small-scale mines have to write an IEE, while medium- and large-scale mines need to prepare an EIA and go through the review process. Medium- and large-scale mines also

need to write an environmental management plan and conduct a public consultation.

Safety concerns and mining moratorium. In the past, coal mines were usually open pit. Starting about three years ago, in part due to public concern and new environmental restrictions, there was a transition from open-pit to underground mining, and now about one-quarter of Myanmar's coal mines are underground.

During 2016 and 2017, there were a number of major accidents, including landslides at jade mines (Topf 2016; Jamasmie 2016) and deaths at coal mines in Magwe region due to the collapse of the air supply systems (Aung 2017). A moratorium on new mining licenses followed, and eventually new mining regulations, which took effect on February 13, 2018. The new regulations transferred licensing of small and artisanal mines to the states and regions. Mining licensing recommenced on July 27, 2018.

Officials said that at the state/region level they do not have enough staff with expertise in mining and related environmental and safety disciplines. They estimated that they needed three to four times more staff, including mining engineers with technical expertise and experience in mine inspection.²⁴

Department of Rural Development

The Department of Rural Development plays a very important role in rural development, including as a partner in the World Bank's large Community-Driven Development Program. DRD also manages the USD 80 million loan for off-grid electrification that is part of the World Bank's USD 400 million loan for the National Electrification Project (see text box in section 2.3, "Myanmar's Natural Electrification Project"). For the NEP off-grid work, DRD is the implementing agent, responsible for disbursing funds and getting households connected through solar home systems and village-level mini-grids.

DRD has been overseeing the installation of solar home systems for several years, and its budget has increased significantly with a contribution from the World Bank NEP loan for the costs of equipment and technical services for off-grid electrification.

As part of the NEP, MOEE received assistance from the Earth Institute at Columbia University to develop a geospatial electrification plan for Myanmar during 2013–2014, which made it possible to prioritize villages for electrification based on distance from the existing grid. The NEP has an electrification road map, which defines five phases for grid expansion. Phase-one to -three villages will be connected to the grid first. Phase-four and -five villages will be electrified later and are covered by DRD as part of its off-grid activities



Starting about three years ago, in part due to public concern and new environmental restrictions, there was a transition from open-pit to underground mining, and now about one-quarter of Myanmar's coal mines are underground.



through what the NEP terms “preelectrification” (Castalia 2014)²⁵. As of early 2019, the geospatial plan is being updated by the International Growth Centre, in cooperation with GIZ and the World Bank, with MOEE as the government counterpart.

DRD’s role in the NEP is to electrify off-grid areas that are designated as Phase 4 and Phase 5. These areas

are also referred to as “remote areas,” and they are usually at least 10 miles from an 11 kV substation of the national grid. The exception is mountainous areas, where villages less than 10 miles from the grid may be designated as Phase 5.

DRD off-grid activities cover both solar home systems (SHS) and solar mini-grids, as summarized in table 4.

TABLE 4. Comparison of main options used for “pre-electrification” in Myanmar.

| TARGET | ELECTRICITY SOLUTION | COMMENTS |
|-------------|----------------------|---|
| Households | Solar Home System | Solar panel generates electricity, which goes to a battery. The system can provide electricity for a home, including basic lighting, phone-charging, and small appliances. |
| Communities | Mini-grid | Mini-grid provides electricity for an entire community or a number of houses in a village or community. Mini-grids can be powered by solar power, hydropower, diesel generators, or combination called “hybrids”. |

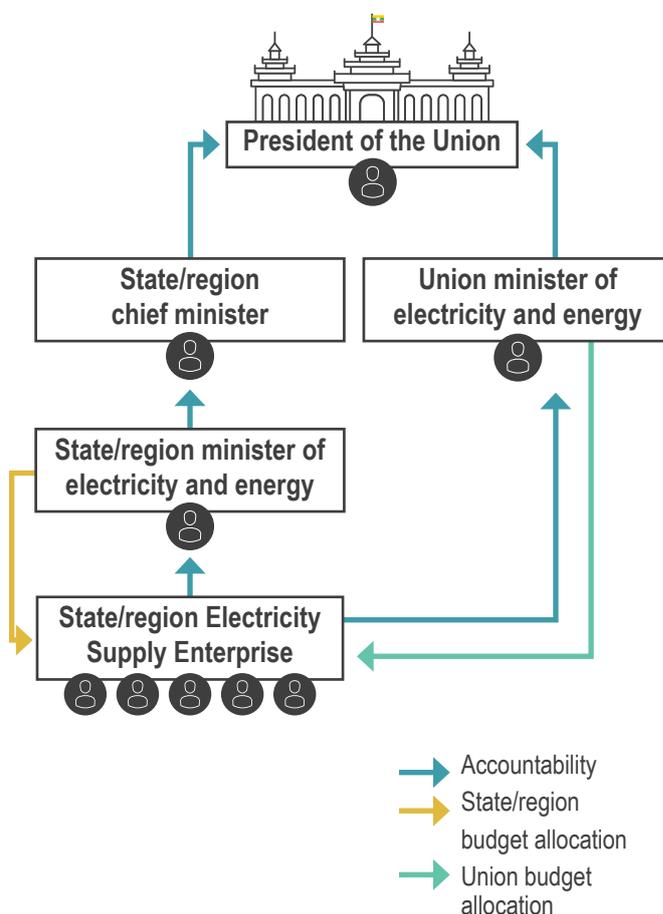
3.3 WHAT IS THE STRUCTURE OF SUBNATIONAL ENERGY GOVERNANCE?

Dual accountability of ministers in the energy sector Each state or region has a chief minister and a minister whose portfolio includes energy. As described by Batcheler (2018), the delineation of accountability between a state/region minister and the departments they oversee can fall into one of three categories:

- 1. Accountable to the state or region:** Departments whose responsibilities fall wholly under Schedule 2 and are wholly funded by the state/region government, and that report exclusively to a state/region minister.²⁶
- 2. Dual accountability:** Departments that receive at least part of their funding from state/region budgets and some of whose activities fall under Schedule 2. These departments are accountable to both their state/region minister and their Union minister. This applies to departments in the energy sector (ESE, EPGE, DEPP, etc.).
- 3. Accountable to the Union, with state/region coordination and oversight:** Departments that are funded solely by the Union and are accountable to a Union ministry, but for which there is a corresponding state/region minister whose role is coordination and oversight of the department’s work.

Batcheler indicates that within the system of dual accountability, departments are increasingly accountable to state/region ministers, although there is

FIGURE 12. Diagram showing dual accountability of states/regions under the current constitution.



variation among individual departments and among the states and regions.

While the majority of departments for which state/region ministers are responsible are part of Union ministries, resulting in a system of “ministers without ministries,” there has been a clear trend toward departmental accountability to state/region ministers. Ways of working have developed that have given state/region ministers greater involvement in, and influence over, the work of the departments. Even in departments with limited accountability to state/region ministers there is evidence that state/region ministers have a growing role in human resource decision-making, policymaking, and planning and budgeting.

In the energy sector, the relevant Union departments or units (e.g., ESE, EPGE, DEPP) have offices in each state or region, and these offices are staffed by engineers who work for the Union ministry. At the same time, the states and regions have limited energy budgets (and limited personnel with energy skills and experience) and therefore often must rely on Union-level officials for technical review and management.

For example, as noted above, ESE is a department under MOEE that manages the national power distribution grid, as well as electricity sales. ESE’s regional engineers sit in ESE offices within states/regions and manage the electricity distribution system. These ESE engineers are hired by, and their salaries are paid by the Union ministry, MOEE. ESE controls

the technical standards for power distribution, but under the principle of dual accountability, the ESE engineers are also responsible to the state/region energy minister. The role of the state/energy minister in relation to the distribution grid can vary somewhat between states/regions, and as noted in section 4.2, state/region government budgets often include funding for the 11 kV system. Figure 12 shows how the concept of dual accountability works under the constitution.

ROLE OF THE HLUTTAW

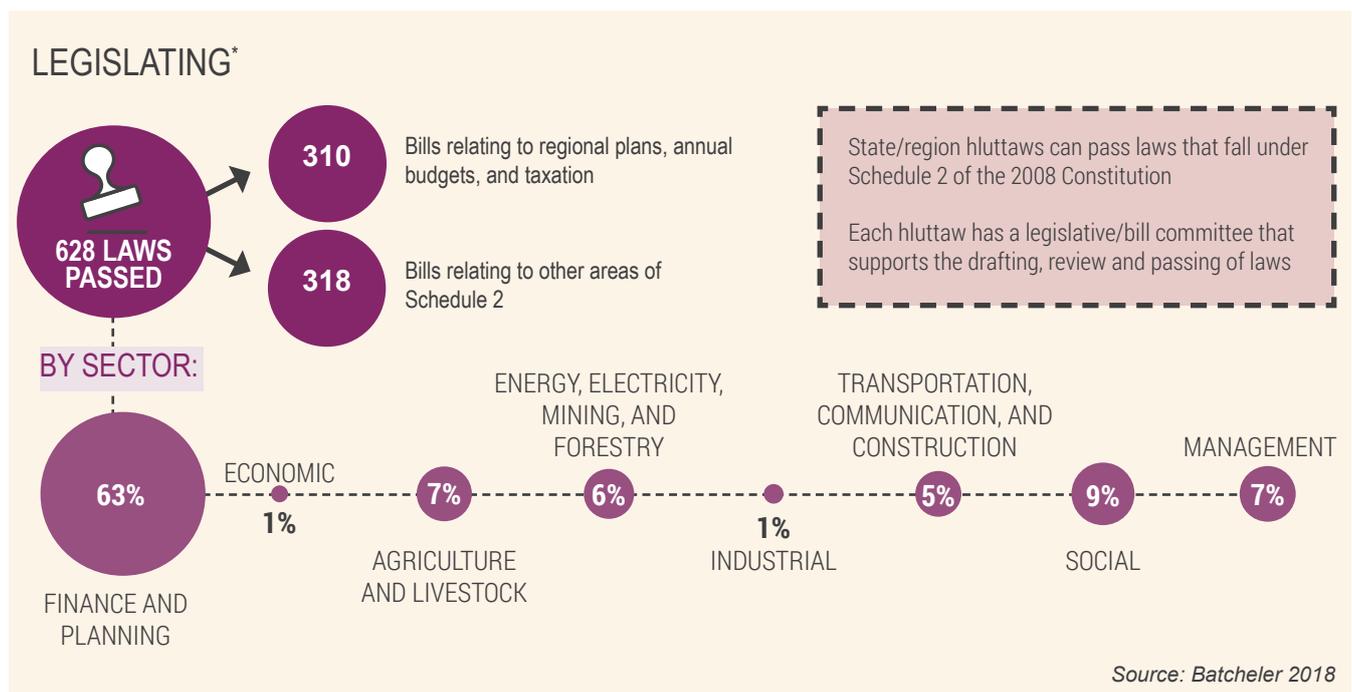
The state/region hluttaws are unicameral legislatures. Under the current constitution, chief ministers must be, and cabinet ministers may be, members of the hluttaw. The hluttaws have three main functions (Batcheler 2018, 34):

- Legislation
- Oversight of the executive
- Representing constituents

Batcheler (2018) discusses in detail how the hluttaws function in the states and regions, describing a commonality of function but significant differences in practice, and he notes their growing role and influence.

Figure 13 shows the legislative functions of the hluttaws, and a breakdown of the laws and bills passed. Nearly two-thirds have been related to finance and planning, while just 6 percent have been related to “energy, electricity, mining, and forestry.” (Batcheler 2018, 39)

FIGURE 13. Functions of the state and region Hluttaws.



Chapter 4

STATES AND REGIONS—ENERGY POLICY AND GOVERNANCE IN PRACTICE

The previous chapter discussed the constitutional and legal roles of state and region governments in energy policy and governance. This chapter draws on desk research and interviews with government, private-sector, and civil society stakeholders to explore how these are realized in practice. It addresses three main questions about state/region governments:

1. What are their key priorities and concerns in the energy sector?
2. What is their current role in the energy sector?
3. Where can they act in the energy sector?

4.1. WHAT ARE THE KEY PRIORITIES AND CONCERNS OF STATE/REGION GOVERNMENTS IN THE ENERGY SECTOR?

STATE/REGION GOVERNMENT INTERESTS AND PRIORITIES RELATED TO ENERGY

State/region energy ministers and MPs identified three main objectives in the energy sector:²⁷

- access to electricity
- affordable electricity
- adequate capacity

To achieve these objectives, they must work within the legal, institutional, and budgetary framework of the Myanmar constitutional and legal system. Below, we present some of their key priorities and concerns, drawn from personal interviews.

COMPREHENSIVE AND EFFECTIVE DISTRIBUTION

State/region ministers and their advisors interviewed for this report emphasized the importance of the distribution system, particularly the 11 kV system and the subsequent 400 V connections to villages. They focus their efforts more on distribution than generation, they said,²⁸ in order to expand access and improve efficiency, with the ultimate goal of delivering quality power 24 hours a day. Power quality is currently poor in many parts of the country, with low voltages and uncertain availability.²⁹ The energy minister of Bago reflected that the current system needs modernization to make it more comprehensive and systematic. The Bago State government focuses

its efforts at the 11 kV level of the electricity distribution system.

ADEQUACY OF POWER GENERATION

State/region ministers said there was private-sector interest in developing small power projects, under the 30 MW limit, that could be managed by the state/region. One minister said,

Many companies approach us that want to generate solar electricity. But we're not in a position to buy their power, since our customers' electricity fees go to the Union government and we only receive an allowance to cover distribution. In the end, the companies leave, and no projects are developed, because the national grid price is so low.

The minister explained that in many states and regions industry is dispersed, which makes central power generation impractical and the cost of transmission high, but he conceded that larger projects connected to the grid are more cost effective for producers than local generation because of the economies of scale.

LOW TARIFF AND INADEQUATE BUDGETS

Inadequate budgets were a common theme of state/region ministers and energy officials. As noted in chapter 3, electricity tariffs are collected in the state and transferred to the Union government; the states and regions receive only an allowance for local power distribution. Ministers agreed that they needed bigger energy budgets, including for the distribution system. The low electricity tariff was a major problem, creating a disincentive for investment in the energy sector, and they called for the tariff to be adjusted upwards.

STATE/REGION ROLE IN PROJECT APPROVAL

In discussions with state/region ministers and their advisors, the question arose of the role of state/region governments in approving power projects larger than 30 MW. What is the specific state/region role in a Union-approved project? While it is difficult for a state or region government to refuse a project, they said, there is room to negotiate project terms and conditions, since the environmental and social impacts will fall within their borders. One minister explained, "We have to negotiate with the Union government, and Union projects cannot proceed without the concurrence of our [state] government."

MOEE officials interviewed in Nay Pyi Taw, on the other hand, were less clear that state/region governments play such a role. One official seemed surprised that a

state would claim the authority to review projects over 30 MW. Large projects are a Union responsibility, he explained, and the states have no explicit role.

PRIORITIES FOR AN OFF-GRID REGION: TANINTHARYI

Tanintharyi's minister of electricity and industry called the high tariff his biggest problem. The tariff is higher in Tanintharyi Region than in any other state or region, because it is remote and unconnected to the subsidized power of the national grid. Consumers and businesses complain about the tariff, he said, and it's a barrier to business development. But he remained optimistic: "The current problem with high tariffs will be solved when the [national] grid comes, except for some remote places like Kyung Su Township that will still not be grid connected."

Because it is unconnected to the national grid, the region has little direct contact with MOEE in Nay Pyi Taw.³⁰ The main interaction is with ESE, which built the distribution lines for Tanintharyi's regional grids (see text box, below, "Regional grids vs. mini-grids"). One significant concern is what will happen to the current network of regional grids—most of which are under concession contracts with the regional government—when the national grid arrives. It might make economic sense to close down these grids, because they are more expensive than the national grid, and there is currently no scheme for compensating their owners should they be forced to close after the main grid arrives.

The minister expressed interest in small-scale distributed energy and thought Thailand's SPP Program could be a practical model for Tanintharyi (see text box in section 4.3, "Thailand's Small Power Producer Program"). He also described potential for his region in the expansion of small diesel systems and renewable energy options such as solar home systems, biomass, biogas, and pico-hydropower.

4.2 WHAT IS THE CURRENT ROLE OF STATE/REGION GOVERNMENTS IN ENERGY?

The state/region governments have three primary roles related to power development:

- 1. Land approval, allocation, and permitting.** These are the basic state government functions of regulating land use and issuing licenses and permits for operation.
- 2. Public consultation and engagement.** The state/region government holds public hearings on power projects, in coordination with the relevant Union departments, and communicates with the public regarding energy-related issues in the state.

3. Negotiating with MOEE. The state/region government reviews Union-level projects and negotiates with MOEE departments regarding plans, siting, and approval. While projects larger than 30 MW are the sole province of the Union government, the state may push for concurrence.

The state and region energy ministers interviewed have limited authority over energy-sector decisions and play mainly a coordinating role. Their activities range from consultation with Union ministries and departments to more specialized contributions to the review and approval of project designs, siting, and impacts. The coordination role is extremely important, because some states have multiple departments with overlapping energy-related responsibilities. In Kayin State, for example, several departments, including the Department of Rural Development (DRD) of the Ministry of Agriculture, Livestock, and Irrigation (MOALI), the Department of Border Affairs of the Ministry of Border Affairs, and numerous departments of MOEE all have overlapping responsibilities related to energy. This coordination role requires a high degree

of strategic planning and effective interdepartmental communication.

Of the four states or regions visited for this report (Yangon, Bago, Shan, and Tanintharyi), the exception was Tanintharyi, where the minister overseeing electricity and energy has significant authority over concessions to build and operate regional grids because most of the region is unconnected to the national grid.

In practice, the power of state/region ministers over energy and electricity is limited by their limited budgets. In addition, the lack of a budget for electricity procurement in most states and regions prevents them from being a buyer (or “offtaker”) of electricity for projects smaller than 30 MW, where in principle they could have some authority.³¹

The tables below show the division of responsibility between state/region governments and the Union government. Table 5 covers power generation, table 6 covers transmission and distribution, and table 7 covers the sale of electricity.

