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Myanmar's Path to Electrification

The Role of Distributed Energy Systems

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Many in the international community see Myanmar as a new economic frontier as the country has opened to the outside world and started to implement political and economic reforms after decades of isolation and military rule. With a wealth of natural resources and a strategic location between China and India, Myanmar could reestablish itself as an important regional trading hub. However, the legacy of economic sanctions, ethnic conflict, weak governance, and underinvestment in core infrastructure translates into significant energy access, capacity, and reliability problems that hinder Myanmar's short- and long-term prospects for economic growth.

Today, Myanmar has one of the lowest electrification rates in Asia and rural communities face significant energy poverty. The Myanmar government estimates that the national electrification ratio is 32 percent and in rural areas only a fraction of the population has access to the grid.[1] The recent census documented that 69 percent of the population uses firewood as a main energy source for cooking and 46 percent uses kerosene, candles, or batteries as the main energy sources for lighting.[2]

As Myanmar's rural population seeks tangible improvements to their quality of life, electrification represents an opportunity for the government to bring near-term legitimacy to the reform agenda. In addition, improved electricity services will support longer-term economic growth. Current residential, commercial, and industrial consumers connected to the grid experience power outages due to inadequate supplies and degraded infrastructure. Economic growth prospects (including foreign investment and domestic enterprise) would be enhanced with sufficient and reliable sources of electricity. For Myanmar to achieve its development goals and economic potential, significant investments are needed in the energy and infrastructure sectors.

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[1] Khin Seint Wint, Department of Hydropower Planning, Myanmar Ministry of Electric Power (MOEP), "Electric Power Sector and Decentralized Development" (presentation to the Renewable Energy Association of Myanmar (REAM) Micro-Hydropower and Decentralized Renewable Energy for Myanmar Workshop, Yangon, Myanmar, November 24, 2014), 6.

[2] The Republic of the Union of Myanmar, Department of Population, Ministry of Immigration and Population, *The 2014 Myanmar Population and Housing Census, The Union Report, Census Report Volume 2* (May 2015), 3, http://unstats.un.org/unsd/demographic/sources/census/2010_phc/Myanmar/MMR-2015-05.pdf.

However, Myanmar's investment environment is characterized by ambiguity and rapid change as the country pursues a broad reform agenda after newly reopening to Western trade and investment. In particular, the electric power regulatory framework includes new laws and policies at high levels, but detailed implementing guidelines and standards are still under development, leaving investors uncertain about legality and market feasibility of private electrification projects, particularly off-grid. This is compounded by a lack of clarity about how the November 2015 election results will affect existing policies. At the same time, the financial sector and telecommunications industries are experiencing major shifts, which will increase energy demands and open new opportunities for rural customers to access markets and services.

The international development community in Myanmar approaches electricity access as a means to improve rural livelihoods, by enabling children to study at night and providing power to health clinics and local enterprises. In September 2015, the World Bank approved a $400 million loan to support the Myanmar government's National Electrification Plan (NEP), which aims for universal electricity access by 2030.[3] In the first phase of the NEP, electricity will extend to over 1 million households, 60 percent of which will connect to the national grid and 40 percent will obtain off-grid electricity by 2021.[4]

Other international donors—including the Asian Development Bank, UN agencies, and development entities from Germany, Japan, Italy, Norway, India, and other countries—are making significant investments in this arena. Also, international oil and gas companies like Total and Chevron now have corporate social responsibility activities addressing Myanmar's rural electricity access; private charitable foundations are scoping potential projects as well. With this influx of interest and resources, local and international nongovernmental organizations (NGOs), social enterprises, and renewable energy service providers are positioning themselves to implement pilot projects and, if successful, launch longer-term, commercially viable initiatives.

The development community is largely promoting distributed renewable energy solutions—meaning localized options such as mini-grids and solar home systems—to provide lighting and electricity to rural communities. While extension of the national electric grid will play an essential role in advancing toward the country's 2030 target, in the medium term many rural customers will remain far from the grid and unable to afford connection fees. Advocates and practitioners also point to the country's abundant renewable energy resources and history of village-level, self-organized use of distributed energy systems as momentum for further off-grid investments.

Where existing renewable systems are already in place, the right technical upgrades and local training could yield dividends for scaling up electricity access. Solar is particularly popular among the donor community given the country's high radiation rates, declining global costs of

[3] World Bank, "Electricity to Transform Rural Myanmar," September 16, 2015, http://www.worldbank.org/en/news/feature/2015/09/16/electricity-to-transform-rural-myanmar.
[4] Ibid.

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photovoltaic (PV) technologies, and modularity of systems to adapt to changing community needs. As NGOs, international companies, and other development actors consider distributed renewable energy initiatives in Myanmar, this paper provides an overview of the country's larger electric power context, reviews shifting regulatory and financial environments that affect viability of these renewable initiatives, and explores the challenges and opportunities particular to Myanmar's off-grid market.[5]

Overview of Myanmar's Power Sector

Myanmar's energy demand is growing in concert with other members of the Association of Southeast Asian Nations (ASEAN). With one of the fastest growth rates in the world, this region's energy demand has collectively risen by two and a half times since 1990 and is now equivalent to approximately 75 percent of India's energy demand.[6] With Myanmar's economic and political transformation, the country's annual power sales rose from 6,312 to 8,254 gigawatt-hours (GWh) between 2011 and 2013.[7] However, compared to Vietnam's 104,000 GWh, Indonesia's 156,000 GWh, and Thailand's 169,400 GWh, Myanmar's electricity consumption remains one of the lowest in the region.[8] The country's electricity consumption is 44 percent for general purpose (residential), 32 percent industrial, 20 percent commercial, and 3 percent other uses.[9]

