



# **TURNING ON THE LIGHTS: INTEGRATED ENERGY AND RURAL ELECTRIFICATION DEVELOPMENT IN MYANMAR**

**Cross-Border Electrification and Potential for  
Regional Energy Integration in Myanmar**



**PHASE III FIELDWORK**

**July – December 2014**

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## **Cross-Border Electrification and Potential for Regional Energy Integration in Myanmar**

### **FINAL REPORT**

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**Produced for Economic Research Institute for ASEAN and East Asia (ERIA) by KWR International (Asia) Pte Ltd.**

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Beginning with our work to produce the energy and electrification contribution to the Economic Research Institute for ASEAN and East Asia (ERIA)'s Myanmar Comprehensive Development Vision report in cooperation with the University of Tokyo, exhaustive research, field visits, and other activities were undertaken over the past two and a half years. This included interactions with hundreds of individuals in Myanmar, Thailand, Singapore, Indonesia and other parts of ASEAN as well as Japan, Korea, the United States and other countries, who were kind enough to provide support and input into this initiative.

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Please send any comments, questions or suggestions to [myanmar@kwrintl.com](mailto:myanmar@kwrintl.com).

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## **INTRODUCTION: GOALS AND OBJECTIVES**

Over the last two and a half years, the KWR International (Asia) Pte. Ltd. (KWR) / University of Tokyo (UT) Team (Team) has worked together to help define the state of Myanmar's electrical infrastructure, and to undertake the fieldwork necessary to develop awareness of important regional, social and geographic commonalities and differences and other circumstances within different areas of Myanmar. This work is helping to facilitate rural electrification and the development of Myanmar's power sector. The Team is also monitoring new developments and a broad range of new and existing stakeholders, while forming deeper insights to help better define and achieve Myanmar's electrification goals. To maintain and build on the momentum that has been achieved, KWR has initiated this third fieldwork phase with the following goals and objectives:

- a) To work with UT/ERIA to monitor evolving developments concerning the energy and electrification sector in Myanmar, drawing upon interactions with a wide range of internal and external stakeholders, including Ministries, trade and business organizations, academics, corporations, donor agencies, media and other targeted entities in and outside Myanmar;
- b) To analyze past achievements and to utilize past fieldwork and the lessons learned both to identify gaps and future priorities, as well as to provide information and support UT, ERIA and other entities in and outside Myanmar including energy-related organizations and Ministries, as well as Japan's Overseas Human Resources and Industry Development Association (HIDA), Asian Development Bank (ADB), World Bank and other targeted entities;
- c) To draw upon past research to formulate broader-level conclusions resulting from the Team's fieldwork and cost analysis and to interface with internal and external stakeholders to undertake an informal "peer review" so that revisions and additions can be made for insertion into a final report; and

- d) To undertake the initial fieldwork needed to better understand regional energy integration issues between Myanmar, China and Thailand, and the general environment for electrification through site visits in North Shan State, and a review of prior fieldwork visits to South Shan State, with an emphasis on the Myanmar-China border, including Self-Administered Regions such as Kokang. Efforts will also be made to initiate contact with government officials and other entities who can facilitate future fieldwork to other areas, potentially including planned larger-scale Thanlwin/Salween River hydro projects, so as to best address ERIA and UT research and priorities and to better understand and analyze the regional energy/electrification relationship and associated economic factors and concerns.

## **RECAPPING PRIOR RESEARCH AND FIELDWORK UNDERTAKEN BY THE TEAM**

To date, the Team has completed three phases of fieldwork on energy and electricity in Myanmar, as well as a prior in-depth study of the power sector that formed the electrification and energy component of the ERIA-led Myanmar Comprehensive Development Vision (MCDV) initiative. For the latter, the Team consulted with technical advisors and other experts and reviewed hundreds of sources, including government statistics and presentations, media coverage and reports from multilateral donor agencies and development banks, nongovernmental organizations (NGOs) and academic and financial institutions.

The Team's contribution to the MCDV, completed in July 2012, presented perhaps the first detailed overview of Myanmar's electricity sector and infrastructure in recent years and identified numerous gaps and inconsistencies in the available data. The report analyzed the complex political, economic, technical, social and environmental issues that must be considered while identifying "roadmapping" concerns that need to be addressed by the Government of Myanmar, donors, private companies and other entities to develop and move forward a comprehensive energy and electrification policy.

This initial MCDV report, completed in July 2012, prepared the Team to undertake Phase I fieldwork during the spring and summer of 2013. During this phase, the Team visited eight locations: 1) **Bagan/Nyaung-Oo**, 2) **Monywa**, 3) **Mandalay**, 4) **Patheingyi**, 5) **Pyin Oo Lwin**, 6) **Tachileik**, and 7) **Kengtung**. In each location, the Team interviewed a variety of stakeholders on a wide range of issues, including availability and local uses of electricity, projected and aspirational demand for electricity, sources of electricity generation, willingness and ability to pay for electrification and the cost-effectiveness of various electrification schemes. The Team conducted these interviews with villagers and village leaders, local electricity officials and private power providers. Follow-up visits were made to Monywa and Mandalay to obtain additional information on certain interview topics, such as incentive programs and activities of regional government.



Following analysis of these interviews, the Team developed a set of conclusions and recommendations based on the broad themes that had been initially identified. These included grid extension, off-grid and cross-border electrification initiatives.

Phase II Fieldwork, carried out between January-June 2014, consisted of village-level site visits to 1) **Tha Yet Taw**, 2) **Kyar Kan Daung**, 3) **Aung Mingalar Kyun**, 4) **U To** and 5) **Me Za Li Ywar Ma** in Ayeyarwady Division; 6) **War Taung** and 7) **Za Di Ya** in Kyaukphyu in Rakhine State; and 8) **Myoma** and 9) **Mu Du** near Dawei in the Tanintharyi Region. Exploratory visits were also made to larger urban and industrial settings, including the **Kyaukphyu Special Economic Zone**—which is also the site of a government-led grid-extension initiative—the **Dawei Special Economic Zone** and a now-defunct hybrid-power facility in **Chaungthar**, which was initially developed with assistance from the New Energy Development Organization (NEDO) in Japan.

While Phase I fieldwork placed an emphasis on visits to towns, urban areas and other locations, supplemented by discussions with individuals brought in from surrounding villages and occasional brief visits to these villages, Phase II placed greater emphasis on deeper examination of the village-level dynamics driving rural electrification, rather than broader, area-wide themes.

A key component of the Phase II fieldwork was the development of a cost model that enabled the Team to examine the comparative benefits and feasibility of various electrification technologies, including solar home systems, mini-hydro turbines, generators, gasifiers and grid extension.

During each of these phases, fieldwork visits were supplemented by more than 100 interviews and meetings in Yangon, Naypyitaw, Bangkok, Jakarta, Singapore and elsewhere with representatives of the following: ministries involved in energy and electricity policy; energy companies and private power providers; associations relevant to energy, electricity, trade and foreign investment; social enterprises and micro-finance institutions involved in rural electrification; donor agencies; fund managers and

investors; lawyers, engineers and accountants; analysts; media; and other individuals and entities with involvement and interest in Myanmar's electricity sector.

The Team also participated in discussions, conferences, stakeholder meetings and other gatherings on energy and electrification development in Myanmar, with emphasis on rural electrification.

### *Documenting the Team's Achievements to Date*

In addition to the fieldwork and research that has been conducted, the Team has made significant contributions to, and been an active participant in, the efforts underway to facilitate the development of national and regional policies and practices on electricity development in Myanmar.

To ensure ongoing continuity and that the Team was able to effectively address evolving priorities as this project entered its third phase, KWR took time to review and document its achievements. This was necessary to better understand and highlight the Team's accomplishments and to ensure any resulting gaps could be identified and addressed in the current and future phases moving forward. Achievements include:

- **Development of comprehensive data and information to drive understanding of electrification and rural electrification in Myanmar**

Initial work done by the Team under the MCDV framework assembled information and identified gaps in available data and research on Myanmar's energy and electrification sectors. This was followed by two phases of fieldwork before the current third phase. These have generated significant data on rural and regional conditions, off-grid electricity providers, government policies and special initiatives, private sector involvement in the electricity sector and a range of other relevant topics that could not be adequately studied without first-hand accounts and field visits. In addition, the development of a cost model, comprising data on all commonly used technologies in

Myanmar, has allowed the evaluation of relative costs, benefits and social and environmental implications of different technologies available.

- **Identification and examination of key drivers and constraints of rural electrification on a village and regional level**

Choices regarding electricity on a village- or household-level are influenced by a wide array of geographic, economic, social, political and demographic factors, which makes it difficult to come up with uniform solutions. For example, part of a village may be down a ravine, making it difficult to access with grid lines. Another village that has the money collectively to connect to the grid may not be cohesive enough to organize and meet the MOEP conditions for grid connection. A village with strong leadership, on the other hand, can have a significant advantage in terms of overcoming certain challenges like arranging financing opportunities and working out a feasible means of accessing adequate and appropriate electricity. The Team's identification and examination of these drivers of village electrification decisions can inform the development of support mechanisms on the part of donor organizations, local and national government, microfinance institutions and NGOs.

- **Examination of commonly-used technologies, comparative cost factors and regional differences**

While a number of actors are engaged in solving Myanmar's electricity challenges, many advocate widespread use of one particular technology, be that grid extension, solar home systems or hydro-powered mini-grids. KWR's cost model is the first in-depth examination and analysis of the technologies commonly used for rural electrification in Myanmar—including grid extension, solar home systems, gasifiers, generator-sets and mini-hydro—with an eye not only toward efficiency, sustainability and cost-effectiveness, as well as location-specific utility. For example, gasifiers may be more feasible in a remote village with abundant and regular access to rice husks than in a densely populated area without a known feedstock supply. By the same measure, while

grid extension may be advisable for a village with high electricity demand, it may be unworkable for populations located on islands or other difficult topographies.

- **Identification and examination of regulatory obstacles to universal electrification**

MOEP's 24 conditions for establishing grid connection requires villages to connect all at once to the grid, using village savings, and prohibits them from requesting donations from MOEP or from an outside source. Further, Myanmar lacks a Rural Electrification Act, or any legislation establishing financing mechanisms for grid extension. The Team's research revealed this combination to be a significant hurdle for villages to overcome, given the high upfront expense of cables, posts and other costs associated with installing grid connections.

- **Identification and examination of social obstacles to universal electrification**

The Team's research and analysis uncovered the unintended consequences of certain efforts taken by the government to improve electrification. For example, as the grid is extended, bringing affordable and regular electricity access to new locations, the basic needs of neighboring villages are often left unmet because they are outside the grid extension mandate or otherwise unable to connect due to geographic or financial constraints. This contributes to potential social dislocation and unrest. There have also been instances of demonstrations in response to grid extension initiatives, as the government requires villages to pay for the connection themselves. These findings may necessitate public information campaigns or other communication mechanisms to ensure public understanding and to bolster support for electrification initiatives.

- **Identification and examination of special projects and electricity initiatives**

Within the first two phases, the Team visited a number of special projects, including cross-border electrification initiatives along the Thai border, Special Economic Zones, such as Dawei, Kyaukphyu and Thilawa, off-grid electricity projects run by MOEP and

grid-extension initiatives led by the President's office. In the latter case, a presidential directive allowed villages in the Kyaukphyu area to connect to the grid on a household level, foregoing the condition that villages connect and meet requirements collectively, and a foreign corporation donated cables and other equipment. This made establishing grid connection relatively easy for households and proved enormously helpful in reducing electricity rates and easing social tensions within this immediate area and 100 meters on each side of the connection. In the case of cross-border initiatives, Tachileik, located far from Myanmar's national grid, receives electricity from a Thai provider at rates higher than those subsidized by the government in other parts of Myanmar. This system proves efficient for the region, whose population has an income roughly twice the national average, and has sustained rapid and intense growth in population and economic activity. Although these initiatives do not conform to standard Myanmar policy and legislation, their successes could inform policies on electrification and regional integration moving forward.

**• Formulation of a stakeholder network and mechanism for peer review**

The Team has helped convene a number of stakeholder meetings, drawing participants from all of Myanmar's energy-focused ministries, the Myanmar Engineering Society, Myanmar Industries Association, Union of Myanmar Federation of Chambers of Commerce and Industry, as well as an array of private companies and academic institutions. This is in addition to organizing well over 100+ meetings and interviews with project developers, micro-finance institutions, NGOs, fund managers and investors, trade development officials, and representatives of the World Bank, ADB and other donor agencies. The network cultivated by KWR/UT has allowed for the review of fieldwork findings and data, development of cost-related information, input of new data and facilitation of further research. This continual review of data helps to develop consensus and to ensure the policy recommendations developed by the Team are feasible from the standpoint of the many actors involved in developing Myanmar's electrification sector.

- **Development and facilitation of working relationships and interactive dialogue with Myanmar ministries, associations and companies.**

KWR/UT has actively utilized its strong base of contacts and relationships within Myanmar to develop and facilitate working relationships and ongoing, interactive dialogue with key Myanmar Ministries, business and industry associations and domestic and foreign firms on a range of electrification-related issues. To cite one example, after Myanmar's newly-formed Ministry for Livestock, Fisheries and Rural Development (MLFRD) was entrusted as the lead agency to facilitate rural electrification in Myanmar, a close working relationship was formed that has since resulted in numerous consultations, the hosting of a joint workshop and other activities.

- **Preliminary discussion and examination of potential policy approaches for electrifying Myanmar**

The Team has been actively engaged in the development of potential policy approaches to help overcome the challenge of electrification and rural electrification in Myanmar. This includes dialogue with, and participation within workshops hosted by, the World Bank and ADB on its strategy for universal electrification in Myanmar by 2030. It also includes consultations with ministries, such as the MLFRD, which requested the Team's input on suggested components of a Rural Electrification Act for Myanmar. KWR and UT both prepared draft memos concerning development of a Rural Electrification Act which were presented to the Ministry in May 2014.

## **WORLD BANK AND ADB ELECTRIFICATION PLANNING AND HIDA WORKSHOPS**

Given the increasing role that donor agencies such as the World Bank, ADB and JICA have been playing in terms of development and implementation of national energy and electrification plans for Myanmar, the Team has participated within several meetings and workshops organized by both ADB and the World Bank. Given the key role the World Bank is playing in the development of a national electrification plan, a special emphasis has been placed on developing an understanding of their planning. In addition to attending meetings in Myanmar, the Team has also met with the Columbia University team in New York who are undertaking geospatial mapping for the World Bank to exchange information and allow for more detailed discussion.

### *World Bank's Initiates Effort to Create National Electrification Plan*

In February 2013, the Government of Myanmar requested the World Bank to develop an energy policy outline. The National Electrification Plan, as it is now known, was developed by the World Bank in conjunction with the Sustainable Engineering Lab, part of the Earth Institute at Columbia University, and Castalia, a private consulting firm, which developed the investment component of the National Electrification Plan.

Four workshops on the topic were held in Naypyitaw between May 2013 and September 2014, the first of which was co-organized by the World Bank and the MOEP, and the latter three by World Bank, MOEP and MLFRD. KWR was one of approximately 100+ participants in attendance at the two latter workshops, which drew participation of representatives from the Myanmar government, NGOs, the private sector and representatives of international and bilateral organizations, including ADB, World Bank, Japan International Cooperation Agency, United Nations Development Programme, UK Department for International Development, US Department of State and International Finance Corporation.

The National Electrification Plan is forecast to cost US\$5.8 billion. This does not include the additional generation and transmission capacity needed to support electrification rollout and is primarily focused on household, rather than commercial and industrial needs. The total investment required to achieve universal electrification is estimated by some analysts to be as high as US\$12 billion or more. It is not certain, however, whether even these higher estimates truly reflect likely cost-overruns and potential increases in commercial and industrial or even consumer demand as capacity expands and both expectations and requirements rise in a nation that has been underserved for almost six decades. Therefore, the immensity of the challenge -- both technically and financially -- points to the need for policies and mechanisms that facilitate the public-private cooperation that will be needed to fund and realize this objective.

According to Columbia's Earth Institute, the national electrification plan will need to connect more than 7.2 million households over the next 16 years to achieve universal electrification by 2030. At the present rate, at which about 189,000 households are brought onto the grid annually, achieving universal electrification would take up to 40 years. Under the National Electrification Plan, the rate is expected to increase to more than 550,000 household connections per year once the rollout reaches maturity.

Over the short-term it is expected that implementation of the National Electrification Plan will be held up—connecting only 2 million households in the first five years—due to human resources capacity, supply chain development and funding and financing constraints. Investment and technical assistance during this period are expected to amount to US\$700 million.<sup>1</sup>

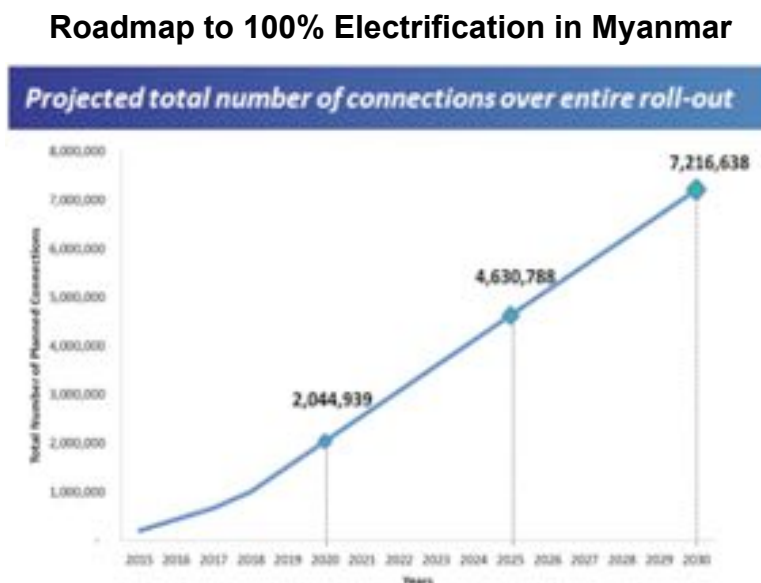
It is important to emphasize that the National Electrification Plan is heavily focused on residential electricity connections, while industry and business, as well as health, education and other service providers are largely to tend for themselves.

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<sup>1</sup> Powering Up Myanmar: More Than 7 Million New Electricity Connections Needed by 2030, World Bank, October 8, 2014



It is understandable that there would be an initial focus on households, given that Myanmar's citizens have long been neglected and have rapidly rising expectations. Ultimately, however, rising demand by industry and business will be critical and will lead to large increases in required capacity. Additionally, while businesses are able to absorb a higher tariff, and are viewed as having sufficient funds to pay these higher prices, their willingness to pay assumes a reliable electricity supply. The real cost of meeting industrial and residential demand, and the requirements to deliver to both must, therefore, must be better understood to effectively move forward with plans for universal electrification.



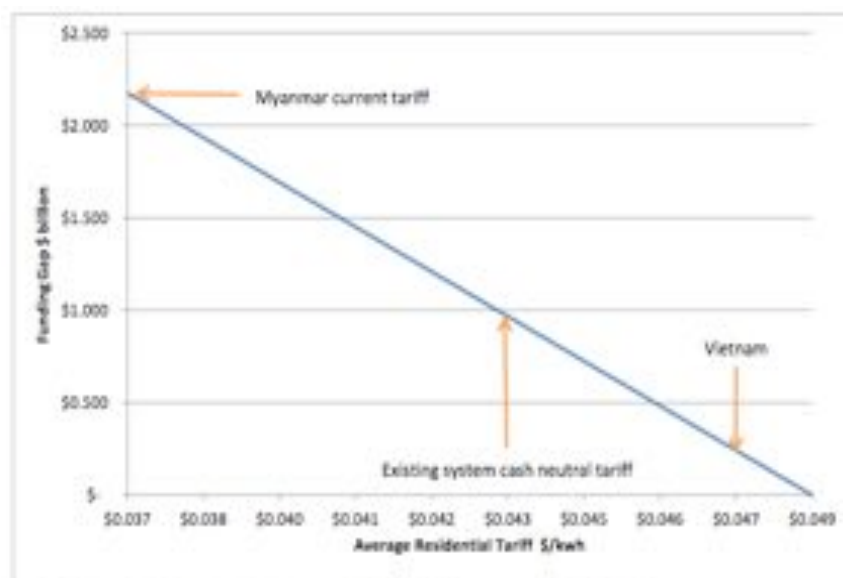
**Source: Castalia and Earth Institute estimates**

There is also uncertainty over what is considered "electrified," and whether National Electrification Plan cost estimates adequately account for increased demand, which, as documented in the Team's village-level fieldwork, is likely to increase exponentially when citizens realize the opportunities and comforts that arise from a regular supply of electricity. As the Team pointed out in its advisory memo to the MLFRD in 2014, rural electrification plans necessitate clearly defined goals. Presently, the understanding and definitions of "electrified" vary widely. In the Team's meetings with MLFRD, it was said that 120 kWh would be considered electrified, while the Sustainable Engineering

Lab/World Bank and ADB understandings of the concept are considerably higher. These differences will have a significant impact on the final costs of achieving universal electrification in Myanmar. This is before taking likely cost overruns into account.

An executive briefing on the National Electrification Plan, delivered on September 15, 2014, estimated a funding gap of approximately US\$2 billion over the course of the program's 40-year lifetime.<sup>2</sup> The briefing states, however, based on the Vietnam experience, that tariffs could be increased to levels that would minimize the funding gap while remaining affordable. Given Myanmar's recent attempts to raise electricity rates have resulted in protests and demonstrations, the briefing notes that rate increases will require careful engagement with the Myanmar public, underscoring one of the Team's previous recommendations. It should be noted that in Vietnam, rate increases were met with protests and reports that rural populations were foregoing electricity use or skipping meals to deal with the rate hikes compounded by the country's raising inflation.<sup>3</sup>

### **Funding Gap Sensitivity to Tariff Levels**



Note: Points on the horizontal axis represent the weighted average residential tariff

**Source: Castalia Strategic Advisors**

<sup>2</sup> [Briefing on Myanmar National Electrification Plan Toward Universal Access](#), August 25, 2014

<sup>3</sup> [VIETNAM: Struggling to cope with rising prices](#), IRIN, March 1, 2011

It has been suggested that the introduction of lifeline rates, or targeted subsidies based on electricity consumption, could diffuse public discontent. This would allow poor households to access a cheaper rate up to a certain amount of usage, such as 1 KWh.

There is also a need to more fully address commercial and industrial use as it will serve to increase employment and compensation facilitating the ability of consumers to pay for their consumption. In addition, as commercial and industrial users purchase electricity at a higher tariff rate, consumption by these users helps to balance, and potentially minimize the need to raise, rates paid by consumers.

Additionally, while the National Electrification Plan places most of its focus on grid extension, which indeed appears to be the optimal long-term goal, it is also important to better understand the supply side and the energy inputs that will be used to make the grid roll out possible. According to the government, 67% of Myanmar's total electricity consumption in 2030 will consist of coal and gas, and there are plans to develop coal-fired power plants in Yangon, Ayeyarwady and lower Myanmar.

Coal may prove problematic in Myanmar's energy mix as the country's coal deposits are located in the far north and are generally viewed as having too high a moisture content. This makes the coal difficult to transport and with its moisture, not ideal for electricity generation. In addition, deposits are largely located in areas where there have been ethnic conflicts. As a result, many analysts believe the coal-fired plants under construction will require imports of more suitable coal from other locations such as Indonesia. According a prominent development economist, Myanmar would have to import 2.5 million to 3 million tons of coal per year, which would require large ships entering every ten days and a deep sea port. There are few places within Myanmar with the combination of port capacity and electricity demand needed for a coal plant.

The use of coal-fired power will also prove challenging for Myanmar as it necessitates considerable operations and maintenance (O&M) costs and higher than average capital

costs in addition to its low efficiency and high carbon emissions. There is also growing environmental concern.

According to a retired official of the Ministry of Energy, the energy balance will ultimately be based upon domestic availability, least cost option and environmental considerations.

Following the fourth National Electrification Plan workshop, held in the fall of 2014, the next stage is to design the National Electrification Plan and begin capacity building among institutions, ministries and financial institutions. Columbia University's Sustainable Engineering Lab has begun training MOEP and regional engineers on how to implement geospatial grid-planning in their areas.

#### *Overseas Human Resources and Industry Development Association Workshops*

The Team has provided support to HIDA as it undertakes training programs and workshops designed to assist Myanmar in improving the industrial structure and business environment of its energy and electricity sectors. Beginning in September 2014, monthly workshops have convened Myanmar nationals recommended by government ministries and the National Energy Management Committee (NEMC)—a body created in 2013, along with the National Energy Development Committee (NEDC) to achieve greater cooperation among Myanmar's ministries—with the following goals:

- To understand the latest energy policy of the world and acquire the necessary policy measures to initiate more efficient and effective energy policy-making, planning and implementation;
- To enhance more effective dialogs, interaction and consensus building among the line ministries, organizations as well as the demand side sectors;
- To prepare policy proposals on specific and selective energy policy issues and present these to a higher stage of the government such as the NEMC; and

- To help initiate continued human resources development both in public and private sectors of energy not only to design policies but also to implement and review them.

In addition to this general support and overall management by UT, in December 2014, KWR delivered a session on rural electrification within HIDA's Energy Policy Workshop to select government officials and other stakeholders in Myanmar.

## **PHASE II CONCLUSIONS AND RECOMMENDATIONS**

At the start of the current Phase III fieldwork phase, KWR engaged in an extensive internal review of Phase II findings to draft a wide range of comprehensive macro-level conclusions and recommendations for discussion and incorporation into a final report.

Unlike the Phase II report, which focused on individual case studies and the needs of the respective locations visited, with conclusions in respect to these localities, these conclusions utilized the data generated in a broader context. This served to determine commonalities and findings across the many sites visited, which could then be utilized in a national and regional context.

Following their development, the findings were again distributed to a select group of stakeholders for their input after which they were refined to include:

### **A) MACRO CONCLUSIONS AND RECOMMENDATIONS**

#### **1. *There Is No “One” Rural Electrification Solution—in Myanmar or Elsewhere.***

A variety of geographic, economic, social, political and demographic characteristics influence choices regarding optimal primary, secondary and often hybrid and multidimensional electricity solutions. For example, a village may be lucky to be in a politically important area, such as Kyaukpyu and benefit from a government-led electrification initiative, while another may be just outside the reach of the grid extension mandate or located on an island or other difficult terrain that makes grid connection unfeasible. Another village may have the money collectively to connect to the grid but lack the leadership and cohesiveness needed to organize and meet the 24 conditions for grid connection, or vice versa. These differences must be addressed in conjunction with the availability of physical and financial resources and relevant time factors. While hybrid solutions were not explicitly addressed in the comparative cost calculations included in this study, given the immense additional

complexity it would entail, village-level recommendations did in some cases include such recommendations. The most notable example is the suggested use of solar as an auxiliary source to supplement small diesel micro-grids and/or to provide occasional backup and relief from the high cost of diesel.

## ***2. Rural Electrical Development in Myanmar Must Balance Optimal with Feasible.***

While steps need to be taken to advance rural electrification beyond installation of the least expensive generators, gasifiers and solar panels with no regard to quality, life-span or environmental concerns, one must also acknowledge the realities that exist in rural villages, and seek incremental and feasible improvements. That is one of the lessons of the Chaungthar hybrid facility, where cutting-edge technology was installed without sufficient attention to the ability of local caretakers to provide adequate operational and maintenance care. In other cases, project lifecycle costs may dictate a choice of solar or gasification but a lack of financing options prevents installation of these technologies over generators, which have lower initial costs but, with the price of fuel and O&M, prove more costly over the long term. That said, in terms of policies and guidance, it would appear best to promote progressive incremental improvement as well as knowledge dissemination. This is why the cost analysis conducted uses incrementally higher quality solar panels and equipment than what is commonly used in Myanmar, as the lower quality commonly found, requires lower up-front investment, but proves more expensive over the long term.

## ***3. Financial Considerations are Almost as Important as Technical Concerns.***

From a technical standpoint, achieving universal electrification in Myanmar is fairly straight-forward. With the development of the National Electrification Plan, consensus is emerging over the promotion of national grid extension to most of the nation by 2030. It also suggests auxiliary movement to utilize solar and other renewable technologies to provide interim power to rural and other areas that are either beyond the reach of the grid or which will be electrified in later stages.

Financing these plans, however, will prove challenging. While the country has a significant number of talented engineers, it is lacking in financial analysts, economists and the bankers who could help structure projects in a way that would be financially viable from the standpoint of foreign investors. Further, as yet there is no clarity whether funding for grid extension plans will come from grants, loans, rate increases or other sources. These financial challenges must be addressed as part of the broader electrification plans for Myanmar.

#### ***4. Maintenance, Efficiency and Operational Upgrades Are Low-Hanging Fruit.***

In the rush to add capacity, substantial attention is being devoted to development of new projects and installations in both urban and rural areas. Planning and funding these projects will require extensive engineering and financial resources. At the same time there is seemingly little effort being placed on the development of mechanisms to teach villagers how to better maintain and operate facilities that are already in place. This would help to reduce losses and ensure equipment remains operational and efficient over its maximum life span. Likewise some analysts believe simply replacing existing generators with more modern equipment could potentially double power output generated from the current energy supply. While transmission losses, partially due to antiquated power lines, stand at about 20%.

#### ***5. Electricity Solutions Can Come From Domestic Suppliers, Benefiting the Overall Economy.***

Upgrades and efficiency measures do not need to depend upon outside sources. To date, there has not been a thorough evaluation of Myanmar's in-country capacity to support electrification, including the manufacturing of engines, solar cells, boilers, pipework, instrumentation, cable, insulators, switchgear, transformers, and other equipment. Such manufacturing, in addition to benefiting electricity development and efficiency, can also play a role in creating jobs and boosting Myanmar's overall economy.



**6. *Improved Regulatory and Environmental Standards and Enforcement Are a Necessity.***

Myanmar lacks adequate regulations and standards, environmental and otherwise, as well as an ability to monitor and enforce adherence. This has negative consequences as it impinges on the development of a coherent and integrated system and the ability of the government to introduce incentives that encourage efficiencies and the use of technologies, such as gasification, which are potentially advantageous but create risks as toxic waste and other undesirable outputs are introduced into the environment. Even where standards do exist, as with those developed by the Myanmar Engineering Society, they are implemented on a voluntary basis. As a result, there is little provision for enforcement and oversight. In addition to ensuring greater health and safety, such regulatory provisions and guidelines and enforcement are necessary to encourage investment in the sector.

**7. *Convergence of Public and Private Sector on Policy and Strategy is Essential.***

The challenge of electrifying Myanmar, both in urban and rural areas, is immense and far beyond the scope of either the government or companies to achieve single-handedly. It is therefore critically important for the public and private sectors, both domestic and foreign, to work together to successfully develop policies that reward and facilitate private participation in the electricity sector. This includes independent power provision and power purchase agreements. In addition to clarifying legislation on these issues, adjustments may also be made to tariffs, microfinance laws, and other regulation to encourage a market-oriented approach that is less dependent on government directives. Passage of a Rural Electrification Act is also vital. There is also a need for public and private actors to engage in dialogue to minimize duplication of efforts and to facilitate the development of public-private partnerships. Toward this end, stakeholder meetings, such as those organized as part of this

initiative, which bring together government officials, private sector leaders and other energy and electrification experts, should be expanded and continued.

#### **8. *Distinguishing between Short- and Long-Term Concerns Is Vital.***

Myanmar must carefully consider its options as it determines future policies and plans to meet growing demand for electricity while balancing a mix of reliable and sustainable energy technologies and sources. Universal electrification through grid extension is the long-term goal for Myanmar, as envisioned by the World Bank and ADB. As outlined in the chart below, however, there are many stages involved in developing the grid system in a realistic and effective manner. In the short-term, off-grid solutions are also needed and must account for the possibility of eventually connecting off-grid sources to the grid system. Off-grid initiatives should also consider that certain villages, due to geographic or financial constraints, may not be able to economically connect to the national grid for the foreseeable future and thus require alternatives that are reliable, affordable and sustainable over the long-term. This is also one of the drivers why adoption of a Rural Electrification Act that can offer incentives and a structure to facilitate electrification activity on the village level.

<b>1. <u>Short-term:</u></b>	<ul style="list-style-type: none"><li>• Subject to cost, maintain power plants and distribution system that are already installed</li><li>• Subsidize diesel for high-speed diesel captive-power in exchange for a percentage of supply to the grid</li><li>• Renegotiate Chinese, Thai and other electricity export contracts to divert higher percentage for national supply</li><li>• Rent gas (CNG) or marine fuel-oil (MFO) fired reciprocating engines for decentralized power (note these have higher efficiency than gas turbines (GT) and require less infrastructure)</li></ul>
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	<ul style="list-style-type: none"> <li>• Where gas is available, rent trailer-mounted aero-gas turbines</li> <li>• Promote energy conservation (e.g. compact fluorescent light bulbs)</li> </ul>
<b>2. Medium-term:</b>	<ul style="list-style-type: none"> <li>• Install open-cycle gas turbines</li> <li>• Install mini-hydro in rural areas</li> <li>• Install high-voltage transmission to urban and industrial centers</li> <li>• Encourage industry to invest in efficient / reciprocating captive-power plant with a percentage for domestic consumers</li> </ul>
<b>3. Long-term:</b>	<ul style="list-style-type: none"> <li>• Maximize hydropower/coal reserves for base-load</li> <li>• Develop gas pipelines</li> <li>• Optimize use of natural gas resources, primarily for peak-logging during maximum demand</li> <li>• Minimize imported oil and coal</li> <li>• Evaluate the geothermal opportunity</li> <li>• Promote biofuels and other cost-effective renewables</li> </ul>

## **9. Adding Electrical Capacity Will Ignite Exponential Increases in Demand.**

Some analysts and government policymakers in Myanmar believe there is adequate capacity in the grid if line losses can be addressed and efficiencies realized. While this may or may not be true, it is in fact immaterial, as successful grid extension will ignite exponential increases in demand. Villagers, who were formerly content with a few lights run off a small generator, battery or solar panel will want television and those who currently have television will want rice cookers, and then refrigerators and more. These demand increases can be seen in the Kyaukpyu experience where villagers who formerly minimized consumption as access was limited and expensive, now enjoy 24-hour access to affordable electricity. This has increased consumption

not only on the consumer level but has also led to significant increases in industrial demand as seen in the emergence of water bottling and other factories. This means that planning must be done on projected rather than present demand.

#### ***10. Social Tensions Will Increase as Myanmar Intensifies Electrification Efforts.***

In the past, rural communities protested the existence of subsidized power in Yangon and Naypyitaw while they endured high off-grid pricing, due to a reliance on diesel, or insufficient electricity, absence of a grid connection and lack of reliable alternatives. As Myanmar steps up grid extension and other efforts and begins to successfully expand generation outside urban areas, this will begin to unleash measurable economic progress and momentum. It will also, however, bring the contrast between the “haves” and “have-nots” closer to home. In Kyaukpyu, for example, where 24-hour subsidized power is present to any individual with 2 lakhs (US\$200) that lives within 100 yards of the main power line, it will be difficult to avoid discontent among those who live 101 meters from the line and beyond. Even if the radius that is eligible for grid connection were widened it is clear that Myanmar cannot successfully expand access to every town and village at same time. This necessitates government emphasis on off-grid electrification plans in conjunction with ongoing grid extension initiatives. It also necessitates greater attention to community relations and public information campaigns that can help rural residents to better understand the process and how they will benefit over the longer-term.

#### ***11. Roles of Local vs. National Government Must Be Clarified and Defined.***

In addition to clarifying and codifying the role and ability of private entities to participate in the development of Myanmar’s electricity sector, more attention should be devoted to enhancing the ability of local governments to better define and respond to projects and electrification needs in their respective regions and communities. These local actors should also have the ability to obtain more input from the central government and to benefit from the synergies that can only be

achieved at the national level. According to an interview conducted with a regional chief minister, local government has generally been focused on implementation rather than project definition and planning. This is true not only between local and national representatives of MOEP and other Ministries, but also local and national administrators, different ministries and with the private sector. At the same time, being locally-based they are better able to assess local conditions and to respond to local needs. Therefore more interactive dialogue is advised.

## ***12. Electrification Enhanced Through Convergence of On- and Off-Grid Initiatives.***

Presently on- and off-grid development projects are viewed largely as discrete initiatives without regard to the potential for synergies and the enhancements that can be obtained if they were viewed as part of an integrated effort. For example, 90% of new household connections carried out under the National Electrification Plan will be grid-based, with about 250,000 connections expected to use “pre-electrification” solutions. This includes temporary mini-grids and off-grid solar home systems. While it may be too early and complex to begin developing a feed-in tariff and other policy measures that would facilitate financing and development of private and off-grid power, more emphasis could be introduced to encourage cooperation between on- and off-grid power. This includes the development of mini-grids and a grid connection standard, which encourages connection to the national grid down the road. This is in contrast to the current perception that off-grid electrification initiatives are largely temporary phenomena that are only necessary until full grid extension can be achieved.

## ***13. Tariff Reform is Vital to Realize Myanmar’s Economic Objectives.***

Grid extension is very difficult with the present tariff structure whereby MOEP is faced with the challenge of increasing capacity for a product that is then sold at a loss. The investment plan for the National Electrification Plan suggests the financing

gap for the grid roll-out can be eliminated by raising tariffs to the levels of Vietnam. These are in the range of MMK 95 to MMK 100 per unit, a roughly three-time increase over Myanmar's current residential rates. Reducing subsidies is not an easy task, as any increase in tariffs results in political backlash. The current tariff structure is also problematic from a private sector perspective. It is believed there is no shortage of investors with an interest in Myanmar's power sector, however, currently companies need to plan off-grid sources largely as captive power. Financing and planning is therefore based strictly on demand forecasts of the particular project in question. By contrast, if it were possible to sell excess power back to the grid at even breakeven prices, it would minimize development risk. The current system of tariffs and subsidies must also be overhauled to meet rising demand from residential users and to encourage industrial consumption at higher rates. One option might be to consider an increase in overall tariffs with a percentage of increase reserved for rural electrification. This type of system, similar to Japan's Electric Power Generation Promotion Law, calls for a charge on electricity production to be used for research and development, plant siting and other uses.