TABLE 5. Responsibility for generation of electricity in Myanmar

| ACTIVITY | RESPONSIBLE PARTY |
|--|--|
| Electricity generation ≥ 30 MW or connected to the national grid | Union level: Electricity Power Generation Enterprise, under MOEE |
| Electricity generation < 30 MW and isolated from the national grid | State/region governments |

TABLE 6. Responsibility for transmission and distribution of electricity in Myanmar

| ACTIVITY | RESPONSIBLE PARTY |
|---|---|
| Electricity transmission, 33 KV and above | Union level: Department of Electric Power Transmission and System Control, under MOEE |
| Electricity distribution, 11 KV | State/region governments ³² (or the relevant leading body of an SAD/SAZ) ³³ |
| Electricity distribution, 400V | Community (or the relevant leading body of an SAD/SAZ) |

TABLE 7. Responsibility for retail sale of electricity in Myanmar

| ACTIVITY | RESPONSIBLE PARTY |
|--|--|
| Retail sale of electricity from the national grid | <ul style="list-style-type: none"> Yangon Electricity Supply Corporation (YESC) in Yangon Region; Mandalay Electricity Supply Corporation (MESC) in Mandalay Region; Electricity Supply Enterprise (ESE) outside of Yangon and Mandalay Regions; and/or distribution franchisees operating on behalf of YESC, MESC or ESE |
| Retail sale of electricity from an isolated regional grid or mini-grid | Permit holders with approval from the relevant State or Regional Government (or Relevant Leading Body of a SAD/SAZ) |

STATE/REGION ROLE: STATE AND REGION ENERGY LAWS

A number of states and regions have developed their own energy laws, beginning with Sagaing in 2012, Tanintharyi and Magway in 2013, Bago and Kachin in 2015, and Mon in 2016. GIZ carried out an informal survey of state and region electricity laws in 2018 that supplements the findings of our interviews. Table 8 summarizes existing state and region energy laws. As of late 2018, it appears that six states or regions had enacted energy laws, at least two are drafting or considering legislation, and six have no energy laws.

These are some features of pending or adopted state/region laws:

- **State/region role:**
 - establishing and conducting inspection procedures
 - permitting and licensing of generation facilities under 30 MW
 - allowing the collection of a fee (a “wheeling charge”) for transportation of electricity over a state’s electricity distribution infrastructure
 - levying penalties and fines
 - taxing electricity usage
 - waiving electricity taxes
 - collecting water tax on hydro projects
 - forming an Electricity Inspection Group
 - allowing the formation of township-level small and medium electric power generation and distribution associations
- **Provisions related to Union government:**³⁴
 - State/region government can negotiate for additional electricity generation in order to export and sell to the national grid.

- **Environmental considerations:**
 - For hydro, the water inflow/outflow must not affect the environment or communities.
 - Waste must not pollute the environment.

Our interviews with state/region ministers revealed strong interest in the development of state/region laws as a framework to promote power generation and distribution and support investment in local generation. It is generally understood that any state/region law would need to be consistent with, and subsidiary to, the Union-level Electricity Law of 2014.³⁵

Sagaing Region’s electricity law, enacted in 2012, sets forth the following objectives:

- to raise the people’s standard of living
- to encourage regional development
- to reduce risks from the electricity system
- to generate tax revenues

Mon State’s electricity law, enacted in 2016, sets forth the following objectives:

- to fulfill Mon State’s electricity needs, and to encourage development and efficient operation of power generation and distribution businesses
- to attract technology and capital investment from both local and foreign companies and to thereby generate economic activity and opportunities
- to establish transparent, fair, and reasonable by-laws and regulations to set suitable electricity charges
- to comply with and support international environmental treaties that Myanmar has signed

BOX 6. Regional grids vs. mini-grids

This report refers to two types of electric power systems that are not connected to the national grid. We differentiate them as follows:

- **A regional grid** is an isolated electric power system, consisting of generators and distribution lines, that is unconnected to the national grid and supplies a specific area. Typically, a regional grid in Myanmar is owned and operated by the ESE, although in some cases, as in Tanintharyi, the term regional grid can apply to the power systems serving townships and cities under concession to the regional government.
- **A mini-grid** is an electric power system, consisting of generators and distribution lines, that provides electricity for an entire community or a number of houses in a village or community. Mini-grids are typically developed by private companies or community groups rather than by the state/region or Union government, and can be powered by solar power, hydropower, diesel generators, or combinations called hybrids.

TABLE 8. Status of state and region electricity laws

| STATE-REGION | STATUS OF LAW | DATE ADOPTED | NAME OF LAW |
|--------------|---------------|------------------|---|
| Sagaing | Enacted | October 9, 2012 | Sagaing Region Medium- and Small-Scale Electric Power Generation and Distribution Law |
| Tanintharyi | Enacted | 2013 | Not available |
| Magway | Enacted | 2013 | Magway Region Small and Medium Enterprises of Electric Power Production and Supply Law (Magway Region Hluttaw Law No. 6 of 2013). |
| Kachin | Enacted | April 13, 2015 | Kachin State Medium and Small-Scale Electricity Generation and Distribution Law |
| Bago | Enacted | December 4, 2015 | Bago Region Small and Medium Electric Power Enterprise Law |
| Mon | Enacted | October 12, 2016 | Mon State Medium- and Small-Scale Electric Power Generation and Distribution Law |

Source: Asia Foundation research

Tanintharyi Region adopted a regional electricity law in 2013. In an interview, the regional minister of electricity and industry said that the law has helped with their extensive tendering on regional grid projects, because

the region government is able to reference the regional law in contracts. This makes the contract process more systematic and saves significant time in the development and execution of concession contracts for regional grids.



The minister [in Bago] also indicated his strong interest in laws and regulations to govern licensing and permitting, compensation, and quality of power for off-grid electricity.



Bago Region established a regional law for small and medium electricity enterprises in 2015. The regional minister of electricity, transport, and industry said he was focusing on trying to improve the quality of power reaching connected households and to ensure that it is available 24 hours a day at standard voltage. Barely one-third of households in Bago, 35 percent, are connected to the grid. The minister said that the regional government is focusing on improving the quality of electricity distribution, and they are conducting a pilot project to reduce losses. The minister also indicated his strong interest in laws and regulations to govern licensing and permitting, compensation, and quality of power for off-grid electricity.

In January 2019, a draft state electricity law was submitted to a Shan State parliamentary committee for review. The draft law sets forth the following objectives:

- a legal and regulatory structure that governs the state's electricity system in a way that is consistent with the federal system of government
- a set of fundamental principles guiding energy-sector policy and activities
- integration into power-sector management of environmental and social objectives (sustainability, self-reliance, equity, etc.)
- improved governance (transparency, accountability, and participation)

STATE/REGION ROLE: THE HLUTTAWS

MPs from the Yangon Region and Shan State Hluttaws described their role in energy-sector governance as one of oversight, providing checks and balances on the work of ministers.

In the Yangon Hluttaw, a committee drafts a bill and then invites international and legal experts comment. The committee then makes revisions and submits the bill to the Hluttaw for possible adoption.

In the Shan State Hluttaw, the Energy Committee has two primary roles:

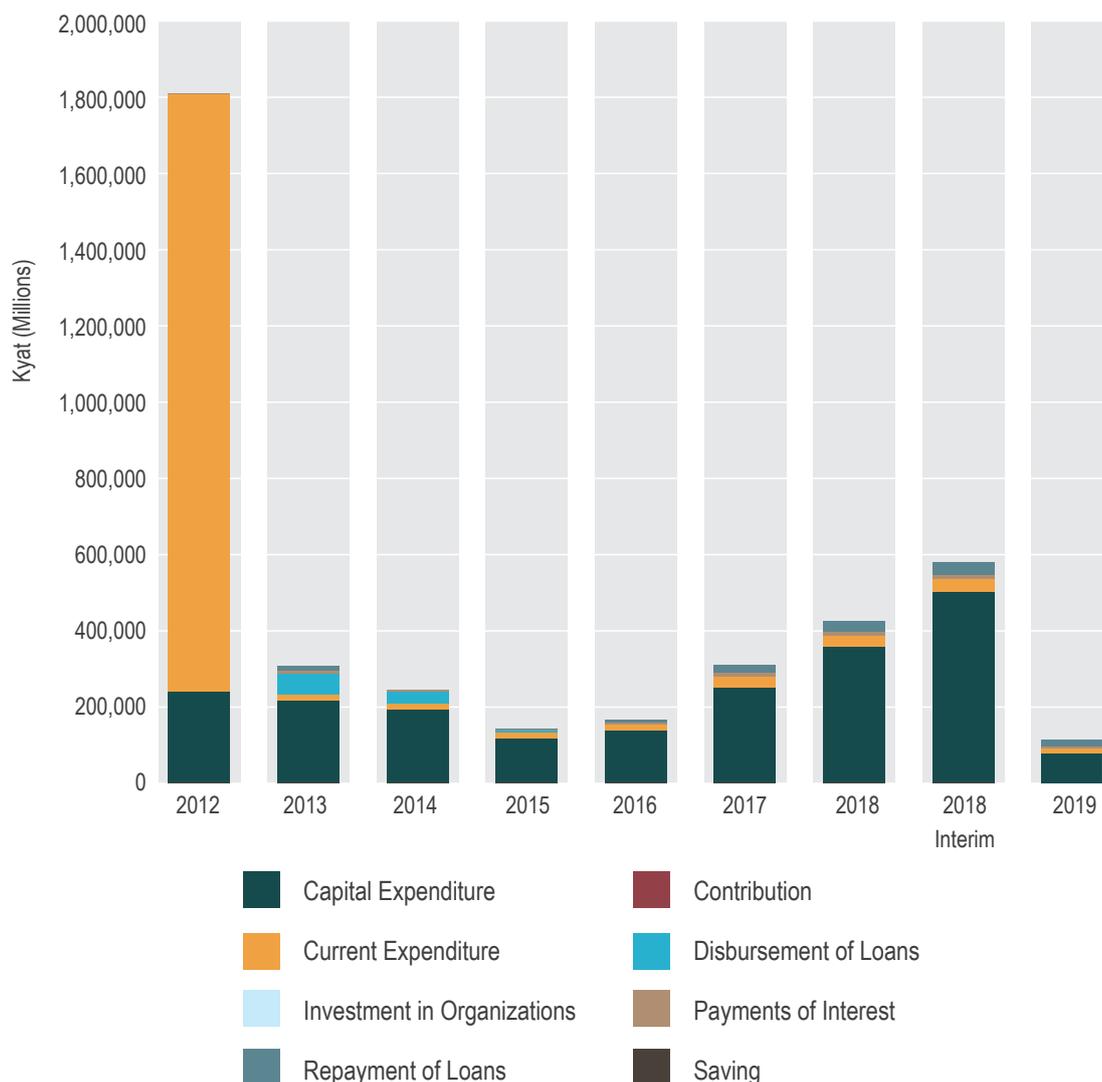
- to raise awareness about the proper use of natural resources and electricity
- to develop and oversee policies to ensure that energy and resources are used effectively and efficiently

The Energy Committee monitors electricity use to reduce waste and inefficiency. It sets and monitors standards on energy use and efficiency for equipment and enterprises.

The Shan State Hluttaw also oversees rural electrification. Members of the Energy Committee said that the government should promote off-grid power from mini-grids throughout the state and then later connect these mini-grids with the national power grid. In their view, this bottom-up and top-down approach would be the most effective way to electrify the rest of the state and country.

Shan State MPs admitted that they don't have much experience yet in their checks-and-balances role, but they sometimes oppose Union government positions. They said Shan State should implement clean, green energy using the state's abundance of resources such

FIGURE 14. Annual Union budget for electricity and energy, 2012–2019



Source: Budget Dashboard, at http://mmbudgets.info/budget_union.html.

as wind and water. Shan State currently has many problematic power projects, they said, and national decision-makers should think very carefully before approving more large power projects.

The Shan State Hluttaw is working with the Mekong Energy and Environmental Network to research the state's experience with mini-grids and renewable energy, to inform a sustainable, green energy policy that will prioritize mini-grids and small-scale power in the state. The proposed policy will also include a draft state electricity law.

More generally, some of the state/region ministers, as well as MPs, voiced concern about the lack of state/region input into large-scale power projects. The Union government is not always forthcoming with information during early-stage development. One adviser to a state minister provided a couple of examples:

- In one case, the Union government recently signed an MoU and was planning a large-scale dam project, but communities and the state government were not informed and were not involved in any of the discussions.
- In another example, senior Union officials went abroad and signed three MoUs for power projects in a state, without input from the state hluttaw or the state energy minister or his advisers.

STATE/REGION ROLE: STATE/REGION BUDGETS FOR ENERGY AND ELECTRICITY

Figure 14 shows the annual Union budget for electricity and energy. It has been rising steadily in recent years, reaching just over MMK 400 billion (USD 260 million) in 2018, and with just under MMK 600 billion (USD 390 million) allocated for 2019.

State/region energy budgets include line items for spending on electricity and energy. Under the annual budgeting process, proposals for spending on electricity and energy are submitted by departments to the state/region governments, before a budget proposal is reviewed by the state/region hluttaw.³⁶

Revenue from electricity tariffs are used by MOEE to run the national electricity system (see section 2.7 on the system's significant operating deficit). Costs include power purchases from generating companies (through EPGE) and the cost of transmission (through DPTSC) and distribution (through ESE).

- EPGE draws on the Union energy budget for power purchases from generators larger than 30 MW.
- DPTSC, ESE, YESC, and MESC draw on the Union budget for capital investment and maintenance of the high- and medium-voltage transmission system (33 kV and above).

In practice, according to our interviews with state/region ministers and state/region Union officials, each state or region ESE receives funding from both the Union and state/region budgets. Generally, the Union energy budget covers all transmission and distribution down to the 33 kV system, while the state/region energy budget covers the 11 kV system.

State/region governments take the lead on electrification of towns and villages. For example, each year they decide which villages will be newly connected to the grid. The 11 kV system is the last leg of the distribution system before it goes into villages and communities, where it ties into the 400 V system that is the main village or community power line. This 400 V power line eventually connects with buildings and households, where it is transformed into 220 V house current.

MOEE engineers working at the state/region level must coordinate the Union and state/region budgets when working with state/region energy governments.

Finally, at the end of the distribution network is the 400 V system, which connects households to the grid. It appears from our interviews that funding for the 400 V system is ad hoc. State/region budgets do not contain funds for constructing these systems, which must be paid for by communities themselves. Our understanding is that the process of constructing and managing the 400 V connections is generally managed by a village electrification committee.³⁷

In Tanintharyi, the situation is much different. Since the region is unconnected to the national grid, the regional government has great autonomy in developing its power system. It grants concessions to companies to construct and operate mini-grids, which include generators and transmission infrastructure. The regional government collects revenues and manages spending for the system.

4.3 WHERE CAN STATE/REGION GOVERNMENTS ACT IN THE ENERGY SECTOR?

This section identifies five opportunities for states and regions to be proactive in the energy sector. These examples may be useful because of the early stage of state/region engagement in energy-sector issues, the occasional confusion about the practical boundaries between state and Union authority, and the importance of building a base of experience to discover best practices and support innovation. The five opportunities described in this section include

- states and regions championing large-scale power projects within their borders (example: Kayin State);
- increasing state/region autonomy in tendering and

licensing of regional grids (example: Tanintharyi Region);

- states and regions promoting mini-hydropower development (example: Shan State);
- decentralizing energy and projects smaller than 30 MW; and
- pursuing off-grid electrification and village-scale mini-grids.

1. CHAMPIONING LARGE-SCALE POWER DEVELOPMENT

Interviews were often unclear about when and where state/ region governments can take action on development of energy projects. As noted above, a number of state/region governments are developing their own energy policies, and they have clear authority over power projects smaller than 30 MW unless they are connected to the grid. But state/region governments also have some say over larger projects, since these projects affect their citizens and their resources and environment.

One example of a state or region government taking the lead on larger energy projects occurred recently in Kayin State. The Kayin State chief minister proposed a coal-fired power plant to the Union—a project that met significant local opposition and was denied by MOEE.

What is the lesson of the Kayin State experience? Local opposition prevented the Union government from approving the project, even though it was proposed by the Kayin State government; but if a state or region government proposed a project that did have local support, it might well win Union approval.

Kayin State case study: proposed coal-fired power plant

Traditionally, state and region governments do not initiate new power-plant projects, but in 2017, Kayin State advanced a proposal for a large, coal-fired facility in the state.

The Kayin State chief minister, Nang Khin Htwe Myint, wanted the new power plant to boost economic development in the state, now that a cease-fire had stabilized the political situation. Lack of industrial development and jobs in the region was precipitating a labor drain to Thailand, and the Kayin government, in partnership with Toyo Engineering Corporation, developed a 1,200 MW coal-fired power plant project to attract industry, and investors more generally. The project was supported by JICA, and the plant was to be constructed by a firm called TTCL Public Co., Ltd., a joint venture of Toyo Engineering Corporation of Japan and Italian-Thai Development, PLC, of Thailand. The advanced technology power station was expected to cost USD 2 billion, plus USD 800 million for a 40-year

lease of the land, and it was to start operation in 2023, with the full 1,280 MW to come on line in 2024 (Han 2018).

In April 2017, the Kayin government and TTCL signed an initial MoU to conduct a feasibility study for the proposed Hpa-An Coal Plant, to be located in Hpa-An in Kayin State. This drew statements of opposition from 42 Karen civil society organizations and several other groups. In October 2017, the Kayin government and TTCL signed joint-venture and lease agreements for 815 acres, with a concession period of 40 years. Local residents collected nearly 3,000 signatures opposing the plan and delivered them to the Kayin chief minister. They followed this with a demonstration in November (Myanmar Times 2018).

In March 2018, the minister of MOEE said that he did not support a coal plant at that site, because it was not required and was opposed by local citizens (Mon 2018). He also noted that there would be technical difficulties with the long river transport of coal from the seaport to the inland power plant. It remained unclear, however, whether these remarks by the minister were final and definitive, or whether the state might attempt to overrule the Union government (Han 2018, Mon 2018).

Meanwhile, a total of 131 local organizations and residents signed an open letter in April, presenting the Union government with three requests: (a) to cancel all proposed and suspended coal-fired power plants, (b) to pass a national moratorium on coal-fired plants, and (c) to promote and regulate the implementation of sustainable, renewable energy projects (Han 2018).

2. INCREASED STATE/REGION AUTONOMY OVER REGIONAL GRIDS

Tanintharyi region is one of the least electrified regions in Myanmar, as it is long and narrow with much coastline and many islands, and is the farthest geographically from the country's national grid. Given this situation, and the fact that states and regions have constitutional authority to manage off-grid power plants under 30 MW, the regional government has emphasized mini-grids and has launched a series of tenders to reduce electricity costs.

Tanintharyi case study: private-sector operation of regional grids

PTC, regional grid pioneer. Pho Thee Cho Co. (PTC) operated diesel-powered regional grids in Dawei district beginning in 2004. Their regional grid expanded from an initial 200–250 households in 2004 to 2,000 households in 2006. The initial generator was 280 kW, and it was later supplemented by two 150 kW generators.