According to the Myanmar government, the country's electricity mix within the national grid in 2012–2013 consisted of 71 percent hydropower, 27 percent natural gas, and 2 percent coal.[10] Myanmar currently sources these supplies domestically, but despite its resource base the country experiences supply shortfalls, resulting in substantial load shedding on the national grid. This is due to a variety of factors, including seasonal fluctuation of hydropower, degraded infrastructure, limited investment in recent years, and long-term contracts that lead Myanmar to export 83 percent of its offshore gas production to neighboring Thailand and China.[11]

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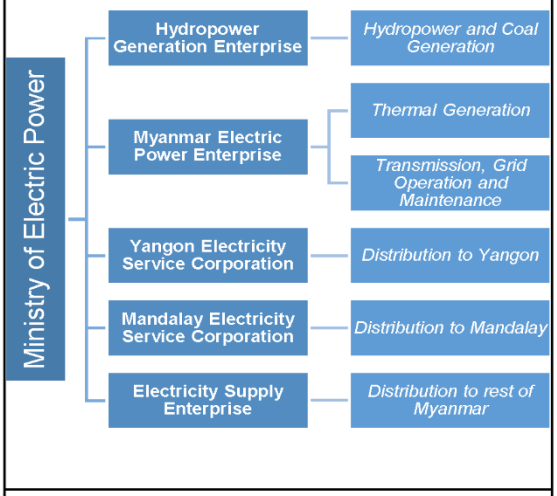
[5] For tracking Myanmar's dynamic energy environment, the following online resources provide information on latest developments: Energypedia "Achieving Universal Access to Electricity in Myanmar," https://energypedia.info/wiki/Achieving_Universal_Access_to_Electricity_in_Myanmar; UN Myanmar Information Management Unit (MIMU), http://themimu.info/; ASEAN Center for Energy, http://www.aseanenergy.org/.
[6] International Energy Agency (IEA) and Economic Research Institute for ASEAN and East Asia (ERIA), *Southeast Asia Energy Outlook: World Energy Outlook Special Report* (Paris: International Energy Agency, 2013), 15, https://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf.
[7] The Republic of the Union of Myanmar National Energy Management Committee (NEMC), *National Energy Policy* (Naypyitaw, 2014), 17, http://spectrumsdkn.org/en/home/other-sectors/energy/people-centred-energy-policy-conference-25-26-february-2015/conference-presentations/138-national-energy-policy-2014/file.
[8] CIA, *World Factbook*, "Country Comparison—Electricity Consumption," accessed July 2015, https://www.cia.gov/library/publications/the-world-factbook/rankorder/2233rank.html.
[9] NEMC, *National Energy Policy*, 17.
[10] Ibid., 13.
[11] Win Ahkar Mein, Ministry of Energy, "Natural Gas Industry Outlook and Opportunities in Powering Electrification for Myanmar's Economy" (presentation at Myanmar Green Energy Summit, Yangon, Myanmar, August 17, 2015), 10.

Downstream, Myanmar's electricity imports are reported as nil, although some of Myanmar's border communities are already purchasing electricity on an informal basis from suppliers in Thailand and China.[12] These cross-border arrangements reinforce the potential for greater regional electricity trade in the future, such as through the ASEAN Power Grid project, which aims to connect infrastructure and align policies for sharing electricity across the region's borders.

Myanmar's State-owned Entities for Power Generation, Transmission, and Distribution



Source: Ministry of Electric Power and author analysis.

Sector Organization and Governance. Responsibilities in the energy sector are distributed across a number of institutions, and the Ministry of Energy is responsible for overall energy policy.[13] In practice the Ministry of Energy leads upstream exploration and production of oil and gas, while the Ministry of Electric Power (MOEP) oversees hydropower, thermal power, and transmission and distribution, including numerous project-planning and implementation departments and operational entities.[14] The Ministry of Livestock, Fisheries, and Rural Development's Department of Rural Development (DRD) is responsible for off-grid rural electrification. The Ministry of Science and Technology leads renewable energy research and development, the Ministry of Environmental Conservation and Forestry directs environmental sustainability issues, and the Ministry of Industry leads electricity-related standardization efforts. The National Energy Management Committee (NEMC) serves as the government's minister-level energy coordination body, but it is a strategically oriented group that does not have operational responsibilities.

The government-owned Myanmar Electric Power Enterprise (MEPE) operates and maintains the transmission network and most gas-fired power plants. As the single buyer, MEPE purchases electricity from public and private producers—including government joint ventures and a small number of independent power producers (IPPs)—and then sells electricity to the

[12] International Energy Agency Statistics, "Myanmar: Balances for 2012," http://www.iea.org/statistics; KWR International and ERIA, *Turning on the Lights: Integrated Energy and Rural Electrification Development in Myanmar—The Critical Importance of Power Development, Executive Summary* (March 2015), 13–14, http://kwrintl.com/library/2015/1KWRERIASummary-MyanmarElectrification.pdf.
[13] World Bank, *International Development Association Project Appraisal Document on a Proposed Credit in the Amount of SDR 286.9 Million (US$400 Million Equivalent) to the Republic of the Union of Myanmar for a National Electrification Project* (August 25, 2015), 2, http://www-wds.worldbank.org/external/default/ WDSContentServer/ WDSP/IB/2015/09/10/090224b0830cd531/2_0/Rendered/PDF/Myanmar000Nati0trification0Project0.pdf.
[14] World Economic Forum, Asian Development Bank, and Accenture, *New Energy Architecture: Myanmar* (June 2013), 12, http://www3.weforum.org/docs/WEF_EN_NewEnergyArchitecture_Myanmar_2013.pdf.