## **B) COST/FACTOR/TECHNOLOGY ANALYSIS CONCLUSIONS**

### **SOLAR**

#### ***1. Solar Home Units Most Suitable for Small, Isolated Villages with Low Demand.***

Scalability factors work against solar as village size and demand increases. Solar home systems seem best suited for relatively poor villages of about 100 households or less with minimal demand. Even though the installation costs are higher than with generators and gasifiers, cost differentials can be addressed within approximately one year when considering the cost of fuel and O&M. This, however, does not account for financing costs.

#### ***2. Pros of Solar Home Units as Primary Energy Source Less Clear in Larger Setting.***

While use of solar home systems also provides potential benefits in larger settings of either villages with more than 100 households and/or those whose income dictates larger consumption/demand, these benefits are eroded by the lack of scalability of this platform. This results in a higher price differential when compared to the costs of installing a generator or gasification facility. While it is arguable that the added costs can be amortized over several years, given the high cost of diesel and other inputs, this does not account for financing costs. In Myanmar this can total 30% annually in a microfinance setting. Irrespective, most villages, which lack initial capital in any case, will not seek to finance the added costs over this longer period of time.

#### ***3. Solar Home Units Help Address Needs of Villages Lacking Social Cohesiveness.***

Grid extension and micro-grid development require organization and cohesiveness, while solar home systems can be installed on an individual basis. For villages that lack leadership or the ability to organize collective payment schemes, and for which

demand is low, solar home units can be an ideal solution to household electrification needs.

#### ***4. Solar Home Units Can Provide Benefits as Auxiliary Power Source.***

Even in larger settings where economic factors favor generators and gasifiers over solar home units as a primary energy source, solar home units can play a valuable auxiliary role. That is because generators and gasifiers commonly used in villages and rural settings run for only two to three hours per night to provide power over the entire micro-grid. Therefore, any individual or commercial use during other times requires auxiliary provision through platforms such as solar home systems.

#### ***5. Future Study Can Determine Potential Scalability Benefits of Solar Farms.***

Solar home systems were chosen as the basis for analysis as this is the commonly used platform for solar in Myanmar. This contrasts to generator sets and gasifiers that utilize a micro-grid approach. Future study needs to be conducted to determine the differences between utilization of solar home units and a solar farm/mini-grid platform to determine potential benefits and whether solar farms/mini-grids can address some of the scalability issues seen with home units.

### **Mini-Hydro**

#### ***6. Mini-Hydro Installations Dependent on Identification of Viable Energy Source.***

Myanmar is clearly rich in hydropower potential, but this energy source is site specific. Installation of viable facilities requires identification of an adequate energy source. This generally requires locating the generating facility close to the point of consumption, and this can be a challenge in rural environments. Otherwise, with lengthy transmission distances, one runs into the same costs with mini-hydro that can make grid extension an expensive and technically challenging proposition.



**7. *Attractiveness of Mini-Hydro Impinged by Need for Up-Front Engineering.***

Identification of a viable energy source creates a need for up-front engineering and feasibility studies. This can be costly and time intensive and makes it difficult to utilize in a rural electrification context, except in special cases. That is because villages lack the financial resources and knowledge needed to initiate the advanced work that must be initiated before an installation can be planned and considered. This is very different from larger hydro projects, where there is sufficient scale for engineering services. At the same time it is also different from micro-hydro, where trial and error siting can be initiated to find optional locations, allowing small turbines to be placed next to viable water sources to generate power for individuals, or small groups of households.

**8. *Mini-Hydro Usually Generates Capacity Beyond Needs of Single Towns/Villages.***

As mini-hydro installations often have generating capacity beyond the need of individual towns or villages, the high up-front costs associated with mini-hydro development could be offset if a group of towns/villages joined together to achieve sufficient scale. This creates greater need for input from national, regional and local government and other entities that can encourage, coordinate and facilitate this activity. This is another process where regulatory guidance could assist, as opposed to leaving it up to the leadership abilities of village heads or the cohesion of villagers.

**9. *Mini-Hydro Generation Can Vary Significantly Depending on Seasonal Factors.***

Another challenge of mini-hydro is that its feasibility varies considerably between the rainy and dry season. This problem is borne out on a national level as the grid, which is highly dependent on hydropower plants, suffers supply inadequacies during the dry season. This is particularly difficult for rural agricultural areas where demand for irrigation is highest during the dry season.

## **10. Mini-Hydro More Sensitive to O&M Than Other Platforms.**

Small mini-hydro projects, with the exception of individual micro-hydro projects, require a basic level of maintenance that place the resource beyond the reach of, and makes it less viable for, individual towns and villages and even small groups of towns and villages. Lacking the scale of larger installations they are even more expensive on a relative basis. This underscores the importance of greater technical training and capacity building around O&M.

### **Generators**

## **11. Generators Key to Rural Electrification Despite High Diesel Costs.**

Despite having the highest O&M costs of all technologies examined and potential environmental consequences, generators rated second highest by a wide margin in the factor analysis conducted. Generators also represented the optimal “market” solution in areas such as Dawei and Kyaukpyu, although electricity rates are high. In the case of PTC, an independent power provider in Myoma, and which operates in the area near Dawei and also in Rakhine State, rates are MMK 490 per unit.

## **12. Generators Not Only Rate High but Second Lowest Deviation of all Platforms.**

Whereas Grid Extension, Mini-Hydro and Gasifiers are very dependent on the unique factors of a particular village, Generators can be more widely deployed. Therefore they rated the second highest both in terms of positive responses but also in terms of second lowest deviation across all sites visited, showing strength in all factors examined.

Summary of Comparative Factor Analysis for Fieldwork Site Visits

Solar Home System	Grid Extension	Hydro Mini-Grid System	Gen-set Diesel Mini-Grid System	Gasifier Mini-Grid System
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<b>Tha Yet Taw</b>	46.5	19.5	12	41	26
<b>Kyar Kan Daung</b>	46	24	14	45	34
<b>Aung Mingalar</b>	45.5	14.5	8	42.5	26.5
<b>U To</b>	45	24.5	15.5	46.5	27
<b>Mezali</b>	46.5	34	14	44.5	45.5
<b>Za Di Ya</b>	45	52	15	44.5	31.5
<b>War Taung</b>	44.5	19	12	41	32
<b>Myoma</b>	46.5	35	33.5	48	36.5
<b>Mu Du</b>	45.5	21.5	13.5	45	32.5
<b>Total</b>	411	244	137.5	398	291.5
<b>Average</b>	45.67	27.11	15.28	44.22	32.39
<b>Standard Deviation</b>	0.75	11.51	7.19	2.36	6.09

### **13. Benefits of Generators Erode Over Time with High Fuel Costs.**

While generators cost less in terms of capital costs, any cost savings quickly erode when one factors in the high cost of diesel, as seen in the following charts. Given the lack of financing options and low levels of savings, many villages may opt for diesel despite higher cost over the long term, as it may be seen as the only option for increasing capacity within available resources.

**Total Estimated Cost Comparison of Capital Costs with Generators**

<b>Village Name</b>	<b>Solar</b>	<b>Gasifier</b>	<b>Generator</b>	<b>Grid Extension</b>
Tha Yet Taw	125%	115%	100%	1498%
KyarKan Daung	170%	114%	100%	1482%
Aung Mingalar	194%	123%	100%	3452%
U To	235%	123%	100%	1868%
Mezali	312%	133%	100%	538%
Za Di Ya	399%	124%	100%	31%
War Taung	226%	118%	100%	1037%
Myoma	442%	132%	100%	3838%
Mu Du	449%	122%	100%	4161%
Average	284%	123%	100%	1989%

**Total Estimated Cost Comparison of Annual O&M Costs with Generators**

<b>Village Name</b>	<b>Solar</b>	<b>Gasifier</b>	<b>Generator</b>	<b>Grid Extension</b>
<b>Operating Hours</b>	<b>6</b>	<b>3</b>	<b>3</b>	<b>24</b>
Tha Yet Taw	2%	87%	100%	43%
KyarKan Daung	2%	76%	100%	50%
Aung Mingalar	2%	68%	100%	56%
U To	1%	64%	100%	58%
Mezali	1%	57%	100%	63%
Za Di Ya	1%	52%	100%	66%
War Taung	2%	61%	100%	60%
Myoma	1%	51%	100%	66%
Mu Du	1%	51%	100%	66%

***14. High Cost of Generators Accentuated Due to Inefficient Wiring and Lack of Maintenance.***

Despite the high cost of diesel, the overall O&M costs associated with generator use would be substantially reduced if proper care were given to the equipment. Many instances were witnessed of poor wiring and inefficiencies that led to power losses, as well as improper care that required equipment to be repaired and replaced more often than would have otherwise been necessary.

**Gasifier**

***15. Gasifiers Attractive but Complicated by Environmental Concerns.***

Gasifiers make sense in theory given Myanmar's rich agricultural resources and abundant rice husks. Pollution, however, is a real concern, and it is estimated more than 1,000 facilities were installed with little regard to toxicity and environmental degradation. Now they are being developed in more populous and higher income areas, where the environmental impact is more noticeable. There are complaints and this issue needs to be addressed. That will be difficult given the reluctance of

developers to bear the extra costs associated with more environmentally friendly technology, and the difficulty of achieving oversight and enforcement.

***16. Gasifiers Need More Operational and Maintenance Care than Alternatives.***

Gasifiers require constant care from the provisioning of rice husks to the monitoring and maintenance of equipment. That is beyond the capacity of most villages, particularly from a technical standpoint. Electrification through gasification was, however, seen as successful in Pathein, where the facility was run by the Ministry of Agriculture. Therefore O&M was not the village's responsibility.

***17. Gasifiers Viable in Coordination with Rice Mills and Producers of Feedstock.***

There were successful examples of gasifiers owned and operated by rice mills, and which provided electricity to villages seen in fieldwork visits. One such example was located in Nayaung, roughly 45 km northeast of Tachileik in Shan State. In addition to powering the rice mill operations, it is also connected to a reported 100 meters. One obstacle, however, which was seen in Mezali, which has two rice mills, is that rice mills operate during the day and villages need electricity in the evening. Rice mills tend to be reluctant to add staff or increase the maintenance requirements necessary for longer operations.

***18. Gasifiers Can Provide Significant Savings Through Reduced Diesel Costs.***

Due to the high cost of diesel, compared with the much less expensive, and sometimes free, feedstock used in rice husk gasifiers, the cost savings of gasifiers are significant. According to the Team's analysis, detailed in the chart below, the annual O&M costs associated with gasifiers can be nearly half that of diesel generators, particularly in areas with high demand.

Comparative Estimated Village Gasifier/Generator Annual Operating & Maintenance Costs
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Village Name	# Households	Tot. Demand (KW)	Gasifier	Generator	Gas/Gen
Tha Yet Taw	48	9	\$5,795	\$6,663	87%
Kyar Kan Daung	72	15	\$7,178	\$9,429	76%
Aung Mingalar	110	24	\$9,402	\$13,877	68%
U To	120	32	\$11,172	\$17,417	64%
Mezali	94	70	\$20,143	\$35,359	57%
Za Di Ya	520	269	\$66,874	\$128,821	52%
War Taung	161	41	\$13,190	\$21,452	61%
Myoma	600	421	\$102,509	\$200,091	51%
Mu Du	700	352	\$86,345	\$167,763	51%

***19. Gasifiers Can Utilize Alternative Feedstocks but Need Testing and Pilot Studies.***

Myanmar holds significant potential in terms of waste-to-energy as well as a range of other feedstocks, due to its large supplies of fish, coconuts and other potential sources. Despite the numerous possibilities, the actual viability of the sources is largely unknown in Myanmar and need to be tested and subjected to pilot projects.

**Grid Extension**

***20. Grid Extension Clearly Optimal Though Beyond Reach of Most Villages.***

Grid extension provides 24-hour electrification, dramatically raising quality of life and economic activity. However, it also requires a huge investment in up-front capital costs not only on the national, but also the local level. This is beyond the reach of most villages by themselves. That makes the adoption of a Rural Electrification Act imperative, as it would establish clear goals in respect to, as well as mechanisms to facilitate, rural electrification and the governance and financing mechanisms necessary to achieve them.

***21. Grid Extension Requires High Social Cohesion Given Current Policies.***

While it is the role of MOEP to provide power to the township level, it is generally up to villages to fulfill the 24 conditions for grid connectivity and raise comparatively high levels of capital to fulfill the “self-help” requirements to successfully connect to the grid. This requires a high level of social cohesion, which is beyond the abilities of most villages. Where individual connections become possible, however, as was seen in Kyaukpyu, most households participate.

## ***22. Grid Extension Is Dependent on Availability of Financing Mechanisms.***

Connecting to the grid on a village level also requires significant capital, which is not readily available, particularly in remote, rural areas. There is currently no uniform financing mechanism for grid connection that might facilitate the process. Where such options are available, they tend to be with terms of one year. This means there is no ability to pay from cash flow. Compounding the situation, interest rates for microfinance can be as high as 30%, which is prohibitive. A Rural Electrification Act could provide for appropriate financing and loan mechanisms. This proved crucial to achieving rural electrification in other countries, including the United States.

## ***23. Grid Extension Best Connected to Off-Grid, Not as Parallel System.***

Off-grid electrification initiatives need to be carried out in conjunction with long-term goals related to national grid extension, and should not be seen as isolated initiatives. Instead the same national standards that apply to grid extension should be ensured in the form of a grid connection code so as to eventually allow and encourage connection of off-grid and captive facilities to the national grid. This would lower the cost of grid connection as well as the ability to finance these developments. Likewise, there should be coordination to facilitate electricity access in locations that may be near to grid extension initiatives but unable to connect due to geographic, financial or other constraints.

## ***24. Grid Extension Initiatives Are Highly Dependent on Tariff Levels.***

While the development of off-grid and mini-grid electrification alleviates some of the burden that government subsidies for grid-generated power places on MOEP, over the long-term Myanmar's tariff system will need to be addressed to make grid extension and the connection of mini-grids more feasible. This may require a politically unpopular rate increases and development of commercial and industrial users who can pay a higher rate and to some extent subsidize residential use.



## **C) INSTITUTIONAL CONCLUSIONS**

### ***1. Capacity Development Needed to Match Intentions to Implementation.***

While there is often criticism over the government's intentions, extensive meetings with Ministries and private companies demonstrates definite commitment and good intentions but an evident lack of capacity and ability to define, plan, finance and manage projects on the scale required. This is true in government as well as in the private sector and applies to the way institutions are structured and the overall decision-making process. It also applies to the professional level in terms of technical know-how. Training is vital to overcoming these challenges.

### ***2. Intra-Ministerial Coordination Is Crucial to Effective Policy Making.***

Greater coordination among ministries is imperative to more effective policymaking. At present, it is difficult for ministries to communicate and coordinate internally between different levels and departments, and even much more difficult to do so across different ministries and institutions. While the establishment of two coordinating bodies, the National Energy Management Committee and National Energy Development Committee, are major steps in the right direction, these committees will need to become institutionalized and structured so they can manage the ongoing implementation process. This potentially includes a secretariat or officials who can help to maximize intra-ministerial coordination, including project reviews to minimize duplication. This body could also be used as a central clearinghouse to facilitate knowledge-sharing and implementation of projects in the electricity sector. This includes development of public-private partnerships and foreign direct investment.

### ***3. Political Will Is an Important Component of Effective Policy Making.***

Just as strong leadership on the village level is important for areas that seek to connect to the national grid, leadership is also important at the highest levels of national government. This goes for both national grid extension and rural electrification initiatives. Particularly evident in Kyaukpyu, a presidential directive brought affordable, 24-hour electricity to a region that previously suffered from high electricity prices, irregular and insufficient access and social unrest. Not all initiatives, however, must come from the President's office, but can also be initiated at other levels.

#### ***4. Regulatory Guidance Must Accompany and Enhance Political Will.***

Political will should not be based purely on individual personalities and charisma, or one-time stand-alone initiatives, such as the Kyaukpyu mini-grid. There is a need to codify as much as possible into longer-term and definitive regulatory guidance and mechanisms, such as a Rural Electrification Act and complementary policies that lay out clear goals for electrification and which establish an institutional framework for implementation. Legislation should encompass: definitions of rural electrification and standards for when a village is considered electrified; targets for the percentage of the rural population and number of villages or districts to be electrified by a certain date; strategy and goals for rural electrification; administration and governance structures; long-term budget; provisions on theft of electricity; financing and loan assistance; involvement and management of the private sector; maintenance and warranty; tariffs; and monitoring and quality check. Electrification goals should also be integrated into five-year plans and other supporting legislation.

#### ***5. Roles of National and Regional Government Must Be Better Coordinated.***

Just as better coordination is needed at a national level, the roles of national and local governments must be better-defined and coordinated to match policy with implementation. This will help balance local knowledge and responsiveness with the potential scale and synergies achievable at the national level. It will also allow local

needs and priorities to become integrated into a national framework. Codifying these various roles and responsibilities may also make villages less dependent on the individual personalities of village leaders in terms of their ability to organize and finance grid connectivity.

**6. Greater Coordination Among Government, Private Sector and International Agencies Is Necessary.**

The Myanmar Government cannot achieve universal electrification single-handedly. A number of parallel, independent electrification projects are ongoing, with the help of donor organizations and private sector actors. There is a need to explore how these projects overlap and can eventually converge with planned grid expansion. A number of projects have also been held up due to a lack of adequate legislation defining private sector involvement in electrification. Ministries should seek to structure themselves in a way that allows for easier communication and coordination with the private sector so as to incorporate the concerns of businesses and investors into its policy frameworks. Likewise, ADB, World Bank and other actors involved in policy advisory support should reinforce efforts to fully coordinate with all branches of Myanmar government and other key stakeholders. Stakeholder dialogues will facilitate this interaction.

These Phase II conclusions and recommendations, have been updated to reflect discussions with, and comments and concerns given by, various internal and external stakeholders, as well as to add reflections based on attendance at donor and other workshops, conferences and presentations.

## **OVERVIEW: PHASE III FIELDWORK AND SHAN STATE**

The fieldwork and analysis undertaken and the conclusions generated by the Team during Phases I and II have led to a basic definition and understanding of the issues surrounding the first two of the three themes identified by the Team—grid extension and off-grid electrification initiatives. As a result, the Team shifted its focus during Phase III to the third theme, cross-border electrification. This was found to play an key role -- not only in terms of regional integration -- but in considerations on grid extension and off-grid electrification initiatives and policies as well.

During Phase III fieldwork, the Team carried out a review of the dynamics that underlie, and Myanmar's role in maximizing the benefits of, regional energy integration within the Association of East Asian Nations (ASEAN) and the Greater Mekong Subregion (GMS).

### **Map of Shan State and Surrounding Region**



**Source: DPmac**

Fieldwork conducted during this period focused on Shan State, a critical nexus where Myanmar, China and Thailand converge, and which possesses abundant and largely untapped hydro resources. Development of this region is vital, not only for Myanmar's domestic needs, but to support energy-intensive growth of the ASEAN region as a whole.

Historically a net exporter of natural gas and other energy resources, Myanmar is now under pressure to meet rapidly increasing domestic demand. As a result, it has taken steps to renegotiate contracts with China and Thailand. In some cases, up to 90% of the output generated by power projects in Myanmar has been exported to these two countries. Enhanced energy integration in ASEAN, however—which, according to the World Economic Forum, possesses "229 GW of potential hydropower generation annually, about 1.2 billion cubic meters of proven reserves of natural gas, 28 billion tons of coal, and 0.82 billion tons of oil"—would mean cost savings for importers, opportunities for exporters, emissions reductions and greater overall energy efficiency and security for the region.<sup>4</sup>

Regional energy integration is also crucial to recognizing Southeast Asia's economic potential and implementing economic integration initiatives under the ASEAN Economic Community (AEC). Maintenance of a stable, secure energy supply is a critical component in attracting foreign investment and developing manufacturing activities. In addition to ensuring Myanmar's domestic needs, upon full integration, the AEC is expected to add between US\$280 billion to US\$625 billion to total annual GDP for the ten ASEAN states.<sup>5</sup>

### *Importance of Shan State: Addressing Challenges and Opportunities for Regional Energy Integration*

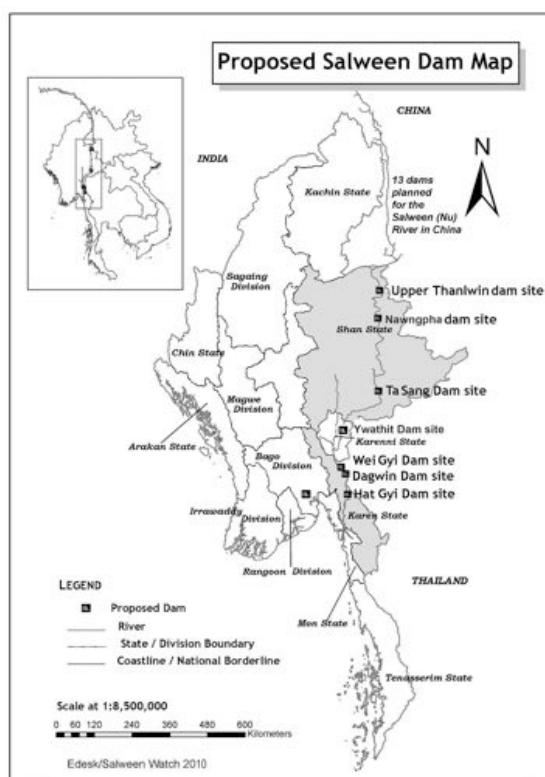
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<sup>4</sup> World Economic Forum (in collaboration with Asian Development Bank and Accenture), *New Energy Architecture: Myanmar*, 2013

<sup>5</sup> Kishore Mahbubani and Fraser Thompson, [Unlocking ASEAN's Potential](#), Project Syndicate, December 19, 2014

In addition to the effects and implications seen through the close integration of North Shan State with China in its border areas and the multiple grid lines which extend from China into Myanmar for 50+ miles, planned hydro projects approved along the Thanlwin River (also known as the Salween in Thailand and the Nu in China), which runs through Shan State, are alone said to account for up to 15,000 MW of hydro potential. These grid extensions have led to heightened economic activity and quality of life, and planned hydro initiatives are slated to be developed with the involvement of Chinese and Thai companies.<sup>6</sup>

### **Proposed Thanlwin (Salween) Dam Map**



**Source: Salween Watch**

The balance between electricity inflows from China, the proportion of energy generated from existing and planned hydro projects allocated for export, as well as the share of revenues that leave the country, will have significant political ramifications, as will the

<sup>6</sup> [Briefing: Current Status of Dam Projects on Burma's Salween River](#), Salween Watch, March 13, 2013

means by which electricity is managed in Special Administrative Regions. Understanding and resolving these issues will impact Myanmar's ability to meet the needs of its citizens, whose expectations for improved living standards are rising rapidly. It is also critical to developing industry, which is anticipated to help Myanmar triple its GDP, create jobs and improve overall social and economic development.

Beyond technical concerns, however, significant political, social and environmental hurdles must be carefully understood and analyzed before progress can be made toward developing this region's potential and vast resources. In addition to industrial development, this includes resolving ethnic conflict, the displacement of communities and preserving eco-systems and livelihoods of local farmers and fishermen.

Shan State is home to approximately 30 ethnic groups, many of which have participated in ongoing, often armed conflicts for many decades. Significant territory remains out of the control of the central government and complaints have arisen that development of energy projects has led to increased militarization and human rights abuses, as well as problems due to the relocation and displacement of local communities.

Projects in Dawei, Thilawa and other areas have been criticized for allegedly failing to adequately address social and environmental impact. Similar concerns have caused indefinite delays in creating new energy resources as well as the industries and facilities vital to increasing employment and higher living standards in Myanmar. Such uncertainty is also harmful as local communities in these areas must wait for decisions over long periods of time. In the interim, they are unsure of how to plan for their future, if they will be displaced, and how compensation issues will be addressed.

Given Shan State's proximity to China, Thailand and Laos, it is also vital to consider the political ramifications of these projects. In prior field research, the Team found politics had interfered in cross-border electricity supply agreements between Thailand and Myanmar. Similarly, in North Shan State there are areas that, despite receiving adequate power from China-supplied grid connections, are now being shifted to Myanmar supply at subsidized rates due to political factors. This requires MOEP to

operate at a loss and diverts power from areas that are not presently connected to the grid. Depending on the needs of these constituencies, certain villages are seeking this cheaper subsidized power, while large-scale and industrial projects are reluctant to switch, or rely too heavily on Myanmar-supplied power, given the Myanmar grid offers less capacity and irregular supply.

### **Local Ethnic Groups in North Shan State**



**Source: KWR International**

In addition to these myriad challenges, understanding electricity distribution systems within Shan State is vital, given the presence of three countries' national grids, as well as self-administered zones, where national regulations on electricity tariffs and public-private partnerships do not necessarily apply. Even more problematic, the calculus between these groups as well as associated challenges and factors can change quickly, making it hard to create reliability and long-term plans.

Based on the Team's observations, a series of conclusions, which are explained in greater depth following the case studies, were developed. In sum, the Team believes that policies surrounding regional energy integration require a careful examination of external and domestic concerns and must balance political and economic issues. While



a history of inequitable distribution and domestic neglect has tainted the populations' views on energy exports, there is no reason Myanmar cannot benefit from the export of certain resources and invest revenues in the development of the national grid as well as off-grid renewable electrification initiatives.

In addition, while much of the present research concerning ASEAN energy integration focuses on Myanmar's role as an exporter, the Team's research in Shan State clearly demonstrated the value cross-border transmission brings to Myanmar. At present, reliable and affordable energy—despite being more expensive than subsidized power—contributes to underpinning relatively strong social and economic growth in Myanmar's periphery. In North Shan State, the Team found, in fact, that connecting off-grid populations to neighboring country grids was a core element of rural electrification strategies. More lax regulations in these areas over privatization, tariffs and foreign involvement in the power sector has also allowed for more rational operating environments and greater opportunities for profit. Electricity markets, as a result, have had the capacity to upgrade equipment, add capacity and connect new users much more efficiently than the national grid, to the benefit of both residential and industrial consumers.

As with rural electrification, there is no one-size-fits-all blueprint for regional energy integration. To maximize the benefits of Myanmar's vast natural resources for the nation itself and the surrounding region, the Myanmar government and other interested parties will need to ensure better coordination between electrification policies and rural development policies. Solutions to the significant limitations in data collection and coordination and the need for regulations that ensure social and environmental concerns related to electrification are addressed along with political and financial issues are also important.

To gain a broader understanding of cross-border electricity relationships in Myanmar, with an emphasis on electrification initiatives between China and Myanmar, KWR spent substantial time working to obtain the multiple approvals needed from the regional Chief Minister, internal immigration and state security necessary to organize a fieldwork trip to North Shan State and several border and other areas that are generally difficult to visit.

After successfully obtaining these approvals, the Team traveled to Taunggyi, the capital of Shan State, to meet with the Chief Minister and other key officials to present the Team's past work and its objectives for this phase of the research. The Chief Minister's office also provided important information on the state's demographics and plans for electrification and assisted in facilitating additional visits and interviews in Shan State.

The Team then traveled to **Lashio**, a town in North Shan State with significant Chinese trade and influence, **Muse**, located on the Myanmar border with China's Yunnan Province, and **Laukkai**, capital of the Kokang Self-Administered Region that also shares a border with China. In addition to these larger cities, the Team visited and profiled four unique villages: **Yay War**, an off-grid village located near substantial water resources; **Mauhit**, a very poor off-grid Kachin community with little electrification; and **Nam Pak Khar** and **Ho Saung**, two villages purchasing power from Chinese suppliers.

### **Security Checkpoint Outside Taunggyi**



**Source: KWR International**

The Team also conducted dozens of interviews with key individuals in cities, towns and villages. This included village heads and electrification committee chairs, officials from local MOEP and MLFRD offices, independent power providers, industrial actors and project developers. The Team also visited several hydropower facilities in Shan State, some that were still under development. Case studies and details regarding these visits are included within this report.

## **MYANMAR'S GROWING IMPORTANCE TO REGIONAL ENERGY INTEGRATION**

The Asian Development Bank (ADB) began promoting energy trade and grid interconnections in the Greater Mekong Subregion (GMS)—comprising Cambodia, Laos, Myanmar, Thailand, Vietnam and China's Guangxi Zhuang Autonomous Region and Yunnan Province—in 1992, as a means of sharing the benefits of rich, yet unevenly distributed, resources. According to ADB, the GMS—encompassing 2.6 million square kilometers and a total population of roughly 320 million<sup>7</sup>—contains "229 gigawatts (GW) of potential hydropower generation annually, about 1.2 billion cubic meters of proven reserves of natural gas, 28 billion tons of coal, and 0.82 billion tons of oil."<sup>8</sup>

The World Energy Council further noted, in 2007, Myanmar alone accounted for approximately 2 million tons of coal resources, 447.7 TCF of natural gas, 206.9 million barrels of oil, and 100,000 MW of hydropower potential, less than 10% of which is presently being utilized.<sup>9</sup> The country's coal resources, however, are low quality and not easily transportable, thus are not considered a highly viable energy source.

Although bilateral energy agreements have existed between ASEAN member countries for decades, beginning in 1966 with an agreement between Thailand and Laos, it is reported that very little energy trade took place in the subregion prior to the 1990s.<sup>10</sup> As Southeast Asia moves toward economic integration with the creation of the AEC in 2015, the ASEAN Plan of Action for Energy Cooperation (APAEC), signed in 2007 as part of the AEC Blueprint 2015, calls for the establishment of a regional power grid and gas pipeline connecting all ten ASEAN countries.

With the broad objective of meeting the needs of rapid and energy-intensive growth in ASEAN, APAEC aims to assist with diversification of the region's energy supply. This is being done with an eye toward limiting green house gas emissions and protecting

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<sup>7</sup> Asian Development Bank, *Building a Sustainable Energy Future: The Greater Mekong Subregion*, 2009

<sup>8</sup> <sup>8</sup> World Economic Forum (in collaboration with Asian Development Bank and Accenture), *New Energy Architecture: Myanmar*, 2013

<sup>9</sup> Ibid.

<sup>10</sup> Adoracion M. Navarro and Maxensius Tri Sambodo, *The Pathway to ASEAN Energy Market Integration*, Discussion Paper Series NO. 2013-49, Philippine Institute for Development Studies

ASEAN member states as best as possible from the effects of climate change. It also seeks to establish an efficient, transparent, reliable and flexible energy market in the region.

### Program Strategies and Division of Tasks under APAEC 2010-2015

Program Area	Strategies	Ownership
1. ASEAN Power Grid	<ul style="list-style-type: none"> <li>Accelerate the development of the ASEAN Power Grid Interconnection projects</li> <li>Optimize the generation sector vis-à-vis the available indigenous energy resources in the region</li> <li>Encourage and optimize the utilization of ASEAN resources, such as, funding, expertise and products to develop the generation, transmission, and distribution sectors</li> </ul>	HAPUA
2. Trans-ASEAN Gas Pipeline	<ul style="list-style-type: none"> <li>Collectively implement the ASEAN MOU on TAGP by ASCOPE Members</li> <li>PERTAMINA and PSC Partners to undertake detailed feasibility study for East Natuna Gas Field Development</li> <li>Implement the approved Roadmap for TAGP by respective ASCOPE Members</li> <li>Implement the approved 5-year ASCOPE Gas Centre (AGC) Work Program</li> </ul>	ASCOPE
3. Coal and Clean Coal Technology	<ul style="list-style-type: none"> <li>Strengthen Institutional and Policy Framework and build an ASEAN Coal Image</li> <li>Promote Coal and Clean Coal Technologies</li> <li>Promote Intra-ASEAN Coal Trade &amp; Investment</li> <li>Enhance environmental planning and assessment of coal projects</li> </ul>	AFOC (ACE as Secretariat)
4. Energy Efficiency and Conservation	<ul style="list-style-type: none"> <li>Develop Energy Efficiency Policy and Build Capacity</li> <li>Enhance awareness raising and dissemination of information</li> <li>Promote good energy management practices, especially for industrial and commercial sectors</li> <li>Facilitate Energy Efficiency Financing</li> </ul>	EE&C-SSN (ACE as Secretariat)
5. Renewable Energy	<ul style="list-style-type: none"> <li>Increase the development and utilization of RE sources to achieve the 15% target share of RE in ASEAN power generation mix</li> <li>Enhance awareness and information sharing and strengthen networks</li> <li>Promote intra-ASEAN cooperation on ASEAN-made products and services</li> <li>Promote renewable energy financing scheme</li> <li>Promote the commercial development and utilization of biofuels</li> <li>Develop ASEAN as a hub for renewable energy</li> </ul>	RE-SSN (ACE as Secretariat)
6. Regional Energy Policy and Planning	<ul style="list-style-type: none"> <li>Enhance energy policy and supply security information sharing network</li> <li>Conduct capacity building in energy and environmental policy planning and energy supply security assessment</li> <li>Prepare regional energy outlooks and conducting ASEAN energy policy reviews and analysis series</li> <li>Strengthen collaboration and dialogues with ASEAN partners and with national, regional and global institutions</li> <li>Monitor and evaluate the progress of APAEC programs</li> </ul>	REPP-SSN (ACE as Secretariat)
7. Civilian Nuclear Energy	<ul style="list-style-type: none"> <li>Conduct capacity building among ASEAN Member States</li> <li>Strengthen public information and public education on nuclear power generation</li> <li>Strengthen institutional, legal and regulatory capacities on nuclear energy for power generation</li> </ul>	(ACE as Secretariat)

Source: ASEAN Centre for Energy

Energy integration in the GMS is expected to reduce dependence on imports from outside the subregion, lower overall costs of generation and drive efficiency and productivity in the energy sector. Total discounted energy costs for the GMS are

estimated at US\$200 billion, or 19% of total energy costs,<sup>11</sup> while a fully integrated ASEAN is expected to result in 3 percent savings in carbon emissions.<sup>12</sup> In addition to lower tariffs for countries with high demand, energy integration presents revenue-generating opportunities for exporting countries.

By 2010, total electricity trade in GMS had reached 34,139 GWh.<sup>13</sup> Currently, Thailand is the largest importer of energy in the subregion, while Myanmar is among the region's three net exporters, along with Laos and China.<sup>14</sup>

### Electricity flows in the GMS

Large-scale flows
From Cambodia to Thailand
From Cambodia to Viet Nam
From Myanmar to Thailand, and
Between Yunnan and Viet Nam (both directions)
From Lao PDR to Thailand
From Lao PDR to Viet Nam
Small-scale flows
Between Viet Nam and Guangxi
Between Viet Nam and Cambodia
Between Viet Nam and Lao PDR
Between Lao PDR and Cambodia
Between Lao PDR and Yunnan

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.

**Source: Castalia Strategic Advisors**

Myanmar's status as a net exporter of energy has political ramifications given the lack of sufficient domestic energy supply. Steps have been taken by President Thein Sein's

<sup>11</sup> Asian Development Bank, *op.cit.*

<sup>12</sup> Economic Consulting Associates, *The Potential of Regional Power Sector Integration: Greater Mekong Subregion, Transmission & Trading Case Study*, January 2010

<sup>13</sup> World Economic Forum, *op.cit.*

<sup>14</sup> *Ibid.*

administration to shift the country's energy output in favor of domestic consumption, and the government is under pressure to renegotiate contracts with China and Thailand to allocate a greater share of hydropower and gas to domestic needs. This pressure is only mounting as the nation moves toward the development of several hydropower projects in Shan State, some of which are scheduled to export up to 90% of energy to neighboring countries. At the same time, Myanmar's lack of sufficient electrical generating capacity is also of critical importance and compounds any input shortage.

This has been a politically salient issue for Myanmar given that revenue brought in from energy exports under the previous regime was not invested productively in domestic development or electricity needs. This has led to current resistance toward energy exports, although export contracts are potentially viable and perhaps essential to developing and financing the energy projects needed to satisfy both foreign/regional and local demands for greater capacity.

Between 2008 and 2011, China imported nearly 5 billion kWh of electricity from two dams in Myanmar.<sup>15</sup> Chinese imports of Myanmar natural gas began in 2013 with the completion of the Shwe natural gas pipeline. Oil imports are expected soon through a parallel line that runs from Rakhine State to Yunnan Province.

Thailand, according to its Power Development Plan, will purchase 5,099 MW of power from neighboring countries between 2012 and 2030.<sup>16</sup> Natural gas exports to Thailand, which currently account for approximately 70% of Myanmar's natural gas output, are expected to increase with new operations in the Zawtika gas field.<sup>17</sup>

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<sup>15</sup> China National Energy Administration, China National Renewable Energy Centre, China's 12<sup>th</sup> Five-Year Plan for Renewable Energy Development (2011-2015)

<sup>16</sup> Summary of Thailand Power Development Plan 2012-2030, Energy Policy and Planning Office, Ministry of Energy, Royal Thai Government, June 2012

<sup>17</sup> Burma (Myanmar): Country Analysis Note, U.S. Energy Administration, accessed January 15, 2015: <http://www.eia.gov/countries/country-data.cfm?fips=bm>

Bangladesh's Ministry of Power, Energy and Mineral Resources states it is negotiating a power trade agreement with Myanmar by which Bangladesh would purchase 500 MW of hydropower by 2017.<sup>18</sup>

Myanmar's agreements on the export of energy were generally made under 30-year contracts, many of which are about midway through. The government has been moving toward renegotiating the terms of export contracts with some success and current policy requires at least 50% of hydropower produced by foreign investors be sold to MEPE.<sup>19</sup>

On a smaller and less formal level, Myanmar—along with other under-developed countries in the region—receives electricity across its borders, to great benefit for local residents and industry. The Team witnessed examples in Tachileik along the Myanmar-Thai border, as well as in Muse and Laukkai along the Myanmar-China border. This supplies the local population with reliable, affordable electricity from the country's more developed neighbors. (See Tachileik case study in Appendix I.)