In 2006, PTC got approval from the regional government to deliver their power through government distribution lines (11 kV and 400 V). They received a license from what was then the Ministry of Electric Power, and had to pay a fee of MMK 5 (approximately 0.6 U.S. cents) per kWh for the use of the power lines. They paid for their own fuel and maintenance and got the right to charge a tariff of MMK 395 (49 U.S. cents) per kWh.³⁸

By 2016, PTC had expanded its capacity to 10 MW and was supplying all 400,000 households in the township. Their license was renewable annually, and their service area had expanded to include Dawei, Maungmakan, and Thayetchaung Townships. They were operating 25 diesel gensets, ranging from 500 to 1,250 kW each.

That year, the regional government changed the approved fuel for regional grids in Dawei District to natural gas. This was the result of two years of campaigns and protests by civil society organizations (CSOs), including the Dawei Development Association (DDA). The CSO coalition asked the Tanintharyi government to provide access to cheap, affordable electricity by diverting some of the natural gas that was being piped to Thailand through the Zawtika Pipeline. Thousands of people protested in four townships in Dawei District, demanding affordable natural gas and chanting the slogan “our people, our resources.” Eventually, the Union ministry (then the Ministry of Gas Enterprises) agreed to supply 2 million cubic feet of gas a day through a new pipeline constructed to serve Dawei District.

Once the pipeline was completed, the Tanintharyi Ministry of Electricity organized a public tender in 2016, drawing six or seven bidders. Dawei Development Public Co. (DDPC) won the distribution license with a bid of MMK 80 (5.3 U.S. cents) per kWh, which was later negotiated down to MMK 70 (4.6 U.S. cents). A company called Global Grand Services (GGS) won the generation license with a bid of MMK 130 (8.5 U.S. cents) per kWh. Three additional townships were added to the concession: Laung Lore, Yay Phyu, and Ka Lan Aung. Customers now pay a total electricity tariff (for generation and distribution) of MMK 200 (13 U.S. cents) per kWh, which is just half the tariff of MMK 395 (49 U.S. cents) previously charged by PTC, the savings being due to the cheaper, gas fuel and more efficient generators.

In 2017, DDPC’s distribution license ended, and GGS won a tender to operate the regional grids. GGS provides both generation and distribution. They have a five-year license for generation, and their operating license for distribution is temporary. The Tanintharyi government will call a new tender for distribution.

PTC’s regional grid expansion. Meanwhile, PTC has continued to operate regional grids, expanding to several new townships. Electricity lines were already in place, and ESE had a few generators providing limited power, often just four hours per day. ESE granted PTC a license to install generators and operate the grid. The tariff in these townships is in the range of MMK 405–450 (27–30 U.S. cents) per kWh. The grid in each township is managed by an electricity committee comprising ESE, the General Administration Department, and the municipality. The electricity committee sets the tariff using the following formula:

- One gallon of diesel produces 10 kWh.
- One gallon of diesel costs MMK 3,000 (approximately USD 2.00).
- The fuel cost for electricity is MMK 300 (20 U.S. cents) per kWh, plus MMK 50 (3.3 U.S. cents) production cost per kWh.
- This means, for example, that if the price of diesel rises from MMK 3,000 to MMK 4,000 per gallon, the tariff will rise from MMK 350 (approximately 23 U.S. cents) to MMK 450 (approximately 30 U.S. cents) per kWh.

Myeik District. Encouraged by the savings from gas and the adoption of more efficient generators through the tender process, Tanintharyi is now trying to consolidate regional grid management in Myeik District. There are nine electricity committees in four townships overseeing many different regional grid operators, and the distribution-line system is very complicated. The current generators are diesel, and they are owned by existing operators (who have the concessions). The Tanintharyi government is working to bring the committees together and has tried to negotiate a consolidated operating framework, but it could not get all the parties to agree. As a first step, the Tanintharyi government called a tender for a regional grid operating license for just Myeik Township, within Myeik District. A firm called Myeik Public Company won the tender in June 2018. This company was set up by a Myeik businessperson, in a joint venture with a Korean firm, as a company with publicly trade shares. Myeik Public Company will provide both generation and distribution in Myeik Township, using heavy fuel oil (not gas). They plan to finish construction by the end of 2018 and start operations by early 2019.

Myeik District has 130,000 households, and Myeik Township itself has 54,000 households. The previous tariff was MMK 415 (27 U.S. cents) per kWh. After the tender, the new tariff will be just MMK 260 (17 U.S. cents).

Kaw Thauung District. In Kaw Thauung District, which has 42,000 households, Kaw Thauung Region Electricity Production and Generation Development Public Company (KDDPC) won a tender in September 2017 for Kawthauung Township (25,000 households). In this

case, the previous tariff was MMK 350 (23 U.S. cents) per kWh, and the winning bid was MMK 280 (18.3 U.S. cents). As of July 2018, the contract for this concession had been reviewed by the Tanintharyi Region Attorney and was being reviewed by the Union government—a legal formality before a contract can be finalized.

Main grid. MOEE plans to bring the national grid to Tanintharyi by 2023, and has agreed with Total and Siemens to build an LNG port and construct a gas power plant in Kanbok District with a capacity of 1,230 MW. Myeik Public Company is also in discussions with MOEE on a 610 MW LNG-fueled plant (Hlaing 2018).

3. STATE/REGION PROMOTION OF MINI-HYDROPOWER

Because so much of Myanmar is unconnected to the grid, thousands of mini-grids, using diesel fuel, hydropower, and biomass, have been built all across the country. They were developed with local expertise and ingenuity, although some of them received technical assistance and expert input from international donor organizations.

Table 9 shows estimates of mini-grid prevalence in Myanmar developed by Greacen (2016) based on data from DRD and census data on the source of lighting. According to 2015 data from DRD, about 16,000 of Myanmar's 64,000 villages had some form of diesel-generator, micro-hydropower, or biomass/biogas mini-grid. However, they concluded that only about 4,000 of the villages were substantially electrified, using a threshold of at least 70 percent of the households in a village having electricity. And Greacen also draws on census data on the main source of household lighting to find that just over 1 million households have access to a diesel generator and that nearly 180,000 households have access to mini-grids powered by mini- or micro- hydropower.

Case study: mini-hydropower in Shan State

Zaw Min is managing director of the Mega Myanmar Energy Company, a designer and builder of mini-hydro plants. He is also coordinator for the Hydro for Community Empowerment and Myanmar network (HyCEM), an association of rural power developers from several states and regions across Myanmar.³⁹ HyCEM supports the development of hydropower for villages in hilly regions, for productive uses such as corn threshing, rice milling, and sugarcane squeezing.

HyCEM's work makes clear that there is a vast, untapped potential for investment in mini-hydropower and that state regulations can play an important role in mini-hydro development. According to Zaw Min, more than 5,000 hydro mini-grids smaller than 1 MW have been developed in Shan State.

Zaw Min has spent his life working on mini-hydro development, following in his father's footsteps and working with him. He and his father have developed 120 projects in the range of 1–250 kW. According to Zaw Min,

People have been working on rural-scale renewable energy for 30 years. The renewable-energy developers have been doing this without any government support, technology transfer, or capacity building support. I personally know a number of developers who have each developed 100–150 pico-hydro, micro-hydro, and mini-hydropower projects.⁴⁰

In late 2018, Shan State was developing a state energy law that would include steps to promote locally produced power and mini-hydro in particular, a significant energy resource within the state. The draft law would facilitate interconnection of mini-grids built to a standard that allows interconnection with the national grid.⁴¹

Zaw Min described the important role of state government in supporting increased development of mini-hydro projects in Shan State:

The state government and project developers need to work together to improve the situation. A key step by the state government to support expansion of mini-hydro would be local energy planning, including energy resource assessments, energy demand assessments, and socioeconomic assessments. In short, we need to know which areas have more or fewer energy resources and which areas have more or less demand for electricity.

4. STATE/REGION ACTION ON DECENTRALIZED ENERGY AND PROJECTS SMALLER THAN 30 MW

As noted above, state/region governments have complete authority for power generation projects smaller than 30 MW as long as they are not connected to the national grid.

As the previous section demonstrates, a number of states and regions have had significant experience with village-level mini-grids, including diesel generators or mini- or micro-hydro plants. However, there has been very little investment in slightly larger scale, decentralized power production in Myanmar. This section covers small-scale projects larger than village mini-grids, in the range of 1–30 MW. The following section covers the state/region role in “off-grid” energy, with a focus on village-scale mini-grids

TABLE 9. Estimates of mini-grids operating in Myanmar.

| DRD DATA | | | CENSUS DATA | | | |
|----------------------------|-------------------------|---|-------------------------|----------------|----------------|------------------|
| Generation type (DRD data) | Villages (DRD Jan 2015) | Villages with 70% households electrified (end FY 2015/16) | Main source of lighting | Households | | |
| | | | | Rural | Urban | Total |
| Generator | 13,088 | 2,407 | Generator (private) | 835,840 | 177,309 | 1,013,149 |
| Mini of Micro hydropower | 2,426 | 1215 | Water mill (private) | 151,721 | 25,786 | 177,507 |
| Biomass/ gas | 1,232 | 472 | | N/A | N/A | N/A |
| Solar mini-grid | | 150 | | N/A | N/A | N/A |
| TOTAL | 16,746 | 4,244 | | 987,561 | 203,095 | 1,190,656 |

Source of DRD Village-level data: DRD, “Rural Electricity Access” (MoLFRD & World Bank Off-Grid Electrification in Myanmar, Naypyitaw, Myanmar, January 28, 2015) and DRD, “End of 2015-2016 FY 70% Rural Electrification Villages”. Source of household data: 2014 Myanmar Census. Cited in Greacen 2017.

The benefits of a more decentralized approach

One foreign businessman, who is highly committed to developing affordable, small-scale energy for communities around Myanmar, praised the benefits of a bottom-up approach to electrification as a complement to the Union government’s focus on large, centralized power plants and extension of the national grid.

There is a question as to whether Myanmar takes the old model or the new model. The Union government, with support from ADB, the World Bank, and others, is planning to spend billions of dollars over the next 10 years to build transmission and distribution infrastructure. But distributed generation near the point of consumption is really the way to go. Even in the U.S., the large utility companies are now building micro-grids. Myanmar really has a wonderful opportunity to leapfrog. The mobile phone industry is a good example [of leapfrogging]. It has gone from virtually nothing to approximately 80 percent penetration in the last three to four years.

Small-scale electricity generation projects in the range of 1–30 MW are technically feasible and can be commercial and cost-effective, but domestic and foreign investors don’t see these projects as “bankable,” meaning that they cannot be financed by a bank or investor. This is because any power project like this needs a buyer, and state/region governments lack the budget authority to enter into PPAs.

One executive who is developing solar power projects in Myanmar—both rooftop solar and larger, grid-connected solar farms—described his concerns about the lack of clarity in the division of power authority between the Union and state/region governments.

If the project is smaller than 30 MW and connects to the grid then the ministry [MOEE] needs to be involved. But if you are building a mini-grid unconnected to the grid, and then the grid arrives, there is a lack of clarity between the state and Union levels. No one decides, and you do not get a clear answer. The problem is that everyone can tell you no, but no one can tell you yes. And if the goal is to attract foreign investment to the power sector, having investment protection and exit scenarios mapped out is very important.

Another development expert based in Myanmar described the basic problem as lack of a buyer (or “offtaker,”) for these smaller projects. He pointed to the problem that smaller, decentralized projects are needed in Myanmar, but there are no actors authorized to be the primary buyers of the electricity from these projects, which could be useful in areas where there are population centers, businesses, and industrial estates.

There is clearly a need for small-scale generation for businesses, townships, and villages and to support economic development. But the 30 MW limit leads to the perverse effect that EPGE, which is the Union government buyer of power from electricity generators, does not care about

or get involved with projects under 30 MW, since these are under the authority of the states and regions.

The Ministry of Industry has entered into an interesting agreement with a consortium that would develop up to 200 MW of rooftop solar power at a number of sites formerly occupied by state-owned industries. If completed, this would be a unique example of decentralized energy production using solar power with EPGE as the offtaker (see text box, “Ministry of Industry promotes decentralized clean energy”).

A framework for small-scale power development

The framework developed for small-scale power development in Thailand in the late 1990s allows PPAs with small power producers (less than 90 MW) at prices providing producers with a slight premium as an incentive. The Thailand generating utility, EGAT, is the buyer, or “offtaker” for these PPAs. In Thailand, about one-fifth of new renewable energy capacity built in recent

years is for projects smaller than 90 MW. Nearly all of this has been financed with private-sector funds, and therefore does not strain the government’s finances (see text box in section 4.3, “Thailand’s Small Power Producer Program”).

Interview feedback on the idea of decentralized, distributed energy

Asked whether there would be more support for decentralized, distributed energy projects, MOEE officials interviewed at both the Union and state/region level were in principle favorably disposed. In addition to the financing issues already discussed, however, some of them cited the logistical and technical challenges of handling a multitude of small projects, each with its own project reviews, assessments, EIAs, approvals, concession agreements, etc. Put simply, they were not convinced that the institutional capacity exists, or could be quickly acquired, to effectively manage a countrywide small-scale power program.

BOX 7. Ministry of Industry promotes decentralized clean energy

Using some of its available in-house capabilities, MOI is working on the design of small-scale hydro turbines. They want to manufacture turbines in the range of 1–5 kW so that villages can generate their own power. MOI would like to support a standardized design that can be widely applied and easily financed to support the development of small-scale distributed generation and mini-grids. The role of MOI would be to support captive use for manufacturing, not overall power generation.

Ministry officials mentioned their interest in supporting the development of photovoltaic panels and electric vehicles, including electric buses for export and eventually for the domestic market. Another initiative they mentioned was promoting the development of rooftop solar by leasing rooftops on industrial sites managed by MOI. Industrial sites that have gas would also be candidates for hybrid power generation using solar and piped gas.

Solar power generation on available land at disused state-owned factories could reach upwards of 200 MW. Recently MOI, in partnership with Energeia AS, an Oslo-based solar investment company, has engaged in long-term PPA negotiations with EPGE to develop these potential sites. Targeting an average price of less than 5 U.S. cents per kilowatt hour through long-term PPA contracts that gradually ramp down over time, such public-private partnerships could become some of the first large-scale examples of distributed renewable energy around the country.

BOX 8. Business network to develop standard PPAs for small-scale hydropower

One problem faced by project developers is that MOEE does not have a standard PPA mechanism. To solve this problem, MOEE, through DEPP and EPGE, has been working with IFC to develop a standard PPA template for small-to-large hydro. IFC is setting up a hydro business network, the Hydro Developers Working Group, which includes hydropower companies and investor groups. This PPA will be the first template in the hydro sector, and it is envisioned as the basis of PPA templates for other energy sources such as gas, coal, and solar. The hydro standards took three and a half years to develop in a joint effort funded by Norway and Myanmar. It is expected that these hydro standards will be approved by parliament in early 2019.

One MOEE official described the combination of technical and investment challenges facing small-scale hydropower, a major distributed energy resource with huge potential to meet Myanmar's energy needs. The official said that MOEE had investigated many potential small-scale hydro sites along river basins and seen great potential, but the perceived risks would make investors reluctant. Projects that go forward are often 100 percent equity, because that is the only funding available in Myanmar. Debt financing is nearly impossible, because the banking system is still undeveloped.

The text box above, "Business network to develop standard PPAs for small-scale hydropower", describes an effort to overcome some of the barriers to development and financing of small-scale hydropower by working with government and a network of hydropower developers, investors, and project developers to develop standard PPA templates and guidelines.

BOX 9. Thailand's Small Power Producer Program

Before embarking on the path of centralized power-sector development, Thailand in the 1950s had two competing models of electrification: centralized grid expansion and micro-hydropower mini-grids run by cooperatives. The centralized model eventually won out, in part due to Cold War politics (Greacen and Greacen 2004).

As a result, centralized, state-owned utilities were established starting in 1958, with the Metropolitan Electricity Authority (MEA) taking charge of distribution in the Bangkok metropolitan area and the Provincial Electricity Authority (PEA) in the rest of the country. The Electricity Generating Authority of Thailand was set up later to be the country's monopoly electric utility. Concessional financing from the World Bank, USAID, and others helped fuel the rapid rate of electrification. By 1990, Thailand was 99 percent electrified.

This rapid electrification, coupled with skyrocketing growth in electricity consumption, led to power shortages and rotating blackouts by the end of the 1980s. Burdened with huge debt loads from the rapid expansion, the utilities struggled to keep pace with the capital investments needed to meet the rising demand (Greacen and Greacen 2004).

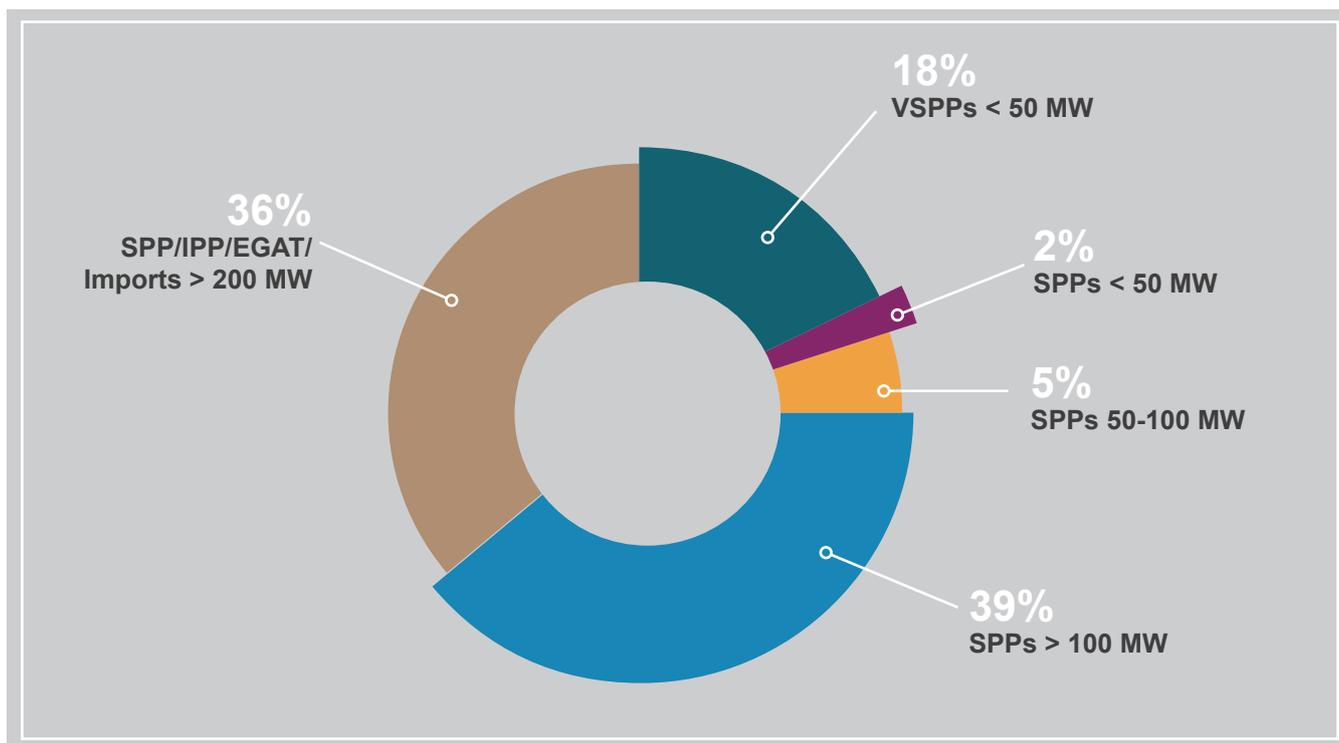
The Small Power Producer (SPP) Program was introduced in 1992, partly to ease the investment burden of EGAT and partly to promote clean, distributed generation (90 MW or less). The private sector responded enthusiastically to sell power to EGAT, with qualified projects utilizing renewable energy or high-efficiency cogeneration technology.