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country's distribution enterprises. The Yangon Electricity Service Corporation, which corporatized in April 2015 but remains state owned, is responsible for distribution to Yangon, while the newly formed Mandalay Electricity Service Corporation covers Mandalay. MOEP's Electricity Supply Enterprise (ESE) is responsible for the rest of the country. These distribution enterprises partner with private companies for delivery to end-users in respective operating areas.[15]

Private-Sector Participation. After the lifting of many U.S. and EU sanctions in 2012, multinational companies are cautiously entering Myanmar and helping to shape the energy sector's trajectory. To date, most of this private-sector participation has been through upstream activity (exploration of coal, oil, and gas reserves); the number of international private players in the power sector has been relatively limited due the size and organization of the market and the lack of legal and policy frameworks for such activity.[16] However, as of August 2015, the small number of existing foreign investment enterprises in the power sector represented approximately 28 percent of Myanmar's total foreign investments (second only to oil and gas at 40 percent).[17]

Today's entrants remain cautious as Myanmar's power sector does not yet have standardized practices for joint ventures and power purchase agreements (PPAs) and thus requires time-consuming, case-by-case negotiations. But in April 2015 Myanmar took an important step forward. Advised by the International Finance Corporation, MEPE completed the first competitive bidding for an IPP and awarded the Singaporean company Sembcorp Industries a contract to operate a 225-MW gas-fired plant in the Myingyan district of Mandalay; under a 22-year PPA, MOEP will guarantee payment for MEPE's offtake.[18] Stakeholders expect this PPA to serve as a blueprint for use by other IPPs in the future.

The government has also signed dozens of memoranda of understanding (MOUs) with other private partners in the power sector; thus initial assessments and feasibility studies are underway for coal-, steam/gas-, large hydro-, and renewable-powered plants. However, many of Myanmar's energy-sector MOUs face slow progress due to excessive bureaucracy and overstretched public servants; it is unclear when or if these plans will become reality.

Beyond traditional private players in the power sector, Myanmar's telecommunications industry is growing exponentially, along with its associated energy footprint and supply chains. According to media reports, mobile penetration increased from approximately 7

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[15] Republic of the Union of Myanmar National Electrification Project, *Draft Myanmar National Electrification Project Preliminary Poverty and Social Impact Assessment to Inform Environmental and Social Management Framework* (April 27, 2015), 105–6, http://www.moep.gov.mm/sites/default/files/PSIA%20(English).pdf.
[16] OECD, *OECD Investment Policy Reviews: Myanmar 2014* (OECD Publishing: 2014), 246–55, http://www.oecd.org/daf/inv/investment-policy/Myanmar-IPR-2014.pdf.
[17] Myanmar Directorate of Investment and Company Administration (DICA), "Foreign Investment of Existing Enterprises (By Sector) as of 30/9/2015," http://dica.gov.mm.x-aas.net/.
[18] Sembcorp Industries, "Sembcorp Awarded Project to Develop the Largest Gas-Fired Independent Power Plant in Myanmar," press release, April 24, 2015, http://www.sembcorp.com/en/news_detail.aspx?NewsID=1111#.VinzPKK5eKI.

percent in 2012 to 42 percent today. Two foreign companies—Qatar's Ooredoo and Norway's Telenor—launched operations in 2014, breaking the monopoly of the state-owned telecommunications firm with an overall goal to reach 90 percent of the population within five years. It is estimated that 17,300 cell sites will be rolled out in Myanmar by 2017, two-thirds of which will be off grid.[19]

Myanmar's energy requirement for base stations in 2015 is approximately 200 GWh and is expected to more than double in the next two years, reaching 455 GWh in 2017.[20] Tower companies and third parties are installing diesel generators at most base stations off grid, but given the high operating costs for refueling these remote locations, some sites are opting for renewables to save over the longer term. Three foreign companies of note—Cummins Power Generation (American), Heliocentris (German), and Flexenclosure (Swedish)—are contracted to provide hybrid power solutions to mobile base stations across Myanmar.

Other off-grid suppliers are providing household and village electricity supplies (diesel and renewables) for rural customers through retail and tenders with the government, international organizations, and NGOs. Some of these local companies and social enterprises have a long-standing presence in Myanmar, while others are relatively new and came into existence primarily to implement government tender programs. Commercially oriented off-grid service providers face risks as there are no standards for setting retail tariffs nor clear options for interconnection upgrades to the utility network as the grid continues to extend into new service areas. Market data and consumer information (e.g., ability and willingness to pay for electricity) are not readily available. Previous off-grid projects are more personality dependent than policy based, and many potential investors are waiting to see how this sector will be affected by the 2015 elections.