In the case of North Shan State, power from China extends along several lines more than 50 miles over the border into Myanmar. This has allowed large-scale development projects to move forward based on assurances concerning electrical supply beyond what the Myanmar grid can offer. Such arrangements were seen as underpinning relatively strong growth in the periphery during the Team's fieldwork visits.

According to ADB, electricity trade has ostensibly helped increase electricity access in the subregion from roughly 37% on average in 1994 to approximately 69% in 2009. This largely benefits rural populations.<sup>20</sup>

While informal, and not widely discussed in the literature pertaining to the ASEAN or

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<sup>18</sup> Cross-border Electricity Trade, Power Division, Ministry of Power, Energy and Mineral Resources, Government of the Peoples Republic of Bangladesh, accessed November 12, 2014: <http://www.powerdivision.gov.bd/user/brec/54/97>

<sup>19</sup> David Doran, Matthew Christensen, Thida Aye, Hydropower in Myanmar: Sector analysis and related legal reforms, *Hydropower & Dams*, Issue 3, 2014

<sup>20</sup> World Economic Forum, *op.cit.*



GMS plans, cross-border agreements like those witnessed by Team could help to inform future policies for the subregion and help to balance Myanmar's status as an energy exporter with its need for greater power supply.

The Myanmar government has pledged to "give priority to building infrastructure projects that will fill the missing links identified in the Master Plan of ASEAN connectivity."<sup>21</sup> The World Bank, the Swedish International Development Agency, the Australian Agency for International Development, and Agence Française de Développement are among the international agencies and bilateral donors supporting energy cooperation in the GMS.

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<sup>21</sup> Framework for Economic and Social Reforms, Policy Priorities for 2012-15 towards the Long-Term Goals of the National Comprehensive Development Plan, Republic of the Union of Myanmar, December 14, 2012

## **IMPORTANCE OF SHAN STATE AS NEXUS FOR REGIONAL ENERGY INTEGRATION**

The largest in land area of Myanmar's seven states, Shan State has a population of roughly 5.85 million people in 55 townships, 13 districts and five special regions. Just over 25% of the population lives in urban areas—with Taunggyi, Kengtung and Lashio being the largest cities—while about 75% of the population is rural.

Taunggyi, the fifth largest city in Myanmar, is the capital of Shan State and site of the headquarters of the Eastern Command of Myanmar's Armed Forces, or the Tatmadaw. It has been called a melting pot for ethnicities inhabiting the area, including indigenous Pa-O and Intha, as well as Shan, Bamar, Gurkha, Chinese and Muslim populations.

### **Chinese Language Signs Near the Myanmar-China Border in North Shan State**



**Source: KWR International**

Shan State as a whole is estimated to have roughly 30 ethnic groups. It is well known as the gateway to China and Thailand, bordering both countries and Laos to the East. It

is a significant trading hub, with four of Myanmar's eleven border gates. Muse in North Shan State is the country's most important check point, accounting for 39% of Myanmar's total documented cross-border trade with Yunnan Province, while Tachileik along the border with Thailand ranks as the fifth most valuable border gate.<sup>22</sup>

The influence of neighboring countries on Shan State is evident. In North Shan State, people are increasingly migrating from China, setting up business and purchasing land. The Shan population in many Northern areas is largely ethnic Chinese and in certain areas the Chinese currency and language take precedence over those of Myanmar.

### *Energy and Electricity Generation in Shan State*

Shan State's strategic location and regional interconnections are especially important for energy trade and development, in particular as concerns hydropower. Shan State is the site of significant hydro resources, including the Thanlwin River Basin, which runs south from China and forms the border with China for about 110 km in South Shan State. In addition, the Mekong River Basin (known as the Lankang in China) forms the border with Laos in the far east of Shan State.

According to a government presentation delivered to the Team by the Chief Minister of Shan State in Taunggyi, four hydro projects, owned by MOEP, with a combined 684 MW of capacity have been completed in Shan State.

These include Zar Gyi 1 (18 MW) and Zar Gyi 2 (12 MW), both located near Yassouth on the Zar Gyi River, KyungTaung (54 MW) near MoeNe along the NanThant River, and Shweli 1 (600 MW) near Nam Kham along the Shweli River. The latter was reportedly completed under a build-operate-transfer agreement with China. One report suggest 80% of the revenues will go to the Chinese companies involved in the facility's development.<sup>23</sup> Shweli 1 is part of a three-dam cascade that will ultimately generate

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<sup>22</sup> Nathalie Fau, Sirivanh Khonthapane, Christian Taillard, *Transnational Dynamics in Southeast Asia: The Greater Mekong Subregion and Malacca Straits Economic Corridors*, Institute of Southeast Asian Studies, 2013

<sup>23</sup> Ibid.

between 1,420 MW and 2,170 MW of electricity, depending on the source, mostly for export to China or domestic mining operations.<sup>24</sup>

### **Inside the Zar Gyi 1 Hydropower Facilities in North Shan State**



**Source: KWR International**

During a visit to Zar Gyi 1, the Team learned that the plant, which was initially intended to supplement a 1 MW hydro facility that powered a nearby military base, was connected to the national grid in 2010. During the lowest water level, capacity at Zar Gyi 1 decreases to 4 MW total and only one turbine can function. At the time of the interview, the plant was said to be operating at 17.5 MW, nearly full capacity.

In addition to these hydropower plants, the MOEP reportedly owns the TiKyit coal plant in Shan State South, with an installed capacity of 120 MW.

No less than ten hydro projects and two coal plants in Shan State are currently under development, or in the initial planning stages. This includes Tasang Dam, a US\$9 billion project and the largest of the proposed hydrodams in the area with 7,110 MW of projected capacity.<sup>25</sup> Owned by China's state-owned development company China

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<sup>24</sup> Ibid.

<sup>25</sup> Ibid.

Gezhouba Group Co. and Thailand's MDX Group, the project is expected to export a significant portion of electricity generated to neighboring countries.<sup>26</sup>

### **The Team's Visit to Zar Gyi 1 Hydropower Facilities in North Shan State**



**Source: KWR International**

These projects are being carried out as part of broader government plans to develop 67 hydropower projects with a total capacity of 41,655 MW over the next 20 years.<sup>27</sup> This includes 11 state-owned projects, with total capacity of 2,132 MW, 4 domestic BOTs, with total capacity of 377 MW, and 43 foreign JV/BOT schemes for the balance.<sup>28</sup>

At least six of the dams being developed under foreign joint venture/build-operate-transfer schemes are located along the Thanlwin River with a combined capacity of 15,000 MW. Two of these projects are located in Shan State (Kun Long, Nong Pa), three in Karen State (Weigyi, Dagwin, Hatgyi) and one in Kayah state (Ywathit).

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<sup>26</sup> Ibid.

<sup>27</sup> Doran et al, *op.cit.*

<sup>28</sup> Ibid.

While these projects require substantial technical and engineering input, social, environmental and other factors must also be resolved to develop Shan State's energy sector. Many of these energy projects are taking place in conflict-affected areas. Shan State is home to up to 13 armed rebel groups, including the National Democratic Alliance Army and United Wa State Army, the largest of Myanmar's rebel organizations.

In October, it was reported that an escalation of conflict between Myanmar's military and the Democratic Karen Benevolent Army in Kayin State was linked to government plans for dams along the Thanlwin River.<sup>29</sup> Therefore the projects' development has become a key issue in both local and national peacemaking and reconciliation efforts. Regional authorities interviewed by the Team in Taunggyi also expressed concern over how power projects in Shan State would move forward without a sustainable ceasefire agreement between warring parties.

In addition to military activity in the area of proposed energy sites, large-scale hydropower can threaten ecosystems and local livelihoods. This includes farming and fishing, and can result in the displacement of large numbers of local residents. The Ywathit Dam in Kayah State, under construction by China's Datang Corporation with 600 MW of projected capacity, is also located near a fault line, causing additional concerns that an earthquake could cause a dam break.

Due to a lack of resources, the Myanmar government has not adequately surveyed dam sites for biodiversity or formalized regulations requiring environmental and social impact assessments of energy projects. In the case of Myitsone dam—one of two large energy projects suspended in Myanmar in recent years due to opposition—a US\$1.25 million environmental impact assessment has never been disclosed.<sup>30</sup>

Similar concerns have been cited in the development of projects in Dawei, Thilawa and other areas. This can cause public opposition and indefinite delays in the production of new energy resources and industries that contribute to the social and economic

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<sup>29</sup> Army offensive in Kayin State 'linked to Salween Dam plans', *Mizzima News*, October 15, 2014

<sup>30</sup> [Myitsone Dam Study Should Be Made Public: Dr. Htin Hla](#), *Mizzima News*, September 26, 2011

development of the country. Such uncertainty is also harmful as local residents remain unsure of what the future will bring.

Given Shan State's proximity to China, Thailand and Laos, it is also important to consider potential cross-border impact of the projects. Hydropower projects underway in Laos have caused demonstrations in Cambodia and Vietnam due to concerns the projects will not only impact the immediate vicinity of the power plants, but also communities located downstream.<sup>31</sup> Environmental consequences of energy projects along the Thanlwin could impact China and Thailand, which share the river. In addition, there is potential for displaced refugees to cross into neighboring countries, with negative social and political ramifications.

As a result of opposition within Myanmar and from international organizations, development of most of the hydropower projects along the Thanlwin is on hold. According to the Team's interviews with several Myanmar engineers deeply involved in power sector development, two of whom are members of government committees concerning development of the energy sector, it is believed the current administration is unlikely to make a decision before the 2015 election on whether large-scale hydropower projects along the Thanlwin can proceed. "Run of River" projects, however, in the range of 100 MW to 120 MW and under will reportedly have an easier time gaining approval. That is because these projects do not divert water flows and therefore do not require as much attention to potential environmental impact and dislocation.

### *Electricity Distribution in Shan State*

In addition to electricity supply, understanding distribution throughout Shan State is crucial to determining how to achieve universal electrification in Myanmar. The presence of grids from three countries—Myanmar's national grid as well as Thailand's and China's—and the fact that areas within Shan State remain largely outside the direct control of the national government, make it a unique case study in electricity development.

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<sup>31</sup> Cambodian Activists Board Boats to Protest Dam Construction in Laos, Radio Free Asia, September 11, 2014



Electricity from China extends more than 50 miles into Myanmar, through grid extensions running north to south from a town called Kyain San Kyut (Chin San Jot in Chinese) just over the border from Muse to Mang Lwat. Villagers are said to inhabit about one mile on either side of the main power line, and electricity is available up to those points. From Muse, Myanmar's national grid also runs west to Shweli.

### **Power Lines from China Extend More than 50 Miles into Myanmar**



**Source: KWR International**

South of Mang Lwat, there is an 18 miles stretch in which neither the Chinese grid nor the Myanmar national grid is available and villages instead rely primarily on generator sets and solar power. According to the Township Engineer, there are no instances of micro-hydro in the area. The Myanmar national grid picks back up in Kat Khaing, 48 miles north of Lashio.

According to the Lashio Township Engineer, the national gridlines run 19.5 miles east of Lashio, after which there is a 30-mile gap before Chinese power lines begin again. As a result, it is not as easy for villages in these gap areas to access power from either China or Myanmar, despite being surrounded by gridlines in relatively close proximity.



Private sector involvement in power distribution was much more prevalent in North Shan State than in other parts of Myanmar. This is due in part to the fact that certain areas are largely outside the direct control of the Myanmar government and therefore not subject to the same level of national regulation and scrutiny that can inhibit investment in the power sector. In interviews conducted in Mang Lwat, where the Chinese grid begins, it was learned that, while the Chinese power company had initially paid a royalty of MMK 5 to the Myanmar government to operate in the country, these payments are not regularly enforced throughout the region and, in this particular location, had ceased.

It was also widely reported that certain sections of MOEP's 24 conditions on grid connectivity (24 conditions) did not apply in many of the areas visited. Importantly, households in a number of places were able to connect on an individual basis, rather than being dependent on the ability of other households in the village to organize and collectively fund the village grid connection. This was true both in areas powered by lines from China as well as Muse where MOEP had outsourced distribution to a private firm, Junction River Trading Company, as highlighted in Muse section below.

### **Interview List**

- San San Htay – Assistant Director, Lashio MLFRD
- Additional Lashio MLFRD Employees
- Myo Ko Ko – Lashio Township Engineer
- Additional Lashio MOEP Representatives
- U Win Hlaing – State Chief Engineer for North Shan State (Lashio)
- U Thein Win – Deputy State Chief Engineer for North Shan State (Lashio)
- U Sao Aung Myat – Chief Minister, Shan State (Taunggyi)
- U Khun Thein Maung – State Finance Minister, Shan State (Taunggyi)
- U Sai Sar Lu – State Agriculture and Livestock Minister, Shan State (Taunggyi)
- U Naing Win – State Minister for Burmese Affairs, Shan State (Taunggyi)
- U Toe Lwin – Taunggyi Department of Hydropower Implementation Officials

- On Shan Mang – Township Engineer, MOEP Kut Khaing
- Kyaw Thu Naing – Executive Engineer, Department of Hydropower Implementation, Yassouth
- Chan Nyain Soe – Assistant Engineer, Department of Hydropower Implementation, Yassouth
- Zin Thet Naing – Special Senior Assistant Engineer, Department of Hydropower Implementation, Yassouth
- U Toe Lwin – Superintendent, Department of Hydropower Implementation, Yassouth
- Shop keepers in Mang Lwat

## **RESEARCH OBJECTIVES AND METHODOLOGY OF PHASE III FIELDWORK**

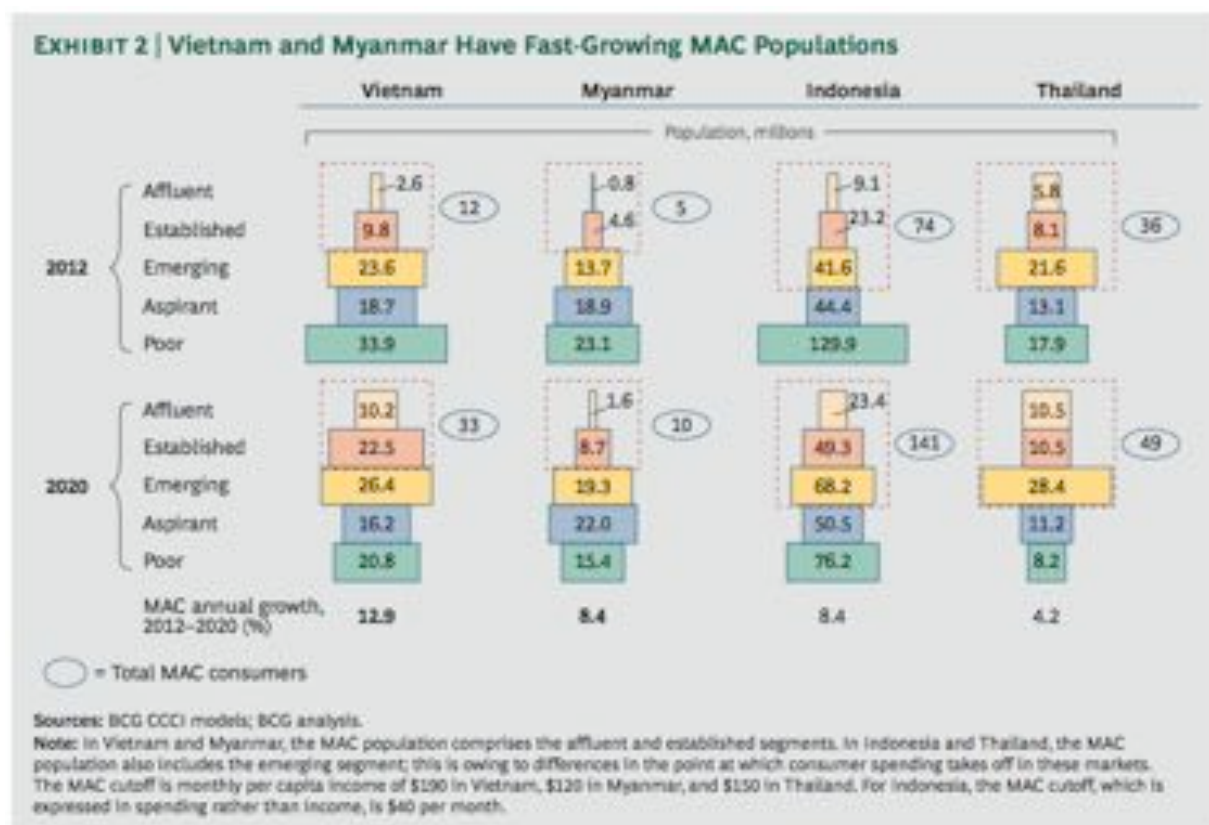
Based on previous field visits to Tachileik and Kengtung in Southeast Shan State along the Myanmar-Thailand border, the Team hypothesized that cross-border power sharing arrangements along the China border would be relatively informal. It was expected they would extend only a few miles into Myanmar and, based on higher incomes in the thriving trading zones, be a welcomed, if more costly, substitute for unreliable power supply from Myanmar's national grid. It was also assumed substantial areas in North Shan State would be off-grid, given the national grid stops at the Thanlwin River.

To test this hypothesis, the Team made visits to several cities and towns as well as four villages, and other site visits strategically selected based on geographic and demographic conditions. In each location, the Team met with targeted individuals including village heads and other village inhabitants, members and chairs of local electrification committees and local power providers. The Team asked the leadership a number of key questions, including: population size, economic activity, income, communal electricity needs, distance from the national grid, distance from the border, locally available resources and preferred electrification strategies. In many cases, the Team addressed a wider range of issues to best understand the village context.

Where possible, the Team also examined the village's or individual household's electricity sources and asked a series of questions about capacity, reliability, cost-effectiveness, O&M, environmental impact and other issues to better understand the context and feasibility of existing electrification schemes.

As with the Phase II fieldwork, the Team first formed a basic profile for each village, using its population, geographic location and context, distance from the national grid and economic profile. The Team then calculated estimated electricity demand for each village based on the number of households, income groupings and rough electricity goals associated with each income level.

Utilizing the demand model developed within the Team's Phase II work, households with the lowest income levels were assigned a projected wattage of 120, which MLFRD has stated is their minimal goal in providing rural electrification access on the household level. Wattage estimates were then determined for four higher income brackets, using categorizations first developed by the Boston Consulting Group and its Center for Consumer and Customer Insight, as follows: Aspirant = 500 W; Emerging = 1,000 W; Established = 2,500 W: and Affluent = 5,000 W).<sup>32</sup>



## Projected household electrification goals based on income

Income Bracket	Minimum Electricity Goals	Potential Electricity Usages
Poor	120 W	Lighting, portable DVD player
Aspirant		

<sup>32</sup> For a complete explanation of the methodology, see Appendix V.

	500 W	Lighting, portable DVD player, portable fan, television set
Emerging	1,000 W	Lighting, portable DVD player, portable fan, television set, rice cooker
Established	2,500 W	Lighting, portable DVD player, music system, television set, air conditioning, rice cooker
Affluent	5,000 W	Lighting, portable DVD player, music system, television set, air conditioning, rice cooker, microwave, refrigerator, water heater

**Source: KWR International**

The Team also carried out factor analyses of electrification strategies and cost analysis for one village, Yay War, which was almost entirely reliant on micro-hydro as it awaits a grid connection.

During Phase I fieldwork, the Team witnessed instances of a micro-hydro system with the capability of powering a restaurant and other small facilities, as well as larger-scale off-grid government-run mini-hydro systems that could power populous areas. Yay War, however, was the first village documented by the Team in which individuals had coordinated a system of micro-hydro grids that provided widespread, reliable electricity to the majority of households in the village. Further, as there were no instances of micro-hydro in the Team's Phase II field visits to Rakhine State and Irrawaddy Delta, in which the comparative cost analysis was carried out, the presence of a functioning system in North Shan State allowed the Team to gather basic cost data for the resource based on the demand profile of Yay War and to fill a gap in the prior research.

Besides Yay War and one impoverished village, located within 1,000 feet of the national grid, all of the remaining sites visited already possessed established grid connections—generally from China, or the Myanmar national grid. As a result, the Team did not complete the cost analysis for other villages as one would presumably not remove grid lines in favor of renewables or micro-grids.

The factor analysis developed during Phase II was, however, implemented for each of the villages, as alternatives could provide auxiliary capacity where the grid needs to be supplemented to meet the population's needs. This analysis examines the feasibility of each technology in the context of a village's available resources, constraints and other characteristics. The factors considered include: ability to pay; population; location; energy resource availability; local/accessible knowhow; and village cohesion.<sup>33</sup>

In addition to the village fieldwork, exploratory visits were made to the following larger areas: 1) **Taunggyi**, where the Team met with the Chief Minister and other senior Shan State officials, as well as officials from regional offices of MOEP and Department of Hydropower Implementation; 2) **Lashio**, where the Team discussed the roles and on-the-ground realities of the ministries dealing with rural electrification with regional offices of MOEP and MLFRD, and examined the circumstances surrounding electrification initiatives in a large, diverse and spread-out setting; 3) **Muse**, a border area and active trading zone experiencing increased economic and industrial activity; 4) **Kut Khaing**, where the Team met the Township Engineer to better understand the reach of the national and China gridlines; and 5) **Laukkai**, where the Team consulted the Chief Administrator; and several hydropower facilities in Yassouth, Kokang and elsewhere.

With the exception of Muse and Laukkai, where the Team visited surrounding villages, independent power providers, substations and local industrial actors, case studies were not written up for the exploratory visits as the interviews were used mainly to better understand the importance of Shan State, the current state of electrification generation and distribution and the variety of factors affecting regional energy integration.

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<sup>33</sup> For a complete description of the factor analysis, please see Appendix VI.

## PHASE III FIELDWORK: VILLAGE-LEVEL CASE STUDIES

### *Yay War – Realizing Potential of Micro-Hydro*



Population	450
Number of Households	110
State/Division	Shan
Township	Per Mal
Distance from Grid	2 miles
Nearest City with Access to Grid	Eleven Mile Village
Main Economy	Farming
Recommended Electrification Strategy	Hydro

Yay War	Percentage	Kilowatt	Demand (KW)
% Poor	50%	.12	6.6
% Aspirant	20%	.5	11
% Emerging	30%	1	33
% Established	0%	2.5	0
% Affluent	0%	5	0
<b>Total Household Demand</b>			50.6
<b>Non- household demand - 1 monastery, 1 school</b>			5
<b>Total Village Demand (KW)</b>			<b>55.6</b>

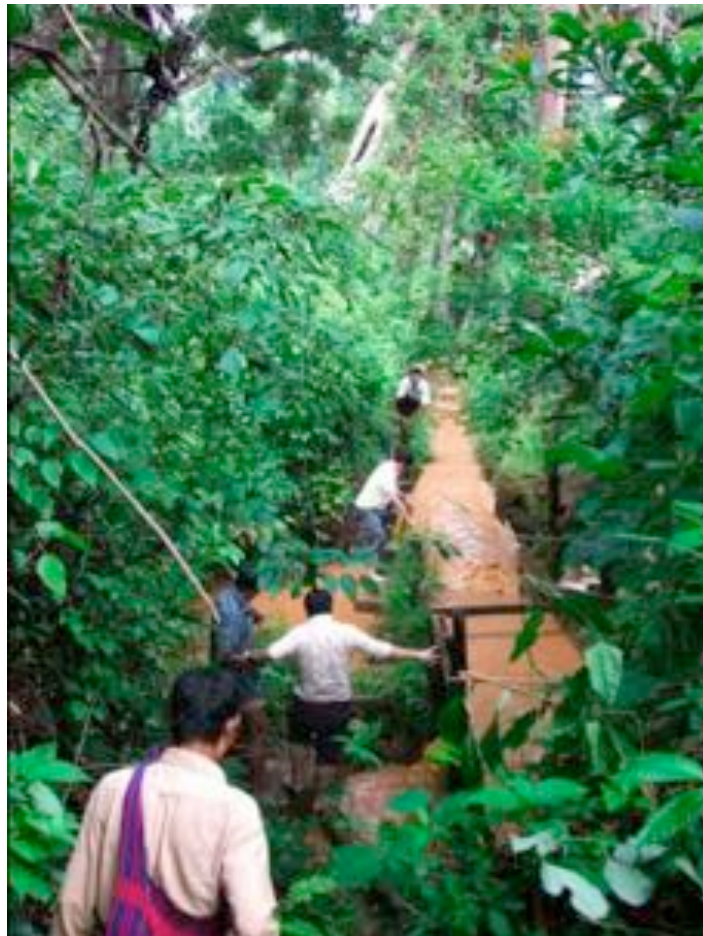
**Overview:** Yay War is a remote, agricultural village with the good fortune of being located along a water source with the ideal conditions for micro-hydro power generation. Yay War's households have coordinated to purchase land and equipment and to install and operate small hydro turbines capable of providing reliable power 12 hours per day at minimal cost. Increasing capacity would not only be cost-effective, but easily recouped as this and other villages who are blessed with viable water sources, utilize additional power to generate greater income, expanded agribusiness and other commercial initiatives. Therefore, while micro-hydro has proven advantageous and cost-effective for Yay War, it cannot be assumed it is a solution for all of Myanmar.

**Economic Profile:** Yay War is an agricultural village in a remote, mountainous area a few hours drive from Taunggyi. Yay War's economy is primarily based on corn, sesame and soy bean, which are sold locally in nearby Yassouth and in China for feedstock. The average salary of villagers was reported to be approximately MMK 70,000 to MMK 80,000 per month. Over the past five years, villagers note economic conditions have improved as better transportation and road conditions have facilitated an increase in trade activity.



**Electrification Reach:** It was reported that 11 micro-hydro turbines power 6-7 households each in Yay War. They supply power for 12 hours per day from 6pm to 6am. To reach the micro-hydro sites, the owners must walk a significant distance from their household through a narrow and difficult to navigate mud trail, then cross a creek using wooden planks without a proper bridge.

### **Navigating the Trail to Yay War's Micro-Hydro Sites**



**Source: KWR International**

As electricity is only in operation 12 hours per day, the owners must walk this route and back twice to turn the hydro turbine on and off. The reason they make this trip is that the owners are concerned about wearing out the turbine and increasing the cost of maintenance if power were to flow 24 hours per day.

**Cost of Electricity:** Villagers report that sets of hydro-power equipment, including a pump and cables, are purchased in Taunggyi for a total cost of about US\$700. Further, land plots, measuring approximately 60 x 80 feet, which are valued at approximately US\$800 are utilized to place the equipment. It was not clear, however, whether these plots are actually purchased or communally owned and utilized by negotiation. Hle Theint, the owner and operator of one of the micro-hydro turbines, said he has not paid for maintenance in the three years since his turbine has been in operation.

### **A Micro-Hydro Turbine Powers 6-7 Households in Yay War**



**Source: KWR International**

The owners of the micro-hydro sets provide for relatives, and in some cases select neighbors, at no cost and there is no charge for electricity beyond the upfront costs paid to purchase and install the equipment other than the time needed to turn on and off the turbine. Nonetheless, the villagers reported if they had the chance to connect to the national grid, which is located two miles away in a place called Eleven Mile Village, they would prefer grid power. The reason is likely the provision of 24-hour power and the ordeal they must go through to turn the turbine on and off twice daily. At the same time,

however, it did not appear they are adequately considering the costs of grid extension and power even at subsidized rates as opposed to the far lower costs of the micro-hydro power they now receive.

#### **Distribution Wires Installed by Villagers in Yay War**



**Source: KWR International**

The villagers also reported there was plenty of extra capacity but usage was limited due to affordability issues as not every household could afford the equipment. With expanded capacity, villagers could think of a variety of uses, including the expansion of small and medium-sized enterprises such as grinders, chopping and food processing.

No generator sets were reported in Yay War, however, some households were said to have solar panels. Although the cost of these panels was said to be about US\$50 each,



the Team believes the price to be closer to US\$100, based on other surveys and assessments as well as visits to local markets.

### **The Team with Yay War Villagers**



**Source: KWR International**

**Cost Analysis:** To calculate the cost of electrifying all of Yay War using micro-hydro, the Team divided the number of households (110) by the number of households that can be powered per turbine (6). The Team then rounded this up as one cannot own a fraction of a micro-hydro system, and multiplied it by the cost of the equipment and installation ( $19 \times \text{US\$}700 = \text{US\$}13,300$ ). Adding an additional system to power the monastery and school brings the total cost of electrifying Yay War, not factoring in existing systems, to US\$14,000.

Land costs were not factored in, nor were they included in the Phase II cost model, since land is a non-depreciating asset and, in the Team's experience, is generally donated or negotiated rather than purchased. Further, while villages did supply an approximate land price of US\$800 for a little over one-tenth of an acre, it was not clear

how many sales had actually taken place and they seemed able to locate hydropower equipment on communally-owned property.

Interest rates were also left out of the equation as they vary depending upon the source, from grants and gifts, subsidized single-digit rates, to up to 30% for certain micro-loans. Loans are also still difficult to obtain in Myanmar. It should be noted, however, that interest rates will be an important factor in determining technology choices, as access to lower interest rates may make capital-intensive choices more favorable.

With current level of O&M, there is no additional cost for upkeep. However, since the Team's analysis factors in more optimal levels of maintenance, and it would be preferable for Yay War's micro-turbines to run 24 hours per day, the Team estimates, based on interviews with other micro-hydro operators, that for a minimal cost of about US\$10-20 once or twice per year—the cost of replacing a small internal ball mechanism—Yay War households could keep their systems running continually. This would also cut down on twice-daily trips now undertaken to turn on and off the equipment.

## **Factor Analysis**

<b>Yay War</b>	<b>Solar Home System</b>	<b>National Grid Extension</b>	<b>Hydro Mini-grid system</b>	<b>Gen-set Mini- grid system</b>	<b>Gasifier Mini-grid system</b>
Cash/non-cash (1 = totally insufficient, 10 = totally adequate)	8	3.5	8	5	4.5
Population (1 = totally insufficient, 10 = totally adequate)	7.5	4.5	9.5	9.5	7
Location /Geography (1 = totally unsuitable, 10 = totally adequate)	7.5	7	9	8.5	5

Energy Resource Availability (1 = totally insufficient, 10 = totally adequate)	6	7	10	8	4
Local / accessible knowhow (1 = totally insufficient, 10 = totally adequate)	7.5	6.5	10	6.5	5.5
Cohesion (1 = totally insufficient, 10 = totally adequate)	9	7	10	6.5	6
<b>Total</b>	<b>42.5</b>	<b>35.5</b>	<b>56.5</b>	<b>44</b>	<b>32</b>
<b>Average across 6 categories</b>	7.58	5.92	9.42	7.33	5.33

Mini-hydro registered as the most suitable technology for Yay War, with an average score of 9.42 out of a possible 10. The village's small number of households, proximity to a strong current and ability for households to contribute funding, negotiate site placements and handle daily operations all made hydro the most favorable power supply for Yay War. The score was pulled down only due to the fact that a portion of the villagers could not afford to contribute to the cost of a turbine, despite it being relatively cost-effective, and because the village's geography requires those who operate the hydro turbine to make a somewhat long and challenging trek through a muddy path and over a small waterfall without a formal bridge. As this task is undertaken twice daily to turn the hydro turbine on and off every twelve hours, villagers expressed a desire for a grid connection. At the same time, however, it is believed that for a relatively marginal increase in maintenance costs of under US\$50 per year these trips could be minimized, though it would likely diminish the maximum lifecycle of the turbine.

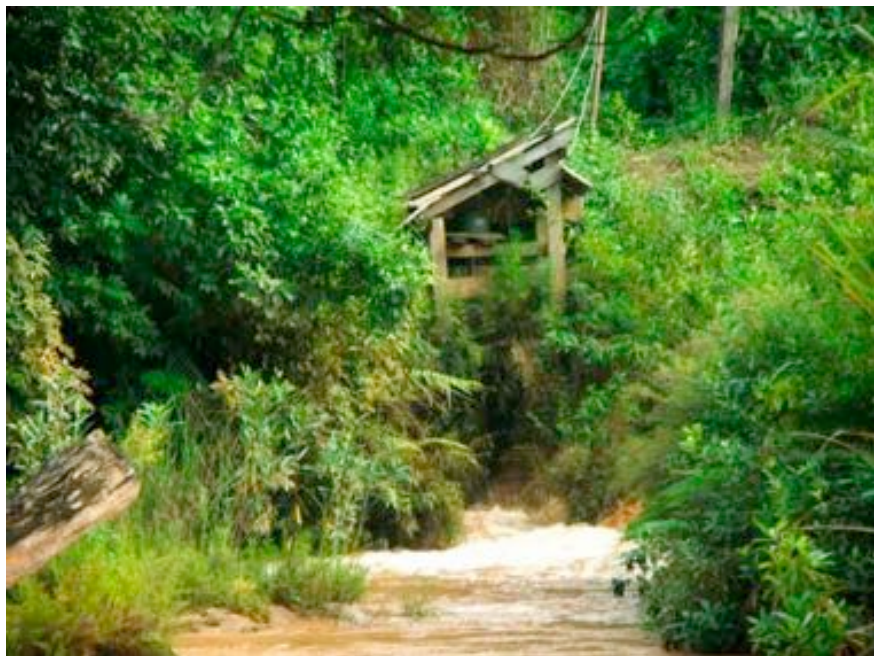
Solar home systems and diesel generator sets also fared relatively well for Yay War, with scores of 7.58 and 7.33 respectively. Yay War's location in the mountains, which is not ideal for sun intensity, was a hindrance to solar, as was the negative effect of the rainy season on solar's effectiveness.

In the case of diesel generators, the high cost of fuel was an issue, as was the fact that technical knowhow would be lacking in the area, as there were no other diesel generator sets reported.

Grid extension ranked fourth, after diesel gen-set mini-grids and solar home systems. Although grid lines are located only about two miles away, a connection to Yay War would be unaffordable given the small and relatively poor population. Myanmar's 24 conditions require village households to collectively contribute funding toward the costs of extending the grid to the village level, and although Yay War has strong cohesion and leadership, a significant portion of the population would not be able to afford the associated costs, nor do they seem to adequately understand the monthly costs of generation that would be incurred even at subsidized rates.

Gasifiers came in last, with a score of 5.33, as the rice husk input would likely have to be brought from another location, adding to the expense. In addition, given the vast water resources and importance of agriculture, the pollution from gasifier emissions and spill off could have a significant and detrimental impact on the local community.

### **Hydropower Equipment Purchased and Installed by Yay War Villagers**



**Source: KWR International**

**Conclusions:** Yay War illustrates the good fortune of villages located close to a particular energy resource, in this case hydro. With a relatively small upfront investment, and reportedly little or no maintenance costs, more than half the village appears able to obtain relatively stable power 12 hours per day. Twenty-four-hour power would be possible with slightly more upkeep and increase in maintenance costs.

These added costs would likely be recouped relatively quickly. Villagers saw the possibility of generating additional income with greater access to electricity, as it would allow for milling, grinding and other value-added agricultural activities. Such activity, in turn, is likely to lead to increased electricity use in households and a higher quality of life for the villagers.

While Yay War presents a strong case for the potential of mini- and micro-hydro in Myanmar, it is important to note that mini- and micro-hydro does not provide a one-size-fits-all solution for Myanmar, or even Shan State. Its viability is specific to factors present in locations such as Yay War, for example proximity to a sufficient water source and strong cohesion. In other villages visited by the Team, which are described in greater depth below, hydro did not score as high. In Mauhit, for example, micro-hydro ranked the lowest due to a lack of resource availability, generally low levels of cohesion and very low income.

## **Interview List**

- U Aye Lwin – Village Head
- Hle Theint – Owner and operator of a micro-hydro system
- Aung Sou – Owner and operator of a micro-hydro system
- Various villagers



***Mauhit – Creating a Platform for Electrification in a Marginal Economy***



Population	400
Number of Households	80
State/Division	Shan
Township	Lashio
Distance from Grid	1,000 feet
Nearest City with Access to Grid	Lashio
Main Economy	Farming
Recommended Electrification Strategy	Solar

Mauhit	Percentage	Kilowatt	Demand (KW)
% Poor	100%	.12	48
% Aspirant	0%	.5	0
% Emerging	0%	1	0
% Established	0%	2.5	0
% Affluent	0%	5	0
<b>Total Household Demand</b>			48
<b>Non- household demand - 1 church, 1 nursery</b>			5
<b>Total Village Demand (KW)</b>			<b>53</b>

**Overview:** Located at the end of the Myanmar national grid in North Shan State, Mauhit is an example of a village without many options for self-sufficient electricity distribution. Although the grid is located only 1,000 feet away, and household connections would be relatively easy from a technical standpoint, villagers in Mauhit, a Kachin community whose inhabitants were relocated from other areas troubled by ethnic conflict, are unable to afford the costs of grid connection or monthly electricity bills. Economic prospects are bleak with villagers reportedly needing to travel seven miles outside of Mauhit for farming opportunities. While Mauhit has received support from international organizations, including the World Food Programme (WFP), which built the village's church and dirt road, this case study raises questions about the role of donor and governments to tie economic development assistance to electrification initiatives in marginalized communities.

**Economic Profile:** Mauhit is a very poor Kachin village located at the very end of the Myanmar national grid, roughly 1,000 feet from the main road that runs from Taunggyi to Lashio. Many villagers are reported to be involved in agriculture, but must travel seven miles outside the village to farm. With low income and limited economic opportunities, Mauhit is highly dependent on aid from WPF, which is said to have built

the dirt road that runs through the town to the main road and to have given the village a Kachin church, called Hkanan Buga Jwikailup Hpung.

### **Hkanan Buga Jwikailup Hpung Church in Mauhit**



**Source: KWR International**

**Electricity Reach:** Mauhit receives very little electricity as most villagers cannot afford more than batteries, which can power a few small lamps. In a few cases, villagers had solar panels. The Kachin church owns a generator, provided by WFP, that powers the church's activities. There is a nursery across the road from the church, which is powered using a solar panel.