In 2002, Thailand became the first developing country to allow electricity customers to sell electricity back to the grid, with the introduction of the Very Small Power Producer (VSPP) Program. The program simplified and streamlined the SPP interconnection regulations to allow very small-scale distributed generation to connect to the grid and sell power to the utilities. The size limit was originally set at 1 MW, but was lifted to 10 MW in 2006 after a flood of private-sector interest in domestic renewable energy resources, particularly biogas and biomass.

To further promote renewable energy, the government in 2007 provided a premium (called an "adder") to further incentivize investments in renewable energy (RE), particularly solar and wind. Funded by electricity ratepayers, the adder mechanism, the SPP Program, and the VSPP Program have resulted in significant investments in generation capacity, increased energy self-reliance, and growth in RE businesses in the country (Tongsopit 2014).

Since 2009, new power generating capacity in Thailand has been significantly cleaner and more decentralized, especially from renewable sources such as biomass, solar, and more recently wind power. Of the 24,750 MW of new generation capacity since 2009, 20 percent is from power plants smaller than 50 MW, 5 percent from plants 50–100 MW, 39 percent from plants 100–200 MW, and 36 percent from plants larger than 200 MW (including power imports from Laos) (see figure 15). These figures do not take into account another estimated 2,000 MW of distributed photovoltaic capacity that is solely for self-consumption at the building or factory site.

FIGURE 15. Additions of new power generation in Thailand since 2009, by plant size.⁴²



5. STATE/REGION ACTION ON OFF-GRID ELECTRIFICATION AND VILLAGE-SCALE MINI-GRIDS

One area that is clearly within the state/region domain is small-scale, off-grid electrification, which provides electricity to villagers who are not connected to the grid by various means, including solar home systems and mini-grids.

The states and regions will need to play a central role in the system of electric mini-grids that are being developed in thousands of villages across the country as part of the preelectrification strategy of the NEP.

Mini-grids under the National Electrification Project (NEP)

The NEP was discussed in section 2.3. Under the NEP, the target for off-grid preelectrification through 2021 is as follows:

- solar home systems: 456,500 households
- mini-grids: 35,000 households
- total preelectrification: 491,500 households⁴³

Although the vast majority of households will be connected through solar home systems, there is a growing emphasis on mini-grids, because they can provide a higher tier of electricity service, they are scalable, and the system costs are rapidly falling to the point where they can be a cost-effective option for grid extension in very remote areas.

Introduction of solar mini-grids

The first significant installation of photovoltaic mini-grids in Myanmar occurred in 2015–2017 under the Off-Grid Renewable Energy Demonstration Project, with assistance from ADB. Twelve pilot solar mini-grid systems were built and successfully installed in the Dry Zone (ADB 2017A). (See annex F for a review of the ADB Off-Grid Renewable Energy Demonstration Project and a summary of key lessons learned.)

DRD, with support from the German development agency GIZ and other development partners, has been building on that initial experience with solar mini-grids to expand development of solar and hybrid mini-grids through a national call-for-proposals process.

DRD has been issuing calls for proposals for mini-grids since 2016, hoping to attract private-sector developers and investors interested in off-grid electrification as a business opportunity. Under the program, the government covers up to 60 percent of the capital cost of the mini-grid, while the remaining equity portion must be agreed upon by the project developer and the beneficiary communities.

The first call for proposals was issued in September 2016 and received 40 submissions. Eight of these proposals were accepted, and the eight proposed systems have all been commissioned. The second call for proposals was issued in August 2017, and it received 83 submissions, 16 of which were selected. There are two pathways for developing a project.

DRD identifies villages from a nationwide pool of villages that are more than 10 km from the electric grid (either in Zone 4 or Zone 5) and holds competitive bidding for the concession to build mini-grids in these villages. Alternatively, developers can identify villages themselves, based on their knowledge of a region and

inspection of the village.

A third call for proposals is currently open. Hereafter, DRD will accept mini-grid applications on a rolling basis, with the goal of electrifying 35,000 households using mini-grids by 2021.

BOX 10. What is a solar mini-grid and how does it work?

A mini-grid is an alternative way to supply power to a remote village. It involves small-scale generation of electricity and the distribution of electricity to a limited number of customers through a distribution grid that can operate in isolation from a national network to supply a village (or even an industrial estate) with grid-quality electricity. This contrasts with a solar home system (SHS), which serves a single customer (RECP 2014).

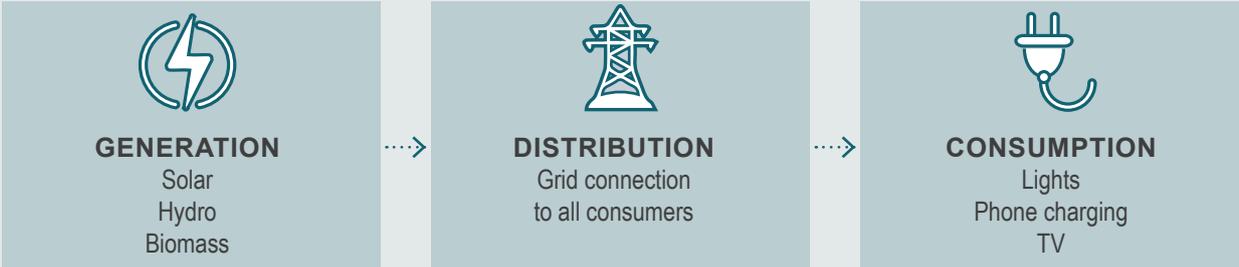
In rural areas, mini-grids provide power for entire communities and villages. At the same time, especially in countries where the national grid is unreliable, mini-grids often provide power to commercial and industrial developments. Over the past decade, many urban developments have included mini-grids to increase their self-reliance and resilience in the face of extreme weather and natural disasters.

Mini-grids vary in size from 10 kW to 10 MW.⁴⁴ For simplicity, this report distinguishes between mini-grids and regional grids, the difference being that, while both are unconnected to the national grid, regional grids are typically larger and are operated by ESE or licensed by a state/region government (see text box, above, “Regional grids vs. mini-grids”).

Among renewable energy mini-grid technologies, solar is becoming more attractive due to its scalability and declining costs. Solar mini-grids are typically smaller due to their limited economies of scale: bigger systems do not necessarily translate into lower per-unit costs.

A village-scale, renewable energy mini-grid usually consists of three main subsystems: (1) generation, consisting of a renewable power source, batteries, charge controllers, and inverters; (2) distribution, a method of connecting and delivering electricity from source to end-users, using three-phase or single-phase AC, or DC; and (3) consumption, which includes meters, electric sockets, and appliances (figure 16).

FIGURE 16. Key components of a mini-grid system.



Source: ADB 2017B

To provide electricity when the sun is not shining, a solar mini-grid requires a bank of batteries to store energy, plus an inverter to convert DC from the batteries into AC for use by most appliances. Given their versatility and declining price, photovoltaics and mini-grids are a good alternative for villagers who are currently using unreliable diesel generators or kerosene lanterns, candles, or flashlights.

The need for mini-grid guidelines and regulations

DRD is not responsible for mini-grids in a regulatory sense; rather, they have the mandate to support their expansion—including technical oversight, assisting with village identification and resource selection (hydro, solar, biomass), and providing incentives for investment. However, DRD concluded early on that for mini-grids to proliferate at the desired rate, they would need investors beyond just the government and the community, and that those investors would not materialize without clear technical and legal guidelines (Zaw 2015).

The Electricity Law of 2014 does not contain regulations related to mini-grids at the Union level, and the states and regions do not have mini-grid regulations either, but a several states are developing their own energy laws and regulations. From our interviews with various stakeholders, it seems clear that MOEE will want to control the regulations and technical parameters governing mini-grids, because they will eventually be connected to the grid, which is managed by MOEE.



GIZ ... has been helping DRD draft regulations for off-grid power systems and consulting with a number of states and regions to promote their adoption.



GIZ, as part of its multi-year program, Promotion of Rural Electrification in Myanmar, has been helping DRD draft regulations for off-grid power systems and consulting with a number of states and regions to promote their adoption. DRD convened a workshop in March 2018 to solicit feedback from numerous stakeholders, including Union line ministries, state/region energy ministers, private developers, and civil society organizations.

During the workshop, DRD held a meeting with states and regions to introduce the proposed regulatory framework, with the aim of getting feedback and eventually getting buy-in for the regulations. Ministers from 13 of the 14 states and regions attended. DRD and GIZ continue to hold bilateral meetings with regional ministers to discuss the draft regulations. DRD's discussion of the proposed regulations was followed by a presentation from MOEE on the Electricity Law. A major emphasis of the presentations was that the guidelines are necessary to bring private-sector investment into the mini-grid sector.

The approach is to have two parallel sets of guidelines: one at the Union level, which would be adopted by MOEE, and the other in the form of a template for state/region regulations, which would be adopted by the state/region governments under their existing electricity laws. Both sets of regulations address three issues:

1. permitting, or “the right to exist”
2. the right to set tariffs that reflect full costs
3. options upon grid arrival

Each set of regulations approaches these three topics in different ways, according to the roles and responsibilities of the Union and state/region governments outlined in the 2014 Electricity Law.

The state/region guidelines would focus on the licensing process, business aspects, and technical requirements.⁴⁵

The draft guidelines were circulated for discussion during the second half of 2018 and are the subject of ongoing discussion among MOEE and various states and regions. The framework covers issues important to developers and investors, such as certificates of exclusivity, permitting, commissioning, interconnection certificates, standardized power purchase/sales agreements, and tariff requirements.⁴⁶

Uncertainty about what happens when the grid arrives

The grid-connection issue causes significant uncertainty for project developers and investors in mini-grids and small-scale energy projects. For example, the state/region government can approve a mini-grid or

a generation project smaller than 30 MW, and the tariff for connected houses or businesses can be agreed upon with the investor. Should the mini-grid eventually be connected to the national grid, however, new negotiations about pricing and tariffs will be required between the investor and ESE. The basic problem is that the national grid has an agreed, subsidized tariff, which is always much lower than the actual cost of production for a stand-alone mini-grid.

One international expert with extensive mini-grid experience in multiple countries put it very clearly:

With subsidized electricity rates, the grid arrival essentially kills (or almost kills) these off-grid, mini-grid projects. As a result, new investments are very risky unless MOEE allows the mini-grid operators to interconnect with the grid under reasonable terms. They don't necessarily need PPAs or offtakers. But they do need the ability to continue to recover their costs through a distribution franchise arrangement.

We spoke with a legal adviser to project developers (primarily Japanese and Korean), who said that nearly all of their work on projects in the range of 1–30 MW⁴⁷ is for stand-alone, or “captive,” power projects for private special economic zones, or for resorts and hotel developments in fairly remote areas where the grid will

not be connected. He said that developers don't want to be connected to the grid; they are trying to make their projects self-sufficient islands.

The clients that we work with finance projects with their own equity and typically don't want to be connected to the government grid. For example, we advised the developer of a resort along the coast, in an area where the grid will not be extended in the foreseeable future. Another example is we helped develop financing for a special economic zone with a total of 90 MW, but it was done in three phases of 30 MW each [to avoid the need for MOEE approval].

The legal adviser noted that such development is for commercial benefit and often does not provide power to local communities. He suggested that a better approach, from a societal perspective, would be a bottom-up approach to developing mini-grids and small-scale power production at the township level, with an opportunity for companies to enter into binding, long-term concession agreements that them with the right to long-term production and sale of power at rates agreed upon with the local townships and communities. The problem is that even if you have a concession from the state/region government, when the national grid arrives promising power for MMK 35 per kWh, it will be difficult to prevent customer flight to the national grid.

Chapter 5

FINDINGS AND RECOMMENDATIONS

The role of Myanmar's states and regions in the energy sector will become increasingly important as energy production and distribution, following regional and global trends, become more decentralized. This report has focused on areas where the states and regions have a mandate, where they need to build capacity, and where they can have agency in energy planning and development within their borders.

This report's findings fall into three broad areas:

- energy legislation, policy, and planning
- energy project review and grid management
- off-grid, decentralized energy and mini-grid development

These are areas where state/region governments can take steps to effectively manage energy issues that affect them. What follows are our principal findings and recommendations.

5.1 MAIN FINDINGS

ENERGY LEGISLATION, POLICY, AND PLANNING

It is impossible to effectively manage the development of Myanmar's rapidly growing energy sector without a clear legal and policy framework at the state/region level. Such a framework should consider how both Union and state/region energy policies will affect the state or region, and provide guidelines and tools for state/region government decision-making. As described in chapter 4, many states and regions are developing their own laws to encourage energy development, attract capital investment, establish transparent, fair, and reasonable energy regulations, and accommodate social and environmental concerns.

The experience gap in state/region energy planning

Because Myanmar's energy sector has been developing rapidly and many of the decisions and procedures are new, Union energy officials face a significant learning curve. Myanmar's energy policy has heretofore been largely the domain of MOEE and Union officials, and the experience gap at the state/region level can sometimes be even greater. State/region energy ministers spend much of their energy responding to proposals from MOEE or from energy investors and project developers, rather than pursuing a comprehensive plan for energy development. Members of parliament with whom we met identified a need for assistance in crafting effective energy laws and the rules and regulations to implement them.

Many MPs find the energy sector to be both technically complicated and politically difficult to navigate. One member of the Yangon Hluttaw said,

When they drafted the Yangon ESC law, experts from Singapore came to help. We need these experts to bring us examples of energy policy from neighboring countries. We want to know what they did, how it worked, and what are the best practices.

MPs stressed the great promise of small-scale power production, and suggested that promoting it could lead to a more development-oriented approach to electrification, with great benefits for Myanmar as a whole. They were particularly interested in legislation: a small-scale production law would be a significant step in addressing the nation's inadequate electricity supply.⁴⁸

State/region planning and energy resource potential

A common theme for interviewees was that the current practice of top-down, national-level planning fails to identify resources and investment opportunities for the smaller-scale distributed energy projects that are uniquely adaptable to the particular needs of the states and regions.

One main finding on state/region energy planning is the need for comprehensive data on each state's energy situation, to provide the basis for systematic planning. The state/region governments are attempting to move forward, and are negotiating with various private energy companies, mostly for larger, grid-connected projects. But there are no systematic discussions of energy development more broadly, either within the states and regions or among them.

State/region energy ministers can make an important contribution by conveying a vision for energy development within their borders. Their role is pivotal, because they are uniquely positioned between the Union government and the communities where energy projects will be realized. These ministers have an opportunity to develop a common vision for the future of the power sector that will bridge the needs of the states and regions and the needs of the country as a whole.

Transparency and participation in power planning and siting

We found that local communities are wary of large power projects because of past experience with large projects that were unaccountable and nontransparent. Many communities fear new energy investments because of past disregard for human rights and

the environment. NGOs also voiced concern about lack of transparency and the impacts of large-scale power plants. Large projects are approved by the Union government, but their negative impacts are borne by the states and regions, and state/region governments must work with the Union government to institute an effective process of public participation in site selection, planning, and the assessment of environmental impacts (see the discussion of EIAs in section 3.1).

As an example of the problems that can occur without effective public review, Aung Kyaw Moe, a member of the steering committee of the Myanmar Alliance for Transparency and Accountability, mentioned three, controversial, large-scale projects in Shan State: the Upper Yewa transmission line and the 140 MW Upper Paunglaung Dam, the 660 MW coal-fired power plant in Xiandong in eastern Shan State, and the 120 MW Tigyit coal-fired power plant in Shan State.⁴⁹

Energy-sector budgeting

State/region ministers and MPs voiced the need for larger budgets for state-level energy systems, including the distribution system. According to our interviews with state/region ministers and state/region Union officials, each state or region ESE receives funding from both the Union and state/region budgets. Generally, the Union energy budget covers all transmission and distribution down to the 33 kV system, while the state/region energy budget covers the 11 kV system.

State/region governments will need bigger budgets to manage off-grid electrification (see below), which is currently managed mostly by DRD under the World Bank-funded NEP, but may eventually become a state/region function.

Some interviewees called for government policies to help poor households get connected, which costs roughly USD 500–1,000 per household. This connection charge has traditionally been covered by the village, but this can slow electrification, because many of the poor cannot afford to pay. In many villages that are electrified, only a tiny fraction of households may actually become connected because of this connection fee barrier.

Both Union energy officials and state/region energy ministers interviewed identified the tariff as a major problem: it is too low to pay for the cost of service, and as the grid grows, so do government subsidies to power providers, creating rising debt. Union energy officials and state/region energy ministers agreed that if electricity customers paid the true cost of service, it would attract significant new investment to the energy sector.

ENERGY PROJECT REVIEW AND GRID MANAGEMENT

Project-level review and analysis

Government officials at all levels have limited experience evaluating private-sector energy proposals. And recently, the number and complexity of new projects has soared, with many of them are using new energy technologies. The present moment represents a significant opportunity to build the capacity of MOEE department officials at the state/region level, along with state/region energy ministers and their advisors, to evaluate the financing, the technologies, and the risks and benefits of new energy projects. One MOEE adviser described the challenge and how they are trying to address it:

We are conducting training at the Union level to address the challenges faced by Union officials in project evaluation. The topics include calculating the levelized cost of energy and how to incorporate environmental and social cost as well. This sort of training is needed by people at every level, including state/region ministers and even state MPs.