Energy Trade. Myanmar's overall electric power sector is affected by the country's role as an energy exporter in the region. Long-term export arrangements began years ago when Myanmar faced international sanctions and sought alternative avenues to generate revenue and access financing for industrial projects beyond the traditional, prohibited international institutions.[21] For example, natural gas exports to Thailand began in 1998 and now account for 60 percent of Myanmar's offshore natural gas output.[22]

Plans for further exports continue while Myanmar faces domestic pressure to maintain more energy resources for local consumption. Although Myanmar's crude oil production is limited, natural gas production is significant and its sale represents approximately 37 percent of Myanmar's total exports.[23] Looking ahead, Thailand's national oil company PTTEP has

[19] Kieron Osmotherly, "The Myanmar tower rollout: FAQs," TowerXchange, November 2014, http://www.towerxchange.com/the-myanmar-tower-rollout-faqs/.
[20] GSM Association, *Green Power for Mobile Energy Outsourcing: Sunlabob Myanmar* (November 2014), 2, http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/11/Sunlabob-Case-Study_FINAL_sm.pdf.
[21] OECD, *OECD Investment Policy Reviews*, 240.
[22] Win Ahkar Mein, "Natural Gas Industry Outlook and Opportunities," 5.
[23] Massachusetts Institute of Technology, The Observatory of Economic Complexity, Burma Country Profile 2013, http://atlas.media.mit.edu/en/profile/country/mmr/#Exports.

announced plans to increase oil and gas investments in Myanmar by $3.3 billion by 2018, representing approximately 20 percent of the company's global capital expenditures.[24] Myanmar's hydropower exports are also expected to increase as 94 percent of installed capacity for planned hydropower projects is under joint venture schemes with foreign companies.[25]

China is also heavily invested in Myanmar's energy sector, although many of these large infrastructure projects have stalled for a host of reasons. For example, the Myanmar government suspended the Myitsone hydropower dam project in the far north in 2011 following civil society protests. The Myanmar-China natural gas pipeline (with 12 billion cubic meter annual capacity) saw only a fraction of gas transported successfully from Myanmar's coast to China's Yunnan Province in its first year, according to media reports. The status of these large projects is intertwined with broader Myanmar-China bilateral complexities, related to a history of strong trade and political ties during Myanmar's decades of military rule and international isolation, changing dynamics following Myanmar's opening, and spillover from ethnic conflict along the Myanmar-China border.

Supply-Demand Imbalance. Myanmar's export practices have left insufficient energy supplies for meeting domestic demand, and this gap will widen as demand growth is projected to exceed supply expansion by double or triple the rate per year.[26] Myanmar's National Electricity Master Plan study, supported by the Japan International Cooperation Agency (JICA), projects by 2030 electricity demand will reach five to eight times 2012 levels (of approximately 2,000 MW).[27]

Degraded infrastructure contributes significantly to Myanmar's power supply-demand gap, as does seasonal variation of hydropower. Old equipment lacking new investments means power-generation facilities operate below peak load capacity. For example, the International Energy Agency (IEA) estimates the efficiency of fossil-fuel power plants in Myanmar is 28 percent, the lowest in the region.[28] Also, the Myanmar government estimates 20 percent of power is lost during transmission and distribution.[29] Together these shortfalls cause significant load shedding and power outages across the country, particularly in the dry season when freshwater inflow decreases for the hydropower base load. For example, Myanmar's NEMC reports that in 2013, Myanmar experienced a 372-MW deficit in the summer season yet

[24] PTTEP, "PTTEP celebrates its 25-year partnership with the Republic of Union of Myanmar," press release, February 19, 2014, https://www.pttep.com/en/News-n-Media/Media%20Corner/Press%20Releases/PTTEP%20celebrates%20its%2025-year%20partnership%20with%20the%20Republic%20of%20Union%20of%20Myanmar.aspx.
[25] Khin Seint Wint, "Electric Power Sector and Decentralized Development," 11.
[26] David Dapice, *Electricity in Myanmar: The Missing Prerequisite for Development* (Harvard University Kennedy School of Government, Ash Center for Democratic Governance and Innovation, May 2012), 6, http://ash.harvard.edu/files/electricity.pdf.
[27] Masahiko Tanaka, "Lack of Electricity Strategy Will Stymie Growth," *Myanmar Times*, September 8, 2014, http://www.mmtimes.com/index.php/opinion/11569-lack-of-electricity-strategy-will-stymie-growth.html; NEMC, *National Energy Policy*, 13.
[28] IEA/ERIA, *Southeast Asia Energy Outlook*, 94.
[29] Khin Seint Wint, "Electric Power Sector and Decentralized Development," 6.

produced a surplus of 19 MW in the rainy season.[30] To mitigate these shortfalls in the coming years, efforts are underway to improve efficiency and increase generation capacity. For example, General Electric (GE) and MEPE signed an agreement to assess and upgrade the existing fleet of GE gas turbines in the country, which should result in an additional 30 MW of power. GE is also investing in human capacity development through training and exchange programs for Myanmar civil servants.[31] The Myanmar government is also planning to construct a number of new gas-fired power stations and retrofit old gas-fired turbines to be combined cycle thus improving efficiency and productivity. However, the physical supplies of gas for future power generation have yet to be identified, taking into account contractual obligations for gas export.

Electricity Tariffs for Residential and Small to Medium-size Commercial Consumers, Public Buildings, and Street Lights (as of April 2015)		
Consumption (kWh/Month)	**Kyats/kWh**	**USD/kWh equivalent**
0–100	35	0.03
101–200	40	0.03
201+	50	0.04
Electricity Tariffs for Industrial and Large Commercial Consumers (as of April 2015)		
0–500	75	0.06
501–10,000	100	0.08
10,001–50,000	125	0.10
50,001–200,000	150	0.12
200,001–300,000	125	0.10
300,001+	100	0.08

Source: Adapted from World Bank NEP Project Appraisal Document, August 2015.