The national grid, however, runs along the main road about 1,000 feet from the village. Asia World, a Myanmar conglomerate, created the connection for the nearby toll-booth which it manages, beyond which there is no grid for 18 miles when power lines running from China become accessible.

Although Asia World could easily allow a connection to Mauhit, it is unlikely the villagers would be able to afford the electricity bills, even at the government-subsidized rate of MMK 35 per unit.

### **A Generator Belonging to Hkanan Buga Jwikailup Hpung Church in Mauhit**



**Source: KWR International**

### **Factor Analysis**

	Solar Home System	National Grid Extension	Hydro Mini-grid system	Gen-set Mini-grid system	Gasifier Mini-grid system
<b>Mauhit</b>					
Cash/non-cash (1 = totally insufficient, 10 = totally adequate)	4	2	5	4.5	4
Population (1 = totally insufficient, 10 = totally adequate)	8.5	3.5	9	9	8.5
Location /Geography (1 = totally unsuitable, 10 = totally suitable)	7.5	9	6	8	7.5

adequate)					
Energy Resource Availability (1 = totally insufficient, 10 = totally adequate)	5.5	9	2.5	7	5
Local / accessible knowhow (1 = totally insufficient, 10 = totally adequate)	7	6.5	4.5	6	4
Cohesion (1 = totally insufficient, 10 = totally adequate)	8	4.5	5.5	5.5	5
<b>Total</b>	<b>40.5</b>	<b>34.5</b>	<b>32.5</b>	<b>40</b>	<b>34</b>
<b>Average across 6 categories</b>	6.75	5.75	5.42	6.67	5.67

None of the technologies fared particularly well for Mauhit, with only two (solar home systems and diesel generators) scoring above a 6 out of 10. While located just off a main road and close to major cities in Shan State, access to equipment and technical knowhow should presumably be easy to come by. Nevertheless the lack of available resources and very low-income levels made most of the technologies less feasible.

Solar home systems rank highest with a score of 6.75 as they require little village cohesion and are well suited to small populations such as Mauhit. The score was brought down, however, by the high costs of equipment, which many villagers in Mauhit are unlikely to be able to afford, as was the potential for the sun's intensity to be affected during the rainy season.

Diesel scored 6.67 out of 10 for similar reasons. While diesel fuel and generators should be easily available in Lashio, a major trading center, and easily transportable to Mauhit along the main road, the high cost of diesel will make the fuel supply unsustainable for the village population.

In the case of grid extension, which scored 5.75, Mauhit's small population and low income presents a challenge to the cost of extending lines even 1,000 feet. Were Asia

World, the government, or another third party like WFP to extend the lines to the household level at no charge to the villagers, the cost of the electricity bill would still likely present a challenge to the Mauhit population.

The lowest scores for Mauhit went to gasifiers and mini-hydro, with 5.67 and 5.42, respectively. This was primarily due to a lack of necessary resources nearby and limited technical knowledge.

### **Villagers Gather Near the Mauhit Village Center**



**Source: KWR International**

**Conclusions:** While not as isolated geographically as other villages visited by the Team during Phase II, such as War Taung, an island, or Tha Yet Daw, which was only accessible by motorcycle, Mauhit's low income levels and limited resources make any electrification initiative difficult to initiate and, in particular, to sustain. Despite the benefit of being located close to the national grid and a major roadway, Mauhit's population



lacks the income necessary to pay for electricity and the resources they could otherwise trade, barter or use as an electricity source.

Mauhit is illustrative of a broader problem Myanmar is facing in its efforts to achieve universal electrification. As grid lines are extended and more villages are connected to the national grid, there will inevitably be poor, marginalized communities unable to access the electricity due to geographic, financial or other reasons. As a result, they will become more alienated and also miss out on the social and economic benefits that come with the ability to access reliable, affordable electricity.

Such disparities underscore the importance of maintaining an ability to deploy renewables, even in areas that will eventually achieve connectivity through the national grid. They also present an important case for coordination among local, regional and national government, as well as government and donor agencies and among ministries themselves on local village needs, particularly in the area of energy and electricity.

In its meetings with the Assistant Director of MLFRD in Lashio, the Team was told that Naypyitaw, in planning its rural electrification initiatives, sometimes makes decisions about which villages to prioritize based on income reported by village heads and administrative officers. If proper coordination is not undertaken, or if a village lacks leadership capable of submitting accurate income data, villages like Mauhit may be left out of government programs to distribute off-grid renewables to populations in need.

Donor agencies or NGOs with an on-the-ground presence, like WFP, can play a role in flagging certain villages, or work with government programs to determine how best to bring electrification and the resultant social and economic benefits to marginalized populations. At the same time it is necessary to address the economic development needs of these communities, as electricity on its own will not ensure their viability.

Irrespective of these concerns, the Team recommended solar as the optimal strategy for Mauhit, as while installation costs are significant, operational and maintenance costs

are low and once installed they should enhance quality of life and the marginal needs of this community. Potentially given their low-income levels they can qualify for support from MLFRD or an NGO which can provide the necessary equipment. Generator sets are also viable if they can be donated and while there is still then the cost of diesel, this might be sufficient to supply the local church, school and some other needs.

### **Interview List**

- Mauhit Village Head
- Mauhit Nursery Leader
- Additional Mauhit Villagers



***Nam Pak Khar – Enhancing Quality of Life through Grid Connection***



Population	10,500
Number of Households	2,000
State/Division	Shan
Township	Kut Khaing
Distance from Grid	On-grid
Nearest City with Access to Grid	On-grid
Main Economy	Farming
Recommended Electrification Strategy	Grid Extension

Nam Pak Khar	Percentage	Kilowatt	Demand (KW)
% Poor	55%	.12	132
% Aspirant	30%	.5	300
% Emerging	15%	1	300
% Established	0%	2.5	0
% Affluent	0%	5	0
<b>Total Household Demand</b>			732
<b>Non- household demand – 3 monasteries, 2 schools</b>			13
<b>Total Village Demand (KW)</b>			<b>745</b>

**Overview:** Nam Pak Khar was the first village visited by the Team that received electricity from the Chinese power grid. A populous area with agricultural activity and small industry, Nam Pak Khar has benefited from a strong and entrepreneurial leader who sought permission nearly a decade ago from the government to connect the area to the Chinese grid. Despite higher tariffs than those subsidized by the Myanmar government, Nam Pak Khar's access to reliable power has allowed for greater economic activity and higher standards of living. Nonetheless, roughly half the population, who possess lower incomes, are seeking alternatives. This raises the issue of income inequality and how the Myanmar government and outside actors determine the need for assistance to poor, marginalized segments of villages where the majority of the population in a certain area has relatively high income and sufficient electricity access.

**Economic Profile:** Nam Pak Khar is a populous and growing area that is divided into four wards. It receives electricity from China via a local entrepreneur. Economic activity in Nam Pak Khar consists mainly of agriculture, including rice paddy, corn and tea. There is also small industry, including welding, pressing and car workshops. Due to its proximity to China, both yuan and kyats are used as currency.

**Electricity Reach:** U Thaung, Chairman of Nam Pak Khar's Electrification Committee, oversees a total of 2,000 households in four wards. Three of these wards are composed primarily of people who relocated to this area from more remote areas for greater economic opportunity. U Thaung was previously village head and notes that he received permission from authorities in Lashio to use Chinese power. He was then elected Chairman of the Electrification Committee and has since retired as the village head.

**The Team Speaks with Nam Pak Khar Electrification Committee**



**Source: KWR International**

Power from China became available to the area in 2006. The Chinese power provider covered all the expenses to extend the grid into Myanmar. Presently, there are 10 transformers in the four wards.

Nine hundred eighty households, or just under half the households under U Thaung's mandate, are said to take electricity from China. The rest of the households gain access from off-grid sources including solar panels, kerosene or candles.

About 50% of households who are connected to the grid in Nam Pak Khar are said to have only lights, television and DVD players. The other roughly 50% of households also have rice cookers and hot plates. No households are reported to have air conditioning.

Unlike most localities in Myanmar, where villages are required under MOEP's 24 conditions to establish connections to the national grid collectively, households in Nam Pak Khar reportedly may connect to the Chinese grid on an individual basis. This makes connection far easier and minimizes the need for coordinated action.

**Cost of Electricity:** New installations are said to cost about 1,600 yuan—roughly MMK 270,000 or US\$270—for a meter box, including installation. The village electrification committee is responsible for installation.

#### **A Chinese Meter Box Inside a Nam Pak Khar Household**



**Source: KWR International**

Households pay 1.7 yuan—MMK 280 or US\$0.37—per unit for electricity. U Thaung purchases power from U Lout Cheng, a representative of the Chinese power provider, for 1.2 yuan per unit. U Lout Cheng in turn purchases the power for .6 to .7 yuan, at a profit of .5 to .6 yuan, roughly MMK 100 or US\$0.10, per unit. U Thaung stated he is taking a credit risk for households given he must fund power consumption on a different schedule than payments received and irrespective of whether a household pays or not. On average, all households combined consume a total of approximately 45,000 yuan to 50,000 yuan, just over MMK 7.5 million or US\$8,000, worth of electricity per month.

**The Team with the Nam Pak Khar Electrification Committee**



**Source: KWR International**

## Factor Analysis

<b>Nam Pak Khar</b>	Solar Home System	National Grid Extension	Hydro Mini-grid system	Gen-set Mini-grid system	Gasifier Mini-grid system
Cash/non-cash (1 = totally insufficient, 10 = totally adequate)	6	7.5	6	6	6
Population (1 = totally insufficient, 10 = totally adequate)	2.5	9	5.5	6.5	6.5
Location /Geography (1 = totally unsuitable, 10 = totally adequate)	5.5	8.5	7.5	6.5	7
Energy Resource Availability (1 = totally insufficient, 10 = totally adequate)	5.5	9	2	8	7.5
Local / accessible knowhow (1 = totally insufficient, 10 = totally adequate)	7	8.5	5	5.5	5
Cohesion (1 = totally insufficient, 10 = totally adequate)	6.5	8.5	7	7.5	6.5
<b>Total</b>	<b>33</b>	<b>51</b>	<b>33</b>	<b>40</b>	<b>38.5</b>
<b>Average across 6 categories</b>	5.5	8.5	5.5	6.67	6.42

Grid connection ranks highest in Nam Pak Khar, with a score of 8.5 out of 10, given the relatively high income levels, large population and access to the grid infrastructure that has already been built to accommodate the Chinese power that is now being distributed. Because the Chinese grid has been in operation for nearly a decade, Nam Pak Khar has ready access to officials with the experience and technical knowhow to handle any necessary installations as well as O&M.

Furthermore, since U Thaung, the electrification chairman and former village leader, showed strong initiative and entrepreneurialism in securing permission to access

Chinese power it is likely he would be able to help coordinate, and manage a grid extension initiative for households not currently connected, even with the more rigorous requirements imposed by the 24 conditions if those should become required for the remaining areas.

Diesel generators and gasifiers came after grid extension, with scores of 6.67 and 6.42, respectively. Both fared worse than grid extension primarily because the grid delivers 24-hour power and Nam Pak Khar's large population is better suited to a more scaleable technology, like the grid, and because neither technology was reported to be prevalent in the area. This means technical expertise may be more difficult to come by than those with expertise in grid operations.

Solar home systems and mini-hydro tied for the lowest with scores of 5.5 out of 10. In the case of solar, Nam Pak Khar's main issue is its large population, as solar is difficult to scale. Hydro suffered primarily due to the lack of a viable water resource within close enough proximity. That said, it is likely solar could be viable in areas that require auxiliary connections or which are geographically difficult to connect to the grid.

### **A Shop in Nam Pak Khar Sells Fans, Satellite Dishes and Other Electronics**





**Source: KWR International**

**Conclusions:** Nam Pak Khar highlights the value of reliable power as well as the role of profit making in incentivizing electrification initiatives. With a business incentive, U Thaung was willing to take initiative to connect his wards to the Chinese grid and is willing and able to take on credit risk for households. As a result, the villagers in Nam Pak Khar have better than average economic activity and quality of life, despite higher tariffs than the government-subsidized rates for power from the national grid.

Had the village leader been attempting to connect households to the national grid, as opposed to the Chinese grid, the costs for the village would have been higher and a burden greater, given the stringency of MOEP's 24 conditions, namely that all households must connect at once with collective savings. Further, there would be no opportunity for profit making.

That said, it is important to consider variations in income within a given area and to accommodate those segments of the population for whom a private model may not be



workable. Roughly 50% of Nam Pak Khar's population that does not purchase electricity from China and is dependent on off-grid generation from solar panels or candles and kerosene. This indicates the importance of renewables and off-grid generation as auxiliary power sources even in areas that have a grid connection. Sliding scale rates, or using commercial and industrial consumption to subsidize residential electricity use might also help to ensure that, where there is income inequality, poorer segments of populations are able to access power through grid connection or renewable alternatives.

### **Interview List**

- U Thaung – Chairman, Nam Pak Khar Electrification Committee
- Other village electrification officials

### ***Ho Saung – Tariff Structure Distorts Allocation of Energy in Myanmar***



Population	500
Number of Households	130
State/Division	Shan
Township	Muse
Distance from Grid	On-grid
Nearest City with Access to Grid	Muse
Main Economy	Agriculture
Recommended Electrification Strategy	Grid Extension

Ho Saung	Percentage	Kilowatt	Demand (KW)
% Poor	20%	.12	3.12
% Aspirant	30%	.5	19.5
% Emerging	30%	1	39
% Established	20%	2.5	65
% Affluent	0%	5	0
<b>Total Household Demand</b>			126.62
<b>Non- household demand – 1 monastery, 1 community center</b>			5
<b>Total Village Demand (KW)</b>			<b>131.62</b>

**Overview:** A small, relatively prosperous village on the Myanmar-China border, Ho Saung is illustrative of the inefficiencies created by government-subsidized electricity tariffs on industrial development, national electrification and economic planning. Although Ho Saung receives reliable power from China at affordable rates, villagers would prefer to switch to the Myanmar national grid to obtain cheaper, government-subsidized power. This incentive structure can be damaging to a national electrification strategy. It is understandable that over the long term Myanmar would like to supply domestic power through its national grid. Over the short term, however, as the country seeks to initiate major capacity expansion, diverting power from areas that need it most to meet demand from locations that otherwise receive sufficient supply may not be an optimal solution. This also demonstrates the need for grid extension initiatives to consider need - based not only on income, but also on locally available alternative resources, such as a neighboring country's grid or a viable hydro supply.

**Economic Profile:** Ho Saung is a small Shan village located just next to a large development in Muse called the Muse Central Business District (CBD). Recently, rice paddies were cleared to make way for the development, and villagers in Ho Saung, who previously worked in the rice paddies were compensated for this

loss. According to the CBD project manager, villagers were compensated at a rate of 240 lakh per acre. While this area may have been considered rural as recently as several years ago, expansion of Muse with the CBD and other development have turned this more into an extension of Muse itself.

### **Paddy Fields in This Once Remote Area Have Been Cleared for Muse CBD**



**Source: KWR International**

In view of this transition, Ho Saung's population is now mostly made up of day laborers who work in nearby Muse at a reported daily rate of between MMK 5,000 to MMK 8,000. This is more than double the average wage for Myanmar. Some villagers also resell fruits, while higher income villagers are shopkeepers or restaurant owners. As the CBD project comes more fully on-stream, this development is also likely to provide employment as well as commercial opportunities for these local residents.

**Electrification Reach:** All of Ho Saung's 130 households are connected to the Chinese grid under an arrangement that has been in place for more than ten years.

**The Team Speaks with Ho Saung Village Head U Sai Tun**



**Source: KWR International**

U Sai Tun, the village head, reported that the Chinese power is very reliable and never drops. His own household has a refrigerator, washing machine, television and lighting. Roughly 30% of the village households also have these items, while about 50% are said to have only lights and television.

**Cost of Electricity:** Households in Ho Saung pay 1 yuan—roughly MMK 160 or US\$0.16—per unit for electricity. U Sai Tun reported his average monthly electricity bill is about 130 yuan—roughly MMK 21,600 or US\$20—while the

households who have only lights and television pay closer to 20 yuan—about MMK 3,300 or US\$3—per month.

### **Electricity from China Powers Appliances in Ho Saung**



**Source: KWR International**

According to U Sai Tun, a Shan man from the village collects payments from households and in turn pays the Chinese electric company, Kyee Gaung, which is named after the town in China in which it is located. This man also installed the meters in every household and it is his responsibility to handle repairs.

A meter is said to cost 40 yuan, about MMK 6,600 or US\$6.50. This is in addition to an installation fee of 300 yuan—just under MMK 50,000 or US\$50—which is paid to the village committee's electrification fund.

Despite reliable power from China, the Ho Saung leadership expressed a preference for electricity from the national grid due to the lower subsidized rates. U Sai Tun told the Team that approximately one month prior to the interview, when the Shan State Electricity Minister visited Ho Saung, villagers asked the Minister for a connection to the national grid. The Minister is said to have told them that upon the completion of the CDB, they would be able to connect to the development's line. In a later interview with the CBD developers, however, it was

learned that they had no plans to connect to the Myanmar grid in the near future as they prefer the predictability of more regular supply received from China.

If this connection were possible, however, it would save the village the cost of the transformer, cables, and other equipment as they would be able to connect at no cost to the development's line.

### Factor Analysis

<b>Ho Saung</b>	Solar Home System	National Grid Extension	Hydro Mini-grid system	Gen-set Mini- grid system	Gasifier Mini-grid system
Cash/non-cash(1=totally insufficient,10=totally adequate)	7	7	8	6.5	7.5
Population(1=totally insufficient, 10=totally adequate)	7	6.5	7.5	7.5	7.5
Location /Geography (1=totally unsuitable,10= totally adequate)	8	9.5	4	7	2
Energy Resource Availability (1=totally insufficient, 10= totally adequate)	8	9.5	0	7	7
Local/accessible knowhow (1=totally insufficient, 10= totally adequate)	7	8	6.5	7.5	6.5
Cohesion (1=totally insufficient, 10= totally adequate)	7.5	7	8	7	7
<b>Total</b>	<b>44.5</b>	<b>47.5</b>	<b>34</b>	<b>42.5</b>	<b>37.5</b>
<b>Average across 6 categories</b>	7.41	7.92	5.67	7.08	6.25

Grid extension is highest-ranking technology for Ho Saung, scoring 7.92 out of 10. The grid is well suited to Ho Saung given availability of grid infrastructure as well as access to people with expertise in grid development and maintenance.

Solar home systems and diesel also fared well with scores of 7.41 and 7.08, respectively. If Ho Saung does in fact switch from Chinese-supplied power to the



Myanmar national grid, the village will likely require one of these as an auxiliary power supply in case of black outs or inadequate supply. Solar ranked slightly higher than diesel generators due primarily to the high cost of diesel. Diesel generators are also a greater source of pollutants than solar home systems.

Gasification came in fourth with a score of 6.25 out of 10. The removal of rice paddy fields nearby decreases the viability of available resources, although with the prevalence of rice paddy in Shan State and the abundance of rice crossing the Muse border suggests rice husks are available nearby. The score was brought down primarily due to environmental concerns. The urban nature of Muse is a hindrance as pollution, a commonly cited problem with standard gasifiers in Myanmar, would have negative effects on the surrounding area.

### **A Satellite Atop a Household in Ho Saung Village**



**Source: KWR International**

**Conclusions:** Ho Saung is an example of the inefficiencies government subsidies can have on village planning and decision-making. Despite having reliable and sufficient access to power from China, and relatively high standards



of living as a result—with villagers, in some cases, possessing washing machines and other appliances—there was a widespread desire among villagers to connect to Myanmar’s national grid because of the lower rates it would afford.

It is understandable that Myanmar would want its population to depend on its national grid, rather than another country's power supply. Given the deficiencies of the Myanmar system, however, and that parts of the country have no access to power whatsoever, it is necessary for the government to prioritize grid extension initiatives. In this case, bringing Ho Saung onto the grid would divert power and resources from villages that are entirely without access to electricity to supply an area that already receives sufficient power.

Uneconomic tariffs encourage demand for a transition to power supplied by the national grid, even where power is already available at affordable, if higher, rates. Power supplied by the Myanmar grid is not likely to be as secure as that from China for some time. While cost savings may be introduced for consumers, this may result in blackouts, place a strain on existing grid infrastructure and decrease the quality of living. It may even cause problems for economic activity and require investments in auxiliary power such as solar or more likely diesel generators. That will create the problematic scenario seen in other parts of Myanmar where residential and business consumers become dependent on tariff-supplied power to subsidize the higher costs of diesel and auxiliary power sources.

As a result, while cheaper power may be beneficial to a small village in isolation in terms of the tariff rate itself, it is not necessarily advantageous for the region or country as a whole. In addition to hampering the involvement of private actors, artificially low tariffs encourage grid extension practices that will ultimately drain resources from locations that have a greater need or could better utilize the power in favor of areas that are already self-sufficient and therefore could be connected to the national grid at a later time. They also introduce the need for auxiliary power sources so the cost savings desired may not be realized.

This highlights the importance of tariff reform, as the low tariffs are not only an impediment to private sector investment and even government grid extension initiatives, but also encourage uneconomical and inefficient planning decisions.

Irrespective of whether power is obtained from the Myanmar or China grid, grid extension was selected as the optimal electrification strategy for Ho Saung.

### **Interview List**

- U Sai Tun – Village Head
- U Sai Tun's Relatives
- Other Ho Saung Residents

## EXPLORATORY CASE STUDIES

### ***Muse: Managing Transition to Myanmar-Supplied Power***



**Profile:** Separated from Ruili, China by the Shweli River, Muse is considered the most active cross-border trading zone in Myanmar and serves as the primary border crossing into China's Yunnan Province. The crossing accounted for US\$2.7 billion in exports to China and US\$1.76 in reported imports during 2013-14.<sup>34</sup> Imports from China include consumer goods and construction materials, while Myanmar exports jade—a trade that is said to employ roughly 40% of Ruili's working population<sup>35</sup>—agricultural products including fruits and rice and other products.

### **The Team's Visit to the Myanmar Rice Federation in Muse**



**Source: KWR International**

A reported 747,000 tons of rice is said to have been exported from Myanmar to China through the Muse border in 2013. According to the World Bank, rice

<sup>34</sup> Kyaw Hsu Mon, [Burma's Border Trade Booms in 2013-14](#), *The Irrawaddy*, April 9, 2014

<sup>35</sup> Fau et al, *op.cit.*

exports to China have increased almost 125 times since 2011.<sup>36</sup> Although China has cracked down on the rice trade this year, expressing concerns that rice grown in Myanmar does not adhere to plant quarantine rules and other sanitary protocols, Myanmar's Commerce Minister said they will begin negotiations with China's Administration of Quality Supervision, Inspection and Quarantine authorities to develop a framework to legalize rice exports to China and finalize a free trade agreement that includes rice and other agricultural products.<sup>37</sup> The Myanmar Rice Federation is hoping to obtain a quota of 1 million tons per year.<sup>38</sup>

### **Rice Varieties Are Bought and Sold at the Myanmar Rice Federation**



**Source: KWR International**

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<sup>36</sup> China Takes Measures to Halt Cross-Border Rice Imports from Myanmar, *Oryza*, September 25, 2014

<sup>37</sup> Ibid.

<sup>38</sup> Zaw Htike, [First step made for a legal China rice trade](#), *The Myanmar Times*, September 29, 2014

In June 2014, consensus was also reached on the development of a free trade zone, and a Ruili-Muse Economic Zone was formed, as a means to boost trade, tourism and other forms of cooperation and cross-border activity.<sup>39</sup>

According to a government presentation delivered by the Chief Minister of Shan State during the Team's visit to Taunggyi, annual income in Muse rose from MMK 664,051 in 2011-12 to MMK 813,647 in 2014-15.<sup>40</sup> The Team's interviews suggest, however, that much higher incomes are prevalent, in particular for male day laborers who reportedly can earn up to US\$300 per month. A power provider interviewed by the Team reported a minimum wage of US\$130 per month, while its workers with computer skills were said to earn approximately US\$250 per month and accountants US\$350.

**Electrification:** The Shan State presentation states that a target of 959 villages in Muse will be electrified in the near future, about one third of which had been electrified as of 2014. Roughly half of the villages already electrified were connected to the China grid.

#### **Electrification Initiatives in Muse**

<b>Muse</b>	National Grid	Neighboring Country Grid	Diesel Engine	Solar	Mini- Hydro
# of Villages Electrified	22	153	0	51	81

**Source: Government presentation delivered by Shan State Chief Minister in Taunggyi on October 13, 2014**

<sup>39</sup> New jade market in Muse will promote Sino-Myanmar jade cooperation, *China News*, August 22, 2014

<sup>40</sup> Government presentation delivered by Shan State Chief Minister in Taunggyi on October 13, 2014

Overall, however, Chinese power appears to be becoming less prevalent in the Muse area, ostensibly because Myanmar would like to decrease the reliance of its citizen's power from China's grid.

According to interviews with the current electricity distributor, the Muse area was using electricity from China between 1993 and 2010. It cost 1.5 yuan—roughly 250 MMK or US\$0.24—per unit and was sold through the District Electrification Committee. Under that arrangement, the Chinese installed the grid system and cabling.

When hydropower from Myanmar's Shweli 1 project became available to Muse in 2010, the region began using local hydropower. According to the Team's interviews, power from Shweli 1 cost MMK 120, or about US\$0.12, per unit when it first became available. Areas that were beyond the reach of this system, as well as small industry, reportedly continued to use Chinese power, while others switched to the Shweli 1 supply due to the lower rates. Power from Shweli 1, currently provided through a joint venture with MOEP and a private Myanmar company, is now available at the standard rate of MMK 35 per unit, while Chinese rates have reportedly gone up to 2 yuan—MMK 330 or US\$0.32—per unit in the Muse area.

The Shweli 1 plant was first connected to the towns of Shweli, Namkham and Muse, before being brought on to the national grid via a connection in Mandalay.<sup>41</sup>

### **Shweli 1 Hydropower Facility**

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<sup>41</sup> More Electricity Soon as Shweli Hydro Plant Feeds National Grid, *Myanmar Times*, September 1, 2008



**Source: International Rivers**

According to a press release on the website of China HuaNeng Group, an affiliate of the Chinese developer of Shweli 1, the plant had supplied more than 7 billion kWh of electricity to Myanmar as of August 2013.<sup>42</sup> This includes 2 billion kWh of free power. The company also reported tax payments to the Myanmar government of 300 million yuan, about US\$48.5 million, and donations of materials and labor to local villages to assist with grid connections.

The company also reports increasing the ratio of power provided to the Myanmar national grid during droughts and other power shortages. According to the press release, during severe blackouts in 2012, which led to protests in Yangon, Mandalay and other cities, one of the Shweli 1 generators meant for use by China was connected instead to the Myanmar power grid. As a result, power from Shweli 1 is said to have accounted for between 15% and 30% of Myanmar's total power supply during the worst of the 2012 power shortage.<sup>43</sup>

While the power supply to Muse seems to be sufficient, the reliability of the system is affected by the existing grid infrastructure, which was designed for a

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<sup>42</sup> China HuaNeng Group, Myanmar Ministry of Electric Power sent a thank-you letter for safe and stable power supply from the Shweli Hydropower Station, Company Press Release, accessed January 13, 2015: <http://www.chng.com.cn/eng/n75863/n75941/c1058168/content.html>

<sup>43</sup> Ibid.



lower population and less demand. An article published July 22, 2010 in *The Irrawaddy* quotes businessmen and manufacturers in Muse complaining about the unreliability of the Shweli power shortly after it became available to the area.<sup>44</sup> Meanwhile the Team's discussions with industrial actors and majors developers in Muse, which are detailed below, highlight that power from China continues to prove vital for commercial activity, whether as a primary or back-up supply. Junction River, however, which is distributing power through a JV with MOEP and which is profiled below, has noted this as one of their main problems. Adoption of lower tariff rates has dramatically increased demand which must be delivered through grid that was built for lower levels, while the existing tariff rates do not allow for the upgrades necessary to handle much higher capacity flow. As a result they must manage the flows carefully so as not to overtax the system.

### ***Junction River Trading Company: The Introduction of Private Distribution***

In December 2012, Junction River Trading Company, a privately held Myanmar company, entered into a joint venture contract with MOEP to distribute electricity to the area. According to the company's Managing Director, Naing Win, the company purchases power from MOEP at a rate of MMK 42 per unit—with a real cost of MMK 50 per unit accounting for distribution losses—and is now required to sell it at the government-subsidized rate of MMK 35 per unit for residential users and MMK 75 per unit for commercial and industrial users. As a result, the company only profits from the industrial base, as well as its agreement with MOEP as the exclusive provider of equipment, such as meter boxes. As a result, it only achieves profitability after absorbing losses on residential sales.

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<sup>44</sup> Sai Zom Hseng, Hydro-power Electricity Erratic in Shan State, *The Irrawaddy*, July 22, 2010

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**Source: KWR International**

Under Junction River's management, it is now much easier to apply for and receive a commercial meter. As a result of these changes, the number of registered commercial users has increased from 741 to 2,000 and reported commercial units sold have increased from 280,000 initially reported to 440,000.

Before Junction River entered the market, the ratio was 68% residential to 32% industrial users. The figure now stands at 55% residential, 45% industrial, according to Naing Win. As industry in the area is increasing, the Managing Director's goal is to get the ratio up to 60% industrial to 40% residential in the long run.

A single-phase meter costs US\$90 plus US\$90 to install. For industrial purposes, a 10 KW (10/30a) three-phase meter costs MMK 928,000, a 20 KW (20/60a) three-phase meter costs MMK 1.215 million and a 30 KW (30/80a) three-phase meter costs MMK 1.5 million. Registration fees are additional.

Arrangements such as the one Junction Rivers has with MOEP are said to be becoming more widespread in Mandalay, which is larger and consumes more

power than Muse. Sinku, Madaya and Thabeikkyin, all towns in Mandalay Division, have similar arrangements. According to the Managing Director, one reason his business model is not more prevalent is the lack of adequate data available on Myanmar's power sector, compared to the needs of businesses.

Companies employing a similar model in other parts of Myanmar include: Pacific Electric, Triple Cycle and Myanmar United Power, in Mandalay; Mya Thin Kyaw in Lashio; Myanmar Golden Highland in Kut Kaing; and Mogok Image Company.

Junction River invested in a 20 MW transformer at a cost of US\$180,000 plus US\$20,000 for installation charges, cables and other auxiliary equipment. The equipment is from China. The Managing Director expects the government to pay him back in the future.

**Transformer installed by Junction River at Muse MOEP**



**Source: KWR International**

The current load at the substation is 7.5 MW. Although there is installed capacity of 20 MW, only 10 MW is connected and 7.5 MW is in use. The government also owns a 10 MW transformer that is currently on standby. If more capacity is needed, the Managing Director said he would install another 20 MW transformer, although the associated expenses were cited as a hindrance to connecting more households in the Muse area to the MOEP grid.

The introduction of market forces into the Muse power system has brought certain efficiencies to MOEP's operations. It should be emphasized, however, that the low profit margins imposed on Junction River by the Myanmar tariff system have hindered the company's ability to invest in the major upgrades needed. The existing grid needs new cables and other costly improvements particularly as demand continues to grow. While these upgrades may have been possible at the previous higher rates, they are much less feasible with the current tariffs, though if higher rates were reinstated demand would likely decline as well.

For now, however, end users benefit from the lower rates. Additionally given that Muse is able to access seemingly abundant power from the Shweli 1 Hydropower plant, there is at present little need for the costly back-up generators seen elsewhere in Myanmar. Therefore factories, like North East Gate Fruit Company, described below, have been able to plan and scale up production much more easily than industrial actors in other parts of Myanmar.

### **The Team at the Muse MOEP Substation**



**Source: KWR International**

### ***North East Gate Fruit Co: Adequate Supply Powers Industrial Growth***

Founded eight years ago, North East Gate Fruit Company is comprised of 26 shareholders, all of which are farmers from different parts of Myanmar. It is managed by Thet Naung, a Shan man who is also a shareholder. North East Gate handles the sale of cucumber, melon, mango, pineapples and other fruits, grown by shareholders, and profits are mostly reinvested in the company.

One year ago, the company opened a seven-acre factory with five machines and 80 workers. It produces plastic baskets, foam packaging and other materials used to package and protect fruit. The plastic products are sold all over Myanmar, not just for their own fruit products. While the company previously bought packaging from China, it now reports using recycled materials from the Myanmar side of the border to manufacture packaging by itself.

### **North East Gate Managing Director Shows Products to the Team**



**Source: KWR International**

The factory is one of the largest consumers of electricity in Muse, along with a paper mill and cold storage facility. The company's operations reportedly consume between 80,000 and 100,000 units of electricity per month. The bill for the current month was 170 lakh.

The General Manager said they have no disruptions of their electricity supply. Unlike in most of Myanmar, where supply constrains productivity, if North East Gate needs more electricity, they can pay more and the supply will be available. Although the business for the fruit packaging products was reported to be seasonal, the factory has been running 24 hours per day year round.

### **Workers at the North East Gate Plastic Factory**





**Source: KWR International**

When North East Gate opened its plastic factory, the company used a generator and lost money as a result of the high electricity costs. The company has kept the generator on standby so as to not disturb production in case of power outages. The general manager reported, however, he has only had to use it about twice per year. Anytime there is a problem, he says Junction River fixes it right away.

By contrast, in Patheingyi, Mandalay, Monywa and many other locations, interviews conducted by the Team during Phases I and II with representatives of factories and special economic zones detailed the difficulties of frequent black-outs and expensive backup diesel generators, which increase production costs, made development of these facilities problematic and cut steeply into profits.



### **North East Gate's Plastic Inventory**



**Source: KWR International**

The General Manager reported an average wage for his factory of about US\$80 per month, which comes out to about US\$130 per month with overtime. The salary includes medical care, dormitory lodging, food, some entertainment and wifi for employees.

The company reported solid growth and is planning for more machines, greater production and additional projects, including a larger distribution facility for the trucks that take the company's fruit to market throughout Myanmar. The company reports up to 1,400 trucks, half from Myanmar and half from China, take their fruit to market on a daily basis. The company reportedly sold 2.5 million baskets this year, up from 1.4 million baskets the year before.

The General Manager said the company has had interest from foreign investors including a German and an American and is attempting to obtain an MIC license.

The existence in Muse of adequate power from Shweli 1 at low, subsidized tariff rates combined with potential backup from China, has benefited local industry. Companies, like North East Gate, have been able to manufacture products, scale up production and plan for future growth, activities which have been a struggle in other parts of Myanmar.

#### **Wall Hanging in the North East Gate Office in Muse**



**Source: KWR International**

#### ***Muse CBD: Reliable Power Supply Is Crucial to Industrial Planning***

The Muse Central Business District project (CBD) has six zones spread over 1.2 square kilometers of land. It encompasses a shop house area with a jade mall, hotel and retail venues; a public service area with banks, offices, community center and other services; a hotel and restaurant area; and three villa and resort areas. A bus station, said to be able to accommodate more than 1,000 buses, is also planned to facilitate travel to and from the region.<sup>45</sup>

#### **The Team Examines the Model for the CBD**

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<sup>45</sup> *China News, op.cit.*



**Source: KWR International**

The project is being implemented by Mandalay-based New Star Light Development Company in partnership with the Shan State regional development committee. It is managed by New Star Light Vice President and Muse native Sai Mauk Kham. The first phase of the project, including infrastructure, required roughly a US\$100 million investment, provided by New Star Light. Currently the shop houses are completed and available for rent, although the market has not opened officially, and may be leased for 50-year periods. A reported 80% of these shop houses—which are 3.5 story buildings with commercial space on the ground floor and living space above—are already leased. Confirmed tenants include supermarkets City Mart and Ocean, a new Ibis hotel and several banks.

It is estimated the total project, which will encompass several phases, will require over US\$500 million in investment, although the latter phases are still in planning.

### **The Team Looks Over the Muse CBD Site**



**Source: KWR International**

The project is currently using a temporary power supply from China in the form of a line running from the Ruili grid, under an agreement that, according to *China News*, began in 2013.<sup>46</sup> According to the developers, there are plans to build a proper underground cabling system within the next few months. It is anticipated that the power supply will continue to flow from China for the foreseeable future, as the developers and their financial supporters had based their investment decisions on the assurance of sufficient power and were unsure of the ability of the Myanmar grid to meet the needs of the project.

Upon completion, it is estimated CBD will consume 28 MW for all of its six zones. As the region develops over the next few years, there will be greater power

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<sup>46</sup> Ibid.

consumption and the developers are concerned whether sufficient power will be available from Myanmar. They were not concerned, however, over the China-Myanmar political relationship and any potential impact on electricity supply.

According to the Project Manager, 90% of the construction materials and 30% of the labor for the project come from China. The rest are from Myanmar. He estimated there were 700+ workers, including some from other parts of Myanmar are working in Muse on this project, however, the operations director estimated a smaller number of workers.

Projects like the CBD, which create jobs for Myanmar citizens and attract trade and tourism to the region, require substantial investment and long-term planning. Such developments are not possible without the guarantee of a reliable power supply. In other parts of Myanmar, this has hindered economic activity as many investors and private actors are unable and unwilling to rely on Myanmar's national grid, which presently does not offer sufficient supply or sufficient reliability to maximize industrial development.

Financing is also extremely difficult. Upgrading Myanmar's power system is only possible with the assurance of long-term investment many projects have been delayed since grid-supplied power is insufficient and investors are reluctant to commit to unproven projects which require large captive power development. In this case, the CBD has been able to move forward due to the project's proximity to China and its ability to connect directly to the Chinese grid.