There is also a timely opportunity to clarify the relationship between (a) the functions of the Union and state/region governments (i.e. the level of devolution of authority to the state/region governments); and (b) between the responsibilities of MOEE's subsidiary departments at the Union level, and their responsibilities at the state/region level (i.e. the level of deconcentration of authority).

As part of their mandate, state/region governments respond to proposals from the Union government or project developers for energy projects such as mini-grids, but at present there is no overarching framework or plan for energy-sector development against which these proposals can be measured. One observer described a common scenario:

A company goes to state minister X and says, "We want to build 50 mini-grids in your state." After that, it's all a tactical conversation about "how do I get permission?"

The implication is that focusing on project-by-project approvals stunts the development of a larger policy framework and ignores important issues such as public notification, community involvement, and important investment risks such as land rights, exchange rates, and the structuring of PPAs and concession agreements.

In addition, the current situation discourages sharing and cross-learning among the states and regions. There is little or no alignment of state/region energy policies or oversight regimes. This creates a significant challenge for project developers, who often want to develop multiple projects across several states and regions.

Interactions with energy project developers
Private-sector developers generally praised the professionalism of government officials at both the Union and state/region levels, while noting their inexperience with newer technologies such as distributed energy systems, solar-powered micro-grids, and battery systems.

Developers complained about the time consumed by negotiations with government officials. One international, private-sector energy developer, who is building a number of solar projects around the country, described the need for patience:

It takes a long time to set up a meeting, and then to get confirmation of things we want to do. Just getting approval for a feasibility study, which we performed entirely at our own cost, took months.

While government approval is not strictly necessary for a feasibility study, the developer said having that approval allowed his team to get introductions to government officials and contact potential clients during the feasibility stage in order to collect the information they needed to assess project feasibility. This approach, of course, also lays the groundwork for an eventual application for a license or concession for the project.

State/region management of the distribution grid

One area where the state/region governments have a mandate and can assume greater agency is planning and managing the distribution grid. A donor-agency representative who is working as an adviser to MOEE said:

One of the key responsibilities for state/region governments, which they should be preparing for, is telling the Union government that they want to have a say in planning and managing the distribution grid. Once the grid gets built, these state and region governments should have a say in managing the grid within their borders.

Importance of effective oversight of franchisees and concessions

Another finding relates to the need for effective oversight of contracts and concessions, and the need

for strong coordination between the state/region governments and franchisees involved in electricity generation and distribution. The adviser to MOEE also talked about the importance of being able to manage franchisees effectively. Franchisees are the entities that buy electricity from ESE (or from YESC in Yangon, or MESC in Mandalay), and then sell that electricity to customers through the distribution grid. For example, franchisees in Yangon report to YESC. Some interviewees suggested that franchisees should answer to the state/region governments—as is the case in Tanintharyi (see chapter 4). The state/region governments could participate in negotiating the price at which electricity is sold to these franchisees. The state/region governments would then be able to audit their accounts. Such a change would, of course, need to be negotiated with MOEE.

One example of improving franchise management comes from Tanintharyi Region. In 2017, there were two companies managing the electricity system in Dawei: one was responsible for generation, and the other was responsible for distribution. The service was not good: reliability was poor and blackouts were common. The Chamber of Commerce organized a meeting to discuss the situation. Interviewees said there was little coordination between the government and the two companies, and neither the contract nor the regulations made clear who was ultimately responsible for delivering reliable electricity. Thant Zin of the DDA said it would be helpful in Tanintharyi to invite public participation in energy policymaking and operational oversight. In some cases, this hasn't happened because the regional government mistakenly views energy issues as primarily technical.



With a mandate covering all off-grid energy projects smaller than 30 MW, the state/region governments will have a key role in mini-grid development.



OFF-GRID, VILLAGE-SCALE ENERGY AND MINI-GRIDS

Mini-grid expansion and public engagement

A critical issue for state/region ministers is how to engage with communities and developers on the expansion of mini-grids. Mini-grid expansion is currently being driven by DRD, with large infusions of funding from the NEP.⁵⁰ The current approach is based on public tenders for mini-grid development, and their gradual expansion through government-subsidized concessions. Technologies and systems are improving, costs are coming down, and large amounts of investment are ready to be deployed to expand mini-grid systems in Myanmar.

With a mandate covering all off-grid energy projects smaller than 30 MW, the state/region governments will have a key role in mini-grid development, and this will create a significant opportunity for them. Clearly, for mini-grid expansion to succeed, it is critical for state/region ministers to understand the business models and be familiar with the ecosystem of energy service companies (ESCOs), which raise funds and then design and install systems in villages. As with any business group that provides jobs and economic benefits, state/region governments need to think through the needs of these ESCOs and understand what they need to develop their businesses and provide energy services to villagers.

One international expert working with an NGO to promote mini-grid systems talked about the big hurdle faced by state/region governments:

State and region governments need to engage directly with the businesses and not just stand off to the side and let it happen. They need to understand how mini-grid business models work, and they also need to be involved in discussions of what happens to the mini-grid system when the national grid arrives.

Experts in off-grid development spoke of these ESCOs as a very positive force for rural development. They can potentially play a significant role in Myanmar's energy future and support state/region governments by successfully bringing affordable power to communities in a sustainable manner.

Intersection of grid-connected and off-grid work

The Renewable Energy Association of Myanmar (REAM) has been focusing on how to help state/region governments with energy policy and planning, because the state/region governments are closer to where the

energy projects are actually being implemented. One of the issues highlighted by REAM and a number of private-sector stakeholders was the lack of integration between the grid-connected work managed by MOEE departments (such as ESE) and the off-grid electrification managed by DRD. As noted earlier, GIZ has been working with state/region governments and MOEE on this issue and has circulated draft off-grid regulations—which could be adopted in parallel at the Union and state/region levels. These draft regulations address the technical standards and performance of off-grid systems and, importantly, the risks associated with grid extension to areas where village mini-grids are operating.

The great unknown for village-scale mini-grids—what happens when the grid arrives—is a major issue (see chapter 4). One of the most common criticisms was that neither the MOEE departments nor DRD has a clear answer to this question, and the fear is that off-grid systems will become stranded assets, because their electricity is significantly more expensive than the subsidized electricity from the national grid. State/region ministers and their advisors interviewed told us that, even though they technically have the authority, they were reluctant to make commitments and to innovate in the off-grid area, because of the lack of clear policy.

5.2 MAIN RECOMMENDATIONS

RECOMMENDATIONS FOR ENERGY LEGISLATION, POLICY, AND PLANNING

1. Greater state/region role in energy laws and regulations

State/region governments should have a greater role in development of all new Union-level energy laws and regulations. In addition, whenever new energy laws and regulations are introduced, at the Union or the state/region level, there should be a standard process to educate the public and solicit public input. As a basic principle, the public should be invited to (a) have input into the drafting of laws and regulations and (b) offer comments on draft laws and regulations. State/region ministers and their staff should receive training in the public participation process for energy projects.

2. Improved capacity for state/region energy data collection and and planning

Myanmar has significant energy resources, and these resources can be cost-effectively developed with private-sector investment. This requires development of state/region energy plans. Each state and region has a particular mix of resources, be they hydro, solar, or biomass. Energy planning for the next 10–15 years will require a systematic assessment of resources and projected demand. The basic planning steps could

be part of a national assessment, but they need to be grounded in data at the state/region level. Steps to be taken include an energy resource assessment, an energy demand assessment, and a socioeconomic assessment. These steps will tell state/region governments which areas have the resources and which will have the greatest demand. The enabling step to make this happen is to build the capacity of state/region governments in the collection of energy data and in state/region level energy planning.

3. Training to increase the knowledge base of state/region energy ministers

Energy ministers are the lead decision-makers for energy at the state/region level, and their responsibilities, and the importance of their work, will grow over time as the energy sector becomes more decentralized. This creates a unique window of opportunity for training to build the knowledge base of state/region ministers and their advisors. With a shared knowledge base would come a common sense of purpose in energy development among the state/region governments, and a clearer common relationship between state/region governments to MOEE departments at the Union and state/region level (e.g., DEPP and ESE). Such training can encourage regular knowledge-sharing in the areas of energy policy, legislation, regulations, and investment trends. It would be helpful for the states and regions to work together to share lessons learned in areas such as energy data, legal requirements for small-scale and off-grid projects, and planning frameworks for energy project development. Such a cooperative effort would not only improve efficiency, but it would also attract greater investment from the many companies that are developing distributed energy systems, technologies, and solutions.

4. Gradual state/region budget increases for energy-sector development

As state/region governments gain experience in managing electricity distribution systems and assume more responsibility for the development of small-scale and off-grid power, there should be a gradual increase in the share of the energy budget allocated to the state/region governments.

5. Assistance to the poorest households to cover the cost of grid connection

The Union government (or perhaps state/region governments) should provide assistance to poor households that cannot afford an electricity connection. The cost, approximately USD 500–1,000 per household, is prohibitive for many households, which delays Myanmar's electrification goals.

RECOMMENDATIONS FOR ENERGY PROJECT REVIEW AND GRID MANAGEMENT

1. More formal role for state/region governments in reviewing grid-connected projects

One finding from our interviews was that state/region governments currently have at least an informal role in reviewing all grid-connected power projects, and that it is undesirable for power projects to proceed without the blessing of the state/region government. The Union government should develop a formal protocol for state/region review of all proposed power projects, including provisions for input from affected communities and other local stakeholders.

2. More formal role for state/region governments in championing selected large-scale power projects

For large-scale power development to be successful, projects will need substantial input from both the leadership and the affected population of the state or region. State/region leadership is arguably a necessary success factor for power-sector projects that both accommodate local social and environmental concerns and benefit the state/region and the Union. The case study of a coal-fired power plant in Kayin State (chapter 4) is an example of state leadership. In that case, the proposed coal plant did not proceed, due to the significant environmental concerns of local communities, and the Union government did not approve it. But the example shows that state governments can play a legitimate role in shaping large-scale projects within their borders.

3. State/region government approval of projects smaller than 30 MW

The research shows that a top-down, centralized, national structure is unsuitable for managing distributed generation. State/region governments must develop the capacity, and the authority, to review and approve licenses for all projects smaller than 30 MW, and potentially—in cooperation with the Union government—even those that are grid-connected. State/region approval could apply to the local aspects of the project such as land rights, siting, public review, and EIAs. This change would have to be carefully worked out with MOEE's Department of Electrical Policy and Planning. MOEE would retain the right of final approval based on the technical requirements of the grid.

4. Active promotion of decentralized, grid-connected energy projects

The Union government should permit state/region governments to promote the construction of small- and medium-scale (approximately 1–30 MW) power projects connected to the grid. As highlighted in section 4.2, these systems can be financed by private-sector investment and could help to reduce the cost and improve the resilience of Myanmar's electricity system. Thailand's SPP Program, described in a text box in

section 4.2, is an example worthy of study by MOEE officials and state/region ministers of energy.

5. Training for power-sector ministers and senior officials in technical and financial literacy

State/region energy ministers, their advisers, and the state/region government officials who are in MOEE departments need training in technical and financial aspects of power-sector projects. Government officials must be familiar with the key metrics that underlie project finance decisions. These include basic characteristics and costs of different energy technologies, calculating the levelized cost of energy, incorporating environmental and social costs, and cost-benefit analysis of different options.

6. Training state/region engineers

As described earlier, state/region ministers do not have their own staff: the engineers working in states and regions are MOEE employees working in MOEE departments, and they rotate jobs every three to four years. Several interviewees recommended an initiative to train engineers working on energy projects in the states and regions. This could be initiated at the MOEE level, and the states and regions could be invited to send their staff. Even with such training, however, there is a question of who at the state/region level will do the planning and “own” the process of data collection, analysis, modeling, etc., especially since the Union officials in MOEE departments periodically rotate to new postings. Another suggestion was vocational-technical training in power systems for ESE engineers working at the township level.

RECOMMENDATIONS FOR OFF-GRID, VILLAGE-SCALE ENERGY AND MINI-GRIDS

1. Adoption of Union and state/region regulations for development of off-grid energy

As noted above, GIZ and DRD have developed draft regulations for mini-grid development, discussed those regulations with representatives of most state/region governments, and submitted them to MOEE for consideration. When adopted at the Union and state/region levels, these regulations will facilitate investment in mini-grids, spur rural development, and help achieve the nation's electrification goals.

2. Risk protection for mini-grid developers

Any guidelines for mini-grid development, as well as licensing or franchise agreements, need to include a clause guaranteeing compensation for the mini-grid developer when the national grid arrives. Without such protection, project developers and investors will be reluctant to invest in village-scale mini-grids, and the country will not achieve its off-grid development goals.

TABLE 10: Framework for scaling up village-scale minigrids across Myanmar.

| | | |
|-----|--|---|
| i | Reduce mini-grid development costs. | Soft costs must be reduced through efficiencies in development, and regulations must be changed to reduce the costs of components. |
| ii | Increase plant utilization and amortize up-front costs. | Mini-grid profitability and the economic benefits of gaining access to energy is dependent on plant utilization. Conditions must be set so that all mini-grids achieve 70-80% utilization within the first year of operation. |
| iii | Streamline project development. | Site selection, feasibility, and coordination on a regional basis must be streamlined to a far greater extent than it is today. |
| iv | Develop mechanisms to reduce risk. | Even with subsidies, the risk perception for mini-grid projects and the ESCOs building them must be reduced. |
| v | Develop new types of mini-grid subsidies. | The existing DRD/World Bank subsidy program is unable to absorb additional capital at this time, and on its own will not result in sufficient scale. |

Source: Smart Power Myanmar

3. Support for development of mini-hydropower in Shan State, and other states/regions as applicable

As noted in chapter 4, the work of HyCEM shows that there is vast, untapped potential to expand investment in mini-hydropower and that state regulations can support mini-hydro development. More than 5,000 hydro mini-grids smaller than 1 MW have been developed in Shan State, and more are needed. Policymakers should support the further development of regional mini-grids, which provide power to groups of communities but are not necessarily connected to the national grid.

4. A comprehensive framework for scaling up village-scale mini-grids in Myanmar

The ADB pilot project on mini-grids, and DRD's ongoing mini-grid expansion, have accumulated a significant base of experience with mini-grids: how sites can be selected, how they can be financed, how they can be constructed and operated, and how they work in practice in the villages. But mini-grid deployment at the scale needed to spur rural economic development will require a common approach to fundamentals such as measuring system costs, assessing village demand, streamlining project development, and determining system subsidies. Table 10, developed by the Smart Power Myanmar initiative, provides a unified framework for unlocking investment and accelerating the development of village-scale mini-grids in Myanmar.

5. Technical training in mini-grids for state/region governments

Over the next few years, the number of village-scale mini-grids will continue to increase rapidly to meet the NEP target of 35,000 households by 2021 (World Bank 2015). Given the level of interest from DRD, development organizations, and the private sector, the build-out of mini-grids will continue well beyond this target. Accordingly, it will be important to provide systematic, nationwide training for state/region governments, including supporting departments, in the technical, financial, and operational aspects of village-scale mini-grids.

Annexes

ANNEX A: INTERVIEWS CONDUCTED IN SUPPORT OF THE REPORT

TABLE 11: Summary of interviews carried out during this research.

| Region/ State | When Visited | No. of interviews | No. of People | State-Region Government | Number of Individuals Met | | | | |
|-------------------|-------------------------------------|----------------------|---|----------------------------|-----------------------------|---------------------|-----|-------------------|--|
| | | | | | State- Region Hluttaw | Union Government | NGO | Private Sector | International Development Organization |
| Yangon | May, July, and Octo- ber 2018 | 24 | 38 | 1 | 6 | 0 | 9 | 12 | 10 |
| Naypidaw | May-18 | 11 | 20 | 0 | 0 | 16 | 0 | 0 | 3 |
| Bago | Jul-18 | 1 | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| Shan State | Jul-18 | 5 | 12 | 6 | 2 | 0 | 3 | 1 | 0 |
| Thanin- tharyi | July and October 2018 | 4 | 4 | 1 | 0 | 0 | 1 | 2 | 0 |
| Bangkok | Aug-18 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 |
| Totals | | 47 interviews | 78 stake- holders inter- viewed | 11 | 8 | 16 | 14 | 16 | 13 |

ANNEX B: ELECTRIFICATION AND PER-CAPITA ENERGY CONSUMPTION IN MYANMAR

URBAN-RURAL DISPARITIES IN ELECTRIFICATION

As figure 17 shows, more than five out of six urban households (85 percent) are electrified, while the rural connection rate is just under one in four (as of 2017).

FIGURE 17. Percentage of Myanmar households connected to the national electricity grid.

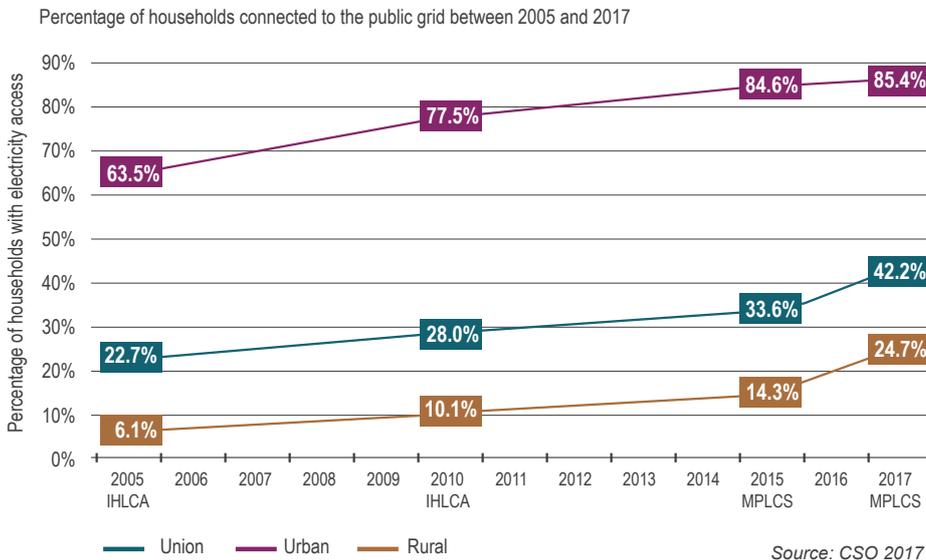
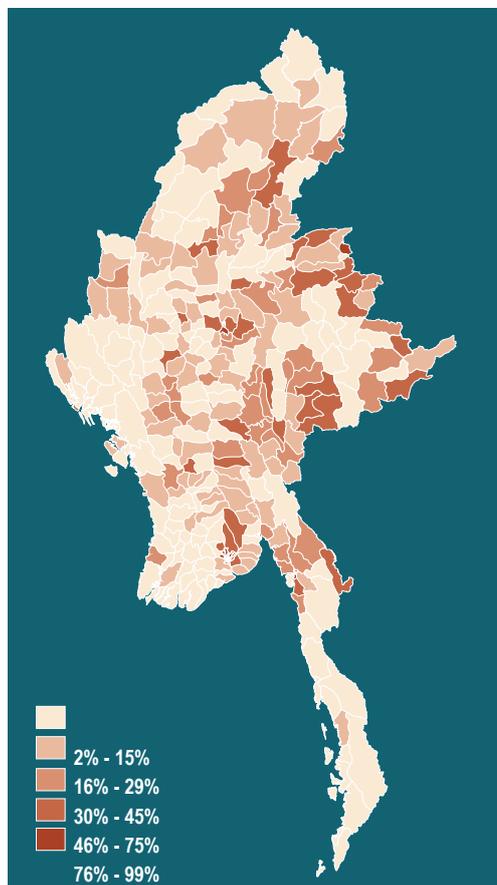


FIGURE 18. Percentage of Households Connected to the National Electricity Grid.