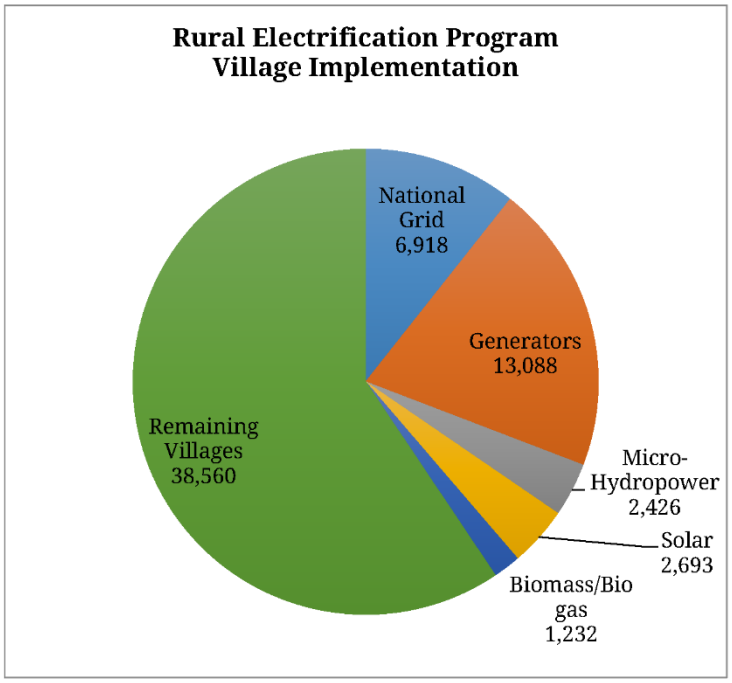
Subsidies. Myanmar's supply-demand imbalance is inherently tied to electricity subsidies that have distorted the market. On average, electricity is sold to end-users at a price lower than the cost MEPE pays producers. As a result, the government loses money with every kilowatt-hour (kWh) sold. In 2014 the government approved a new block electricity tariff scheme that raised prices for households and industry (see table at left). Under the new tariff structure, large commercial and industrial users cross-subsidize residential, small-medium commercial, and public-sector customers, whose tariffs remain below the average cost of supply (65 Kyats, equivalent of 5 cents, per kWh).[32]

Despite these recent changes, Myanmar's average electricity tariff remains among the lowest in Asia, according to the IEA.[33] This carries a range of implications for the energy sector, including disincentives for residential and small-medium commercial consumers to invest in energy-efficient and renewable energy technologies. Also, because these subsidies apply primarily on the national electric grid, the rural poor outside these

[30] NEMC, *National Energy Policy*, 14.
[31] GE, "GE to Extend Investment and Technical Assistance to Generate Additional 30 MW of Power for Myanmar," press release, November 13, 2014, http://www.ge.com/mm/sites/www.ge.com.mm/files/Press_Release_GE_Repowering_Myanmar_Eng.pdf.
[32] World Bank, *International Development Association Project Appraisal Document*, 86.
[33] IEA, "Recent Developments in Energy Subsidies," *World Energy Outlook* (2014), http://www.iea.org/media/weowebsite/developmentsenergysubsidies.pdf.

service areas often pay much higher rates per kWh for privately generated diesel or renewable electricity.

Electrification Needs. Myanmar's national grid reaches only a minority of the country's 51 million people; electrification is concentrated primarily in large cities such as Yangon, the capital Naypyitaw, and Mandalay. The government estimates nearly 40,000 rural villages remain without access to government-sponsored electricity services, though programs are proceeding to extend the national grid and deploy renewables to off-grid communities.[34] More specifically, of Myanmar's 64,917 villages, the government claims its rural electrification program has reached 26,357 villages by providing access to the national grid, diesel generators, or renewables (see chart).[35] But it is important to note that in this program, "electrification" of a village may mean that less than half of households actually receive electricity sufficient for lighting and charging electronics for several hours each day. The World Bank estimates electrifying the entire country will require $444 million annually over 15 years.[36] In particular, the cost of connecting the national grid to 7.2 million households by 2030 (excluding generation and transmission costs) is estimated at $5.8 billion.[37] To attract such financing, Myanmar will need a strong regulatory framework that guides private and public energy-related investments.



Source: Ministry of Livestock, Fisheries and Rural Development, Department of Rural Development, January 2015.

Policy and Regulatory Framework

A number of groups are advising the Myanmar government in updating national energy-related policies and laws. In real time, these regulations are affecting how various players can participate in Myanmar's energy sector. However, because these policies and laws are high

[34] Myanmar Department of Rural Development—Ministry of Livestock, Fisheries and Rural Development (MLFRD), "Rural Electricity Access" (presentation to World Bank Off-Grid Electrification in Myanmar Workshop, Naypyitaw, Myanmar, January 28, 2015), 12.
[35] Ibid.
[36] World Bank and Australian Government, *One Goal, Two Paths: Achieving Universal Access to Modern Energy in East Asia and the Pacific* (Washington, DC: International Bank for Reconstruction and Development/World Bank, 2011), 48, https://www.astae.net/sites/astae/files/publication/OGTP-Web.pdf.
[37] Xiaoping Wang, "Myanmar: Towards Universal Access to Electricity by 2030" (presentation to World Bank Off-Grid Electrification in Myanmar Workshop, Naypyitaw, Myanmar, January 28, 2015), 3.

level and lack detailed implementation plans or guidelines, the energy regulatory environment remains ambiguous and challenging to navigate, particularly for off-grid service providers. Practitioners expect this uncertainty to continue at least until a new government is formed following the 2015 elections.