### **The Team with the Muse CBD Developers**



**Source: KWR International**

**Conclusions:** Muse further illustrates the utility of private involvement in the power sector, as well as some of the challenges. Given the present tariff structure, the independent power provider, Junction River, is operating at loss when it brings households onto the grid and only profits when it connects industrial users at higher rates. As a result, Junction River is motivated to introduce efficiencies into the system and increase its industrial base, whereas the national government and international plans for universal electrification have been more focused on residential usage. This will be an important consideration as national electrification plans will ultimately require the involvement of private actors, which, at present, are disincentivized from participating in the household electrification due to the low tariffs.

Furthermore, with minimal opportunities to profit from electrification, neither Junction River nor MOEP have the funds necessary to upgrade the area's power

lines and other infrastructure to properly accommodate increasing economic activity and demand. Although Junction River financed the cost of a higher capacity generator for the area—with no guarantee of being repaid by MOEP—much greater investment will be needed to upgrade and maintain other infrastructure, including necessary transmission and distribution lines.

Muse is also an interesting case study in how areas with access to both China-supplied power and the Myanmar national grid can potentially benefit from both the reliability of the former and the low prices of the latter. Despite the reliability of Chinese power, which was widely used in Muse in the past, many commercial and residential users switched to power from the Myanmar national grid when it became available due to the lower tariffs. Larger-scale industrial actors, meanwhile, have continued to use direct electricity supply from China.

This set-up has allowed small industry to lower costs and increase production, while industries with higher scale and demand, such as the CBD, are able to rely entirely on power provided by China. Such a large-scale, high-cost investment would not be possible without the assurances guaranteed by China-provided power. The ability to plan for projected demand, which the Myanmar grid would be unlikely to accommodate, has facilitated investment and project development, allowing early movers to take advantage of increasing economic activity, tourism and migration to the Muse area.

### **Interview List**

- Naing Win – Managing Director, Junction River Trading Company
- Mg Aye – Assistant Director, Junction River Trading Company
- Various Employees, Junction River Trading Company
- Officials at MOEP Substation in Muse
- Thet Naung – Manager, North East Gate Fruit Company
- Various Employees, North East Gate Fruit Company

***KWR International (Asia) Pte. Ltd.***

- Ko Maung Sein – Operations Director, New Star Light Construction Co. Ltd.  
(Muse CBD)
- Rocky Tsai – Project Mgr., New Star Light Construction Co. Ltd. (Muse CBD)
- Arvin Zhang – Shwe Hlaing Tun (Rice Trader)



## **Laukkai: Introduction of Market Forces and More Rational Operating Environment**



### **Overview**

*Laukkai is located in a mountainous area along the Myanmar-China border, roughly 117 miles northeast of Lashio. Capital of the Kokang self-administered region, Laukkai is largely outside the direct control of the national government and has been troubled by ethnic conflict. Its investor-oriented approach to electricity generation and distribution, led by the Kokang Electric Company, can inform national and regional energy and electricity policies. The local electric company has been able to set its own tariffs—significantly higher than Myanmar's government-subsidized rates. As a result, it has garnered enough profits to invest in new power plants, equipment upgrades and higher quality transmission and distribution lines.*

**Profile:** Laukkai is the capital of Kokang, a Self-Administered Region that between 1989 and 2011 was classified as one of Myanmar's Special Regions, and a brown zones, which means it has been troubled by ethnic conflict. Located in North Shan State, Kokang is bordered by China's Yunnan Province to its east and the Salween River to its west, separating it from Wa, another self-administered area. Laukkai is situated roughly 400 meters above sea level, but several villages and hydro facilities visited by the Team are located in the mountains at much higher altitudes.

Isolated from the rest of Myanmar, Kokang has long been independently administered and at times compared to a private fiefdom. The locals speak Chinese and Shan, not Burmese. The Chinese yuan is used as currency, and telephone lines and others services are provided by Chinese companies.

Kokang is home to no less than seven ethnicities: Kokang Chinese, Shan, Palaung, Lahu, Lisu, Wa and Miao, in addition to transient Chinese populations who cross the border for temporary employment and other opportunities.<sup>47</sup>

According to local officials, income of around US\$300 per month is possible in Laukkai for porters, day laborers and other workers.

### **Villagers Converge at the Local Marketplace**



**Source: KWR International**

A government presentation delivered by the Chief Minister in Taunggyi projects annual per capital income of MMK 712,767 for 2014-15 in Laukkai, up from MMK 690,060 in 2011-12, which is roughly 5.5 times lower than the income reported in other border towns, including Tachileik. Local Kokang administrators reported higher income levels for certain villages, in the range of 1.20 lakh to 1.30 lakh, more than US\$100 per month, which is roughly on par with Yangon. It was reported that villages closer to the local marketplace, in the village of Tan Shwe

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<sup>47</sup> Joint Kokang-Wa Humanitarian Needs Assessment Team, Replacing Opium in Kokang and Wa Special Regions, Shan State, Myanmar, 2003

Htan, have even higher income as they have greater opportunities to sell products. Income in Tan Shwe Htan was reported to be between US\$175 and US\$200 per month. Within Laukkai itself, there are also gambling casinos and other service businesses, which provide higher compensation levels.

### **Marketplace in Tan Shwe Htan**



**Source: KWR International**

Kokang is also the site of ongoing ethnic tension and carries a legacy as one of the region's top producers of opium, which at one point accounted for over 20,000 acres of land in Kokang and a significant portion of the local economy. According to local officials and business people, several decades ago opium was sold openly alongside vegetables and other products in the local marketplace.

Despite a ban on the opium trade in the early 2000s, and reports from local officials that it is much less widespread than in the past, Shan State as a whole

was reported to have accounted for 92% of Myanmar's opium production in 2013, according to the United Nations Office on Drugs and Crime.<sup>48</sup>

At present, much of the economic activity in Kokang has been promoted as an alternative to poppy cultivation. According to local officials, the region's economy is now based mainly on agriculture, including sugarcane, tea, rubber, paddy, corn and walnut. A large proportion of crops produced in Kokang are sold to China.

Casinos and other gaming centers, massage parlors and karaoke bars are also a large part of the local economy and line the streets of downtown Laukkai. Although many of the employees are from China, the Team was told casino revenues help fund roads and other development projects for Kokang.

The region has also received significant foreign support to help reduce its dependence on opium cultivation and to mitigate the adverse effects of narcotics activities on the local economy, which have included food shortages and disease.

#### **Plaque Describing Japan's Assistance to Kokang**



**Source: KWR International**

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<sup>48</sup> United Nations Office on Drugs and Crime, Southeast Asia Opium Survey 2013: Lao PDR, Myanmar



A malaria clinic was set up in Laukkai by the NGO Global Fund, while WFP and the Chinese government provided emergency relief. CARE and other organizations, including the Japanese government, have been involved in crop substitution programs. In 2005, as part of its assistance to the area, Japan also donated 15 km of power lines to Laukkai, infrastructure that continues to distribute power to the area.

There have been a number of challenges to crop substitution in Laukkai, including poor transportation and storage methods, as well as lack of technical knowhow on the part of local farmers and inability to purchase fertilizers and high-yield varieties of seeds. In contrast to the crop substitutions, opium cultivation requires low levels of technology and no special packaging or storage. Technical and economic assistance to the region is reportedly difficult for the Myanmar government due to the language barrier and overall isolation, while monitoring and enforcement along the porous borders has also posed a hurdle.<sup>49</sup>

Nonetheless, there is significant potential in Laukkai for further economic development. With its rich scenery and mountainous landscape, the Team witnessed significant opportunities for eco-tourism and hiking. This might, however, hinge upon a resolution to the ongoing ethnic conflict, as some of the hills surrounding Laukkai are reported to be inhabited by armed rebel groups.

Cross-border trade and manufacturing are also being developed in the region. In October 2014, it was announced that MIC had set aside more than 1,000 acres in Kokang for the development of a special economic zone.<sup>50</sup> The Team was shown the site of this development just next to the China border. It will include a rubber factory and a cigarette factory, among other commercial activity. The

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<sup>49</sup> Carl Grundy-Warr and Elaine Wong, Geopolitics of Drugs and Cross-Border Relations: Burma-Thailand, International Boundaries Research Unit, *Boundary and Security Bulletin*, Spring 2001

<sup>50</sup> [MIC Assigns Over 1,000 Acres in Kokang Self-Administered Area as SEZ](#), *Eleven Newsmedia*, October 20, 2014

special economic zone will be carried out as a joint venture between the Kokang self-administered government and Kokant Mar Li Par Development Company.<sup>51</sup>

### **Hillside in Laukkai**



**Source: KWR International**

### ***Kokang Electric Co.: Special Circumstances Overcome Tariff Obstacle***

Kokang Electric Company (KEC), a privately held company in the self-administered zone, distributes 7 MW of power to 7,000 meter boxes in Laukkai and 3,000 meter boxes in Chone Chin, for a total 10,000 registered users. KEC also distributes water and water treatment. The company is run by Director Kaw Kyin Lone and Managing Director Myint Swe, who is also the Chairman of the District Development Committee,

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<sup>51</sup> Ibid.

### **KEC Director Myint Swe Shows the Team His Company's Hydro Facilities**



**Source: KWR International**

KEC is a reseller for a Chinese power company and distributes electricity at a rate of 1 yuan (MMK 160 or US\$0.16) per unit. KEC purchases electricity from China at 0.6 yuan per unit, for a 0.4 yuan per unit profit, minus a royalty of approximately MMK 5 per unit of electricity sold which is paid to MOEP. This agreement, according to KEC's directors, has been going on since the late 1990s.

According to the KEC directors, MOEP began operating a 320 KW hydro power plant in the area in 1992, with only 128 meters under its control. Another ten meter boxes connected government offices in the area, with power supply coming from a diesel generator. The power available from MOEP, which was distributed at the government-subsidized rate at the time, was reportedly not adequate for the region's needs and China soon moved in with better supply. Of



the 7 MW currently distributed by KEC, 6 MW come from China. The other 1 MW comes from a hydropower plant owned by KEC.

The company owns four hydropower plants total, including the 320 KW hydropower plant that was transferred from MOEP to KEC's ownership in September 2013. The KEC directors told the Team the plant is currently in "test mode" and is not yet distributing power to the area.

### **Hydropower Facility Owned by KEC**



**Source: KWR International**

The other plants owned by KEC are under construction and include a 2.4 MW hydro facility, with 3 800 KW units, in Char Hom which provides temporary water supply to Laukkai, and a 3.2 MW plant in Konegyon.

The Char Hom hydropower facility is slated to provide for the local industrial zone. The investment cost for the facility is 50 million yuan, or just over US\$8 million. KEC's directors anticipate it will be paid off in about ten years time.

### **The Char Hom Hydropower Construction Site in Laukkai**



**Source: KWR International**

During a site visit to the Char Hom facility, the Team was told it was being built so Kokang can achieve energy independence from both China and the Myanmar central government. Within six years, they plan to cut off Chinese power.

Although a substantial portion of the electricity supply is from China, local officials say there is no formal agreement on cross-border electrification here, simply a mutually beneficial understanding between Myanmar and China.

Most of the transmission and distribution lines in the area are extended from the China grid, or were installed or upgraded by KEC using Chinese technology. Due to the profits made by KEC, they are able to afford proper maintenance and upgrades, including coated cables to lessen transmission and distribution losses.

### **The Team Discusses KEC Equipment with Company Directors**



**Source: KWR International**

MOEP is said to be extending the Myanmar national grid to the region in preparation for the rollout of the national electrification plan. The KEC directors told the Team that roughly 25 miles of MOEP lines were already in place in the area. They expect the Myanmar national grid to begin distributing power to the area by 2016.

The Team raised the question of what would happen to the business model when the national electrification plan takes shape in the region and the government requires the company to sell power for MMK 35 per unit. The KEC directors said they would be open to an agreement with MOEP along the lines of Junction River's in Muse. They did not, however, believe they would be required to lower rates, citing an announcement by the MOEP that they are losing money at the MMK 35 per unit rate. The KEC directors also believed locals in this area would

not protest the need to maintain current pricing, which would remain above the subsidized rates.

**The Team with KEC Directors at the KEC Office in Laukkai**



**Source: KWR International**

***Off-grid electrification initiatives in Kokang rely heavily on China***

According to the presentation delivered by Shan State officials in Taunggyi, there is a goal of electrifying 278 villages in the Laukkai area, more than half of which (162) have already been electrified. The vast majority of these were brought on to the China grid. According to the Team's interviews with local administrators in Laukkai, villagers in Kokang can connect to the Chinese grid on an individual basis and are not required to adhere to the MOEP's 24 conditions.

### **Electrification Methods in Laukkai**

<b>Laukkai</b>	National Grid	Neighboring Country Grid	Diesel Engine	Solar	Mini- Hydro
# of Villages Electrified	0	102	3	14	43

**Source: Government presentation delivered by Shan State officials in Taunggyi on October 13, 2014**

Micro-hydro systems are much more prevalent in Laukkai than other types of off-grid technologies. The regional administrators reported only two villages using solar panels, although the presentation delivered in Taunggyi stated 14 villages in Laukkai were recently electrified using solar panels. It is possible one source is citing figures for the city proper, while the other is citing figures for entire township. Such inconsistencies highlight a common challenge of relying on data in Myanmar.

Interestingly, donor assessments of off-grid villages to be brought online by the National Electrification Plan generally do not count villages currently electrified by the Chinese grid as off-grid. This is important as costs associated with switching villages from the Chinese-supplied grid, which is already in place, to the national grid will vary substantially from the cost of extending the national grid into new areas and villages that presently do not have any connections or facilities.

### **Conclusions**

Laukkai's location within a self-administered region has created unique circumstances that have allowed for the introduction of market forces and an operating environment that is connected to the grid and at least for now is not constrained by Myanmar's tariff structure. KEC, does not operate within the confines of the existing tariff structure as it produces power independently and



receives it from China. In addition, its self-administered status may allow it more flexibility once the Myanmar grid is fully connected. As a result, there is sufficient mark-up on electricity distribution to pay for installations and grid connections and to develop hydro plants, power lines and other infrastructure. KEC officials were confident they would not be required to charge the standard subsidized rate of MMK 35 per unit even when MOEP extends its reach into the Laukkai area.

Because of the economic potential in Laukkai, with opportunities for growth in agriculture, tourism, trade and industry, and the presence of entrepreneurial locals, electrification and development initiatives become easier than in marginal areas such as Mauhit.

One concern, however, is that MOEP appears to be building grid lines running parallel to the existing system from China in preparation of extending the grid to the Laukkai area. This highlights a similar problem as that seen in Ho Saung that plans are being made to switch over populations to the national grid even if they are already receiving reliable, regular and affordable power from China or, in this case, independent domestic producers.

Laukkai also highlighted a challenge prevalent throughout Myanmar: that of poor data collection and coordination. Township officials and a regional government presentation differed substantially in the figures cited for Laukkai's population and the number of villages being prioritized for rural electrification initiatives.

This is significant as local data may be more accurate given it is produced by people who are on-the-ground but it is the regional office that ostensibly will be making decisions and budgetary allocations, particularly as the country moves forward with a national electrification plan. Therefore an examination of these differences and why they exist is extremely important.

## **Interview List**

- Myint Swe – Chairman, District Development Committee and Managing Director, Kokang Electric Company
- Myint Swe's son
- Kaw Kyin Lone – Director, Kokang Electric Company
- Kokang Electric Company Employees
- U Wynn Ko Ko – Township Administration Official
- Township Administration Employees
- Villagers
- Hydropower Plant Employees

### **PHASE III FIELDWORK ANALYSIS**

North Shan State's integration with China was far more substantial than what the Team had hypothesized based on prior observations in Tachileik and Southeast Shan State. The Chinese grid extended more than 50 miles into Myanmar in at least two different locations, compared with only a few miles in Tachileik, and served as an integral component of the region's development. In addition to facilitating the creation of the CBD and other areas as a primary power source, power from China was used in some places as an alternative or backup supply, minimizing the need for high-cost diesel generators.

The Myanmar grid was also present in some locations in North Shan State and is being expanded. This is partly due to the Myanmar government's desire to maintain sovereignty, and enhance control of a region that has been troubled by ethnic conflict as well as a desire to adequately provide services to its citizens. In some cases this is also driven by demand for cheaper, subsidized tariffs on the part of residential and industrial consumers in these areas. Although the power supply in the Muse area appeared adequate by Myanmar standards, it was limited by existing grid infrastructure. The current distribution and transmission lines were not developed for the current and growing demand which is rising both due to increased development in Myanmar and low tariff rates. At the same time, because the tariff on Myanmar-supplied power is so low, upgrading and maintaining the infrastructure will be a challenge.

The use of off-grid electricity sources was less prevalent than in other parts of Myanmar, given the prevalence of Chinese power. Such alternatives are important, however, for isolated or impoverished communities and those that are not yet able to connect to the Myanmar national grid.

A number of factors influenced the reliability of power distribution, and there are several lessons to be learned from examples of both efficient generation and distribution in North Shan State.



*Private Involvement and the Importance of Tariff Structures*

The prevalence of private actors in power generation and distribution was also a major distinction of North Shan State. In Nam Khar Kam, Ho Saung and Laukkai, local actors were able to make a profit by purchasing electricity from agents of Chinese power suppliers and reselling to households and businesses at market rates that are seemingly based upon distance from the China border, competition and the amount of transformers and other equipment required to transmit power. Profits increased as new consumers connected to the grid and electricity demand rose. This allows the private actors to upgrade cables and other equipment, increase capacity and bring new households onto the grid as paying customers.

Private involvement differed in Muse, where the local distributor, in a joint venture with MOEP, was required to apply Myanmar tariffs, therefore requiring a loss on household connections. The incentives in this case were toward the onboarding of industrial consumers, who pay higher rates, as opposed to household consumers. This is significant as, despite the fact the models based on Chinese power supply functioned well and were affordable to locals who had higher than average income levels, villagers in some cases expressed an interest for MOEP-subsidized power. Plans were underway, even in Laukkai, to extend the Myanmar national grid to areas that were already sufficiently covered by Chinese power. The Myanmar government's desire to maintain and enhance sovereignty and provide services like electricity to its citizenry is understandable and a sound long-term goal. Over the short-term, however, it is questionable whether areas that receive adequate power from another source should take precedence over those that currently receive no electricity.

Besides diverting resources from more remote, off-grid locations, replacing Chinese-supplied power with that of the Myanmar national grid will affect private actors as well. For instance, if a village like Ho Saung, with little industry, were to switch to the Myanmar national grid, it would ostensibly fall under the mandate of Junction River in Muse, which is trying to increase its ratio of industrial users to

household users and has no immediate incentive to take on such a village. That said, there would be ample opportunities for Ho Saung's industry to develop given the overall growth of the Muse area over the longer term.

### *Continuing Challenges in Data Collection*

The reliability of data in Myanmar continues to be a challenge to national planning and private sector involvement. Employees of local government offices in North Shan State admitted that, despite receiving some training on data collection, they did not believe they were sufficiently prepared and were not confident of the data they were submitting to international agencies involved in developing national electrification plans. This is significant as many of these agencies are relying on data submitted by these offices and are not undertaking in-depth surveys or fieldwork independently.

Furthermore, in Laukkai it was reported that villages that receive power from China's grid are classified in Myanmar as "off-grid." As a result they are included in the targets to be electrified under various initiatives when in reality, the infrastructure for power provision largely exists.

The Team also witnessed discrepancies in data between its prior research, what was cited by Shan State officials in Taunggyi, and that given by township officials and representatives of local MLFRD and MOEP offices in the region.

In addition to the difficulties this creates for national planning, poor data was cited as a barrier to greater private sector participation in the electricity sector. Businesses considering joint ventures with MOEP, like that of Junction River, for instance, require accurate data to create business plans and project future earnings.

*Greater Coordination Needed in Electricity and Economic Development Planning*

Phase III fieldwork also highlighted the difficulties in coordinating rural electrification initiatives. In some cases rural electrification initiatives are being undertaken in areas where MOEP is already connecting populations to the grid. Interview subjects, however, said coordination is getting better, potentially in preparation for the implementation of a national electrification plan. It is still unclear, however, how well the ministries are able to determine priority villages, and whether the income data submitted adequately recognizes income disparities within villages or merely average income.

## **PHASE III FIELDWORK CONCLUSIONS**

### **CROSS-BORDER/REGIONAL INTEGRATION CONCLUSIONS AND RECOMMENDATIONS**

#### *Regional Energy Integration*

#### **1. *Regional Energy Integration Requires Myanmar to Carefully Balance External with Domestic Concerns.***

While much of the discussion taking place around regional energy integration focuses on Myanmar's role as an exporter of oil and gas—a controversial stance given rising domestic energy supply needs—it is clear from the fieldwork conducted that Myanmar in fact has much to gain from cross-border electricity trade. While there will be difficulty building political support within Myanmar for regional plans that emphasize oil and gas exports, this stance overlooks the myriad examples of power supply from China and Thailand that have facilitated economic growth along the periphery. In addition, these cross-border arrangements present an opportunity for Myanmar to learn from its neighboring countries' expertise to help establish more rational electricity distribution structures. One area where Myanmar could enhance the benefit is by strictly enforcing a favorable royalties system on actors distributing power in its territory.

#### **2. *Regional Integration Must Balance Political and Economic Concerns.***

Despite the benefits of the electricity supply certain border areas in Myanmar receive from China, the Myanmar government is moving to switch the areas over to power supplied by the Myanmar national grid. It is understandable that Myanmar would like to maintain and enhance its sovereignty and ensure that electricity provision is not used as a means of exerting foreign influence over the country. Myanmar residents have largely encouraged the shift as they will be able to pay government-subsidized rates that are lower than the market rates they pay to Chinese power providers. The tariffs, however, are not

economically feasible and do not allow for the profits necessary to undertake proper upgrades and maintenance to the grid system. The Myanmar power supply is also less reliable than that from China and cannot accommodate large-scale development or industrial needs. Further, switching over areas to the national grid that already receive adequate power supply from China diverts electricity and resources from more remote, unelectrified areas that could make better use of a grid connection. Therefore, the Myanmar government might question whether it is better to prioritize other areas and switch the border regions to the Myanmar power supply during the latter stages of national electrification.

### ***3. Myanmar Is a Beneficiary As Well As a Contributor to Regional Energy Integration.***

In addition to the benefits accrued from Myanmar's cross-border arrangements with China and Thailand, revenues from energy exports—which are generally seen as less desirable than domestic use given the country's history of poor resource management—can, if handled properly, be used in a way that will contribute to rural development and electrification. This can also drive improvements to the national grid and power stations. Instead of dismissing exports, Myanmar can seek to put into place a system that acknowledges the stabilizing role of energy exports in Myanmar's financial history and that learns from and corrects past mistakes. Hydropower generation, for example, is more sustainable than gas and exporting this resource may have less of an impact domestically. In addition, reports on Shweli 1 power, the majority of which is slated for China's use, suggest the developer has been flexible in allocating a greater share of power to Myanmar in the midst of severe power shortages. While a more detailed analysis would need to be undertaken to determine the specific balance between exports and imports that would maximize the benefits to Myanmar, the conversations on regional integration must first transition from that of a zero-sum game to one

that acknowledges the potential for a mutually beneficial and multi-faceted role for Myanmar.

***4. Regional Energy Integration Can Assist in Catalyzing Myanmar's Growth and Development.***

The development of the Muse area in general, and the CBD in particular, has relied on the availability of stable power from China which provides the capacity to handle high demand projections. This project would not have likely been able to access financing or make development plans without a guarantee of stable and sufficient power, which the Myanmar grid could not supply. In turn, as the region develops and the CBD is launched, the area is likely to see increased trade, tourism and economic activity. A visit to Tachileik along the Myanmar-Thai border demonstrated similar outcomes: higher incomes, greater economic activity and population growth generally follow reliable, stable power supply.

***5. Regional Energy Integration Requires Myanmar to Address Social and Environmental As Well As Financial Concerns.***

Potential negative social and environmental impact from Myanmar's ongoing and future energy projects—ranging from pollution and carbon emissions to displacement of local communities and destruction of livelihoods—requires greater attention. This is particularly true in relation to projects along the Thanlwin, where the stakes are high both in terms of the potential power output as well as the potential political and economic backlash that would occur if a disaster were to affect Myanmar and its neighbors. Financial considerations are also important and, in some cases, intersect with social/socioeconomic impact. For instance, villagers in Ho Saung, just outside Muse, despite having access to power from China, are seeking to transition to the Myanmar national grid and reliance on a subsidized tariff even though that

may mean less reliable supply and have a subsequent negative impact on economic activity. Further, on a national level, this line of thinking will divert resources from off-grid areas that are in greater need of power supply from the national grid.

## ***6. Myanmar Can Play a Key Role in Facilitating Regional Integration.***

A changing Myanmar, with its economic opening and political reforms, has attained a higher profile on the international stage, most recently as host of the ASEAN summit in November 2014. The country can leverage its international standing to contribute to policies on regional energy integration, as well as economic integration, in a way that not only facilitates regional connectivity but also promotes growth within Myanmar and the region as a whole. As a major link to regional powers, Shan State and the direction taken with energy projects under development with Thai and Chinese investment, can play a critical role in shaping these policies.

## ***7. Regional Energy Integration Can Take Many Forms.***

Whereas certain areas of Myanmar currently gain access to Chinese and Thai power, primarily through informal, independent lines such as those seen in Laukkai and Tachileik it is also possible that electricity supply from China and Thailand can be provided through the Myanmar national grid. While there are political and other implications that need to be resolved, and perhaps a trade-off made in respect to export sales of gas or hydropower, this would provide for continuous connectivity during peak periods while eliminating the need for cross-border distribution lines with payments going directly to a foreign utility. Myanmar would therefore be providing for its citizens through its own national grid and maintaining its sovereignty and control of power provision. If for some reason power from China and Thailand were shut off, Myanmar could continue to supply power through the national grid at reduced

levels. This could position Chinese and Thai power as a substitute for the costly procurement of many individual generators, which is seen throughout Myanmar as a back-up to Myanmar's unreliable supply. As Myanmar's national energy and electrification plans develop, supply from China and Thailand could be reduced if it is decided the country's resources can adequately power its residential and commercial needs.

### *Electricity Generation and Distribution*

#### **8. Rural Electrification Becomes Less Complex with a Rational Structure.**

Shan State is home to several self-administered and special regions, and its northern areas are somewhat isolated and more integrated into China, with less involvement from Naypyitaw. This has significance in terms of electricity generation and distribution. As a result, there appeared to be more room for experimentation and greater involvement by the private sector, with a prevalence of public-private partnerships in electricity generation and distribution. Policies on electrification were different in border areas, particularly in the Self Administered Region of Kokang. Tariffs were not always subject to government-subsidized rates, meaning private providers were able to generate the higher returns needed to connect villages, replace equipment and scale up capacity based on economic factors, with national political or institutional considerations playing a lesser role than in other places in Myanmar. It also placed less emphasis on off-grid solutions or home units, given the relative ease of grid connection and mini-grid development in the region.

#### **9. Electrification Becomes More Feasible When Motivated by Entrepreneur.**

Private involvement in the electricity sector was more widespread in border areas than much of the country. With an incentive to profit from power



provision, either due to higher, unregulated tariffs or existence of industrial users with whom there is room for profit even with government-subsidized rates, private actors have introduced efficiencies and capital investment into Northern Shan State. While household electrification has been prioritized within Myanmar's national electrification efforts for political and other considerations, for the public-private partnerships witnessed, household electrification loses money when sold at the residential tariff rate. While this is also true for power provided by MOEP, private concerns do not have the same political concerns and objectives and must achieve profitability to maintain solvency. Therefore it is a more immediate priority. Thus the emphasis by entrepreneurs and developers is on promoting growth of the industrial base. Therefore, such border area practices can inform Myanmar policies as the country moves toward the creation of new regulations governing the power sector and private and foreign investment.

#### ***10. Stable Power Supply Benefits Industrial and Residential Activity.***

A stable supply of power, as was seen along the border—either due to supply from China or functioning public-private relationships—helped local industry develop and increase capacity without concerns over power availability. This generated employment opportunities, greater economic activity and, in turn, more demand for power. Households, likewise, benefited from relatively advanced appliances, as well as tools that could add value to agriculture and other activities. The introduction of such appliances and tools also allows individuals to save time on menial tasks and turn attention to income-generating activities. This further adds to economic development. Therefore electrification policies cannot be divorced from industrial and commercial activity. While arguably somewhat longer-term than immediate residential connections, placing an emphasis on industrial and commercial usage and the economic benefits of electrification will provide a more sustainable base. It will also lead to higher income generation and ability of the local population to afford power consumption and maintenance.

***11. Particular Attention Should Be Given to Areas Where Economic Inequality Exists.***

Fieldwork visits witnessed villages wherein roughly half of residents had functioning electricity schemes, while the other half, generally corresponding to the poorest households, were said to have only batteries or kerosene as a power source. Discussions with MLFRD in Lashio in Shan State suggested that the national government decides priorities for rural electrification assistance based on village income, however, merely looking at average income may overlook the needs of the poorest households in villages with income inequality.

***12. Data Collection and Coordination Remains an Important Challenge to National Planning.***

Discussions with regional and self-administered governments underscored the challenges that still exist in data access and collection in Myanmar. One engineer in a regional government office confided they had not received enough hands-on training on data collection to provide sufficient data to donors and other international organizations seeking to develop national electrification plans. Poor data was also cited as a challenge to private sector involvement in the power sector, as investors need accurate data to make business decisions. In the case of Junction River in Muse, the company was able to obtain and analyze data on residential versus household users and adjust inaccuracies to raise the number of industrial users and increase revenues.

***13. More Coordination Is Needed Between Electricity and Rural Development Policies.***

Increased cooperation between MOEP and MLFRD—the two ministries charged with facilitating national electrification and rural electrification

development—would assist in efforts to improve data collection, prevent duplication of efforts and enhance the ability to coordinate off-grid and grid extension initiatives in a way that would eventually converge. The importance of this was noted by both MOEP and MLFRD officials, in separate interviews, noted the lack of coordination between the two ministries as a hindrance to rural electrification initiatives. Furthermore, as a number of international agencies and NGOs are engaged in rural development and economic empowerment initiatives in Myanmar, in particular in Shan State, these activities could likely be enhanced if coordinated with rural electrification schemes.

## **E) NEXT STEPS**

The development of a framework by which various electrification options can be assessed according to national, regional and village resources and circumstances has been lauded by a number of stakeholders seeking to contribute to Myanmar's electrification plans. Furthermore, dissemination of information, workshops and convening of key public and private stakeholders, whose work and focuses overlap, but who were not previously interacting to discuss issues of this kind, has proven extremely valuable. It has helped to build shared understanding and consensus and to provide a forum in which discussion of important issues can be held. Future activities can be focused on the following four areas:

### ***1) Research and Fieldwork***

Through extensive site visits and examination of the three core issues of grid extension, off-grid electrification and cross-border energy and electricity sharing, this research has helped to contribute to a broad understanding of the dynamics that underlie Myanmar's national electrification efforts. Myanmar, however, is a large and diverse country. Further research and fieldwork can help frame other geographic and functional issues that need to be addressed. This might include study of planned large-scale Thanlwin hydropower projects, Myanmar's energy relationship with India, and the potential of solar and other mini-grids. As much of the focus of past rural electrification research and initiatives in Myanmar has been on residential connectivity, examination of the relationship between, and how best to synergize, electrification and economic activity in rural areas would also prove valuable.

Further study might also be initiated to detail potential parameters of a Rural Electrification Act, to facilitate better provision of operations and maintenance training and certification for off-grid installations, and how to best frame

standards to allow more effective use of gasification technologies. Grid convergence and potential characteristics of a grid connection code might also be examined so that off-grid installations can potentially be planned in a way that will allow them to ultimately be connected to the grid. This would help encourage private sector activity as presently off-grid installations face high risk given their utility is threatened once grid lines reach their respective areas and generation begins under Myanmar's tariff regime.

## ***2) Strategic Analysis, Integration & Report Preparation***

Substantial data has been assembled through this research on Myanmar and its electrification and rural electrification needs. This is true both on the macro/national as well as on micro/village level, including identification of many of the factors and policy issues that need to be addressed for the country to achieve its electrification and rural electrification objectives. While the primary emphasis on this research and fieldwork to date has been on the development of this information, additional attention should be focused on analyzing and integrating this data through a strategic framework so that it can be refined using policy evaluation metrics and utilized in a manner that will help to give focused insight and direction into Myanmar's rural electrification needs moving forward.

## ***3) Policy & Network Development, Consensus-Building & Facilitation***

Numerous public and private entities in Myanmar as well as foreign stakeholders have provided input into this initiative. These people and institutions are seeking help in their efforts to better understand energy and electrification issues in Myanmar as well as how best to navigate and help transform its complex and evolving regulatory environment. The Myanmar government is also seeking support and assistance as it tries to engage and involve foreign investors, and other new actors, and to adapt new policies and regulation after decades of sanctions and isolation.

Distribution of reports and materials, as well as activities and events organized as part of this initiative, including stakeholder and other meetings as well as international symposia, have played an important role in promoting communication across these groups and building a shared consensus on how to resolve these issues. To continue and maximize the benefits of these activities, these initiatives should be expanded and continued moving forward.

In a similar vein, interactions with government ministries, regional officials, business associations and companies should be reinforced, through formal discussions, relationships, the provision of advisory support and a dedicated in-country presence developed and maintained to respond to needs and requests as required.

#### ***4) Creation of a Myanmar Integrated Energy & Capacity Development Center***

A number of economic, political, institutional, financial, environmental and other obstacles exist to developing an integrated energy and electricity policy for Myanmar that is both functional and socially and politically acceptable. Capacity building, communication and information sharing must all be improved to move forward with viable policies and legislation. This is essential to build consensus and public-private cooperation as well as to avoid duplication among the various ministries, urban and rural populations, corporations, donors and investors involved in policymaking and the provision of resources, including funding and technical expertise.

The creation of a Myanmar Integrated Energy and Capacity Development Center can facilitate interactive dialogue and organize workshops and briefing sessions for, and among the various stakeholders involved in, energy and electricity development in Myanmar. This can include involved participants in training programs and stakeholder meetings, as well as domestic and foreign investors, companies and project developers and sponsors, development

partners and other entities that will play important roles in developing the energy and electrification sector in Myanmar.

This entity could address a number of topics including but not limited to rural electrification, tariff structure, energy efficiency, grid extension, grid convergence, renewable technologies and regional integration. It will also help Myanmar to successfully draw from the energy and electrification plans proposed by World Bank, ADB, JICA and other entities as it moves forward toward a goal of universal electrification.





## **APPENDIX II**

### **Overview and Agenda of International Workshop on Achieving Universal Access to Electricity in Myanmar**

#### **Third Workshop**

##### *Overview*

The Third Workshop on Development of Myanmar National Electrification Plan towards Universal Access, co-organized by the MOEP, MLFRD, and the World Bank, took place in Nay Pyi Taw on March 20, 2014.

Approximately 150 participants attended the workshop, including representatives from government agencies, international and bilateral organizations, the private sector, and domestic institutions. Stakeholders present at the Workshop include JICA, ADB, UNIDO, US Department of State, Norway, GE, and IFC in addition to the World Bank. The workshop presented and discussed the interim results and development of Myanmar's National Electrification Plan (NEP).

##### *Background and Objectives*

With strong commitment and support from GoM, both components of NEP, the **Geospatial Least Cost Electrification Rollout Plan**, and the **Universal Access Roadmap and Investment Prospectus**, was able progress and develop since the Second NEP Workshop which has held last November.

The objective of this workshop was to share the **Interim Results** of NEP, and continue discussion and debate of key issues related to geospatial least-cost electrification planning, universal access roadmap and investment prospectus, as well as enabling policy and institutional framework. Moreover, to share **Development Partners' Initiatives Supporting National Electrification in Myanmar**.

The workshop enabled to engage various stakeholders to discuss a way to reach the goal of achieving universal access in Myanmar.

##### *Presentations and Discussions*

#### **March 20, 2014**

#### **Interim Results of the NEP Study**

1. NEP Study: Implementation Progress

[1 NEP workshop Overview presentation.march 19.pptx](#)

2. Myanmar Geospatial Least-Cost Electrification Plan

[2 MMR-EIMarchPres w3states-V12.pptx](#)

3. Institutional Framework for NEP implementation

[3 March Workshop Institutional Presentation v2.pptx](#)

4. Universal Access Roadmap and Investment Prospectus

[4 Investment Prospectus Presentation March Workshop v10.pptx](#)

**Development Partners' Initiatives Supporting National Electrification**

5. Off-grid Electrification: Field Findings

[5 ADB presentation at WB NEP workshop March20 2014 CCN final pm.pdf](#)

6. Electricity (Power Sector) Master Plan: Update and Implications for Electrification

7. UNIDO's Support in Energy Access in Myanmar

[7 UNIDO MYNUNIDORE0314.ppt](#)

8. Technology Solutions for Grid and Off-grid Electrification

[8 Grid and Offgrid Electrificationdraftver12.pdf](#)

**Fourth Workshop**

*Overview*

The Fourth Workshop on Development of Myanmar National Electrification Plan towards Universal Access, co-organized by the MOEP, MLFRD, and the World Bank was held on **September 15, 2014** in Naw Pyi Taw.

The proposed Myanmar National Electrification Plan, with financial support from the ESMAP SE4ALL Technical Assistance Program, converts Myanmar's aspirational goal of achieving **universal access to electricity by 2030 into a structured and actionable national plan**. Moreover, the NEP will set the evidence base for **further investment and technical assistance** support by the development partners, central and local governments, and the private sector.

A two-pronged and planned approach is proposed under the Myanmar NEP: an aggressive grid electrification rollout program and an ambitious off-grid program. A detailed investment prospectus for the first five years lays out in details the investment requirements, fundamental institutional reforms needed and comprehensive solutions to the financing constraint.

### *Background and Objectives*

The Fourth Workshop presented the results of the National Electrification Plan (NEP), and discuss the next steps for its implementation.