Source: Township level data mapped by The Asia Foundation

The sharp disparity in electrification across the country can be shown by mapping electrification rates. The Asia Foundation has collected and disaggregated township-level data for a range of social, economic, and environmental indicators, and develops township-level maps to better display and understand trends and disparities across the country. When the data on electrification is viewed on a township-level map, the disparities are readily apparent (see figure 18.).

NIGHT LIGHTS: VISUALIZING ELECTRIFICATION AND DEVELOPMENT FROM SATELLITES

A good way to estimate electrification (and economic development in general) is by “night lights,” using satellite measurements of the light emitted at night by cities and towns. Studies have confirmed a correlation between nighttime luminosity and GDP in a large number of countries. This technique is typically used where economic development data is limited or not available in time series. Night-light data is available from the Defense Meteorological Satellite Program, which aggregates and analyzes data from satellites managed by the National Oceanic and Atmospheric Administration (Fox and Verrucci 2017).

FIGURE 19. Changes in national luminosity, Yangon luminosity and national GDP. (Note: 2003 luminosity = 100)

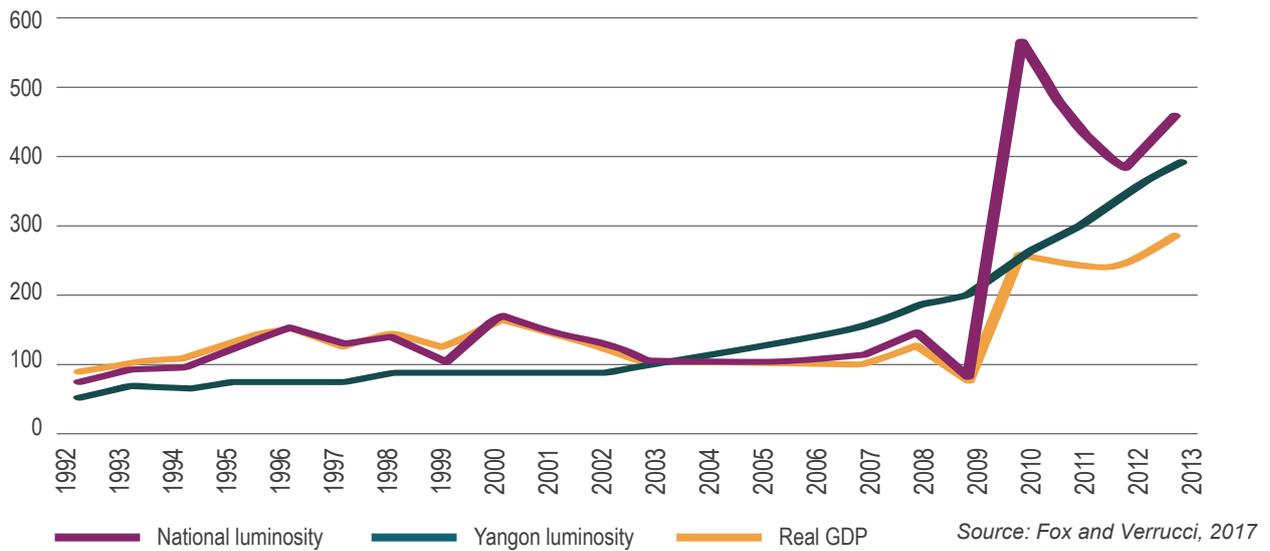


Figure 19 shows the correlation of night lights with GDP over time. Researchers from the UK collected night-light datasets for Myanmar as a whole, and Yangon in particular, for the period 1992–2013. The correlation is fairly strong, although there are measurement errors, which result in outlier data points for 2010 and 2011. The researchers think the data variation may be due to extensive infrastructure damage from Cyclone Nargis, which hit Myanmar in May 2008 (Fox and Verrucci 2017).

The Asia Foundation has also coded night-light data for the entire country of Myanmar down to the township level. The resulting night-lights map for the entire country is shown in figure 20. It gives a graphic picture of the economic and energy development challenges facing Myanmar.

PER-CAPITA CONSUMPTION AND LIKELY GROWTH

To understand the dynamic of growing electricity demand in Myanmar, it is helpful to put Myanmar’s electricity consumption in context. Not only does it have the lowest electrification rate in ASEAN, but it also has the lowest per-capita electricity consumption—about 235 kWh/year in 2016 (figure 21). That amounts to an average of about two-thirds of a kilowatt hour per day. This is just enough electricity for one of these activities:⁵¹

- watching an old-style (plasma) television for around two to three hours, or a new-style (LCD) television for about
- powering three small lamps for 24 hours
- boiling water in an electric kettle six to seven times
- using a desktop computer for 10 hours

FIGURE 20. Nighttime lights in all Myanmar states and regions.

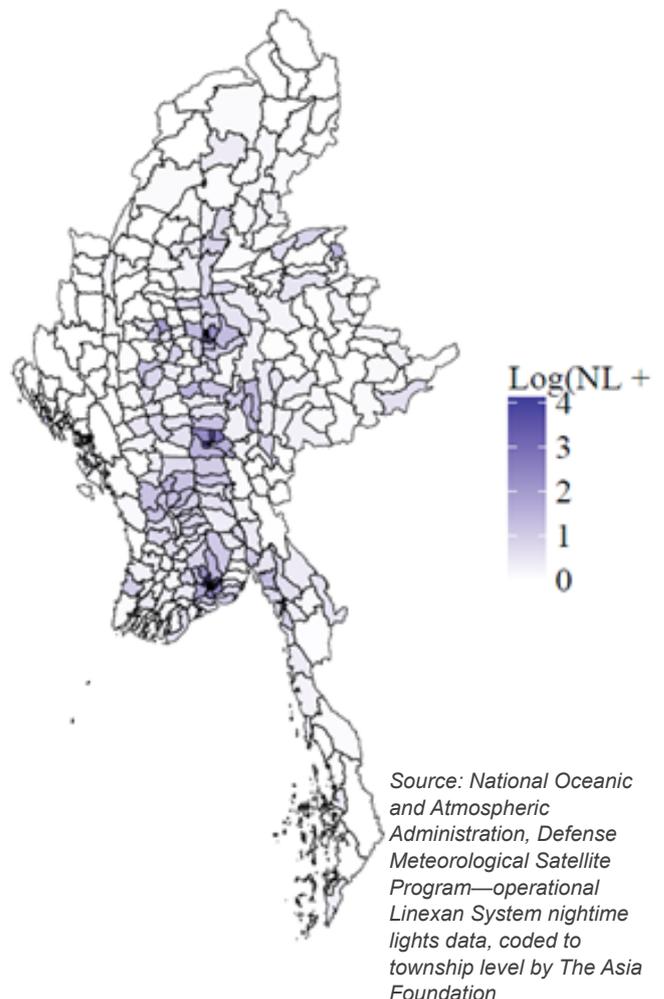
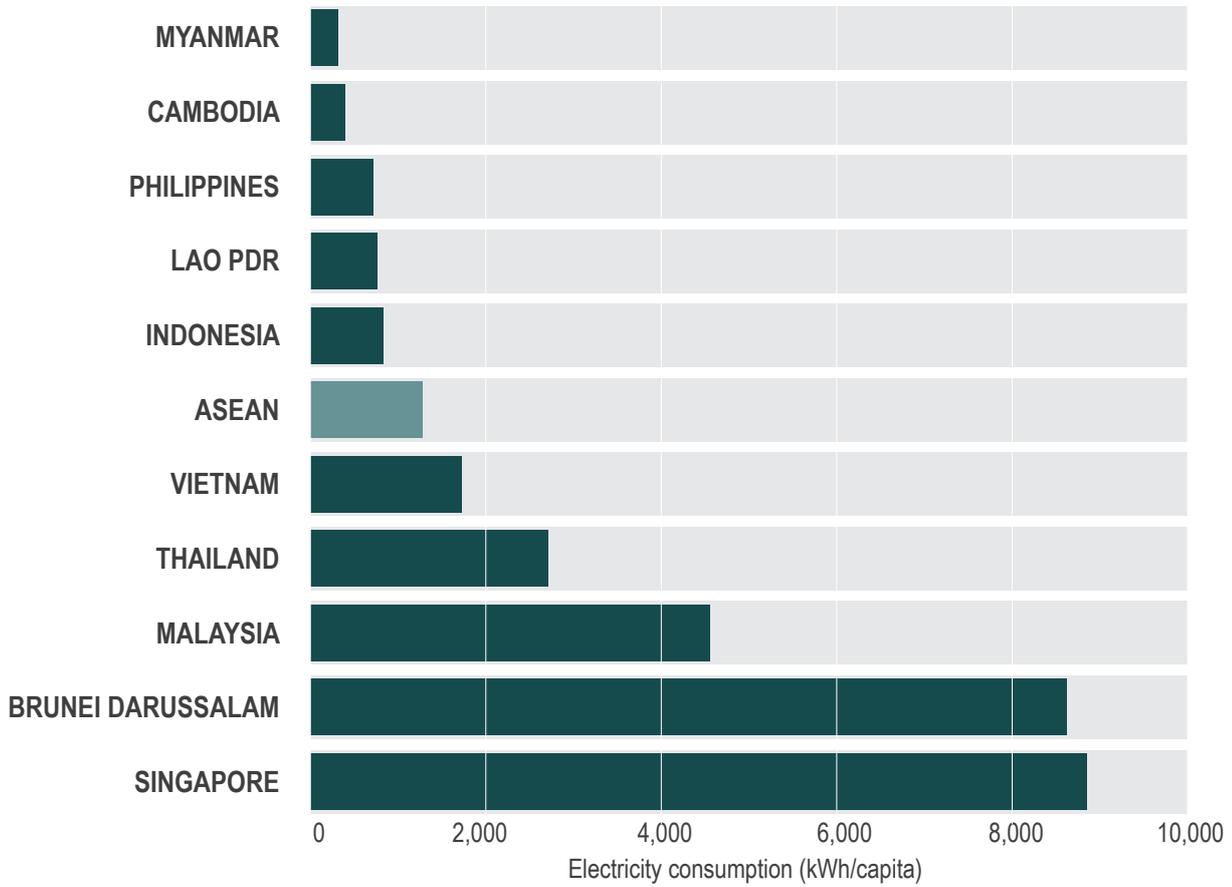
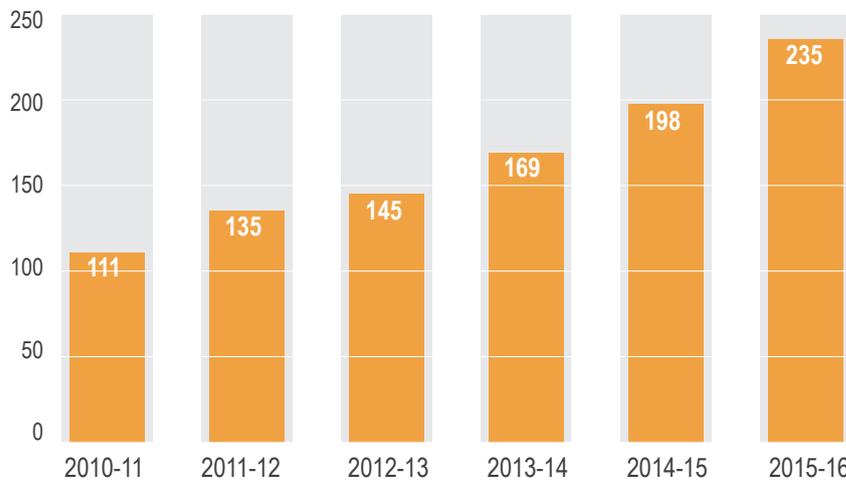


FIGURE 21. Myanmar electricity consumption in regional context: per-capita consumption of ASEAN countries.



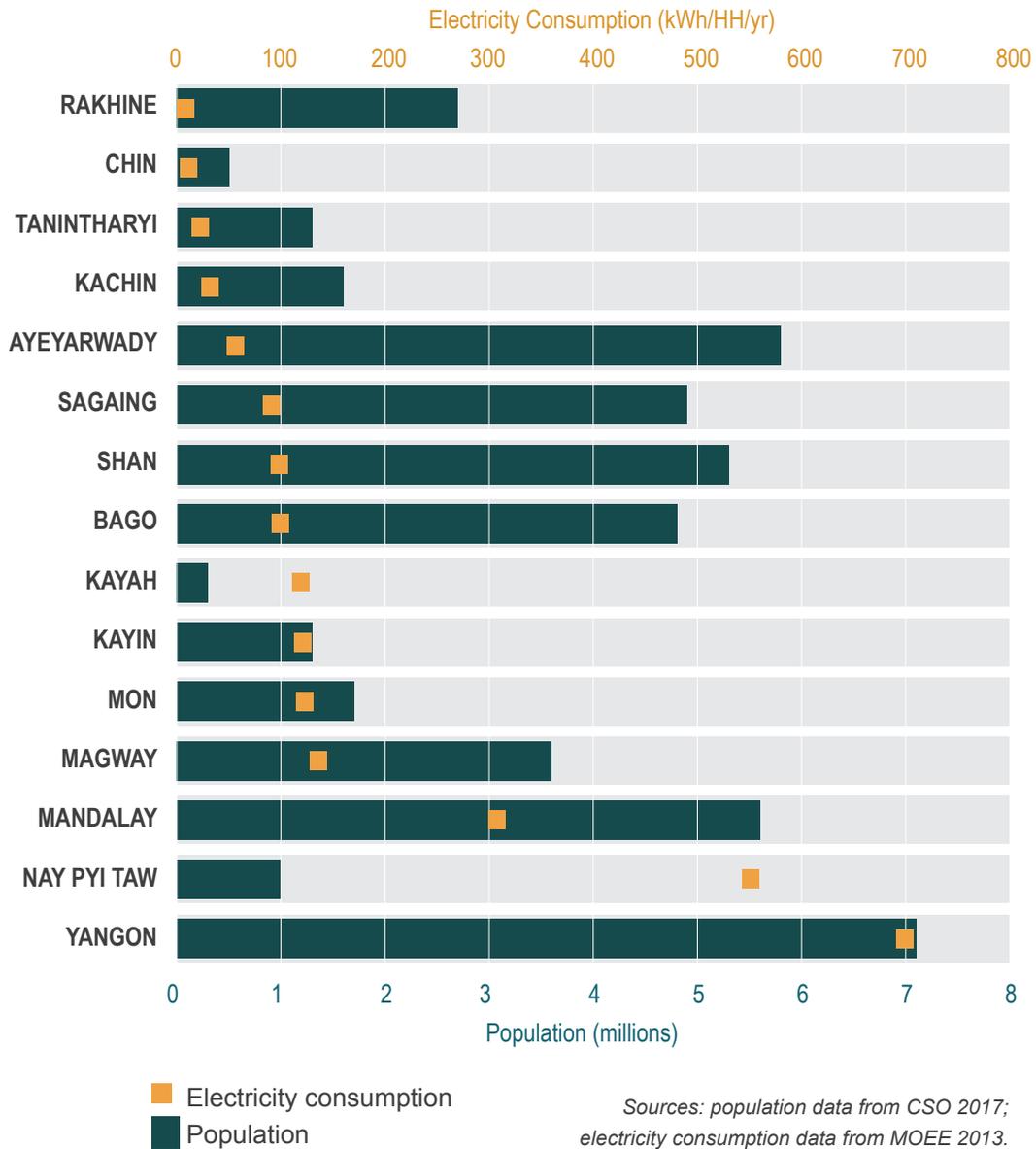
Source: ASEAN Centre for Energy – 2018, based on 2016 data

FIGURE 22. Myanmar electricity consumption, 2010–2016. (Units: kWh/person/year)



Source: MOEE

FIGURE 23. State/region population and per-capita electricity consumption



In regional perspective, the per-capita electricity use of Myanmar is 2.5 times less than Lao PDR or Indonesia, 4 times less than the ASEAN average, 9 times less than Thailand, and 28 times less than Singapore. That is rapidly changing, however, as households become electrified, businesses grow, and consumers purchase more appliances. Figure 22 shows that per-capita electricity consumption more than doubled from 2011 to 2016.

If we move from comparing Myanmar to ASEAN to comparing states and regions within Myanmar, the differences get even larger. Figure 23 shows both the population and the per-capita electricity consumption across the 14 states and regions. There are just three states or regions that consume more than 300 kWh/person/year, but there are seven that consume less than 100 kWh/person/year, four of them less than 50 (Tanintharyi, Chin, Rakhine, and Kachin).

ANNEX C: PLANS FOR POWER-SECTOR DEVELOPMENT

With its low electrification rates and its commitment to 100 percent electrification by 2030, the Myanmar government will face a real challenge meeting that new demand with new generating capacity.

The National Energy Management Committee released the Myanmar National Energy Master Plan in December 2015, after two years of review and consultation. The massive, 943-page plan presents a framework for energy development in Myanmar. It includes a demand forecast with scenarios for low, medium, and high demand, as seen in figure 9 in section 2.5. The figure also shows data from MOEE for installed generating capacity through 2016. The demand forecasts are clearly much lower than actual generating capacity. According to MOEE data, about 10 percent of the electricity generated in 2015 and

2016 was for export. In addition, the system needs some reserve capacity, since power plants need time for routine maintenance and repairs.