National Policies and Plans. With guidance from the Asian Development Bank's Technical Assistance Program, the NEMC published the National Energy Policy in 2014.[38] The policy is meant to capture objectives across all energy sectors, including oil and gas, electricity, environment, renewables, and energy efficiency. The policy's key objectives are for Myanmar to:

- Develop energy resources that are accessible, while considering environmental and social impacts;
- Institute laws, rules, and regulations to promote private-sector participation and privatize state energy organizations;
- Compile data on Myanmar's domestic energy supplies and demands for various sources;
- Implement programs that enable local populations to benefit from energy reserves discovered in their areas;
- Implement sustainable energy development programs that scale up use of renewables (e.g., wind, solar, hydro, geothermal, and biomass);
- Promote energy efficiency and conservation;
- Establish a research, development, design, and dissemination institution to:
    - Track international practices in energy resource exploration and development
    - Produce and manufacture international quality products
    - Conduct energy resource exploration in accordance with international standards;
- Promote international collaboration on energy matters; and
- Formulate appropriate policy for energy product pricing, which supports economic security for both producers and consumers.

[38] The Republic of the Union of Myanmar President's Office, "Announcement of National Energy Policy," January 6, 2014, http://www.president-office.gov.mm/en/?q=issues/energy/id-4827.

The World Bank and Columbia University's Sustainable Engineering Lab supported the Myanmar government in developing a National Electrification Plan (NEP), using a least-cost geospatial analysis to determine a blueprint for extending the national electric grid and fully electrifying Myanmar by 2030. The recently approved $400 million World Bank loan will fund electricity connections through grid extension, off-grid technologies, and community centers (e.g., clinics, schools, and religious buildings); it will also include technical assistance for government capacity building.[39] As the program proceeds—led by MOEP and DRD—implementing partners have an opportunity to cooperate with government and help shape this program.

Legal Framework. On the regulatory side, a number of new laws are influencing Myanmar's energy arena. In 2014, the government passed a new electricity law, which aims to improve electric power sector development and management for meeting the nation's electricity demands. Among other objectives, the law seeks to increase foreign and local investments in electricity activities, promote standards and norms to reduce electrical hazards and equipment damage, and encourage generation and distribution projects of all sizes across Myanmar.[40] The law codifies definitions for various scales of power projects and assigns oversight and licensing responsibilities to particular government entities.

At the national level, the relevant ministry is authorized to issue (or deny) licenses for and manage large-scale power generation and distribution projects (i.e., more than 30 MW). The law delegates authority to regional and state governments—as well as heads of self-administered divisions and zones if negotiated with government—for licensing and oversight of off-grid projects smaller than 30 MW. These local officials are encouraged to coordinate with the Myanmar government regarding off-grid projects, but the law does not provide a standard framework for such coordination or licensing decisions. Also, the law requires that any local or foreign parties wanting to invest in electricity activities must apply for licenses with the appropriate government authority.[41]

The electricity law does not yet include implementing rules or detailed guidelines. For small power producers, this means a lack of standards for connecting rural renewable energy supplies with the national grid. Thus most electrification activity to date has been bifurcated between grid-extension efforts and entirely off-grid rural projects, with limited opportunities to integrate these approaches.[42] Further guidance to encourage such integration may be forthcoming, as ADB technical assistance is in the early stages of supporting the government in drafting a rural electrification law, which may clarify some uncertainties surrounding renewables and independent power projects.

[39] World Bank, "Electricity to Transform Rural Myanmar."
[40] Convenience translation by Polastri Wint & Partners, "Electricity Law Pyidaungsu Hluttaw Law no. 44/ 2014" (October 27, 2014), 3.
[41] Ibid., 5–7.
[42] KWR International and ERIA, *Turning on the Lights*, 29.

International participation in the power sector is governed by the foreign investment law of 2012, which aims to make Myanmar a more attractive investment environment. Notably, the implementing rules prohibit foreign investment in administration of electricity systems, trading of electrical power, and inspection of utilities. Electricity generation under 10 MW is reserved for Myanmar citizens.[43] This can pose obstacles for companies seeking to promote distributed-energy solutions and mini-grids throughout rural Myanmar. However, the complex web of regulations in this sector has created sufficient ambiguity and room for interpretation that enterprising groups have built relationships with local authorities and gained approval for off-grid renewable projects.

Financial Sector

Along with regulatory issues, Myanmar's financial environment presents a challenge for electrification projects. The country's banks are acknowledged as offering limited financial services that are inadequate for meeting the needs of individuals and businesses, and this has created significant barriers to local energy entrepreneurs. Today, most borrowers—including mini-grid developers—are limited to one-year loans at 13 percent interest rates, and they must use their homes or other immovable property as collateral.[44]

However, the situation is slowly improving with financial reforms. For example, more business financing is anticipated now that several foreign banks received final licenses, opened branches, and launched the first foreign bank operations in Myanmar in decades. And although mobile banking is not yet widely accessible in Myanmar, Telenor is poised to partner with Yoma Bank, one of Myanmar's largest private banks, for a mobile money service (pending further guidelines from the Central Bank of Myanmar). Such mobile money services would offer new opportunities for off-grid renewable energy suppliers to interface with rural customers.

Renewable-energy systems are becoming more accessible to rural communities following the 2011 microfinance law and implementing framework, which enabled domestic and foreign investors to launch privately owned microfinance institutions (MFIs) for the first time in Myanmar. In the year following this legislation, 118 MFI licenses were issued, and overall microfinance outreach is estimated at 2.8 million micro-clients (as of 2013).[45] Some MFIs in Myanmar—such as Pact Global Microfinance Fund—are starting to offer low-interest loan products to rural clients for purchasing solar lanterns and home lighting systems. These loans go up to approximately $200 and interest rates are capped annually around 24 percent.