### *Presentations and Discussions*

## **September 15, 2014**

### **Results of the NEP Study - ppt**

#### 1. NEP Study Overview

[Myanmar NEP overview 9-12-2014.pptx](#)

#### 2. Myanmar Geospatial Least-Cost Electrification Plan

[Myanmar NEP Geospatial 9-15-2014.pptx](#)

#### 3. Institutional Framework for NEP Implementation

[Myanmar NEP Investment Prospectus 9-12-2014.pptx](#)

#### 4. Universal Access Roadmap and Investment Prospectus

[Myanmar NEP Institutional Presentation 9 12 2014.pptx](#)

### **Results of the NEP Study- pdf**

#### 1. NEP Study Briefing

[Myanmar NEP EXEC Briefing AUG 25.pdf](#)

#### 2. Myanmar Geospatial Least-Cost Electrification Plan

[MMR-NEP-Geospatial Least Cost Planning Draft FinalReport-2014-08-28.pdf](#)

#### 3. Universal Access Roadmap and Investment Prospectus

[Myanmar NEP Roadmap and Prospectus Draft Final 14 08 28.pdf](#)

## APPENDIX III

### ADB: Myanmar Energy Master Plan Workshop Agenda



## Objectives of today's workshop

Report on the progress on our project to develop an Energy Master Plan ("EMP") for Myanmar:

- Overview of Myanmar's energy landscape
- Articulate issues and challenges for Myanmar's energy sector
- Report on findings to date in relation to the development of an Energy Master Plan for Myanmar: data collection, assumptions, projections & modelling
- Energy policy implications
- Implementation of an EMP
- Obtain feedback – very much welcome questions & comments!

Note that all material presented today is preliminary

## Introduction to TA-8356: Myanmar Energy Master Plan – Project scope of work

- Prepare a 20-year Myanmar Energy Master Plan ("EMP") for Myanmar, including:
  - Energy balances
  - Energy surveys and data collection
  - Energy demand forecasts
  - Energy resource assessments and expansion options
  - Energy planning model and planning scenarios for 20 years
  - Investment requirements for 20 years
  - Institutional enhancements to implement the EMP
- Capacity building to strengthen capability of NEMC and EDC

## Project work streams



## Workshop sessions (1 of 3)

No.	Time	Content	Presenter
1	9:40-9:45	<b>Workshop Introduction:</b> <ul style="list-style-type: none"> <li>Introduce the project</li> <li>Terms of reference / work streams</li> <li>Overview of workshop sessions</li> </ul>	Stuart Thornicroft
2	10:10-10:40	<b>Myanmar Energy Master Plan:</b> <ul style="list-style-type: none"> <li>Current situation: supply and demand</li> <li>Current issues and challenges</li> <li>Energy master plan concept</li> <li>Outline of the approach that we have taken</li> </ul>	Michael Emmertan
3	9:45-10:10	<b>Myanmar's Energy Landscape:</b> <ul style="list-style-type: none"> <li>Part A: Myanmar Energy Balances</li> <li>Part B: Household energy consumption survey</li> </ul>	Stuart Thornicroft

## Workshop sessions (2 of 3)

No.	Time	Content	Presenter
4	10:40-11:00	<b>Economic outlook for Myanmar:</b> <ul style="list-style-type: none"> <li>- Economic scenarios</li> <li>- Related issues</li> <li>- Relationship to energy planning</li> </ul>	Michael Emmertsen
5	11:00-12:00	<b>Energy demand forecasts:</b> <ul style="list-style-type: none"> <li>- Agriculture</li> <li>- Transport</li> <li>- Households</li> <li>- Commercial</li> <li>- Industry</li> </ul>	Michael Emmertsen
	12:00-12:30	Questions and answers session	
	12:30-13:00	Lunch	

## Workshop sessions (3 of 3)

No.	Time	Content	Presenter
6	13:00-14:00	<b>Resources and expansion options:</b> <ul style="list-style-type: none"> <li>- Primary energy resources assessment (solar, gas, oil, coal, hydropower)</li> <li>- Pipeline of projects and developments</li> <li>- Costs and technologies</li> <li>- Other assumptions relevant to expansion planning</li> </ul>	Robert Olesen
	14:00-14:30	Coffee / Tea Break	
7	14:30-15:45	<b>Expansion planning techniques:</b> <ul style="list-style-type: none"> <li>- Economic dispatch model</li> <li>- Policy cases, prioritization and ranking</li> <li>- Financial evaluation of portfolios</li> <li>- Policy adjusted costs &amp; competitive results</li> </ul>	Robert Olesen Michael Emmertsen
8	15:45-16:30	<b>Institutional arrangements:</b> <ul style="list-style-type: none"> <li>- Implementation of energy master plan</li> <li>- Relationship to organizational structure</li> </ul>	Stuart Thompson
	16:30-17:00	Questions and answers	

## APPENDIX IV

### Description of HIDA Energy Policy Workshop in Myanmar

The Overseas Human Resources and Industry Development Association

**HIDA**

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#### **Participation Requirements of The Energy Policy Workshop in Myanmar**

Implemented by the Overseas Human Resources and Industry Development  
Association [HIDA]

In cooperation with the Ministry of Energy [MOE],

#### ■ **Background**

Globalization calls for improved business environments to promote trade and investment for more prosperity in Asia. The *Training Program for Improving the Business Environment related to Trade and Investment* by the Ministry of Economy, Trade and Industry (METI) of Japan has been assisting developing countries in improving their industrial structure and business environments by sharing the Japanese economic/ social system, technologies and know-how, all of which have been proven effective for the economic growth of Japan. The Overseas Human Resources and Industry Development Association [HIDA \*1] is entrusted with this program in FY2014 \*2 by METI, to implement training programs and workshops that contribute to the economic development and the needs of individual countries.

\*1 <http://www.hidajapan.or.jp/>

\*2 A year covering April 2014 –March 2015

#### ■ **Introduction to HIDA:**

The Overseas Human Resources and Industry Development Association (HIDA) was established on March 30, 2012, by the merger of the Association for Overseas Technical Scholarship (AOTS) and Japan Overseas Development Corporation (JODC). AOTS has been promoting technical cooperation through training activities in Japan and developing countries for over 50 years. JODC has also been encouraging the transfer of technology for over 40 years by dispatching experts to over 60 countries. With this merger, HIDA will generate a synergy through coordinated efforts based on our rich expertise and experiences over many decades.

The AOTS Department of HIDA promotes technical cooperation through training inside and outside of Japan, which was former implemented by AOTS before the merger with JODC.

#### ■ **Introduction to the Ministry of Energy:**

Ministry of Energy ("MOE") has the main responsibility to carry out Exploration and Production of Crude Oil and Natural Gas, Refining, Manufacturing of Petrochemicals and Transportation, Distribution of Petroleum Products in Myanmar.

MOE was reformed during 1985 and composed of Minister's Office, one Department and three Enterprises.

Energy Planning Department ("EPD") is the technical arm of the Ministry and has overall responsibility for Energy Policy Formulation within the Ministry of Energy and coordination, discussion and negotiation of Energy Development Programme.



■ **Outline of the workshop:**

<b>Objectives:</b>	<p>(1) To understand the latest energy policy of the world and acquire the necessary policy measures to initiate more efficient and effective energy policy-making, planning and implementation.</p> <p>(2) To enhance more effective dialogs, interaction and consensus building among the line ministries, organizations as well as the demand side sectors.</p> <p>(3) To prepare policy proposals on specific and selective energy policy issues and present these to a higher stage of the government such as Myanmar's National Energy Management Committee(NEMC)</p> <p>(4) To raise awareness for the continued human resources development both in public and private sectors of energy not only to make policies but also to implement and review them.</p>
<b>Target Participants:</b>	Participants are supposed to work and prepare policy proposals to the government authorities such as NEMC
<b>Date &amp; Time:</b>	<p>The workshop consists of six series of sessions a year as shown below.</p> <p>■1st session - Monday, 1<sup>th</sup> September – Friday, 5<sup>th</sup> September, 2014</p> <p>■2nd session - Monday, 29<sup>th</sup> September – Friday, 3<sup>rd</sup> October, 2014</p> <p>■3rd session - Monday, 27<sup>th</sup> October – Friday, 31<sup>th</sup> October, 2014</p> <p>■4th session - Monday, 24<sup>th</sup> November – Friday, 28<sup>st</sup> November, 2014</p> <p>■5th session - Monday, 15<sup>th</sup> December – Friday, 19<sup>th</sup> December, 2014</p> <p>■Wrap up session - Monday, 26<sup>th</sup> January – Friday, 28<sup>th</sup> January, 2015</p> <p>Time: 10:00-12:00 / 13:00-15:00</p> <p>Number of the group: 50 people</p> <p><i><b>*Participants are requested to attend all six sessions.</b></i></p>
<b>Venue:</b>	The meeting room in the MOE in Nay Pyi Taw
<b>Language used:</b>	The workshop is conducted in Japanese or English with translation into Burmese and the workshop documents and texts will be prepared in English.
<b>Schedule:</b>	See the attached tentative schedule.
<b>Number of participants:</b>	50 persons from nine line ministries and three NGO/NPO

## APPENDIX V

### KWR Presentation Summarizing Fieldwork and Proposed Next Steps



## ELECTRIFICATION IN MYANMAR

### Summary of KWR/UT Fieldwork and Proposed Next Steps

Bangkok - October 2, 2014

#### MAJOR ACHIEVEMENTS OF KWR/UT FIELDWORK AND RESEARCH



- Development of comprehensive data and information to drive understanding of electrification in Myanmar, with particular emphasis on rural electrification, cross-border electricity initiatives and grid extension.
- Identification/examination of key drivers of electrification on village/regional level, filling gaps and building research undertaken by other actors based on national circumstances and international experience
- Development of a cost model to examine/assess commonly-used technologies, comparative cost and other factors and regional differences
- Identification/examination of social obstacles to universal electrification, including unintended consequences
- Identification/examination of special projects and electricity development initiatives
- Identification/examination of regulatory obstacles to universal electrification
- Formulation of a stakeholder network and peer review mechanism, including 100+ meetings and interviews with Myanmar ministries, Myanmar Engineering Society, Myanmar Industries Association, UMFCCL, village leaders, local and district power officials, academic institutions, project developers, micro-finance institutions, non-governmental organizations, fund managers and investors, trade development officials, and representatives of the World Bank, Asian Development Bank and other donor agencies and foreign firms.

## ELECTRICITY DEMAND ASSUMPTIONS BASED ON INCOME

Income Bracket	Minimum Electricity Goals	Potential Electricity Usages
Poor	120 W	Lighting, portable DVD player
Aspirant	500 W	Lighting, portable DVD player, portable fan, television set
Emerging	1,000 W	Lighting, portable DVD player, portable fan, television set, rice cooker
Established	2,500 W	Lighting, portable DVD player, music system, television set, refrigerator, rice cooker
Affluent	5,000 W	Lighting, portable DVD player, music system, television set, rice cooker, microwave, refrigerator, water heater, air conditioning

KWR/UT Team overlaid Myanmar household income data with projected household electricity goals, using categorizations developed by Boston Consulting Group. Team then developed potential electricity uses for each category.

"Affluent" could have much higher demand capacities over 5,000 W. However, for the purposes of this study, there were no examples of households even at 5,000 W capacity.

During field visits, household income data was attained from village leaders and fit into the various categories to develop projected electricity demand for each village visited.

## Cost Model with Data from Villages Visited in 2014

## Capital Costs

Village Name	Number of Households	Distance from National Grid (miles)	Total Village Demand (kW)	Solar Home System	Hydro Mini-grid System	Gasifier Mini-grid System	Gen-set Mini-grid System	Grid Extension
Tha Yee Taw	48	10	9	\$34,285	\$0	\$11,610	\$27,485	\$463,738
Ryar Kan Daung	72	11	15	\$51,798	\$0	\$34,610	\$30,485	\$451,780
Aung Mongalar	110	42	34	\$78,671	\$0	\$50,842	\$41,086	\$1,357,585
U To	120	37	32	\$96,006	\$0	\$51,360	\$41,756	\$1,381,752
Morali	94	7	70	\$182,618	\$0	\$77,839	\$56,949	\$104,846
Za Di Ya	120	2	269	\$708,798	\$0	\$220,130	\$177,430	\$54,167
Wai Tawng	161	13	41	\$121,271	\$0	\$63,350	\$53,714	\$557,112
Myoma	600	246	421	\$1,944,402	\$172,912*	\$312,776	\$236,171	\$9,083,329
Mu Du	700	234	352	\$321,918	\$0	\$250,118	\$205,138	\$4,544,246

## O&amp;M Costs

Total Estimated Cost - Annual

Region	Village Name	# Households	Total Demand	Solar	Mini-hydro	Gasifier	Generator	Grid Extension
Operating Hours				B	B	B	B	24
Ayerwaddy	Tha Yee Taw	48	9	\$110		\$5,795	\$6,663	\$2,878
	Ryar Kan Daung	72	15	\$160		\$7,178	\$9,429	\$4,733
	Aung Mongalar	110	34	\$240		\$9,402	\$13,877	\$7,717
	U To	120	33	\$240		\$11,295	\$17,662	\$10,256
	Morali	94	70	\$220		\$20,143	\$35,359	\$22,126
Bakine	Za Di Ya	120	269	\$1,090		\$66,874	\$128,821	\$84,817
	Wai Tawng	161	41	\$330		\$13,190	\$21,452	\$12,798
Tawintharyi	Myoma	600	421	\$1,260	\$24,280	\$502,509	\$200,091	\$132,623
	Mu Du	700	352	\$1,450		\$86,345	\$167,763	\$110,917

\* Capital cost estimate is for 100 KW mini-hydro system and does not include construction of dam or advanced engineering study. O&M costs assume same labor, maintenance and overhead cost for all capacities from 500 KVA and below. This is based on \$0.01 per kWh and 60% availability per year.

#### Technology Factor Analysis

- Capital/Financing Cost
- Energy Resource Cost
- Operation and maintenance cost, sustainability/life-span
- Importance of local knowhow
- Ease of capacity growth
- Front-end engineering/project management
- Ease/lead-time of installation
- Energy resource availability
- Environmental impact



#### Broader Factor Analysis

- Cash/non-cash** considers a village's ability to pay for various technologies, including O&M costs, with cash or resource bartering
- Population size/density and clustering of villages** relates to energy demand and the ability to spread costs across villages and nearby communities
- Location/geography** looks at the proximity of village to grid, road accessibility, captive power access, ease of transportation of materials, local siting locations and topographical challenges
- Energy resource availability** looks at proximity to and viability of energy resources, as well as ease of connecting to the grid
- Local/accessible knowhow** considers a village's proximity to knowledge and expertise needed to handle project design/management, installation, operation, maintenance and safety demands
- Cohesion** examines a village's capacity for leadership, cooperation and planning necessary to implement electrification schemes (with the exception of solar home units)

## SELECT FINDINGS AND CONCLUSIONS

#### Improved Regulatory/Environmental Standards and Enforcement Are a Necessity

Myanmar lacks adequate regulations/standards dealing with safety, environmental and other issues. This impinges on developing coherent/integrated system and incentives that encourage efficiencies and technologies, such as gasification, which may be advantageous but create risks such as toxic waste

#### Social Tensions are Sure to Increase as Myanmar Initiates Electrification Efforts

Tension between electricity "haves" and "have-nots" has largely existed between city dwellers and rural populations. With grid extension initiatives moving into more remote areas, this tension is likely to increase as off-grid communities see their neighbors achieve electricity access. Many communities will remain off the grid for some time, necessitating more attention to off-grid initiatives over short-term.

#### Electrification is Enhanced Through Convergence of On- and Off-Grid Initiatives

Current perception views off-grid electrification as largely a temporary phenomenon only necessary until full grid extension can be achieved. More emphasis should be placed on cooperation/integration between on- and off-grid power, such as mini-grids that can be connected to the national grid in the future.

#### Engagement with Private Sector and General Public on Electrification is Crucial

Greater dialogue among the government, private sector and general public is needed to develop policies and tariff schemes that reward/facilitate IPPs, PPAs and other private involvement, and which are understood and supported by local communities, who have at once rising expectations for improved quality of living and skepticism over electrification initiatives and rate increases. Adjustments to policies can also be made to allow more of a market-oriented approach to electrification.

#### Grid Extension Clearly Optimal Solution though Beyond Reach of Most Villages

Grid extension provides 24-hour electrification, dramatically raising quality of life and economic activity. It also requires a huge investment - that is beyond the reach of most villages. A Rural Electrification Act is imperative, establishing clear electrification goals and governance/financing mechanisms to achieve them.

#### Solar Home Units Most Suitable for Small, Isolated Villages with Little Demand

Scalability factors work against solar as demand increases. Solar home systems seem best suited for relatively poor villages of about 100 households or less. Even though installation costs are higher than with generators and gasifiers, cost differentials can be addressed within approximately one year when considering the added cost of fuel and O&M with other technologies. This, however, does not account for financing costs.



## SELECT FINDINGS AND CONCLUSIONS (CONT.)

### Attractiveness of Mini-Hydro Impinged by Need for Up-Front Engineering, Sensitivity to O&M

Viable hydro resource require up-front engineering and feasibility studies. This makes it difficult in rural context, except in special cases. Villages lack resources/knowledge needed to initiate advanced work before installation can be planned/considered. In larger hydro projects there is sufficient scale for engineering services and micro-hydro where trial and error siting can be initiated to find optimal locations.

### Generators Key to Myanmar's Rural Electrification Despite High Diesel Prices

Despite having the highest O&M costs of all technologies examined and potential environmental consequences, generators rate second highest in factor analysis by a wide margin. Generators also represent the optimal "market" solution in areas such as Dawei and Kyaukpadaung, although electricity rates are high. In the case of PTC, an independent power provider in Myoma, rates are 490 kyat per unit.

### Gasifiers Can Provide Significant Savings Through Reduced Diesel Costs

Due to the high cost of diesel, compared with the much less expensive, and sometimes free, feedstock used in rice husk gasifiers, the cost savings of gasifiers are significant. According to the Team's analysis, detailed in the chart below, the O&M costs associated with gasifiers can be nearly half that of diesel generators, particularly in areas with high demand.

	Solar	Grid	Hydro	Gasifier	Gasifier
	Home System	Extension	Mini	Diesel	Gas engine
			Mini system	Mini system	Mini system
Tha Yai Taw	46.5	18.5	12	40	26
Kyar Kan Daung	46	24	14	45	34
Kung Mingalar	45.5	14.5	8	42.5	28.5
U Ya	45	24.5	15.5	46.5	27
Mesali	46.5	34	14	44.5	45.5
Za Di Ya	45	32	15	44.5	31.5
Wai Taung	44.5	18	12	40	32
Myoma	46.5	35	15.5	48	36.5
Mu Du	45.5	21.5	13.5	45	32.5
Total	422	244	137.5	388	291.5
Average	46.47	27.11	15.28	44.22	32.39
Standard Deviation	0.75	11.51	7.18	2.36	6.08

## CURRENT FIELDWORK – July-December 2014



Cross-border electrification initiatives are crucial component of ASEAN regional integration. Previous fieldwork undertaken by KWR/UT Team to Tachileik, on Myanmar-Thai border illustrated the utility of such arrangements.

To better understand the dynamics, best practices and potential risks of such initiatives, and support policies moving toward greater prominence and formalization of cross-border power arrangements, other examples will be examined within context of Myanmar China context.

Through December 2014, the KWR/UT Team is seeking to undertake the following activities:

- Field visits to Muse and Mongla or other areas near China-Myanmar border, as well as other areas in Shan State, including Lashio, that are heavily influenced by trade with, and investment and immigration from, China
- Meeting with Chief Minister in Taunggyi, capital of Shan State, who controls areas of great interest to China and Thailand for their hydro electricity potential and which are essential for regional energy integration
- Initial interviews with non-governmental organizations and other entities about potential social impact and other "costs" of ongoing and proposed energy projects, including large hydro projects on Salween River
- Continued engagement with stakeholders and peer review of research and findings
- Participation in meetings on electrification hosted by World Bank and Asian Development Bank
- Training, meetings and workshops on energy issues for Myanmar officials, parliamentarians and practitioners

### **NEXT STEPS – Proposed Fieldwork – January/June 2015**

Building from its current effort, KWR proposes to undertake additional fieldwork from January-June 2015 to better evaluate the social impact of potential hydropower initiatives, with a combined 15,000 MW capacity, that are proposed or underway on the Salween/Thanlwin River. These tentatively include as possible the Hat Gyi Dam, Ta Sang or Mai Tong Dam, Nong Pha Dam, Mantawng Dam (on a tributary), Ywathit Dam, and Upper Salween or Kunlong Dam.

A lack of complete, independent social and environmental impact assessments, and the overall secrecy surrounding the projects, has inhibited the ability to garner the support of local communities and international actors. This is tarnishing Myanmar's image and the reputation of investors. It is also stalling the development of these crucial electrification initiatives.

The cross-border nature of these projects also puts Myanmar's relationships with China and Thailand at risk. Any negative impacts could cause broader damage to political relationships and could result in sudden disruptions to electricity and, consequently, development.

Potential social impacts potentially include:

- Displacement of tens of thousands of poor and marginalized villagers
- Destruction of fragile ecosystems and livelihoods
- Increased flooding, erosion, landslides and earthquakes
- Militarization of distribution networks and areas where energy projects are underway
- Increased conflict and human rights abuses in areas of ethnic tension
- Abduction and endangerment of workers on energy project sites

**APPENDIX VI****Explanation of Electricity Demand Projections**

When the Team visited each village, the leadership was asked to give an approximate breakdown by income of the village inhabitants. Few villages in Myanmar have any "affluent" people. There can be a few residents in the second category (established), while the majority of village inhabitants will likely fall into the remaining three (emerging, aspirant and poor). For example, in one village visited in early 2014, the headman broke down inhabitants into three categories. No villagers were truly "affluent"; the richest residents were traders, merchants and property owners, the second group comprised small farmers and property owners, and the third comprised day laborers.

From there, the Team examined further to fit these groups as possible into the five categories and household demand was calculated accordingly. The Team would also ask about other facilities in the village and then calculated a rough projection of the electrical demand required. For example, below is the demand estimate for U To village.

	Percentage	Kilowatt	Demand (KW)
% Poor	80%	0.12	11.52
% Aspirant	15%	0.5	9
% Emerging	5%	1	6
% Established	0%	2.5	0
% Affluent	0%	5	0
<b>Total Household Demand</b>			26.52
<b>Non- household demand</b>			6
	<b>Total Village Demand</b>		32.52

These calculations were derived to project the estimated capacity needed for stand-alone off-grid projects. With grid extension, however, total demand on a village- or township-level is not as much of an issue. That is because within reason, villagers can get what they need from the grid or a larger source (ie hydro or generator, in the case of regional micro-grids) as opposed to village-level projects in which there is a clear finite limit. At the same time, total demand is important for determining the approximate cost of potential electrification schemes. This is necessary to put the costs and comparative advantage of grid extension into context with the other four options examined.

Non-household demand was calculated based on facilities commonly found in villages, with emphasis on monasteries and schools. Although the Team encountered small businesses, such as teashops and small industry in some villages, given the difficulty in assessing their energy demand, and an assumption that the electrification costs for these facilities would likely be underwritten by the owners utilizing captive power sources rather than drawing from village-installed installations, the cost model omits these elements from its

non-household demand estimate. This is because this usage would not commonly be included within village mini-grids.

Through consultations with local inhabitants and consultants, the Team made the following assumptions on the average non-household demand required for these facilities: monasteries would consume about 3 KW of electricity, schools 2 KW, and clinics 500 W. In most villages, monasteries host celebrations and religious ceremonies that often use sound equipment. Community wells, requiring electrical pumps, may also be found on monastery grounds. Schools were assumed to consume 2 KW of electricity because they often serve as meeting halls for the village. Additionally, there are a growing number of night classes held for improving literacy among adults. Village clinics do not have any medical equipment that requires electricity. They are often very modest and at minimum have basic lighting.



## APPENDIX VII

### Explanation of the Factor Analysis

To supplement these cost evaluations, the Team also assessed each technology solution for each village on a broader set of indicators. These indicators look at factors that affect how each technology fares in the context of each village's resources and constraints. Below, for example, is an example of one such assessment done for the village of Tha Yet Taw.

Item	Category	Electricity Category				
		Solar Home System	National Grid Extension	Hydro Mini system	Gen-set Diesel Mini system	Gasifier Gas engine Mini system
1.1	Cash/non-cash (1=totally insufficient, 10= totally adequate)	6.50	2.50	1.00	8.00	4.00
1.2	Population (1=totally insufficient, 10= totally adequate)	9.00	2.50	1.50	7.00	2.50
1.3	Location /Geography (1=totally unsuitable, 10= totally adequate)	8.00	3.50	2.00	7.50	5.00
1.4	Energy Resource Availability (1=totally insufficient, 10= totally adequate)	7.50	3.00	1.50	7.50	7.00
1.5	Local / accessible knowhow (1=totally insufficient, 10= totally adequate)	6.50	6.50	5.00	6.50	4.00
1.6	Cohesion (1=totally insufficient, 10= totally adequate)	9.00	1.50	1.00	4.50	3.50
	<b>Total</b>	<b>46.50</b>	<b>19.50</b>	<b>12.00</b>	<b>41.00</b>	<b>26.00</b>
	<i>Average across 7 categories</i>	<i>7.75</i>	<i>3.25</i>	<i>2.00</i>	<i>6.83</i>	<i>4.33</i>

The first item assessed the village's ability to pay for the respective electrification method, including O&M costs, with cash or bartering of resources.

The second item looked at factors related to the population of the village and those surrounding it. Population size, density and clustering of villages are important determinants. Some installations require a minimum use of energy that a small village may not need. In other cases, such as grid extension, clustering of villages is important as the combined electricity demand would justify the construction of the distribution line and help disperse the costs over a larger group of people.

The third item—location/geography—looked at the proximity of the village to the grid, road accessibility, captive power access, ease of transportation of materials, local siting locations and potential topographical challenges. Some of the villages the Team visited are flooded every year during the monsoon months, while others are in particularly hilly areas. Such factors affect where generation sites are situated and the manner in which distribution networks are established and can lead to higher expenses.

The fourth item, resource availability, is also a key component to the success of off-grid electrification strategies. For grid extension, this indicator looked at the ease of connection to the grid. While the previous category looked at the proximity, this indicator evaluated whether or not connection is feasible. For hydro, the distinction between location and resource availability is that while a

village may be near a river source, the river may not hold consistent water levels throughout the year.

The fifth item—local/accessible knowhow—examined a village’s ability to handle the design, project management, installation, operation and maintenance and safety demands of each technology. While a village in itself may lack the knowhow, vicinity to larger cities and towns where the expertise is available can suffice. As the Team witnessed, O&M of equipment is a critical issue in Myanmar. Therefore, while a technology may be suitable in other respects, if it involves regular maintenance or some technical training, certain villages may not be equipped to handle them well and may be better off with a different electrification strategy.

Finally, the sixth item, cohesion, recognizes that villages must be self-reliant in securing means of electrification, and cohesion among the community is of great importance. This indicator examines a village’s capacity for leadership, cooperation and planning. With the exception of solar home systems, the other means of electrification require coordination among villagers, especially to deal with the financing of these projects.

## **APPENDIX VIII**

### **Twenty-Four MOEP Conditions Allowing Grid Connection**

In the presence of responsible personnel of Department of Power Transmission and Distribution, Electrical Power Transmission and Distribution, Ministry for Electrical Power No (2), Nay-pyi-daw, the three members of Village Electricity Supply Committee of Pauk-Kon Village, Pauk-Kon Village Tract, Patheingyi, Ayeyarwady Region, signed the agreement on the following 24 items to be followed in the implementation of the tasks for the access to the electricity in their village.

24 items to be pledged and performed by the Electricity Supply Committee

- 1) The committee shall have public agreement.
- 2) It shall be well established.
- 3) Sufficient amount of money shall be saved to do that task. (This money shall be able to shown in term of a bank account.)
- 4) The posts supporting the electric wires/power cables shall be the concrete ones having the following specifications.
  - a) Standard 12 M concrete posts for 33 KV line
  - b) Standard 10 M concrete posts for 11 KV line
  - c) Standard 9 M concrete posts for 400 line
- 5) The power cables shall be the ones having the following specifications.
  - a) ACSR 120 mm<sup>2</sup> (or) 150 mm<sup>2</sup> cables shall be used to take electricity from 33 KV line owned by Ministry for Electrical Power No (2).
  - b) ACSR 95 mm<sup>2</sup> cables shall be used to take electricity from 11 KV line owned by Ministry for Electrical Power No (2).
  - c) The construction of 400 V line in the village shall have the following specifications  
-HDBC Wire No 4 shall be used for 5 lines of triple-strand wire in 400 V line; HDBC Wire No 6 shall be used for 3 lines of double-strand wire in 400 V line HDBC Wire No 6 shall be used for 2 lines of single-strand wire in 230 V line; and HDBC Wire No 8 shall be used for roadside bulbs.
- 6) Specific cross-arm shall be fixed in posts.
- 7) Standard pin-insulator horn shall be used.
- 8) Standard transformers produced domestically, which are permitted to use by Ministry for Electrical Power No (2), shall be used. Red, yellow and blue colours shall be used in electric wires, switches and nodes. Other colours shall not be used. The substation for transformers shall be built in specific model. A fence having 16 feet each side shall be built around the substation and it shall be obstructed with wire mesh. The floor of the substation shall be the cement one.

- 9) Roadside lights shall be included.
- 10) The committee shall bear expenses for losses.
- 11) Electricity utilization shall be according to the specific days agreed.
- 12) The posts shall be supported with the concrete footings (2 x 2 x 2 ½ ft high) according to the specific standards and these footings shall be built 6 inches over the ground and 2 feet in the ground.
- 13) Trees and bushes shall be cleared up completely within the specific distance from electrical power lines and posts.
  - a) Trees and bushes shall be cleaned up completely within the area of 20 feet – 10 feet to the left and 10 feet to the right from the centre of 11 KV line. There shall be no trees 10 feet high or higher within 5 feet on both sides of the cleaned-up area. (illustration attached)
  - b) Trees and bushes shall be cleaned up completely within the area of 10 feet – 5 feet to the left and 5 feet to the right from the centre of 400 V line. There shall be no trees 10 feet high or higher within 5 feet on both sides of the cleaned-up area. (illustration attached)
- 14) Since the project is not considered completed as soon as the electric power lines, posts and transformers have been constructed, the electricity supply committee shall save “maintenance fund” because the strength of transformers, posts and electric power lines shall always be examined and they shall always be repaired and maintained.
- 15) If the transformers used in the private electric power line are destroyed due to natural disasters, the maintenance fund saved by the electricity supply committee shall be spent for repairing works.
- 16) The committee members shall sign the agreement that Ministry for Electrical Power No (2) shall not be asked for help or donation to get the materials free of charge which are needed in implementing for electricity supply and that Ministry for Electrical Power shall not be asked for help to get the materials free of charge with the help of other people.
- 17) The committee shall sign the agreement that the steps in implementing for the access to electricity supply shall be carried out by making plans within the period of at least four years.
  - a) First Year - Making posts
  - b) Second Year - Fixing cross-arm and pin-insulator horn to the posts and connecting cables
  - c) Third Year - Building substations
  - d) Fourth Year - Finish connecting cables and accessing electricity supply
- 18) If the construction of electric power lines and substations are to be carried out by external technicians, they shall hold certificate of electrical inspection Grade (1) recommended by Ministry for Industry No (1). Lists of items to be used in construction works and maps of the electric power lines and

substations shall be presented to the chief engineer of Department of Electrical Power Distribution and his permission shall be taken.

19) Concerned with the access to the electricity in the village, the permission is only for the village having the savings relied on themselves. If the project cannot be implemented as the village's programme, and if the help from others are asked for or the donation is asked for, the project for the access to the electricity in the village shall not be permitted. And even if it has been permitted but it is found out that there is asking for donation here and there, the permission shall be terminated.

20) The permission for the installation and implementation of the access to the electricity in the village relying on the village itself is not the permission for the 24 hours electricity utilization. The permission is just the preparation for the future electricity supply programme, aiming to be ready to be able to utilize the electricity when there will be enough electricity supply in future. An agreement shall be signed to show the proof of knowing that the distribution of the electrical power is based on the electrical power gained.

21) To implement the access to the electricity, the village electricity supply committee shall contact directly to Ministry of Electric Power No (2) with the state and/or divisional electrical engineers and shall make a formal promise not to contact with brokers and agencies.

22) While getting the electric power for the access to the electricity in the village, there shall be a formal promise made not to take the electric power connecting with the electric power lines which are not of Ministry of Electric Power No (2) such as the electric power lines of other ministries, those of the army, those of industrial zones and so on. The electric power shall only be taken from the lines allowed by Ministry of Electric Power No (2). For example, the electric power shall not be allowed to take from the lines such as those for pumping up the river water, those by industries and workshops, those by airway, those by navigation, those by the hospital, those by Myanmar Economic Bank, those by battalions and military units, private electric power lines.

23) The committee shall agree on knowing that unless the above 22 items for implementing access to the electricity supply are followed, the permission for implementing access to the electricity supply be cancelled.

24) The committee members shall agree on understanding that they shall be sued by Department of Electrical Power Transmission and Distribution, on behalf of villagers and the ministry, together with the representative of the villagers as the plaintiff if they misuse, do wrong and unfairly spend the money collected from villagers without spending it for any tasks related to implementing access to the electricity in the village.

Agreed on the above 24 items to be followed in implementing access to the electricity supply

**APPENDIX IX** The following case study was undertaken during Phase I fieldwork but as it pertains to Shan State is included again here as an appendix.

**Phase I Fieldwork: Case Study (Tachileik, Shan State)**

***Tachileik: Obtaining Electrical Capacity Through Cross-Border Arrangements***

*A border city situated on an important crossing into Northern Thailand, Tachileik is one of a few areas in Myanmar that purchases electricity from a neighboring country. Similar activity has been reported in Kachin State and North Shan State on the China border and Kayin State further south along the Thai border. The Tachileik situation illustrates the economic and social utility of cross-border integration with Myanmar's more developed neighbors and reveals that certain regional arrangements can supersede and supplement national regulation. Such cross-border understandings, which have underpinned the relatively strong growth of this peripheral region, could have important implications and help to guide Myanmar's national policies on foreign participation in the electricity sector. These arrangements may grow in prominence and importance as ASEAN moves toward regional integration by 2015.*

**Overview**

Tachileik is a city in Myanmar that borders Thailand to the South and is located roughly 29 kilometers west of the Laos border. It is an active trading zone in eastern Shan State. In addition to vast quantities of consumer goods, including DVDs, appliances, clothing, perfumes and luggage, Tachileik is also well known as an important border crossing for illicit activity, which has thrived for centuries in the mountainous tri-border area known as the Golden Triangle.

This trade is conducted across the fairly porous border, demarcated by the Mae Sai River, only a few meters wide at its most narrow point. Mae Sai, Thailand, connects to Tachileik via two bridges, the First Mae Sai Friendship Bridge and the Second Mae Sai Friendship Bridge. In 2007, about three million people entered and departed Thailand through the Mae Sai Immigration Office.

Due in part to this economic integration, as well as the relative proximity of Bangkok to Tachileik—a 12-hour drive, as opposed to the three days it would take to access Yangon by road—the area is heavily influenced by Thailand. The Thai baht is used as currency as opposed to Myanmar's kyat, which is not generally accepted, and electricity is delivered from Thailand's grid system.

Tachileik initially connected to Thailand's grid in 1995, after two years of planning and construction. This is a notable exception, as in the rest of Myanmar, the Myanmar Electric and Power Enterprise is designated under the State-owned Economic Enterprises law of 1989 as the sole legal provider of electricity. Prior to 1995, less than 500 KW of electricity was available for the entire Tachileik area, which at the time had a population of about 20,000 people.

The power supply from Thailand, though reliable, is susceptible to political disputes. It was cut off by Myanmar's government in 2002 due to rising tensions with Thailand. For several years afterward, a private provider supplied 3MW to the area via 6 high-speed diesel generators. By the mid-2000s, power supply from Thailand had resumed under a different structure. The generators are no longer used to supply power to Tachileik and it is unknown whether they are still in existence.

Because of the availability of electricity in Tachileik, in addition to lucrative trading opportunities, and ability to serve as a gateway to Northern Thailand, the area's economic development has steadily increased over the years. By 2001, the

population was reported to have grown to 100,000, about five times what it had been in the mid-1990s.

As Myanmar continues to develop and open to foreign travelers, Tachileik holds significant potential for the tourism industry because of its hiking trails, scenic views, and ancient pagodas as well as its proximity to Thailand. Thanks to the recent loosening of government regulations, tourists entering Myanmar via Tachileik—once required to depart over the same border crossing within one week of entering, and prohibited from leaving the Tachileik vicinity—are now able to leave the country via international airports in Yangon, Naypyitaw and Mandalay. This will likely have a dramatic effect on the area's overall economic activity providing it can obtain adequate supplies of electricity to enable additional development in Tachileik and the surrounding region.

### **Electricity Reach and Reliability**

According to a member of the local electricity committee, 9MW is currently transmitted to Tachileik via 22KV power lines running over the bridge from Thailand. The electricity supply is distributed over approximately 23 km of territory via 400 volt lines. This is said to provide sufficient electricity to all of Tachileik's 100,000+ inhabitants. Less than 10 percent of these are industrial users, which primarily consist of small-scale factories and workshops that produce welding, steel structures and other "installation" products.

The electricity supplied by Thailand is reportedly very reliable with no blackouts, however, there are reported transmission losses of roughly 15% per year, about one third of which may be the result of illegal power tapping. The local electricity committee has proposed increasing electricity supply to Tachileik to 16MW by upgrading the cables.



When an agreement was first reached to supply electricity from Thailand to Tachileik in 1995, the Thais extended the grid all the way to the household level, though bills were collected locally. Now Myanmar's MOEP is responsible for the technical administration of electricity, such as wiring, from the Myanmar side of the border. In addition to the local MOEP office, a local electrical committee was formed and given a permit, renewable on an annual basis, which allows them to assist with electricity operations, including payment collection.