POWER GENERATION

Myanmar has a total of 83 power plants (figure 24):

- 20 gas-fired power plants
- 62 operational hydropower plants (of which 35 are small hydropower projects), located mostly in Shan State, Kachin State, and Sagaing Region
- 1 coal-fired power plant located in southern Shan State

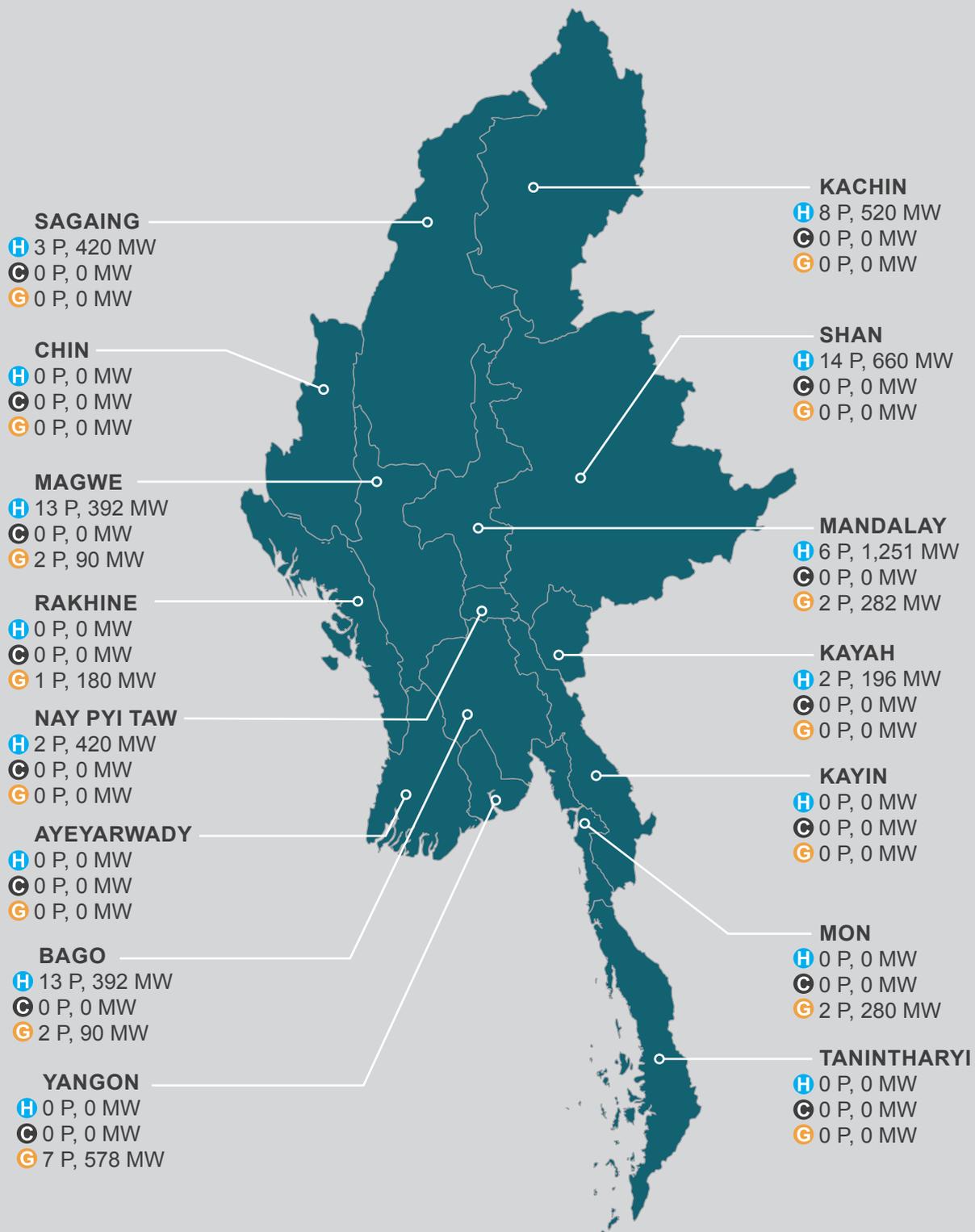
Table 12 shows MOEE's pipeline of power plant projects as of August 2018.

TABLE 12. MOEE pipeline of power projects

| PIPELINE OF POWER PLANT PROJECTS (AUGUST 2018) | | | | | | | |
|---|--|-------------|---------------|---------------------|--------------|----------------------------------|------------|
| No. | Thermal Projects | Fuel Type | MW | Hydropower Projects | MW | Solar Projects | MW |
| 1 | Thaton CCGT (WB) | Natural gas | 106 | Upper Keng Taung | 51 | Minbu (Green Earth) | 170 |
| 2 | Myingyan CCGT (Sembcorp) | Natural gas | 225 | Upper Yeywa | 280 | Wundwin (ACO) | 150 |
| 3 | Be Lin Gas Engine | Natural gas | 110 | Middle Paung Laung | 152 | Nabuaing (ACO) | 150 |
| 4 | Myan Aung Gas Engine | Natural gas | 20 | Deedoke | 60 | | |
| 5 | Ywama CCGT (WB) | Natural gas | 225 | Thahtay | 111 | | |
| 6 | Ahloné LNG (Toyothai) | Natural gas | 356 | Shweli (3) | 671 | | |
| 7 | Kanbauk LNG (Total and Siemens) | Natural gas | 1,350 | Maingwa | 66 | | |
| 8 | Myingyan Gas Engine | Natural gas | 90 | Upper Balu Chaung | 30 | | |
| 9 | Kyaukphyu CCGT | Natural gas | 135 | Nangpaw | 20 | | |
| 10 | Meelaungyint LNG (Zhefu) | Natural gas | 1,390 | | | | |
| 11 | Thahton (UREC Phase II) | Natural gas | 106 | | | | |
| 12 | Shwedaung (Daewoo) | Natural gas | 73 | | | | |
| 13 | Belin CCGT (JICA) | Natural gas | 300 | | | | |
| 14 | Belin Gas Engine | Natural gas | 90 | | | | |
| Subtotal | | | 4,576 | | 1,441 | | 470 |
| POWER PLANT PROJECTS UNDER FEASIBILITY STUDY (AUGUST 2018) | | | | | | | |
| No. | Thermal Projects | Fuel Type | MW | Hydropower Projects | MW | Solar Projects | MW |
| 1 | Myeik LBN (KPMI) | Natural gas | 662 | Sweli (2) | 520 | Shwebo (Quasar) | 100 |
| 2 | Thilawa LNG (Japan) | Natural gas | 1,000 | | | Shweykin Floating Solar (Suneap) | 50 |
| 3 | Kungyankone LNG (GS) | Natural gas | 1,500 | | | | |
| 4 | Kingyankone Elephant Point LNG (Exxon) | Natural gas | 1,200 | | | | |
| 5 | Daw Nyein CCGT (PTTEP) | Natural gas | 1,200 | | | | |
| Subtotal | | | 5,562 | | 520 | | 150 |
| GRAND TOTAL (Confirmed and in feasibility stage) | | | 10,138 | | 1,961 | | 620 |

Source: MOEE 2018A

FIGURE 24. Map of Myanmar showing power plants by region.



H Hydropower
C Coal
G Gas
 P No. of plants and their category
 MW Installed capacity

Source: Eurocham Myanmar 2017

ANNEX D: DONOR SUPPORT IN MYANMAR'S ENERGY SECTOR

OVERVIEW OF DONOR SUPPORT

Table 13 provides a comprehensive overview of donor support in the major areas of energy policy and planning, rules and regulations, financial sustainability, and investment. Subsequently, we briefly summarize the main recent energy-sector initiatives of each donor.

TABLE 13. Overview of international donor support in the Myanmar power sector.

| Policy and planning | | Resource planning | |
|---|--|--|--|
| <ul style="list-style-type: none"> Energy policies, Energy Master Plan (ADB) | | <ul style="list-style-type: none"> Improving environmental & social standards of hydro, SEA (IFC) IHA protocol, hydro standards, hydrological network and database (NVE) | |
| <ul style="list-style-type: none"> Power-sector development planning, Power Master Plan (JICA) | | <ul style="list-style-type: none"> Study of economics of gas and LNG, and planning (WB) | |
| <ul style="list-style-type: none"> National Electrification Project , geospatial planning (WB) | | <ul style="list-style-type: none"> Solar mini-grid business model (ADB) Wind mesoscale study (DFID) | |
| | | <ul style="list-style-type: none"> Grid integration of RE (USTDA, WB) | |
| | | <ul style="list-style-type: none"> Power import options (ADB, WB) | |
| Rules and Regulations | | Financial Sustainability | |
| <ul style="list-style-type: none"> Rules and regulations under the electricity laws (ADB, NVE) | | <ul style="list-style-type: none"> Financial Viability Action Plan (WB) | |
| <ul style="list-style-type: none"> Grid code (NVE) | | <ul style="list-style-type: none"> Tariff review and financial strengthening (WB) | |
| <ul style="list-style-type: none"> Template documents for PPP (IFC, JICA) | | | |
| <ul style="list-style-type: none"> Promoting off-grid rural electrification (GIZ, DFID) | | | |
| Investment in generation | | | |
| <ul style="list-style-type: none"> Public, hydro-based (AFD, JICA) | | <ul style="list-style-type: none"> Public, gas-based (JICA, WB) | |
| <ul style="list-style-type: none"> Private, gas-based (IFC, various donors) | | | |
| Investment in T&D | | | |
| <ul style="list-style-type: none"> 500 kV transmission (JICA, Korea, others) | | <ul style="list-style-type: none"> 230 kV transmission (ADB, JICA, WB) | |
| <ul style="list-style-type: none"> Distribution (ADB, JICA) | | | |
| Investment in Rural Electrification | | | |
| <ul style="list-style-type: none"> Grid electrification (ADB, JICA, KfW, WB) | | <ul style="list-style-type: none"> Off-grid electrification (DFID, KfW, KOICA, WB) | |

Source: MOEE 2018B

ANNEX E: CATEGORIZATION OF PROJECTS FOR ENVIRONMENTAL IMPACT ASSESSMENTS

This section is excerpted from annex 1 of Myanmar's Environmental Impact Assessment Procedures (MECF 2015).

CATEGORIZATION OF ECONOMIC ACTIVITIES FOR ASSESSMENT PURPOSES

- a. This annex provides guidance as to whether an IEE or EIA is required for any proposed project or activity. If, as a result of that determination, an IEE or an EIA is determined to be required, then the proponent of the project or activity will be obliged to prepare, obtain approval for, and implement an appropriate EMP in respect of the proposed project or activity. Any appeal from such determination must be made in accordance with the EIA Procedure.
- b. If a project proponent of an existing project or activity intends to expand that project or activity, then the Department shall consider and use the type and size thresholds specified in the categorization below as the basis for determining whether such expanded project or activity will be required to conduct any additional assessment, either in the form of an IEE, an EIA or an EMP.
- c. If a production capacity included in the categorization below has not been explicitly expressed as a total production capacity (e.g., installed capacity for energy production), then the applicable production capacity threshold shall be the total production output under normal operations.
- d. The ministry reserves the right to interpret, clarify, and amend this annex from time to time as and when it deems necessary in accordance with Article 30 of the Procedure.

TABLE 14. Categorization of environmental review requirements for energy sector projects

| No. | Type of economic activity | Criteria for IEE-type economic activities | Criteria for EIA-type economic activities |
|------------------------------------|--|---|--|
| SPECIAL INVESTMENT PROJECTS | | | |
| 1. | Projects in which investment is decided by the parliament or the government cabinet or the president | — | All sizes |
| ENERGY SECTOR DEVELOPMENT | | | |
| 2. | Hydropower plants | Installed capacity \geq 1 MW but $<$ 15 MW and reservoir volume (full supply level) $<$ 20,000,000 m ³ and reservoir area (full supply level) $<$ 400 ha | Installed capacity \geq 15 MW or reservoir volume (full supply level) \geq 20,000,000 m ³ or reservoir area (full supply level) \geq 400 ha |
| 3. | Nuclear power plants | — | All sizes |
| 4. | Natural gas or bio-gas power plants | Installed capacity \geq 5 MW but $<$ 50 MW | Installed capacity \geq 50 MW |
| 5. | Coal-fired power plants | Installed capacity \geq 1 MW but $<$ 10 MW | Installed capacity \geq 10 MW |
| 6. | Power plants from waste products | Installed capacity \geq 50 MW | All activities where the ministry requires that the project shall undergo EIA |
| 7. | Geothermal facilities | Installed capacity \geq 5 MW but $<$ 50 MW | Installed capacity \geq 50 MW |

| | | | |
|-----|---|---|---|
| 8. | Combined-cycle power plants (gas & thermal) | Installed capacity \geq 5 MW but $<$ 50 MW | Installed capacity \geq 50 MW |
| 9. | Thermal power plants (other than the types in items 4, 5, 6, 7, and 8) | Installed capacity \geq 5 MW but $<$ 50 MW | Installed capacity \geq 50 MW |
| 10. | Wind power plants | Installed capacity \geq 5 MW but $<$ 50 MW | Installed capacity \geq 50 MW |
| 11. | Solar power plants | Installed capacity \geq 50 MW | All activities where the ministry requires that the project shall undergo EIA |
| 12. | Onshore oil and gas seismic surveys | All sizes | |
| 13. | Onshore oil and gas exploration drillings | — | All sizes |
| 14. | Onshore oil and gas drilling and production activities; transportation activities including pipelines; pump stations, compressor stations, and storage facilities; ancillary and support operations; and decommissioning | — | All sizes |
| 15. | Offshore oil and gas seismic surveys | All sizes | — |
| 16. | Offshore oil and gas exploration drillings | — | All sizes |
| 17. | Offshore oil and gas drilling and production activities; offshore pipeline operations, offshore transportation, compressor stations, and storage facilities; ancillary and support operations; and decommissioning | — | All sizes |
| 18. | Petroleum refineries or natural gas refineries (including manufacturing of liquefied petroleum gas, motor gasoline, kerosene, diesel oil, heating oil, fuel oil, bitumen, asphalt, sulphur, and intermediate products—e.g., propane/propylene mixtures, virgin naphtha, middle distillate and vacuum distillate for the petrochemical industry. | — | All sizes |
| 19. | Natural gas processing plants; production of liquid products from natural gas (this may include methanol and petroleum liquid products such as naphtha, gasoline, kerosene, diesel fuel, waxes, and lubes) | — | All sizes |
| 20. | Natural gas liquefaction plants | — | All sizes |
| 21. | Oil or natural gas terminals | — | All sizes |
| 22. | Petroleum depots or liquid gas depots | Storage capacity: petroleum $<$ 10,000 tn liquid gas $<$ 2,500 tn | Storage capacity: Petroleum \geq 10,000 tn Liquid gas \geq 2,500 tn |

| | | | |
|-----|---|--|---|
| 23. | Oil or gas transmission or distribution systems | < 10 km | ≥ 10 km |
| 24. | Filling stations (including liquefied petroleum gas and compressed natural gas) | ≥ 10 m ³ (10,000 liters) fuel storage capacity All activities where the ministry requires that the project shall undergo EIA | |
| 25. | Petroleum-based organic chemicals manufacturing | — | All sizes |
| 26. | Electrical power transmission lines ≥ 115 kV but < 230 kV | ≥ 50 km | All activities where the ministry requires that the project shall undergo EIA |
| 27. | Electrical power transmission lines ≥ 230 kV | All sizes | All activities where the ministry requires that the project shall undergo EIA |
| 28. | High voltage (230 kV and 500 kV) transformer substations | ≥ 4 ha | All activities where the ministry requires that the project shall undergo EIA |

ANNEX F: ADB MYANMAR OFF-GRID RENEWABLE ENERGY DEMONSTRATION PROJECT

PROJECT DESIGN

ADB's Myanmar Off-Grid Renewable Energy Demonstration Project, implemented in cooperation with DRD and regional and local government agencies, consisted of three main components: (i) pilot mini-grids, (ii) a geospatial planning and off-grid investment plan, and (iii) a program to strengthen the government's capacity in mini-grid development.

This project is worth noting because it was a pioneering effort to systematically build solar mini-grids for Myanmar villagers. The project also used a procurement model based on bidding, and a pay-as-you-go model whereby the customer prepaays for the service.

From 2015 to 2017, the project successfully installed solar mini-grid systems in 12 villages located in the country's Dry Zone (Magway, Mandalay, and Sagaing Regions). These consist of 10 stand-alone projects, one diesel hybrid system, and one project built to grid standards so that it can be connected to the national grid when it arrives in the village (see table 15). ADB financed 80 percent of the total system costs, and the village communities contributed 20 percent.

FIGURE 25. *Left: a PV mini-grid installed as part of ADB's demonstration of solar mini-grids. Right: battery powerhouse, part of a pilot solar mini-grid.*



Source: ADB 2017B

Another component of the project was the development of a geospatial plan, an investment plan for off-grid RE in Myanmar, and an online, geospatial web-mapping tool to help project developers identify opportunities for RE mini-grids in Magway, Mandalay, and Sagaing Regions (figure 26). The project also produced a guidebook documenting the experiences and lessons from the 12 mini-grid systems using RE, and training materials from various capacity building activities under the third component of the project (ADB 2017B). This guide was aimed at helping government officials, RE developers, and potential investors, as well as sharing some lessons learned in the development of mini-grid projects in Myanmar

LESSONS LEARNED FROM THE PROJECTS

The main lessons learned from the implementation of the 12 mini-grid pilot projects are summarized below.

Community participation and organization. Community engagement, involving several rounds of facilitated discussions, was a critical element of the successful mini-grid pilot projects. This engagement was difficult to sustain over time, and future mini-grid projects should begin installation

TABLE 15. Renewable energy mini-grid pilot projects supported by ADB.

| Township | Village | Number of Households | Population | PV Capacity (kW) | Battery Capacity (kWh) | Total Cost (\$) | Type |
|------------------------|----------------|----------------------|------------|------------------|------------------------|-----------------|---------------|
| Magway Region | | | | | | | |
| Thayet | Gon Ma Ni | 197 | 931 | 7.2 | 57.6 | 73,350 | Stand-alone |
| Sinbaungwe | Kone Thar | 270 | 2170 | 8.7 | 63.3 | 82,368 | Stand-alone |
| Minbu | Pauk Lay Pin | 89 | 336 | 4.9 | 57.6 | 44,100 | Diesel hybrid |
| Yenangyaung | Koke Ko Gwa | 330 | 1,654 | 13 | 92.2 | 102,300 | Stand-alone |
| Salin | Kone Char | 143 | 625 | 6.5 | 38.4 | 50,832 | Stand-alone |
| Pauk | Mone Kone | 157 | 836 | 6.0 | 46.1 | 50,856 | Stand-alone |
| Mandalay Region | | | | | | | |
| Kyaukse | Myin Chi Naing | 317 | 925 | 10.8 | 86.4 | 98,580 | Grid ready |
| Nyaung-U | San Kan | 200 | 977 | 9.8 | 115.2 | 75,000 | Stand-alone |
| Kyaukpadaung | Kyet Su Taw | 103 | 484 | 4.9 | 57.6 | 87,980 | Stand-alone |
| Taungtha | Son Lun | 110 | 654 | 4.9 | 57.6 | | Stand-alone |
| Sagaing Region | | | | | | | |
| Sagaing | U Aing Kyun | 170 | 569 | 6.0 | 46.1 | 102,770 | Stand-alone |
| Khin-U | Yauk Thit Kan | 165 | 668 | 7.0 | 61.4 | | Stand-alone |

Source: ADB 2017A

promptly once a village confirms its interest. Villagers particularly like the improved nighttime security offered by streetlights, and they are willing to pay for them. Payment mechanisms should be flexible and take into account the seasonal nature of villagers' income. The government could include these lessons in a training program to prepare for future mini-grid development.