[43] OECD, *OECD Investment Policy Reviews*, 94.
[44] Interviews with micro-hydropower developers, REAM delegation to Shan State, Myanmar, as part of Micro-Hydropower and Decentralized Renewable Energy for Myanmar Workshop, November 26–27, 2014.
[45] Eric Duflos, Paul Luchtenburg, Li Ren, and Li Yan Chen, *Microfinance in Myanmar Sector Assessment* (IFC and CGAP, January 2013), iv–v, https://www.cgap.org/sites/default/files/Microfinance%20in%20Myanmar%20Sector%20Assessment.pdf.

Social enterprises like Proximity Designs have offered credit to rural customers purchasing solar lanterns and home lighting systems, with short-term loans ranging from one to four months. As the financial sector evolves there may be increased opportunities to finance local entrepreneurs managing mini-grids for village electrification as well. However, in the meantime, demand for microcredit far outweighs supply. The limitations of short-term loans currently available, combined with relatively high capital costs of quality renewable energy systems, mean many potential customers still cannot afford the high-quality energy solutions designed to improve their livelihoods and reduce energy poverty.

Distributed Energy in Myanmar's Development

Although diesel generators are pervasive, renewable energy technologies—including solar, hydro, and biomass—have also helped meet Myanmar's energy needs for decades. Together resourceful local entrepreneurs and communities have installed and maintained village- and household-level renewable energy systems, often with self-financing and limited technologies. For example, in areas of Shan State (in northeastern Myanmar) with the right mix of topography and population density, local developers have installed hundreds of micro-hydropower sites to electrify thousands of households.[46] In rice-growing areas such as the Irrawaddy Delta where feedstocks are abundant, local entrepreneurs have installed rice-husk gasifiers (usually on a self-help basis) to power rice mills and provide electricity to local communities. It is estimated that more than 1,000 gasifiers have been installed throughout the country, though the lack of environmental safeguards presents risks associated with toxic effluent.[47]

In addition, the Myanmar government began distributing biogas digesters in the 1980s (though most of these are now defunct) and more recently installed 152 community-sized plants across the country.[48] Over the last decade, UN agencies and other donors have partnered with local groups for dissemination of solar home-lighting systems as well. And in recent years, as solar products have become widely available on the open market across the country, thousands of households have purchased their own solar home systems on a self-help basis. Despite these local demands and implementation of various organizations' off-grid energy projects, the penetration of renewable technologies remains at a relatively small scale compared to the vast electricity needs for almost 70 percent of the population.

To address this electrification gap, a variety of government ministries are implementing programs to bring off-grid renewable energy supplies to Myanmar's rural areas, in addition to

[46] REAM, WISIONS, and Hydro Empowerment Network, "Micro-Hydro and Decentralized Renewable Energy for Myanmar: Practice-to-Policy Dialogue, Applying Lessons from Indonesia, Nepal, and Sri Lanka" (workshop proceedings, Yangon and Shan State, Myanmar, November 23–28, 2014), 13, http://www.hpnet.org/myanmar-2014.html.
[47] KWR International and ERIA, *Turning on the Lights*, 26.
[48] Asian Development Bank, *Myanmar: Energy Sector Initial Assessment* (Mandaluyong City, Philippines: Asian Development Bank, 2012), 18, http://themimu.info/sites/themimu.info/files/documents/Report_Energy_Sector_Initial_Assessment_ADB_2012.pdf.

extending the national grid at a rapid pace. To date, the largest off-grid program has been managed by the Department of Rural Development (DRD). Between 2013 and 2015 fiscal years, DRD supported over 200,000 solar home systems and more than 100 mini-grids, with a tenfold program budget increase reaching $37 million for 2015.[49] Looking ahead, DRD will direct the off-grid component of the NEP, focusing on remote communities primarily in border areas. Although the government's programs have a wide reach geographically, Myanmar will need a robust private market and commercially viable technologies—accessible and affordable for the rural poor—to enable distribution at the levels needed to meet rural energy needs.

Off-Grid Opportunities. Practitioners in Myanmar see promising potential for collaboration with the telecommunications industry to improve rural electricity access and promote distributed renewable systems. GSMA (Groupe Speciale Mobile Association) forecasts by 2017 approximately 9,900 telecommunications sites in Myanmar will be viable for renewable power generation, and adoption of these renewables could collectively save $137 million in operating expenses every year by 2017.[50] Energy service companies (ESCOs) could potentially partner with tower companies and mobile network operators for deployment and management of renewables throughout the country, serving both tower sites and nearby communities. However, the business environment for ESCOs remains risky in Myanmar, as a variety of key conditions—such as clear policies, regulations, and financing mechanisms—are lacking at this time.

Of the renewable energy technologies available for off-grid use in Myanmar, solar technology has become particularly popular among international donors, private companies, and NGOs launching market-based off-grid projects. With globally declining prices of photovoltaic (PV) systems (which convert solar energy into electrical power), and with widespread use of highly efficient light-emitting diode bulbs in Myanmar, a relatively small amount of energy from a solar panel can now provide lighting to a rural household for a significant amount of time. The modularity of solar is also attractive, as the technology can adapt to communities' changing energy-demand profiles.

The ADB is piloting solar home systems and solar mini-grids in rural areas, with the goal of generating data to help determine the commercial viability of future off-grid renewable investments. The energy company Total—in partnership with several NGOs and MFIs—is enabling off-grid communities to purchase solar lamps and home lighting systems. Pact Myanmar and Mercy Corps are launching off-grid renewable electrification programs to finance PV systems and promote commercialization of high-quality products in rural areas. The local social enterprise Proximity Designs has sold solar lanterns and home lighting systems to rural customers in the Delta and Central Dry Zone since 2012. Numerous other groups are launching pilot projects and evaluating Myanmar's market for distributed renewables.