The local MOEP and electricity committee are considering extending the Thai connection outside Tachileik. The area is bound by the nation-wide regulations on grid connection, however, certain aspects of the system, such as switch gears, must also meet Thai standards.

### **Cost of Electricity**

Under the current agreement, it is reported that Allure Resort, a Thai-owned hotel in Tachileik, has assumed responsibility for purchasing power from Thailand and selling it to Tachileik users at a price that allows for mark-ups by both the Thai intermediary as well as the local township. Allure Resort purchases power from Thailand at a rate of 3.25 baht (about 100 kyats) per kWh and sells it to households for 6 baht (186 kyat) per kWh and to industrial users for 7.25 baht (225 kyat) per kWh.

This is, respectively, about 5 and 3 times more than electricity purchased from the Myanmar national grid. However, it is much less expensive than the electricity that was provided by diesel generators when electricity distribution from Thailand was prohibited. Then, per unit costs varied according to the price of diesel from 6.25 baht to 14 baht.

Because of the border zone's relatively strong growth and proximity to Northern Thailand, the average salary in Tachileik is high compared with national

standards—about US\$200 per month compared with US\$100 to US\$150 in Yangon. As a result, the electricity costs are not prohibitive for locals.

Additionally, because of the high mark-up on electricity, the return on investment resulting from upgrading or expanding Tachileik's electrification supply would be realized in a relatively short period of time. Allure gives a portion of the mark-up to the electricity committee, which is a non-profit organization, to cover operational costs.

This situation, however, raises concerns over the area's reliance upon Thailand. If Myanmar's relationship with Thailand were to sour—as it has in the past—or if either government decided to cut off Tachileik's access to Thai electricity for any reason, the area would suffer an immediate and drastic change in living standards and a potential set-back in terms of economic development and tourism revenue.

### **Alternative Options**

Given that the region's electricity development—and overall economic viability—are dependent on Myanmar-Thai relations, attention should also be devoted to alternative options that allow more self-sufficiency. Fortunately, with its proximity to multiple rivers, including the Mekong—the 10<sup>th</sup> largest river in the world by volume—Tachileik has a strong potential for the development of hydropower. This is already generating a sizeable amount of electricity for other parts of Shan State. The potential for hydropower is well known on both sides of the border and several nearby sites have undergone feasibility studies. In the case of Tarsan on the Salween River, a study undertaken by ItalThai found there was a potential to generate more than 7,000 MW of electricity—almost enough to power the entire country.

Concerns have arisen, however, over land ownership and environmental risks, particularly if a dam were to malfunction. The issues are particularly sensitive in Tachileik, a border zone, as any negative impact has the potential to cause problems between Myanmar and Thailand.

Similar issues arose over coal. A lignite power plant that was under development in 2000 was ultimately cancelled following protests over concerns for the health and safety of Thai residents living close by.

Given the reliability and affordability of electricity from the Thai grid, there is little incentive for Tachileik inhabitants to invest in the high start-up costs associated with large-scale power generation, whether from hydro, solar or coal.

Smaller-scale development, however, particularly in areas that are relatively distant from Tachileik, and therefore would be too expensive to connect to the existing connection are now underway. For example, a local entrepreneur in Nayaung, Myanmar, roughly 45 km northeast of Tachileik, has installed a rice-husk gasifier which powers a 50KW generator via a dual-use gas and diesel engine. In addition to powering his rice mill and a factory that manufactures tiles and other building and infrastructure-related materials, the gasifier is connected to one hundred reported electricity meters, which charges 30 baht (roughly 1,000 kyat) per kWh. Users are required to purchase a minimum 10 kWh per month and are limited to 40-50 kWh per month for a range of 300 baht to 1,500 baht.

Electricity from the gasifier is available to the village for about 4.5 hours per day, from 6pm to 10:30pm. Electricity is available on an irregular basis during the day when the provider's rice mill and factory is operating and utilizes the supply. At that time, households and shops, including one owned by the owner of the gasifier itself, rely on small-scale solar and hydroelectricity to power lights, air conditioning, electronics and refrigerators.

## **Interview Participants**

- U Htein Min (Local Representative of Ministry of Electric Power)
- U Maung Win (Representative of Local Electricity Committee)
- U Sai Shen (Owner and Operator of Rice Husk Gasifier in Nayaung)
- U Sai Shen's son (Shopkeeper in Nayaung)

## **Additional Sources**

- Masami Ishida, [Border Economies in the Greater Mekong Subregion](#), IDE-JETRO, July 26, 2013
- Myanmar blasts: Electricity one of the fuses, *The Asia Times*, June 28, 2003
- Phyu Nu, [Myanmar Borders Purchasing Electricity from China and Thailand](#), Eleven Media Group, October 4, 2011
- [Plant Fuels Pollution Concerns](#), *The Nation*, April 23, 2001
- [Troubled History of Power Supply at Tachileik](#), Electrical industry of burma/myanmar on-line compendium
- Takao Tsuneishi, [Border Trade and Economic Zones on the North-South Economic Corridor: Focusing on the Connecting Points between the Four Countries](#), IDE Discussion Paper No. 205, July 2009

**APPENDIX X** The following case study was undertaken during Phase I fieldwork but as it pertains to Shan State is included again here as an appendix

### **Phase I Fieldwork: Case Study (Kengtung, Shan State)**

#### ***Kengtung: Powering Off-Grid Locations Beyond the Micro-Level***

*A relatively large but isolated township in Eastern Shan State, Kengtung highlights the potential for hydropower to provide electricity to off-grid locations on a scale beyond that of the village level. The MOEP-run projects here differ from those in other areas, like Pyin Oo Lwin, in that they are not supplementing power from the grid or small-scale generators, nor are they merely supplying niche areas, such as small, isolated and geographically challenging villages where grid connection is not feasible. While Myanmar has plans to extend its grid to all corners of the country, in the interim, off-grid Ministry-run projects, like those in Kengtung, play an important role in filling gaps in the nation's ability to supply expanded electricity distribution.*

#### **Overview**

Kengtung is located roughly 163km north of Tachileik in Kengtung District, roughly 2,500 feet above sea level with some mountain peaks rising above 7,000 feet. With a population that is estimated to be approximately 78,000 within the city itself and 200,000 or more within the overall district, Kengtung is one of the largest cities in Shan State, along with Lashio and Taunggyi, Shan State's capital 456 km away.

Known as the "Walled City of Tung," Kengtung is fairly isolated in the highlands of Eastern Shan State. Separated from Yangon and other parts of Myanmar by the Salween River, Kengtung lies close to the borders of China, Laos and Thailand and, like Tachileik, is heavily influenced by its neighbors. It is a multi-

ethnic environment made up of Khun, Shan-Chinese, Akha, Wa and Lahu inhabitants among others. Roughly half the population is Buddhist and a significant number are Christian owing to a history of missionary influence.

Due to the presence of rebel armies, such as the Shan and Wa insurgencies, and illicit activity, the area has been historically closed to outsiders and is considered a strategic location for the nation's defense.

In recent years, however, as roads have improved and travel restrictions within Shan State have been lifted, Kengtung has seen an increase in visitors, both traders and tourists. It is commercial region with a number of small workshops and markets for local goods and those from neighboring countries. It is rich in teak, rice, sugarcane, cotton, produce, poppy, tobacco, and tea. It is not a site of heavy industry.

Often called the most scenic location in Shan State, Kengtung is midway between the Thanlwin and Mekong River valleys and is built around several lakes, Naung Tung Lake, Naung Kham Lake and Naung Yarng Lake. The city features colonial architecture and an array of Buddhist temples and monasteries, including Maha Myat Muni Pagoda and Wat Zom Kham Temple.

Its size, natural resources and distance from the national grid makes Kengtung an interesting case study for the use of off-grid hydropower on a scale beyond that of village-level. Country-wide, the Ministry of Electric Power runs 32 off-grid hydroelectric power plants with a total installed capacity of 33MW.

### **Electricity Use and Reach**

Kengtung is home to two off-grid hydroelectric plants under the administration of the MOEP, one in Namwote, with an installed capacity of 3MW, and one in Namlut with an installed capacity of 480KW.

The Namwote plant supplies local military facilities as well as nearby villages. According to the MOEP district officer, about 8,000 consumers receive electricity from the Namwote plant. The Kengtung MOEP has no plans to establish a mini-grid and has not connected a village to the Namwote plant in several years.

Although its installed capacity is 3MW, the Namwote plant has a maximum capacity of 2.5MW during the rainy season. This drops to 1MW during the dry season, at which point it is supplemented by a 500KW diesel generator. The area requires 5MW, according to the district official.

Considering most parts of Myanmar, including those on the grid, receive a limited number of hours of electricity per day, the Namwote off-grid hydropower plant is a relatively reliable electricity source for Kengtung residents. The district officer reported that the area is divided into four zones and power is rotated among these four areas..

### **Cost of Electricity**

Both households and commercial users, the small workshops in the area, are charged 60 kyat per kWh for electricity from the off-grid hydropower plant. This compares to the standard rate of 35 kyat per kWh for consumers and 75 kyat per kWh for commercial users for electricity from the national grid. Consumers receive meter boxes and pay based on electricity use. The reason for this differential bears investigation given that other facilities visited in Pyin Oo Lwin that were managed by the MOEP and elsewhere sold their output at the standard rates.

The district-level MOEP noted it is paid by the local committee for the electricity they produce, therefore, any losses that occur due to illegal power tapping are borne by the committee, not the Ministry.

One off-grid site that was visited reportedly cost between 10.6 million kyat and 16 million kyat to construct but it was unclear how the exchange rate would have been calculated at the time of construction.

### **Alternative Options**

MOEP's off-grid projects consist only of hydroelectric plants and diesel generators.

Although they have no plans to supplement the off-grid hydroplant with alternative sources, it was noted that upgrading the system's transmission and distribution lines could help the Namwote plant meet Kengtung's power needs. The transformers and cables for off-grid projects are set to national standards, but, like those of the national grid system, are a source of transmission losses.

The district officer said that the national planning department has yet to develop a plan for Kengtung, however, he believes hydropower to hold substantial potential for the region. He also referenced proposals put forth by private companies to the regional government to develop hydropower capacity.

According to the Asian Development Bank, hydropower projects with a total of 41,276MW installed capacity are to be implemented in Myanmar by foreign direct investment. One 96MW hydropower project is planned in Kengtung with others in nearby Wantapeng (25MW), Solu (165MW), Kengyang (28MW), Heku (88MW) and Namkha (200MW). The hydroplants will supply the region and surplus electricity will be supplied to the national grid.

### **Interview Participants**

- Nay Ye Myint, Namwote District Officer, MOEP



- Officials at Namwote MOEP Off-grid Hydropower Plant

### **Additional Sources**

- Masami Ishida, [Border Economies in the Greater Mekong Subregion](#), IDE-JETRO, July 26, 2013
- Takao Tsuneishi, [Border Trade and Economic Zones on the North-South Economic Corridor: Focusing on the Connecting Points between the Four Countries](#), IDE Discussion Paper No. 205, July 2009
- Tin Win Lay, [Kengtung in Shan State \(East\) benefiting from smooth transport and agriculture](#), The New Light of Myanmar May 19, 2009
- [Myanmar: Energy Sector Initial Assessment](#), Asian Development Bank, October 2012
- Myo Aung San, [Rural Electrification in Myanmar: Policies and Recent Initiatives \(Grid and Off-grid\)](#), Ministry of Electric Power, Electricity Supply Enterprise

## APPENDIX XI

### Myanmar Comprehensive Development Vision

The energy and electrification components of ERIA's Myanmar Comprehensive Development Vision (MCDV) were prepared in **July 2012** by KWR International (Asia) Pte Ltd in cooperation with the University of Tokyo and incorporated into the Infrastructure and Energy chapter of the MCDV included below.

#### Infrastructure and Energy

##### 1. Infrastructure

###### 1.1. Current Situation and Challenges

Myanmar's aspiration to high and balanced growth could not be achieved without having proper development of public infrastructure. Indeed, infrastructure is a driving force to the economic growth since there is a positive and statistically significant correlation between investment in infrastructure and economic performance (Aschauer 1990). Although there is no empirical analysis, the observers noted that absence of reliable infrastructure such as poor transportation, energy shortage and low-grade communication is great bottleneck not only to harness its growth potentials but also to fulfill obligation to ASEAN Economic Community in the near future. As well, the IMF's 2012 report argued for industrial development citing that Myanmar has an advantage of lower wages but the manufacturing sector remains stifle by poor infrastructure amongst the others. Therefore, immediate implementation of infrastructure development becomes very crucial in recent days of economic liberalization and reception to global investments.

In order to determine major obstruction in infrastructure sector and to find the way to overcome, it is important to see the present status. Table 6-1 tabulates connectivity related indicators in ASEAN compiled by UNESCAP. Myanmar has all the data in the list. However, this table explains the seriousness of the current situation of infrastructure and infrastructure usage in Myanmar. Myanmar is far behind other ASEAN countries in road density per 100 km<sup>2</sup>. It had more than half of below class III level road sections of the Asian highway network in ASEAN. Paved road in Myanmar was 11.9 percent<sup>52</sup>, which was better than Cambodia and the Philippines but still very low<sup>53</sup>. The number of passenger cars per 1,000 persons was only 5. Port container freight was comparable with Brunei despite the huge difference in population. Only railway density, 5.1 km per 1,000 km<sup>2</sup>, was relatively higher in ASEAN countries. The number was lower than Singapore<sup>54</sup>, Thailand and Vietnam but better than other countries. Of course, it does not

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<sup>52</sup> By now, it increases to 21.7 percent

<sup>53</sup> According to the ministry of construction, paved roads reached 21.7% for whole country in March 2012.

<sup>54</sup> Data was not available for Singapore.

necessarily mean that Myanmar has better railway system when we think of the quality of the services and technology.

**Table 6-1: Connectivity Related Indicators in ASEAN<sup>55</sup>**

	Railway density	Road density	Paved road	Passenger cars	Air passengers carried	Port container freight	Asian Highway	
							Total	Below class III
	(2010)	(2010)	(2010)	(2010)	(2010)	(2010)	(2010)	(2010)
Brunei	-	564	77.2	485	1,263	0.09	-	-
Cambodia	3.7	216.7	6.3	18	455	0.22	1,347	0
Indonesia	1.9	262.9	59.1	45	52,283	8.37	4,091	0
Lao PDR	n.a.	171.4	13.5	2	555	-	2,857	306
Malaysia	5.1	300.5	82.8	313	30,997	18.25	1,673	0
Myanmar	<b>5.1</b>	<b>41.3</b>	<b>11.9</b>	<b>5</b>	<b>396</b>	<b>0.17</b>	<b>3,009</b>	<b>1,064</b>
Philippines	1.6	470.9	9.9	8	21,024	4.95	3,367	451
Singapore	n.a.	4794.3	100	121	26,709	29.18	19	0
Thailand	8.7	352.4	98.5	57	27,162	6.65	5,111	2
Viet Nam	7.6	516.3	47.6	13	14,407	5.98	2,597	264
Unit	per 1000 km <sup>2</sup>	per 1000 km <sup>2</sup>	%	per 1,000 population	1,000	million TEU	km	km

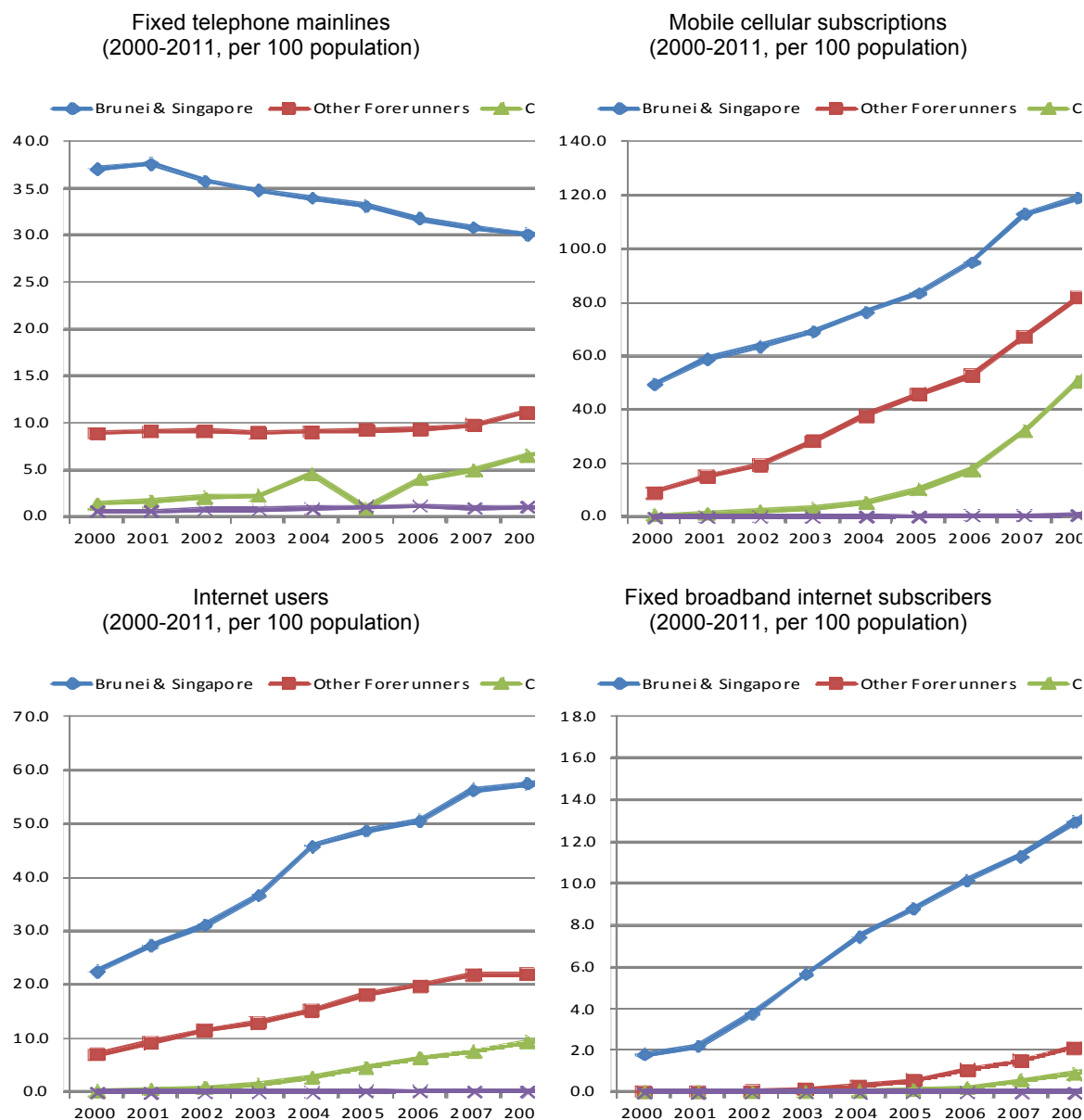
*Source:* UNESCAP (2012) and database on the UNESCAP website

The data on telecommunications shows much serious backwardness. Figure 6-1 depicts the ICT related indicators in ASEAN countries. Given the different development stages, we divided ASEAN countries in to 4 groups, that is, (1) Brunei and Singapore (small and advanced countries), (2) Other forerunner countries, (3) Cambodia, Lao PDR and Vietnam (CLV), and (4) Myanmar. Myanmar has a long way to go to catch up with even CLV countries. In the other ASEAN countries, we saw rapid increase of mobile cellular subscriptions and declining trend in fixed telephone mainlines. In fact, the

<sup>55</sup> According to Myanmar official data, Railway density is 8.6 (Myanmar Railways), Road density is 203.3 (Public Works), Paved road is 20.89% (Public Works), Passenger car is 5 (Dept. of Road Transport Administration), Air passengers carried is 2074 (Dept. of Civil Aviation) and Port container freight is 0.3034 (Myanmar Port Authority)

indicators on mobile cellular subscriptions per 100 population of the 3 groups exceeded 100, which meant that people have more than 1 mobile phone on average. On the other hand, mobile cellular subscriptions per 100 population in Myanmar were only 2.6 and fixed telephone mainlines were 1.1 in 2011. Myanmar has not experienced the downward trend in fixed or even upward trend. The figures for internet users and fixed broadband internet subscribers showed the same backwardness. For the internet users in 100 population, Brunei and Singapore reached 65.5, other forerunners got 32.9, and CLV countries also had 15.7 while Myanmar had only 1.0 in 2011.

**Figure 6-1: ICT related Indicators in ASEAN (2000-2011)**



Source: ITU website.

We could say that Myanmar had 10 years of delay in getting internet users to the average of Cambodia, Laos and Vietnam. Fixed broadband internet subscribers in 100 population showed relatively lower figures in other countries, while Myanmar's figures are evidently lower than the others. Telecommunication service costs were extremely high due to monopoly of Myanmar Post and Telecommunication (MPT), a state-owned enterprise, which has monopolized license for 2G and 3G and this created a great challenge for telecommunication sector to grow in Myanmar. The situation is now

changing after the reform. The government has started inviting private sector to invest in the country.

Table 6-2 and Table 6-3 indicate access to improved water sources and sanitation in ASEAN countries. Access to improved water resource in Myanmar is the 2<sup>nd</sup> lowest in both of rural area and urban area in 2008. The percentage in the urban area had dropped from 87 percent to 1990 to 75 percent in 2008. It seems to imply that development of water supply infrastructure could not catch up with the speed of urban development.

**Table 6-2: Access to Improved Water Sources (% of population)**

Unit: %

	Rural				Urban				Total			
	1990	2000	2005	2008	1990	2000	2005	2008	1990	2000	2005	2008
Myanmar	47	60	69	69	87	80	75	75	57	66	71	71
Vietnam	51	74	85	92	88	94	97	99	58	79	88	94
Cambodia	33	42	51	56	52	64	75	81	35	46	56	61
Lao PDR	-	40	47	51	-	77	74	72	-	48	54	57
Thailand	89	95	97	98	97	98	99	99	91	96	98	98
Malaysia	82	93	99	99	94	99	100	100	88	97	100	100

Source: Statistical Yearbook for Asia and the Pacific 2011

**Table 6-3: Access to Sanitation (% of population)**

Unit: %

	Rural				Urban				Total			
	1990	2000	2005	2008	1990	2000	2005	2008	1990	2000	2005	2008
Myanmar	15	59	79	79	47	81	86	86	23	65	81	81
Vietnam	29	50	61	67	61	79	88	94	35	57	68	75

Cambodia	5	10	15	18	38	50	60	67	9	17	24	29
Lao PDR	-	16	30	38	-	62	77	86	-	26	43	53
Thailand	74	92	96	96	93	94	95	95	80	93	96	96
Malaysia	81	90	95	95	88	94	96	96	84	92	96	96

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*Source:* Statistical Yearbook for Asia and the Pacific 2011

Access to sanitation is better than water supply as indicated in the Table 6-3. The percentage has improved significantly during 1990 and 2000, and the result of the total (81%) ranked Myanmar at top in the CLMV countries.

## **1.2. Key strategies**

### **(1) Need for prioritization**

Given the circumstances, Myanmar needs all-round reforms. We need new roads, and existing roads need to be paved and upgraded. Passenger and commercial cars will increase and it will require new roads. There is a need to reduce road traffic deaths. Ports and airports need to be upgraded. Railway needs rehabilitation. Myanmar needs to catch up with increasing ICT demand of people and industries. We must tackle various MDG issues. At the same time, Myanmar needs to provide internationally comparable data and improve data quality.

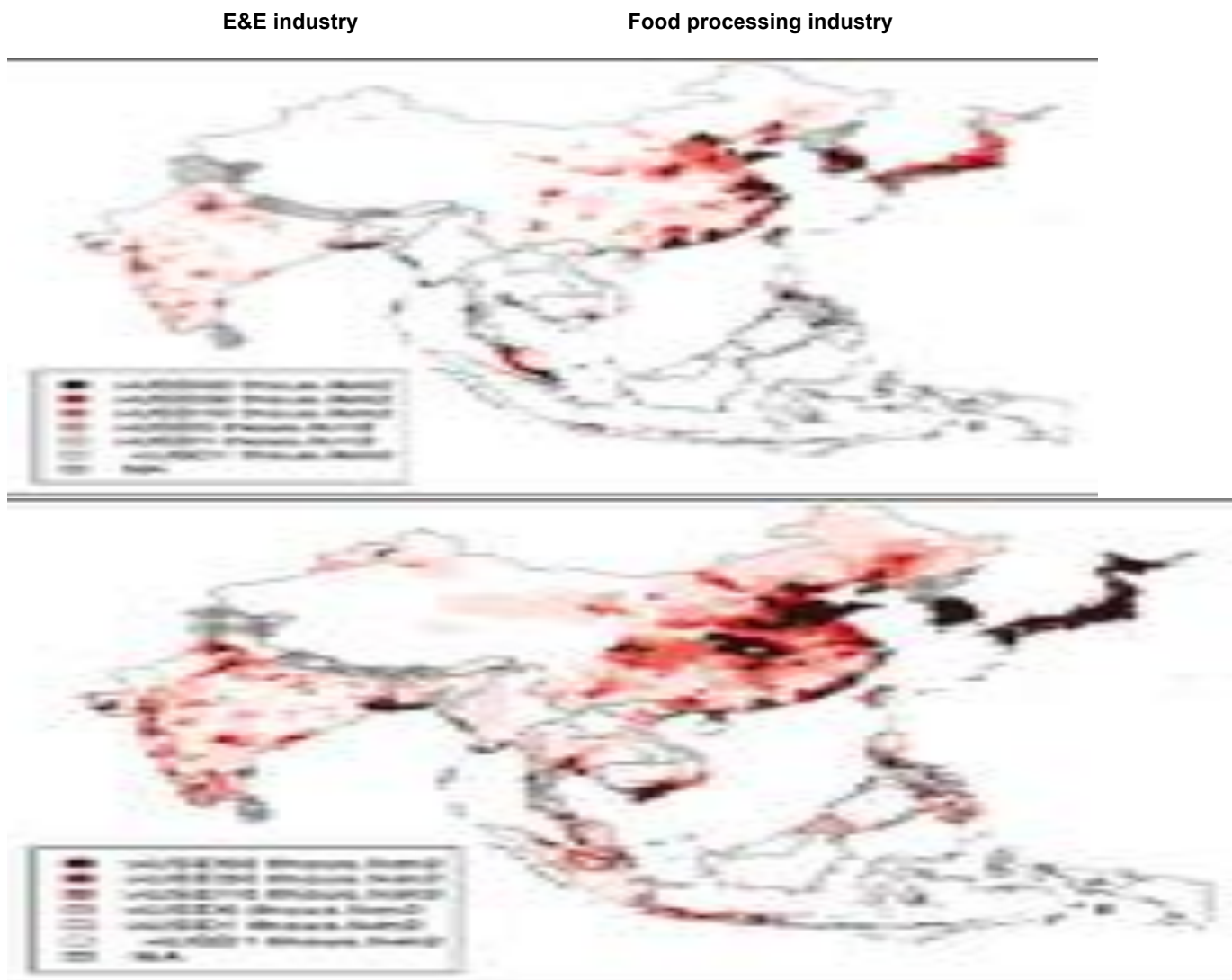
Obviously these cannot be achieved at once, even though Myanmar is now addressing them all in parallel. Finance and human resources are limited and infrastructure projects take time. Therefore, *we must have clear objective and strategy to prioritize the infrastructure projects.*

*One practical way to prioritize the projects is taking the same way as the other ASEAN countries have taken. ASEAN forerunners and Vietnam have long pursued the trade and FDI driven industrialization. Fragmentation theory and the concept of ‘2<sup>nd</sup> unbundling’ clearly explain what we have seen in those countries. ASEAN forerunners and Vietnam have successfully attracted some production processes and tasks in the production networks developed by multinational enterprises (MNEs). The East Asian countries including ASEAN forerunners and MNEs were main drivers to promote international division of labor in terms of production processes and tasks and created the most sophisticated production networks in the world. Moreover, ASEAN forerunners have expanded the variety of the processes and tasks as they raised their capacity.*

Those countries initiated trade and FDI driven industrialization from their primary cities. In ASEAN, most production processes in automotive industry and electronics and electric appliances (E&E) industry are located in limited areas near the big cities. Figure 6-2 illustrates the agglomeration of E&E and food processing industries based on the industrial value added divided by area. There is more uneven distribution of E&E

industry, when compared with food processing industry. E&E industry is located near the big cities and only a few other regions can attract the industry. Malaysia succeeded in dispersing the electronics industry to the states along the Strait of Malacca, but for Thailand, Indonesia, the Philippines and Vietnam, agglomerations in production can be seen in limited areas. It implies that even though ASEAN forerunners and Vietnam could attract FDI and some production processes, it is still a long way for them to disperse the industry to other regions in the countries.

**Figure 6-2: Agglomeration of E&E and food processing industries (2005, USD per km<sup>2</sup>)**



*Source:* IDE-GSM team. NA for some countries and regions due to data availability.

The Comprehensive Asia Development Plan (CADP, ERIA 2010) emphasized the interactions among the regions in different development stages. The report classified the



regions to three tiers, that is, existing industrial agglomerations such as Singapore, Bangkok and Chennai (Tier 1), potential growth nodes to be linked with production networks (Tier 2) and other regions (Tier 3). In the report, Yangon, Mandalay and Dawei are mentioned as possible Tier 2 regions to be involved with the production networks. Realistically, Yangon, Mandalay and Dawei have great opportunity to be connected with production networks.

## (2) Development of Yangon with international standardized infrastructure

Myanmar's primary city is Yangon and its primary port is Yangon port. As there is going to be a gradual shift of the primary port from Yangon port to Thilawa port, so both the ports are discussed in this section. There is a need to think of upgrading infrastructure, providing new infrastructure, and providing international standard infrastructure. Especially, as international infrastructure requires higher costs and technical assistance from other countries, there is a need to identify which infrastructure projects should be of international standard.

**Table 6-4: Strategy for Yangon (target years for partial operation)**

	Urban	Industrial
	<b>Thilawa Port</b>	
Up to 2015	<b>Yangon to Thilawa access road</b>	<b>Thilawa SEZ</b>
	Rehabilitation and upgrading the roads	Upgrading current Industrial Zones
2016-2020	<b>Ring road (Yangon)</b>	Thilawa and suburban Yangon
	<b>Urban railway (Rehabilitation)</b>	
	<b>Hanthawaddy International Airport</b>	
2021-2025	<b>Urban Railway (New in Yangon)</b>	
	<b>Airport Link to Hanthawaddy</b>	
2026-2030	<b>Urban Expressway</b>	

*Note:* Bold text items require international standard and/or technical assistance

*Source:* ERIA.

As far as infrastructure is concerned, international standard infrastructure is needed for industrial estates/SEZ, primary ports, and access roads between them in the Greater Yangon area. Thilawa SEZ and Thilawa port upgrading will be a model case of international standard infrastructure in Yangon and Myanmar. International standard SEZ should be with stable electricity, internet and water supply, wastewater treatment facility, international standard customs office, international standard freight forwarders,

transparent labor/SEZ laws and regulations, and various incentives to the investors. One stop center of trade and investment can be established in SEZ as in Cambodia so that firms can get all information and all import, export and investment related documents, and consult with the staff of the center on any kind of difficulties in trade and investment.

*Living condition should also be improved to attract foreign investors.* High-standard hotels, residents, service apartments, hospitals, supermarkets, international schools, and even golf courses or other entertainment facilities are necessary for the visitors, managers and their families. Although those amenities are provided by private companies, Myanmar government can give incentives and facilitation measures to attract these companies and enhance living condition for the investors.

*Mitigating the traffic jams in Yangon must be a long-term effort as in all other countries.* Because economic development must induce the inflow of households and firms into the primary city, we can say the population of Yangon, including suburban areas, can exceed 10 million<sup>56</sup>. There should be continued upgrading of current roads and urban railways, build new bridges, plan for new urban railways such as subways, and develop a ring road. And the territory of Yangon City should be expanded so that urban functions work smoothly.

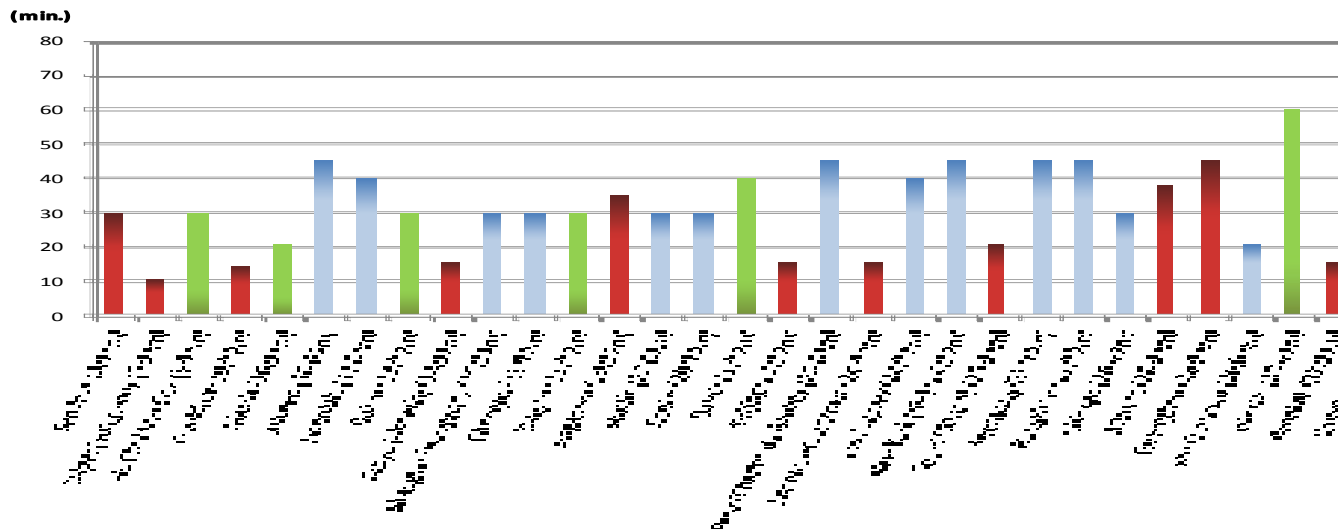
Myanmar needs to upgrade the current industrial estates. New industrial estates in suburban areas of Yangon, especially north-eastern area of Yangon along national roads should be planned. Better access from these areas to the Thilawa port will be critical.

Yangon will have new Hanthawaddy International Airport and start its construction very soon. Current handling capacity of the Yangon International Airport is 2.7 million passengers. The Yangon Airport already exceeded 3 million passengers in 2012 and forecast tells that traffic will be 5.4 million in 2015, so the development of the new port is an urgent matter. *Better access to the Hanthawaddy International Airport will also be a key in the global competition, especially in electronics sector and services industry.* As shown in Figure 6-3, many airports have access times less than 45 minutes. Especially, airports in distant place have railway access from/to the city, e.g., Bangkok, Hong Kong, Shanghai (Pudong), Seoul (Incheon) and Tokyo (Narita). Given the 80 km road distance between Hanthawaddy International Airport and Yangon city center, better rail link between the two is essential.

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<sup>56</sup> Both JICA study on Master Plan for the Greater Yangon and IDE/ERIA-GSM analysis estimated that the Greater Yangon will have more than 10 million populations.

**Figure 6-3: Shortest Time between The Cities and The Airports**



*Note:* Need to choose a better mode between “Rail” and “Bus”.

*Source:* ANA (Japanese airline)’s magazine.

### (3) Mandalay and Yangon-Mandalay link

Mandalay is the second largest city in Myanmar and is a logistics hub connecting northern cities. Yangon-Mandalay link is the most important link within Myanmar. Infrastructure development in Mandalay is crucial because it should be the first step to industrial dispersion in Myanmar. If some industries are successfully in dispersed to Mandalay, the geographical coverage to other cities, regions and states could also be expanded. Otherwise, inclusive growth and high economic growth cannot be achieved simultaneously.

**Table 6-5: Strategy for Mandalay and Yangon-Mandalay link  
(target years for partial operation)**

	Urban	Industrial	Intercity
Up to 2015	Rehabilitation and upgrading Incentive in Mandalay airport	Upgrading current Industrial Zones	Rehabilitation and utilization of existing infrastructure, incl. Yangon-Mandalay Expressway
2016-2020		<b>Mandalay area</b>	<b>Further upgrading of Yangon-Mandalay link, incl. rehabilitation of railway</b> <b>Upgrading inland waterways</b>
2021-2025	Ring road (Mandalay)		
2026-2030	Urban Expressway		

*Note:* Bold text items require international standard and/or technical assistance

*Source:* ERIA.

The issues in Yangon-Mandalay link can be divided by two stages. First is *enhancing the capacity of current expressway running between Yangon and Mandalay via Nay Pyi Taw to allow freight transport*. Currently, there is an expressway with 4 lanes between Yangon and Mandalay, which has enough space to be upgraded to 8 lanes. However, trucks are not allowed to run on this road till the full pavement width of expressway is finished. Most freights are shipped through narrow National Road No.1. For better accessibility between Yangon and Mandalay, upgrading the current expressway to allow freight transport is important. Second is *planning and forecasting better modal mix among National road No.1, expressway, railway and inland waterway*. Rehabilitation of railway and inland waterway can be assisted by other countries or international organizations. *Collection of quality data, especially in terms of usage of those modes, is essential to discuss the current and future modal mix*. Also, we should consider the gradual modal shift of passenger and cargo transport from inland waterway to road as industries and people become more time-sensitive.

Mandalay can be a growth pole as well as an international hub in terms of air-cargo. Based on other countries' experience, Myanmar needs to have an international logistics company in Myanmar. Also, landing fee should be lowered. Malaysia and Thailand

have lower landing fees for Kuala Lumpur International Airport and Suvarnabhumi Airport, respectively. Myanmar can consider better incentive schemes to the air carriers as well as to the logistics companies.