Government capacity. DRD is very capable in some areas, particularly GIS, but it needs capacity building in others, namely technical specifications and procurement, training of technicians, mini-grid technology and design, assessment of target areas, and business models for mini-grids, including setting tariffs and payment mechanisms. Additional training for DRD and MOEE is advisable to familiarize them with RE technologies other than solar, so that the many existing mini-grids that use these other technologies can be incorporated into rural electrification planning.

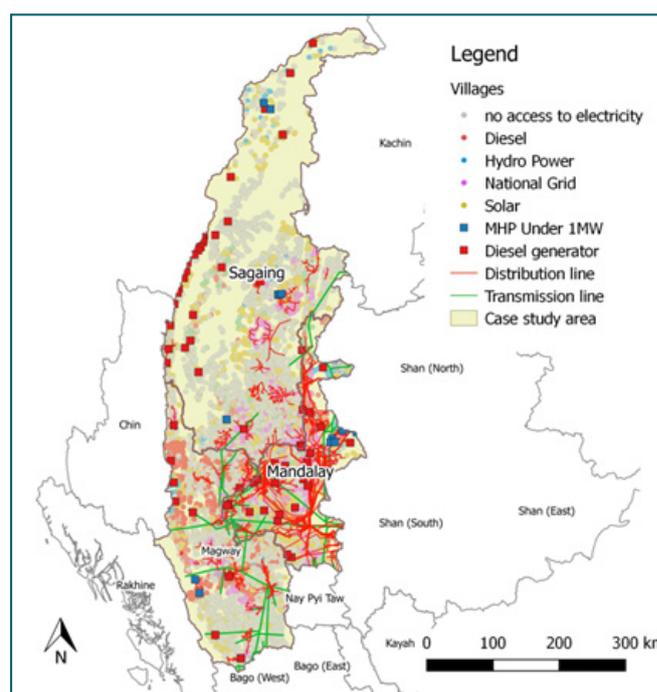
Coordination among ministries involved in rural electrification. Training activities should foster cooperation among the several agencies—at least five ministries and several departments—involved in rural electrification.

Benefits of geospatial web-mapping tool. The free tool developed for Magway, Mandalay, and Sagaing was helpful to developers in planning where to develop new mini-grids. Expanding that functionality to other areas would make it a very useful planning tool.

Regulatory/policy challenges. Electrification projects using RE mini-grids will continue to be risky

propositions in the absence of regulations to protect the existing systems, and their investors, from the cheaper, subsidized electricity of the national grid when it arrives.

FIGURE 26: Geospatial web-mapping tool for planning new mini-grids in Magway, Mandalay, and Sagaing Regions.



Source: Cader 2018 and <http://adb-myanmar.integration.org>

ANNEX G: MINI-GRID INITIATIVES IN MYANMAR

SMART POWER MYANMAR: MOBILIZING MINI-GRIDS FOR RURAL ELECTRIFICATION AND ECONOMIC DEVELOPMENT

Launched in May 2018, Smart Power Myanmar is building a viable, decentralized, renewable energy ecosystem by getting the right incentives and policies in place to bring electricity to those who need it most, with a focus on customer-centered solutions, long-term socioeconomic development, and systemic change. Smart Power Myanmar aims to mobilize hundreds of millions of dollars to support the rollout of thousands of mini-grids and other rural electrification solutions. Smart Power Myanmar's founding members include the Rockefeller Foundation, the World Bank, USAID, and Yoma Strategic Holdings.

Smart Power's "Decentralized Energy Market Assessment," due to be published in the first quarter of 2019, suggests that with the right incentives and regulatory environment, 24,000 profitable mini-grids could be constructed in Myanmar by 2030, covering over 88 percent of the off-grid population.

It is essential, however, to ensure that mini-grids are fully utilized, both for the financial health of developers and to bring the full benefits of modern energy services to the people of Myanmar. Richard Harrison, the CEO of Smart Power Myanmar, described the problem as follows:

With the mini-grids that have been developed to date, there have been limited efforts to ensure that the people gaining access to energy can acquire the energy-efficient appliances they need to actually use the energy, and little or no work on developing productive uses such as small-scale agricultural processing that can generate jobs and income. There are no linkages to the broader business ecosystem or to value chains or other businesses. The strategy is basically "build it and they will come." But unfortunately, it's not working out that way, and history has shown that rural electrification needs to include well-designed programs for educating consumers about appliances and providing low-interest financing for the purchase of such equipment.

Smart Power Myanmar is working with communities to develop productive uses of energy that generate income through enterprise development and in turn improve the economics of mini-grids by increasing utilization.

Harrison continues:

To identify scalable productive-use solutions, Smart Power Myanmar has deployed a team to work directly with communities and ESCOs to get connections in place, introduce appliances, support micro-enterprise development, and solve value-chain issues. The other critical element we are working to address is broader access to cost-effective appliance financing specifically designed for consumers.

Smart Power Myanmar has started an Energy Impact Fund to help communities finance connections, household appliances, and commercial appliances and machinery for small businesses. Loans are made available to villagers through a governance structure known as Village Electrification Committees (VECs), established by Smart Power Myanmar. These VECs are modeled on Pact's microfinance and community empowerment systems. Financing is provided to the VECs, and they in turn lend to households or to local businesses, charging interest, which they retain. The principal is returned to Smart Power so that the funds can be recycled ("revolved") into other communities. Such schemes may evolve into commercial models in the future as the sector scales up and sustainable solutions are required.

THE CELLULAR TOWER MODEL: YOMA MICROPOWER

With rapid technological advances, Myanmar has opportunities to leapfrog, by skipping less efficient, more expensive, or more polluting technologies and moving directly to more advanced ones.

Its expansion of phone service is an example, as the country bypassed wired technology and moved straight to cellular phone towers. With a supportive regulatory and policy environment, the mobile industry expanded the cellular network from 10 percent coverage to 80 percent in four years.⁵²

A similar path is possible for the electricity sector. Interestingly, the mobile industry is not only a model to emulate but potentially a key collaborator in an electrification leapfrog. Technological advances, falling renewable energy costs, and innovative models of collaboration between mobile phone operators and mini-grid investors could efficiently and cost-effectively bring both electricity and phone connectivity to the people of Myanmar.

Already, solar-diesel hybrid generation is the technology of choice to power cellular towers in some remote areas in Myanmar. If partnerships between mobile phone operators and mini-grid investors could be forged, and a supporting regulatory environment enabled, 2,000 planned cell phone towers could be powered by solar-diesel hybrid or other RE mini-grids that would also provide electrification to 4,000 villages. There are 24,000 unelectrified villages in the country.

Yoma Micro Power Co., together with International Finance Corporation (IFC), has plans to raise capital to electrify “hundreds of telecommunications towers and rural communities,” with a potential to scale up further (Htwe 2018A). In April 2018, Yoma Micro Power announced a blended investment fund, with investments from IFC (USD 13 million) and Norfund (USD XX million) and a loan from the Canadian government (USD 6 million).

During an initial 18-month trial period through the end of 2019, a planned 250 telecom towers will receive solar hybrid generation systems, at least 10 percent of which will be extended to provide power to local communities.

In the future, the use of “mobile money”—payment by mobile phone—will be a major opportunity to develop services for remote communities, including off-grid energy. Related to the cellular tower project above, Wave Money, a joint venture between Telenor, FMI, and Yoma Bank, was launched an initiative to provide mobile financial services in Myanmar. Wave Money was the first company to receive a license under a new regulation released by the Central Bank of Myanmar.

A driver of this change is that Telenor requires all cell tower operators to go solar. As of mid-2018, Telenor had 13,000 cell towers and plans for 20,000 more in the next five years. Ultimately, the effort could bring community power to as many as 2 million people in Myanmar (Chetia 2018).

Endnotes

1. As one of many recent examples, Hawaiian Electric Company announced seven new solar-plus-storage contracts in early January that were a landmark in terms of both pricing and size. Six of these projects were at record-low PPA prices for the state, under 10 U.S. cents/kWh (Merchant 2019).
2. Engie pledged to divest USD 15.1 billion of its fossil-based assets during a three-year period (2016–2018) and to reinvest in lower-carbon, distributed, and renewable energy assets. Engie is shifting its investment into low-CO2 power generation, global gas and power networks, and downstream customer solutions (Baker 2016).
3. The energy sector is particularly subject to tensions between central planning and decentralized authority because of the traditional natural monopoly of electricity distribution and the economies of large-scale power generation.
4. Natural gas accounted for 78.8 percent of Myanmar energy exports in 2012, and generated USD 2.1 billion in export revenue in just the first half of fiscal year 2014 (ADB 2015).
5. From www.worldometers.info.
6. OneMap is an initiative of the Ministry of Forestry. It is an online, open-access, spatial-data platform developed in collaboration with MIMU—the Myanmar Information Management Unit. Data is compiled and made available on the OneMap platform, which brings together authoritative government data on land use, forest cover, and land tenure and combines it with participatory maps, developed by local communities, and crowd-sourced public contributions. See http://www.cde.unibe.ch/research/projects/onemap_myanmar/index_eng.html and <https://themimu.info/about-us>.
7. Based on Eurocham Myanmar 2017 and interviews with international donors.
8. See Shin 2018 and Venderbruggen 2018 for more details. The four projects are (1) a 1,230 MW gas-fired power plant, to be built by a consortium of Total and Siemens, at Kanbawk in Taninthary Region; (2) a 1,390 MW gas-fired power plant, to be built by a consortium of Hong Kong-based Zhefu Group, Gunvor Group from Switzerland, and Supreme Group of companies from Myanmar, in the Patheingyi Township of Ayeyarwady region; (3) a 356 MW gas-fired power plant, to be built by a consortium called TTCL, which is a joint venture between Italian-Thai Development and Toyo Engineering Corporation, in Yangon Township; and (4) a 135 MW gas-fired power plant, to be built by Sinohydro and Supreme Trading, in a Special Economic Zone in Kyaukpadaung, Rakhine State.
9. One respondent noted that these LNG projects could cost as much as USD 6 billion, and that the financing was not in place when the projects were approved. Others remarked that there was no bidding process and a lack of transparency on pricing and financial commitments. They expressed concern that, with a current power-sector subsidy of approximately USD 500 million per year, expected to increase to as much as USD 1 billion per year (see section 2.7), commitments to buy power from for these four LNG projects would further strain the government budget.
10. The chart reflects an August 2018 presentation by MOEE (MOEE 2018A), which divided pending power-plant projects into two broad groups: “power-plant project pipeline” and “power-plant projects under feasibility study.”
11. The respondent did not say which laws and regulations would need to be changed.
12. See Batcheler (2018) for more detail.
13. Pyidaungsu Hluttaw (Assembly of the Union) 2014. [RICHARD: is there a better reference?]
14. The policy is included in the National Energy Master Plan, published in December 2015. See NEMC (National Energy Management Committee) 2015. This brief description of the policy is based on an interview with a senior adviser to the Myanmar government.

15. The National Electricity Master Plan (final draft II) was prepared by JICA and submitted to the ministry in August 2014.
16. This feedback is based on experts and consultants familiar with the NEP who have been involved in assisting MOEE with the roll-out of the grid extension efforts.
17. These procedures were laid out in guidelines dated December 29, 2015 (MECF 2015).
18. Meeting with ECD staff on July 26, 2018.
19. The public consultation process for EIAs is a major management task for the Union and state/region governments. ECD is now preparing public-consultation guidelines with the assistance of the Vermont Law School. Other donors, including JICA and ADB, have been providing assistance in the area of environmental compliance and EIAs.
20. This observation is based on interviews with energy-sector experts and some Myanmar government officials during July and October 2018.
21. The summary of the strategic environmental assessment in this text box is adapted from IFC 2018.
22. GIZ hosted a study tour to Thailand in September 2017 for officials from DRD and MOEE. The aim was to increase awareness and understanding of the process of procuring power from SPPs. Thailand has had experience in this area since introducing procurement regulations in the late 1990s.
23. The Department of Mines does not have offices in all the states and regions. It has eight offices located in areas where there is mining development. The offices are located in Shan State, Kayah State, Kayin State, Sagaing Region, Magway Region, Kachin State, Tanintharyi Region, and Mandalay Region.
24. The German government has been providing staff with technical training in mine safety, mine ventilation, and mine stability. Officials of the Department of Mines said they also need more inspection equipment, including gas-detection and other safety and environmental inspection equipment, and a mobile laboratory with portable X-ray fluorescence meters for nondestructive chemical analysis of rocks, minerals, sediments, and fluids.
25. The term preelectrification implies that the solar home systems or mini-grids are only a temporary measure until the grid arrives. In fact, mini-grid costs have been declining rapidly and service has been improving, and it is expected that, worldwide, mini-grids rather than national grid extensions will be the most cost-effective way to electrify the world's remaining unconnected households (IEA 2017).
26. The Department of Development Affairs, reporting to the state/region minister of development affairs, is the only department that meets this criterion.
27. These priorities are nested within the NLD's national development priorities: roads, water, power, and education.
28. Tanintharyi is an exception, since the region is not connected to the grid, and a major role of the regional energy ministry is to oversee and manage concessions for mini-grids.
29. This observation is based on comments from multiple stakeholders.
30. The overall electrification rate for Tanintharyi Region is around 10 percent, according to MOEE data. It is highest in Dawei, at 35 percent, followed by Myeik, 27 percent, and Kaw Thaug, 20 percent.
31. A notable exception to this is the case of Tanintharyi, where the regional government enters directly into purchase agreements with the operators of mini-grids and related electricity distribution systems.
32. The Union government supports subnational governments not only with technical standards but also with grid-extension planning. Interviews for this report suggest that state/region ministers and their staff generally lean heavily on Union ministry staff at the subnational level and frequently invite them to join planning meetings.

33. Technically, under the 2014 Electricity Law, self-administered divisions and self-administered zones have authority in their areas. According to Section 9(a) of the law: “A Relevant Leading Body of a Self-Administered Division or Self-Administered Zone may issue permits to any local or foreign individual and organization wishing to invest in electricity works related to the respective towns and villages within the respective areas after coordination with the relevant Region or State Government, in accordance with the existing laws” (Electricity Law, Section 15).
34. Interviewees conveyed the importance for project developers that both state and Union laws and regulations contain a compensation clause, which would require the Union government to provide compensation if it takes over the generation assets of a small or medium electricity enterprise, or if it connects the national grid to a village where there is a mini-grid in operation. Without such a clause, project developers will be unable to secure investment for mini-grids or small-scale power projects.
35. Interviews indicated, however, that minority populations in some states, mostly ethnic minorities, believe in and are fighting for a federal system of government and do not wish to be constrained by the Electricity Law.
36. The state/region budgeting process is described in detail in Dickensen-Jones 2015, 7–8.
37. Village electrification committees (VECs) have been in operation for at least a couple of decades in Myanmar, and are set up by villages to manage the electrification process, including raising funds and operating the system. Our interviews and desk research turned up a funding challenge for VECs: new 400 V systems must be paid for up front or with short-term loans of less than six months (Castalia 2014, 11).
38. This is a very approximate USD rate, based on a street value of about MMK 800 per USD during the mid-2000s. See https://en.wikipedia.org/wiki/Burmese_kyat.
39. <http://hycem.weebly.com/>
40. Pico-hydro refers to turbines up to 10 kW capacity; micro-hydro is in the range of 10–100 kW, and mini-hydro is in the range of 100 kW to roughly 1 MW. See https://energypedia.info/wiki/Hydro_Power_Basics#By_Size.
41. Interview with Shan State MPs, July 30, 2018.
42. Sources: Thailand Energy Regulatory Commission (ERC), SPP/VSP Database, at <http://www.erc.or.th/ERCSP/MPowerPlantType.aspx>; Electricity Generating Authority of Thailand (EGAT), at https://www.egat.co.th/index.php?option=com_content&view=article&id=355&Itemid=116 and https://www.egat.co.th/index.php?option=com_content&view=article&id=452&Itemid=116; EGAT Power Development Plans 2007, 2010, and 2010 revision 2.
43. World Bank 2015. An additional 750,000 households will be electrified by connection to the national grid, bringing the target for electrified households under the NEP to 1.24 million by 2021.
44. Smaller village grids, called micro-grids, are often defined as 1–10 kW in size. The terminology is not settled, however, and micro-grids can refer to power systems for industrial or commercial facilities that have the ability to operate independently of the national grid (to be “islanded”).
45. It was mentioned in several interviews that ADB hired consultants to develop a rural electrification law with MOEE; however, the law was never completed, and in the end the effort was abandoned.
46. GIZ 2018. The proposed guidelines are well summarized in PowerPoint presentations by Greacen (2018) and Reindahl (2018).
47. A typical village-level mini-grid could range from 10 kW to 500 kW or larger, depending on the size of the community and the activities and businesses there. These 1–30 MW projects would be for a business or group of businesses with a significant load, such as an industrial estate, a commercial complex, or a resort.

48. See text box, “Thailand’s Small Power Producer Program.”
49. Aung Kyaw Moe, personal communication, July 25, 2018. For more information, see Environmental Justice Atlas 2019, Sway 2016, and SourceWatch.org 2019.
50. A large amount of capital is also being invested in solar and solar hybrid systems for telecom towers, which can be linked to mini-grids to provide power for neighboring villages; however, the impact of this approach on village electrification remains to be seen (see annex G).
51. Assumptions include approximately 200–300 W for a plasma TV, 30 W for an LCD TV, 10 W LED lamps, a 1,000 W water kettle, and a flat-screen desktop computer using about 70 W.
52. In 2014. Source: <https://www.cleantech.com/power-to-the-people-remote-microgrids-across-southeast-asia/>.

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