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[49] World Bank, *International Development Association Project Appraisal Document*, 38.
[50] IFC and GSMA, *Sizing the Opportunity: Green Telecoms in Myanmar—Green Power for Mobile Market Analysis* (2014), 37, http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/06/GPM-Market-Analysis-Myanmar-June-2014.pdf.

Addressing Market Challenges. With this rise of activity, stakeholders have identified a number of challenges—including quality control, after-sales support, consumer education, and policy coordination—which will need to be resolved for the off-grid renewables market to function over the longer term.

For PV systems in particular, price and quality vary dramatically in Myanmar. On one hand, questionable-quality products are imported from China (often over the land border between Myanmar's Shan State and China) at remarkably low costs. These systems are widely available in electronics and hardware shops throughout the country. The popular panels are Chinese imitations of reputable brands like Tata and are often paired with car batteries for use in rural homes. Assessments by the Renewable Energy Association of Myanmar, World Bank advisers, and others have documented performance issues associated with these low-quality systems.[51] And as such systems lack warranty and after-sale services, when they fail (due to user error or hardware malfunction), customers have limited options for repair.

On the other hand, private companies, NGOs, and international organizations are attempting to sell high-quality PV products imported from reputable suppliers. But it can be difficult for these more expensive systems to compete in the open market when customers lack access to information to distinguish among various products. This challenge is exacerbated by the unintended consequences of the DRD off-grid program, as its solar home systems have been provided at full subsidy to participating villages in recent years. Thus in some cases, when companies and development organizations have approached communities to sell high-quality PV systems, the local expectation for free gifts eliminated villagers' willingness to pay. But overall, Myanmar's rural communities remain enthusiastic about renewable energy and demand for affordable solutions is high.

Off-grid service providers have also highlighted that rapid extension of the electric grid currently influences where their systems are appropriate for installation and sale. The government's village-level plans for grid extension are not yet publicly available, and without the right information (nor clear legal and technical guidelines for grid connections), mini-grid service providers risk making plans that become obsolete if their target communities will be connected to the grid soon. But if equipped with appropriate data, regulatory frameworks, and technical standards, service providers can take steps in the near term to allow for future grid integration (if appropriate), while donors and other private partners can make the most of their resources.

Other developing countries in the region are addressing similar challenges and can offer useful lessons. For example, Bangladesh's Infrastructure Development Company Limited (IDCOL) program is often cited for its comprehensive approach and is recognized globally for certification of off-grid technologies. Though established by the Bangladeshi government in 1997, IDCOL is an independent institution that works with private-sector partners for

[51] Chris Greacen, "DRD Solar Home Systems (SHS) in Myanmar: Status and Recommendations," Report to the World Bank (January 2015), 14–21, https://energypedia.info/wiki/File:Assessment_of_DRD_SHS_Myanmar25Jan15-Greacen.pdf.

financing and disseminating solar and other renewable technologies primarily in rural, off-grid areas.[52]

IDCOL has enabled successful installation and maintenance of 3.45 million solar home systems in Bangladesh. Suppliers are required to provide warranties for system components as well as three-year free after-sale service and yearly maintenance agreements with households.[53] IDCOL also has a fleet of 150 inspectors who monitor the quality of PV system components and after-sale services across the country. Along with several other organizations in Bangladesh, IDCOL has implemented public awareness campaigns about renewable energy technologies, using methods such as television, print media, and mobile exhibition events in remote areas.[54] A similar, concerted effort in Myanmar—combined with human capacity building and training—could improve the PV market and supply chain to help the country reach its electrification goals.

Conclusions

To increase the nation's electricity access and support broader economic development, Myanmar will need to follow through with planned supply and demand-side solutions for the power sector, as well as national grid extension and utilization of distributed energy strategies. The private sector will play a central role in these efforts and Myanmar's policymakers will need to create an enabling environment for future business, addressing issues such as market-distorting subsidies and inadequate banking services.

Myanmar's abundant renewable resources and history of rural communities' ingenuity with distributed energy systems has attracted great interest from the development community. This presents opportunities for electrification in remote areas where the national grid is not viable in the medium to long term. But given the extent of poverty in Myanmar's rural areas, financial products will need to be available at scale for rural customers to afford quality distributed renewable energy systems. Detailed regulations and standards are also needed to clarify the role of independent power producers in Myanmar's electrification.

In particular, clear guidelines would help private developers navigate the provision of energy services to a range of off-grid customers, whether telecommunications clients or rural villages. As policies and plans are finalized, sharing information and data among public and private players will allow stakeholders to coordinate and target activities appropriately, thus maximizing resources available to meet Myanmar's electrification and development goals.

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[52] Castalia Strategic Advisors, "Myanmar National Electrification Program (NEP) Roadmap and Investment Prospectus" (Draft Final Road Map and Investment Prospectus, August 2014), 65–66, https://energypedia.info/images/3/37/Myanmar_NEP_Roadmap_and_Prospectus_Draft_Final_14_08_28.pdf.
[53] Nazmul Haque, "IDCOL Solar Home System Program" (presentation to the World Bank Off-Grid Electrification in Myanmar Workshop, Naypyitaw, Myanmar, January 28, 2015), 9.
[54] A. K. M. Sadrul Islam, Mazharul Islam, and Tazmilur Rahman, "Effective Renewable Energy Activities in Bangladesh," *Renewable Energy* 31 (2006) 677–88.

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