#### (4) Dawei and Kyaukphyu as development node

Dawei and Kyaukphyu, which have SEZ plans, can be a milestone to disperse the international production networks to other cities in Myanmar. First of all, Dawei and Kyaukphyu have different characteristics in that they will be the gateways for Thailand and China, respectively. To develop these cities, connectivity enhancement to Thailand and China is required. For China, Kyaukphyu will be a strategic project to get a gateway to Indian Ocean as well as disperse the industries from coastal areas of China to western areas (Isono, Kumagai and Kimura, 2012). For Myanmar, Kyaukphyu project must be accompanied with domestic road/railway improvement. For Thailand and other Mekong countries, Dawei will create large economic impacts, as we discuss in the next section. If we provide good gateways for China or Thailand, SEZ and other industrial development near the SEZ sites can be considered. Upgrading Dawei airport into an international airport will provide a better access from Bangkok or other cities.

#### (5) Fulfilling the basic needs

Yangon development is essential for the economic development of Myanmar, though it does not ensure inclusive growth. Yangon development will attract people and firms which will lead to increased traffic congestion. *Upgrading of current infrastructure outside Yangon should be undertaken simultaneously either with ODA or through Myanmar's own budget.*

However, two facts must be borne on mind. First, Yangon development together with institutional development benefits real per capita GRDP growth in northern regions, despite the outflow of households and firms from those areas. People in northern regions and states can increase their sales and purchase to/from Yangon and increase exports and their imports to/from other countries, through efficient port or airport of Yangon. For example, agricultural sector can benefit from better access in Yangon area, because deregulation and better access from Yangon port to other countries will induce relocation of the distribution center function of agricultural goods to areas closer to Yangon city (Kudo, Gokan and Kuroiwa). It also applies to ICT. Better internet connectivity is a primary requirement, and ensuring better internet access in Yangon city should be pursued continuously despite the rapid increase in demand. Second, just because Yangon's congestion is too severe, building of other industrial estates and SEZs outside Yangon should not be considered. Industries, especially FDI driven development cannot be dispersed without better infrastructure in the primary city. Building other industrial estates and SEZs in other regions without tackling the congestion in Yangon cannot attract foreign firms to another industrial estate. It will also lessen the economic impact and long-term economic growth will slow down.

Better decentralization mechanism is a key to provide basic infrastructures in rural areas. Local governments should have better knowledge about their regions and elected local governments must think of voter's preferences. We can learn from Indonesia, which has experienced drastic change toward decentralization and has a lot of literature in both qualitative and quantitative analyses. Some key findings are as follows:

- A statistical analysis revealed that decentralization has increased infrastructure provision in rural areas (Chowdhury, 2009). Moreover, villages with lower average income acquired infrastructure provision more than pre-decentralization era and the decentralization has narrowed the infrastructure gaps between higher income villages and lower income villages.
- Another statistical analysis showed that corruption increased the local government expenditure significantly (Murwito, *et al.*, 2012). The study suggested that we need an e-procurement system as well as a monitoring mechanism by third-party outside the local government.
- The law No. 22/1999 in 1999 eliminated the decision hierarchy between provincial and district governments for the decentralization. Since districts had started to have similar projects of new port construction or new bus station development without any direction or coordination, the law No. 32/2004 in 2004 restored the decision hierarchy and required approvals from provincial governors for districts' spatial planning (Okamoto, 2010).

### 1.3. Domestic Corridors Utilizing International Initiatives

The principle infrastructure to facilitate smooth transportation along economic corridors should be upgraded. Transport infrastructure in all modes of transport related facilities and services should be improved for domestic transport, overseas trade and border trade. Potential investment projects in road and logistic facilitation subsectors are needed.

**Table 6-6: Strategies for Investment on Infrastructure Development**

Area of focus	Short-term strategy	Medium-term strategy	Long-term strategy
Road Infrastructure	<ul style="list-style-type: none"> <li>• Construction of major trade routes</li> <li>• Upgrading existing roads</li> </ul>	<ul style="list-style-type: none"> <li>• Improve all Union Highway road status to meet at least ASEAN Highway Standard Class III</li> </ul>	<ul style="list-style-type: none"> <li>• Improve all Union Highway road status to meet at least ASEAN Highway Standard Class II</li> </ul>
Road transportation services	<ul style="list-style-type: none"> <li>• State-owned transportation services should be further privatized</li> <li>• Efficient public</li> </ul>	<ul style="list-style-type: none"> <li>• Expand Intra and Intercity transport</li> <li>• Extend network in the international and regional cooperation</li> </ul>	<ul style="list-style-type: none"> <li>• Implementation of the Intelligent Transport System in Nay Pyi Taw and Yangon</li> <li>• Implementation of</li> </ul>

	transport	programmes	international road Safety standard
		<ul style="list-style-type: none"> <li>• Construction of roads and bridges</li> </ul>	
Railway transportation services	<ul style="list-style-type: none"> <li>• Encourage investment to improve Yangon – Mandalay railroad to meet the travel time of 12 hours.</li> <li>• Cooperation with private sectors to improve the effectiveness of Yangon circular railway system</li> <li>• Improve cargo trains for cargo transport</li> </ul>	<ul style="list-style-type: none"> <li>• Construction of Muse- Kyauk Phyu rail line and Dawei-Kanchanaburi rail line which connects neighbouring countries by BOT system</li> <li>• Change railroad in line with ASEAN gauge in main railroads</li> </ul>	<ul style="list-style-type: none"> <li>• Change railroad in line with ASEAN gauge to all railroads</li> </ul>
Air transport services	<ul style="list-style-type: none"> <li>• Construction of new Hanthawaddy International Airport</li> <li>• Allow private sectors to operate the airports</li> <li>• Upgrading airline services</li> </ul>	<ul style="list-style-type: none"> <li>• Operation of four International Airports in full swing</li> <li>• Upgrading the existing domestic airports</li> <li>• Expansion of domestic and international airlines and air routes</li> </ul>	<ul style="list-style-type: none"> <li>• Upgrading the existing domestic airports to international airports such as Bagan, Dawei and Kyauk Phyu</li> </ul>
Port Infrastructure	<ul style="list-style-type: none"> <li>• Upgrading existing port facilities especially in Yangon</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Implementation of deep seaports projects in Dawei and Kyauk Phyu</li> <li>• Implementation of other seaports projects in Sittwe , Patheingyi, Myeik and Kaw Thung</li> <li>• Construction of 6 ports: Bhamaw port, Mandalay port, Pakokku port, Magway port, Monywa port,</li> </ul>	<ul style="list-style-type: none"> <li>• Myanmar ports to be on the international sea routes</li> <li>•</li> </ul>

Kalaywa port			
Inland water and maritime transport	<ul style="list-style-type: none"> <li>• Upgrading existing ports facilities along the Yangon river</li> <li>• Improve inland water transportation especially Yangon-Mandalay-Bhamaw route</li> <li>• Formulation of the national integrated transport master plan</li> </ul>	<ul style="list-style-type: none"> <li>• Improve shipping lines</li> <li>• Extend cargo ships for inland water transport</li> <li>• Introduce routes to connect international maritime routes</li> <li>• Implementation of the national integrated transport master plan</li> </ul>	<ul style="list-style-type: none"> <li>• Upgrade all shipyards of the inland water transport</li> <li>• Implementation of the national integrated transport master plan</li> <li>• Construction of new international port terminal in mouth of Yangon River to approach Regular mother vessels routes</li> </ul>

*Source:* ERIA.

Among them, many sections have been designated as international economic corridors by ADB GMS, ESCAP, ASEAN or other organizations and initiatives. Yangon-Mandalay, Myawaddy-Paan-Yangon and Mandalay-Monywa-Tamu sections are part of Asian Highway No.1 as well as ASEAN Highway No.1. A part of the expressway between Yangon and Mandalay is a part of India-Myanmar-Thailand Trilateral Highway. Muse-Mandalay section is Asian Highway No.14. Myanmar can ask for assistance for these infrastructure developments, starting from repairing current pavement and reduce missing links. Myanmar can gradually extend the sections at international standard with clear prioritization.

As domestic corridors are part of international corridors, trade and transport facilitation at the borders are indispensable. As an ASEAN member state, Myanmar has a responsibility to take part in the ASEAN Framework Agreement on the Facilitation of Goods in Transit (AFAFGIT) signed in 1998<sup>57</sup>, the ASEAN Framework Agreement on Multimodal Transport (AFAMT) signed in 2005, and the ASEAN Framework Agreement on Facilitation of Interstate Transport (AFAFIST) signed in 2009. Myanmar has acceded to the GMS cross border transport agreement (CBTA) in 2003<sup>58</sup> so that it can fully utilize the agreement should it want to.

<sup>57</sup> There are 9 Protocols. Five were ratified. Protocol 2 & 7 are to be signed and 1 & 6 are to be ratified.

<sup>58</sup> There are 20 Annexes and Protocols. All except Annex 5, 13 (a), 13 (b) & Protocol 3 have been sent to other GMS members and ADB.



## 2. Integrated Energy Development

### 2.1. *Energy situation and policy of Myanmar*

#### (1) General condition

While the development of a comprehensive integrated energy strategy requires attention to both the sourcing of primary power inputs as well as distribution, perhaps no challenge is as important as Myanmar's ability to electrify its domestic economy. This is due to the massive scale and scope of the initiative needed, and capital required, to maintain, repair, expand and supplement existing infrastructure. In addition there are many technical, social, political, financial and other issues that need to be addressed. Furthermore, without adequate power, Myanmar cannot industrialize as it will not be able to create competitive manufacturing facilities. Nor will it be able to upgrade its telecommunications, technology and overall capacity to deliver necessary services to businesses and consumers.

Until these issues can be resolved, the nation is experiencing increased blackouts, even during the rainy season when hydropower plants operate at high capacity. Rapid growth in electricity consumption—averaging 14.7 percent per year between 2008 and 2011<sup>59</sup>—is placing further strains on capacity and increasing generator failure<sup>60</sup>.

Efforts to improve electrification have also come under literal and figurative attacks. After insurgents bombed transmission lines linking Shweli hydropower station to the national grid, generator capacity was reduced by 200 MW. People in Myanmar have also organized protests and accused the government of diverting electricity to neighboring countries. Projects funded by Chinese and Thai companies have been suspended or cancelled and last year a government official declared all future natural gas finds reserved for domestic purposes<sup>61</sup>.

Myanmar's size, as well as its lack of development and large rural population, necessitates an integrated and comprehensive approach to energy, including electricity. It is not a question of addressing selective deficiencies within largely functional infrastructure but rather building on a rudimentary and largely antiquated system almost from scratch. Further, it requires an in-depth understanding of political, social and economic issues.

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<sup>59</sup> According to the Dept. of Electric Power, household electrification rates (% of households) are 21, 23, 24, 25 and 27 for the years 2008/09 to 2011/12 respectively.

<sup>60</sup> David Dapice, [Electricity in Myanmar: The Missing Prerequisite to Development](#), Harvard University, May 31, 2012

<sup>61</sup> Patrick Winn, [Myanmar's Real Power Struggle? Keeping on the Lights](#), *Global Post*, June 23, 2012

## (2) Supply and Demand of Energy

### Supply and Demand of Energy

Myanmar possesses substantial energy resources. The country's natural gas reserves are the 10th largest in the world; its vast water supply provides the country with rich hydropower capacity; and forests and abundant arable land contribute to a sizeable potential for renewable energy including geothermal. It is no coincidence that Myanmar's energy industry has been the country's leading recipient of foreign investment.

Given Myanmar's underdeveloped state, its Ministry of Energy introduced a diversification strategy emphasizing exploration and production to generate export revenues and meet domestic demand. The country's total energy mix is comprised of 61 percent biomass, 11 percent natural gas, 11.5 percent oil, 14.5 percent hydropower, and 2 percent coal.<sup>62</sup>

Of total electricity generation in 2009, production from hydroelectricity climbed to 72 percent, from 62 percent in 2008 and 57 percent in 2007.<sup>63</sup> Production from oil, gas and coal declined to 29 percent, from 39 percent in 2008 and 43 percent in 2007.<sup>64</sup> Natural gas produced 1,146 million kWh in 2009, or 20 percent, down from 29 percent in 2008 and 30 percent in 2007.<sup>65</sup> Production from crude oil and petroleum decreased to 523 million kWh in 2009, or 9 percent, down from 10 percent the year prior and 14 percent in 2007. Renewable sources, including solar, wind and biofuel, are being explored to meet rural household needs.

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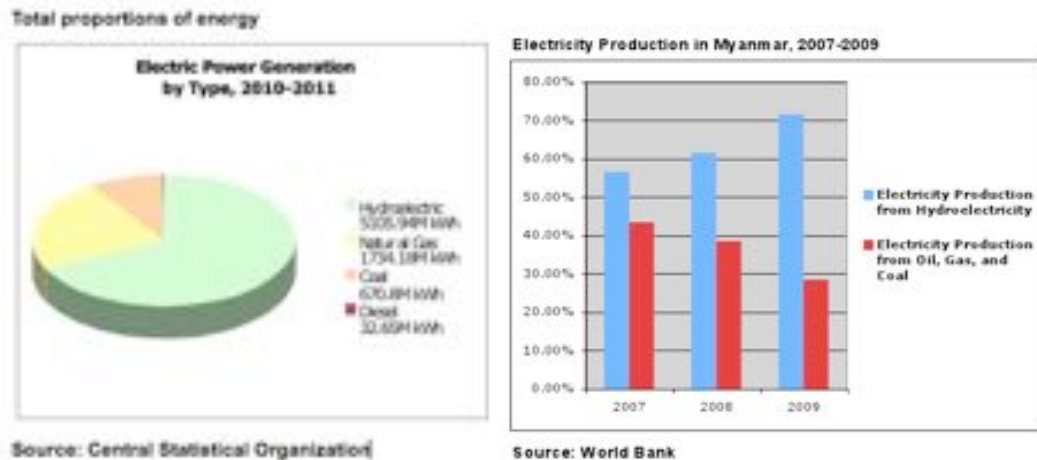
<sup>62</sup> Wah Wah Thaung, Oil and Gas Sector in Myanmar: The energy related issues and challenges from the perspective of Ministry of Energy, Myanma Oil and Gas Enterprise, Ministry of Energy, Republic of the Union of Myanmar. Presented at "Energy challenges in ASEAN: Implications for Myanmar" workshop, February 2013

<sup>63</sup> [Electricity Production from Hydroelectric Sources \(% of total\)](#), The World Bank Group, accessed: June 29, 2012

<sup>64</sup> [Electricity Production from Oil, Gas and Coal Sources \(% of total\)](#), The World Bank Group, accessed: June 29, 2012

<sup>65</sup> [Electricity Production from Oil Sources \(% of total\)](#), The World Bank Group, accessed: June 29, 2012

Figure 6-4: Power generation in recent years



**Oil and Gas:** Myanmar has about 150 million barrels of future recoverable oil reserves and 11.197 Trillion cubic feet of natural gas reserves as of April 2012. It produces over 17,000 barrels of Crude Oil and nearly 1300 MMCF of Natural Gas per day.<sup>66</sup> Of natural gas produced, more than 80 percent is exported to Thailand.<sup>67</sup> Given public demand to utilize this resource domestically, a contract with Thailand has been renegotiated to allocate more natural gas for domestic use in Myanmar.<sup>68</sup>

Myanmar's electricity production from natural gas sources reached a peak of 70.6 percent of total electricity production in 1998 and declined to 19.6 percent of total production in 2009, according to the International Energy Agency.

More than 90 percent of Myanmar's natural gas production comes from the Yadana and Yetagun offshore fields in the Andaman Sea. These primarily supply Thailand though some gas from Yadana is used for domestic supply. Gas from Nyaungdon, Myanmar's largest onshore gas field, located roughly 55 km off the coast of Yangon, supplies state and privately owned factories as well as Yangon. Thai company PTTEP has made discoveries in M-9 and M-7 blocks which include Zawtika, Gawthika, Shweypyihay, Kakona and Zatila. Shwe, an offshore field near Sittway was discovered in 2004, and will deliver gas to China. Production in Shwe and Zawtika, both scheduled to begin in 2013, is anticipated to bring Myanmar's total gas output to roughly 2.2 billion cubic feet a day by 2015<sup>69</sup>. The country's gas exports are expected to reach a record

<sup>66</sup> Nicky Black, "The Myanmar Oil and Gas Industry," in *Blood Money: A Grounded Theory of Corporate Citizenship: Myanmar (Burma) as a Case in Point* (University of Waikato, 2009)

<sup>67</sup> [Myanmar's Power Struggle Endangers Economic Boom](#), *op.cit.*

<sup>68</sup> [Thailand to Supply More Gas to Meet High Demand in Myanmar](#), Arakon Oil Watch, June 21, 2012

<sup>69</sup> Jacob Gronholt-Pedersen, [Myanmar to Launch Offshore Oil, Gas Bidding Round in April](#), Dow Jones, Mar. 4, 2013

USD4 billion for 2012-2013<sup>70</sup>. A new discovery, block M-3, will be entirely used for domestic supply<sup>71</sup>.

To meet the challenge of increasing domestic demand, Myanmar will step up exploration for natural gas by 25 percent in FY2013-14, according to the National Planning Bill approved by parliament in March 2013. Myanmar has also relaxed its policy on the import of crude oil and petroleum products and welcomed joint venture operations with foreign companies for domestic oil exploration and production.

As of June 2013, 11 foreign companies were exploring for oil at 20 offshore sites, and 13 foreign companies, in addition to 18 joint ventures with Myanmar firms, were exploring in 18 onshore fields.<sup>72</sup> Myanmar is reported to have more than one hundred exploration blocks, 60 of which are open for investment. Of those, 29 are onshore, 12 in shallow and 19 in deep water.<sup>73</sup>

Companies operating in Myanmar's oil and gas sector include Hong Kong's EPI Holdings, India's Jubilant Energy, Switzerland's Geopetro International Holding, Malaysia's Petronas, Thailand's PTT Exploration and Production, South Korea's Daewoo, Indonesia's Istech Energy, and U.S.-based Chevron, which is operating in Myanmar under a grandfather clause. Australia's Woodside Petroleum and France's Total SA are also operating through partnerships.

The country held its first international bidding round for 18 onshore blocks in August 2011, and 8 blocks were awarded to 6 companies. A second international bidding round for another 18 onshore blocks was announced in January 2013, but it is unlikely decisions will be finalized before November 2013. Some onshore blocks will be kept as reserves by state-owned Myanma Oil and Gas Enterprise (MOGE).

Offshore oil and gas blocks tend to be seen as having more potential and therefore generate more interest from foreign firms. Myanmar announced first international bidding round on 30 offshore blocks on April 10, 2013 and in a new development has allowed foreign companies to bid for full control without mandating the companies take a local partner as in the past<sup>74</sup>. Bidding firms are, however, required to enter a production-sharing agreement with MOGE<sup>75</sup>.

It is also noted that the pipelines for natural gas and oil connecting the coast of the Western Myanmar with China will be completed in 2013.

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<sup>70</sup> [Myanmar Gas Export May Touch \\$4bn](#), Natural Gas Asia, March 27, 2013.

<sup>71</sup> Wah Wah Thaung, *op.cit.*

<sup>72</sup> [Foreign oil companies ink exploration deals](#), Agence France Presse, June 21, 2012

<sup>73</sup> Daniel Ten Kate, [Myanmar Oil Veteran Rebuffs Suu Kyi a Shell](#), Chevron Weigh Bids, Bloomberg, Sept. 18, 2012

<sup>74</sup> [Myanmar open to foreign energy bids](#), Bangkok Post, March 6, 2013

<sup>75</sup> [Myanmar opens keenly awaited oil and gas auction](#), Agence France Presse, April 10, 2013

**Coal:** Myanmar produced an average 416 thousand tons of coal per year between 1988 and January 2009<sup>76</sup>. The country has 36 major coal deposits with total estimated reserves of over 519.21 million tons, mostly in the north. Higher quality coal deposits, consisting of lignite to sub-bituminous coal, are primarily found in Sagaing Division, Magwe Division, and Tanintharyi Division, while lower quality coal is found in Shan State. Coal accounts for roughly 8 percent of electricity production. It is mainly used for power generation, cement production, steel production and industrial zones or for export to Thailand and, to a lesser extent, China. There is growing concern, however, over coal's environmental and societal impact, as evidenced by the recent cancellation of the Dawei coal-fired plant.

Nevertheless, Myanmar's Ministry of Mines is emphasizing exploration—with coal production scheduled to increase by 6 percent annually up to FY2031—to allow expanded use for both power generation and non-power-related uses. There are currently ten mining companies involved in coal production in Myanmar: Htun Thwin Mining, Geo Asia Industry and Mining, Myanmar Economic Corporation, Yangon City Development Committee, AAA Cement Int'l Co., Ltd., U.E Export & Import Co., Ltd., Mine Htet Co., Ltd., Ngwe Yee Pale Mining Co., Ltd., and the Max Myanmar Group. Myanmar's membership in the ASEAN Forum on Coal (AFOC) has opened additional opportunities for coal investment, including as a means to promote rural electrification. Myanmar is also introducing clean coal technology.

**Hydropower:** Myanmar has a high potential for renewables that provide a low-cost alternative to diesel. The largest source is hydropower, which grew in importance after the World Bank conducted a 1995 study that predicted Myanmar had a potential production capacity of 108,000 MW<sup>77</sup>.

In 2006, Myanmar announced plans to wean the country off gas to make hydropower the sole electricity source by 2030. Twenty-four hydropower plants would be developed, varying in output from 48 MW to 7,100 MW, with a projected 23,300 MW of electricity by 2030.<sup>78</sup> Certain hydropower resources are earmarked for export, while gas would be directed to fertilizer production and other projects.

Several power plants are currently under construction in Mandalay, Magway, and Bago divisions as well as Rakhine state and the Chindwin River Valley. Additional projects are located in Upper Paunglaung, Nacho, Shwegyin, Htamanthi, Pyuchaung, Kunchaung and Thahtaychaung. Feasibility studies are also underway in Thanlwin and Tarhsan.

Although hydropower is a sound long-term option, it requires long lead-time, a significant amount of investment and environmental consideration. This must come from

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<sup>76</sup> Myanmar Energy Sector Assessment, Asian Development Bank, October 2012.

<sup>77</sup> [Harnessing Energy from the Clouds](#), *The Myanmar Times*, August 20-26, 2007

<sup>78</sup> [Government Will Prioritize Hydropower Projects Over Gas](#), *The Myanmar Times*, July 10, 2006

foreign companies, and Myanmar would prefer not to rely on external entities for basic power needs. Hydropower also suffers shortages during dry season, requiring back-up. Therefore, even though hydro capacity should be expanded, the nation must remain diversified so it will not be reliant on any one energy source.

Gas can plug short-term gaps and be stored during times of low demand for use in maximum demand periods. For base-load, however, hydropower, geothermal and tidal energy are preferable. Natural gas can be used as a feedstock to increase added-value of Myanmar's consumer products and exports. Liquefied petroleum gas (LPG) and compressed natural gas can also be diverted for domestic use. This would reduce carbon emissions and help to develop the gas industry.

**Other Renewables:** Traditional biomass is, and will remain, the primary energy source in Myanmar for many years to come. In addition to hydropower, Myanmar is working to develop other renewable energy sources, including wind, solar, geothermal, and biomass, consisting of fuel wood, charcoal, agricultural waste, and animal residue.

**Table 6-7: Biomass Resources in Myanmar**

Type	Quantity
Rice Husk	4.392M ton/year
Lumber Waste	1.5M ton/year
Bagasse	2.126M ton/year
Molasses	240M ton/year
Livestock Waste	34.421M ton/year

*Source:* Myanmar Engineering Society.

While it is difficult to obtain accurate data given unreported logging, more than 50 percent of Myanmar's total land area is reported to be forest. This represents approximately 344,232 square kilometers. Myanmar's potential annual yield of fuel wood could be as high as 23.5 million hoppus tons. According to the data from the Ministry of Environmental Conservation and Forestry, fuel wood and charcoal represent about 70 percent in 2010 of the country's primary energy supply and will have a 58 percent share in 2020. Consumption is directly proportional to population growth and indirectly proportional to availability of other energy sources<sup>79</sup>.

To preserve forests, Myanmar's government has undertaken initiatives to substitute use of fuel wood with other biofuels or, in areas near oil and gas fields, LPG. Efforts are also being made to introduce more efficient stoves and appliances to rural households.

<sup>79</sup> [Renewable Energy Sector](#), Myanmar Ministry of Energy, accessed: June 29, 2012

These measures are expected to decrease dependence on fuel wood by 46 percent over a 30-year period.

Per year, Myanmar also has 4.392 million tons of rice husk resources, 1.5 million tons of lumber waste, 240,000 tons of molasses, 2.126 million tons of bagasse, and 34.421 million tons of livestock waste. All of these sources can be used for biomass gasification<sup>80</sup>. As of 2008, 428 biomass gasification plants were operating in Myanmar. Cost savings makes biomass especially attractive for Myanmar's rural population. Nevertheless, as one analyst interviewed noted, "Use of in-country biomass is only attractive if it substitutes for imported oil. It will not replace hydro for base-load generation."

Solar energy also holds promise. Myanmar's Ministry of Electric Power reports available solar energy is about 51,974 tTWh per year.<sup>81</sup> Solar energy is abundantly available in central Myanmar with a radiation intensity of 5 kWh per square meter per day during the dry season. At present it is only being used on an individual scale, primarily through photovoltaic cells. Solar panels have been a source of electricity for certain monasteries and schools in Myanmar and were provided to villages in Myanmar's Ayeyarwady Delta following power interruptions due to Cyclone Nargis<sup>82</sup>. Despite the savings over diesel fuel when viewed over a long timeframe, solar electricity has a relatively high start-up cost.

Myanmar's wind energy potential is 365 terawatt hours per year, according to government data, and the country has identified 93 geothermal locations.

The potential for tidal electricity generation may also be great due to 1,700+ miles of coastline and expansive delta areas. Two tidal-powered hydroelectric facilities were completed in 2005, in Ngapudaw Township, Ayeyarwady Division<sup>83</sup>.

### (3) Structure of electricity industry

Myanmar's electricity system is centralized under government and state-owned enterprises with some private sector involvement in the generation, distribution, sale and service of electricity. The industry is regulated by the Electricity Act of 1948 (as amended in 1967), the Myanmar Electricity Law of 1984 and the Electricity Rules of 1985.

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<sup>80</sup> [ASEAN Countries' Presentation on Renewable Energy Projects and Business Opportunities \(Myanmar\)](#), Myanmar Engineering Society

<sup>81</sup> Mercedita A. Sombilla, Urooj S. Malik, A.K. Mahfuz Ahmed, and Sarah L. Cueno, [Integrating Biofuel and Rural Renewable Energy Production in Agriculture for Poverty Reduction in the Greater Mekong Subregion](#), Asian Development Bank, 2009.

<sup>82</sup> [Electricity in Myanmar](#), *op.cit.*

<sup>83</sup> Delta Holds Great Potential for Tidal Power Generation, *Voice Weekly*, February 13, 2006



The Ministry of Electric Power, established in 1997, was restructured in 2006 and divided into two separate ministries: the Ministry of Electric Power 1 (MOEP-1), which was responsible for the development and maintenance of hydropower and coal-fired power plants; MOEP-1 was comprised of the Department of Hydropower Planning (DHPP), Department of Hydropower Implementation (DHPI) and Hydropower Generation Enterprise (HPGE). The Ministry of Electric Power 2 (MOEP-2) was responsible for the development, operation and maintenance of gas and combined power plants, transmission and distribution system. MOEP-2 was comprised of the Department of Electric Power (DEP), Myanmar Electric Power Enterprise (MEPE), Electricity Supply Enterprise (ESE) and Yangon City Electricity Supply Board (YESB). In September 2012, these two ministries were reorganized into a single ministry, Ministry of Electric Power (MOEP).

MEPE, established in 1997, is a state-owned, state-run utility. It operates and maintains Myanmar's gas turbine power stations and combined cycle power plants, and is charged with financing, constructing, and operating the country's transmission lines. MEPE also constructs distribution lines as well as substations. It is charged with distributing electricity through the national grid to five of Myanmar's seven states and six of seven divisions.

Distribution of electricity was managed under a state monopoly until 1994, when, to meet increasing demand for power, the government invited the private sector to invest in Myanmar's electricity sector<sup>84</sup>. Low returns, coupled with international sanctions against the country, however, have been a challenge to commercialization.

YESB was formed and tasked with approving small businesses to generate and sell power to consumers in Yangon division. HPGE and MEPE supply power to local consumers, but only Shweli Hydropower Company (JV Company of HPGE and YUPD) exports electricity to other countries. Off-grid power is supplied by the Electricity Supply Enterprise<sup>85</sup>.

#### (4) Decision-making structure of Ministry of Electric Power

Independent Power Providers (IPP) still cannot own transmission lines and large plants remain under government control. What constitutes an IPP in Myanmar is in a state of flux<sup>86</sup>. In rural areas, small-scale hydro and bio-fuel projects generate and distribute electricity under local or commercial auspices. Commercial captive-power producers also supply some larger towns and suburban areas.

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<sup>84</sup> Burma Eyes Private Power Producer, *Nation (Bangkok)*, February 13, 1996

<sup>85</sup> Myanmar: Summary of Asian Development Bank's Initial Sector Assessments, Asian Development Bank, June 2012

<sup>86</sup> [Electric Industry in Burma/Myanmar](#), Online Compendium, Burma Library, accessed: June 28, 2012

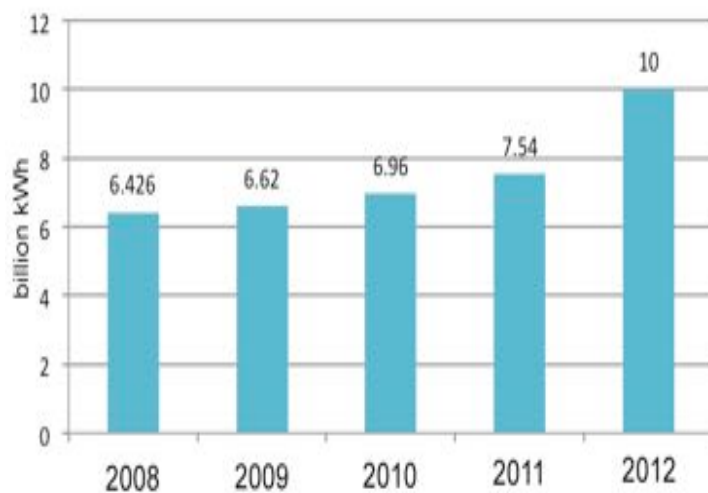


Industrial parks and other captive-power producers have their own transmission systems. State utilities are unlikely to allow sale of captive power to independent buyers in other locations. However, there is insufficient clarity regarding connectivity and power purchase agreements of IPPs.

On a larger scale, the Myanmar government has signed contracts with commercial interests on a Build-Operate-Transfer (BOT) basis. Electricity generated under a BOT contract is sold to MEPE, which then transmits and re-sells the electricity to consumers. The generating facilities are to be transferred to the government, generally after 20 to 40 years. Myanmar's largest power plants have been developed under BOT contracts with foreign power companies, including China's Yunnan Joint Power Development Co. and Thailand's Italian-Thai Industrial Company. The majority of electricity generated is exported.

State agencies produce electricity for their own use and industrial zones are known to establish their own electrical substations, transformers, transmission lines and stand-by generators. Captive-power transmission systems could account for the transmission of up to 66 kV, but more likely are less than 33 kV.

**Figure 6-5: Electricity Generation in Myanmar**



*Source:* CSO, 2012.

**Electrical Capacity:** Myanmar produced roughly 10 billion kWh of electricity, consisting of hydroelectricity, gas, coal, and diesel in 2011-2012<sup>87</sup>. Myanmar's Central Statistical Organization (CSO) reports that 6.62 billion kWh of power generation in 2008-09, 6.96 billion kWh in 2009-10, and 7.54 billion kWh for 2010-11<sup>88</sup>. This follows

<sup>87</sup> David Dapice, *Electricity Demand and Supply in Myanmar*, Proximity Designs, December 2012

<sup>88</sup> [Electric Power Generated and Sold by the Myanma Electric Power Enterprise](#), *op.cit.*

an increase in electricity generation from 5.804 billion kWh in 2005 to 6.426 billion kWh in 2008<sup>89</sup>.

Despite an average 15 percent annual increase in electricity generation between 2008-2011, the CSO does not report any additions to installed capacity between 2009 and 2012.<sup>90</sup> If accurate, this suggests the already inadequate power grid is being worked more intensively, increasing potential generator failure risk and power outages. Blackouts, already a common occurrence in most parts of Myanmar, became even more frequent in Yangon and Mandalay in 2012.

It is possible the CSO has not updated its statistics on installed capacity. Asian Development Bank reports installed capacity in 2011 was 3,361 MW, compared with CSO data that states installed capacity stood at 2,947 MW in 2010, made up of 94.06 MW off the grid capacity and 2,852.94 on the grid<sup>91</sup>. According to CSO, installed capacity on the grid is comprised of 2,013.5 MW of hydroelectricity, 120 MW of coal, 550 MW of gas, 165 MW of steam, and 4.5 MW of diesel. ADB states total installed capacity for 2011 was comprised of 2,520 MW of hydropower capacity, 715 MW of gas-fired capacity, and 120 MW of coal-fired capacity.

Installed capacity may, however, be lower than government statistics suggest. For example, the EIA reports an installed capacity of 1,840 MW in 2008, up from 1,800 MW the year before and 692 MW in 1980.

Either way, installed capacity in the 1,800 MW to 3,500 MW range is far too low for a country of Myanmar's size. In comparison, Thailand, which has a similar population and is Myanmar's largest export partner, has an installed capacity of 28,479 MW, according to the Electricity Generating Authority of Thailand—up to 10 times that of Myanmar<sup>92</sup>.

Myanmar currently has one of the world's lowest per capita electricity consumption rates. Myanmar consumed 104 kWh per person in 2009, compared to 131 kWh per person in Cambodia, 590 kWh per person in Indonesia and 2,045 kWh per person in Thailand<sup>93</sup>. Only Nepal, Haiti and a handful of sub-Saharan African countries consumed less electricity per capita than Myanmar.

Estimates place Myanmar's present electricity supply at only about half of future demand<sup>94</sup>. ADB, citing the Ministry of Electric Power, estimates individual power

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<sup>89</sup> [Country Analysis Brief: Myanmar \(Burma\)](#), U.S. Energy Information Administration

<sup>90</sup> [Electric Power Generated and Sold by the Myanma Electric Power Enterprise](#), *op.cit.*

<sup>91</sup> The Republic of Union of Myanmar, Country Report, Myanmar Ministry of Agriculture and Irrigation, presented May 26, 2011-July 6, 2011

<sup>92</sup> [International Energy Statistics](#), U.S. Energy Information Agency

<sup>93</sup> [Electric Power Consumption \(kWh per capita\)](#), The World Bank Group, accessed: June 29, 2012

<sup>94</sup> Dapice, Electricity in Myanmar: The Missing Prerequisite to Development, *op.cit.*

consumption will grow from 203.9 kWh in 2012-2013 to 550.13 kWh in 2021-2022<sup>95</sup>. Generally speaking, electricity demand grows at the same rate as GDP, but that assumes those already connected to the grid have adequate power supply. Electricity demand in Myanmar is estimated to be growing at an annual rate of between 10-15 percent<sup>96</sup>. This is twice as fast as GDP growth, which the International Monetary Fund estimates at 5.5 percent in FY 2011-12 and 6.25 percent for FY 2012-13<sup>97</sup>. Given the state of Myanmar's power system, the growth rate of electricity demand could be 2.5 times international norms<sup>98</sup>.

Myanmar's Forest Department reports industry accounts for roughly 10 percent of final energy consumption, transportation for just over 6 percent and other users, which likely includes residential users, for 83 percent<sup>99</sup>. One consulting firm states households account for 70 percent of Myanmar's electricity consumption<sup>100</sup>. An October 2012 ADB report cites 5.4 percent annual growth in energy consumption in Myanmar's commercial sector between 2000 and 2009, 4.8 percent annual growth in the industrial sector, and negative annual growth of 1.9 percent in the transport sector. The residential sector, although it is the largest consumer of energy, experienced only 1.3 percent annual growth between 2000 and 2009<sup>101</sup>.

As mentioned, the government is increasingly looking toward hydroelectricity to address its capacity problem. According to feasibility studies, this can add about 46,300 MW of generating capacity<sup>102</sup>. A May 2012 article in *The Myanmar Times* states Myanmar's hydropower plants have maximum generation capacity of 1,270 MW, which fluctuates in a monsoon climate. During Myanmar's dry season, hydro capacity drops to 1,000 MW due to lower water levels. Citing Ministry figures, *The Myanmar Times* reported peak electricity usage during rainy season averages 1,450 MW, rising to 1,850 MW during dry season.

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<sup>95</sup> Asian Development Bank, Myanmar Energy Sector Assessment, *op.cit.*

<sup>96</sup> Dapice, [Electricity in Myanmar: The Missing Prerequisite to Development](#), *op.cit.*

<sup>97</sup> [Myanmar Set for Economic Takeoff With Right Policies](#), IMF Growth Survey, May 7, 2012

<sup>98</sup> By contrast, according to a Harvard University study authored by David Dapice, the government's planned investments over the next five years will add only 617 MW of capacity, representing less than 5% annual growth.<sup>98</sup> Dapice estimates electricity consumption for 2012 will be roughly 160 kWh per capita.<sup>98</sup> According to report, annual growth averaged 3.8% over a two-decade period, and electricity consumption rose from 45 kWh per capita in 1987 to 99 kWh per capita in 2008.

<sup>99</sup> Myanmar Forest Department, presented at Stakeholders Meeting on March 25, 2012

<sup>100</sup> [Electricity in Myanmar](#), Thura Swiss Research, April 12, 2012

<sup>101</sup> Asian Development Bank, Myanmar Energy Sector Assessment, *op.cit.*

<sup>102</sup> [Myanmar's Electric Power Generating Capacity Reaches 2,256 mw](#), *Xinhua*, January 1, 2001

Hydropower can be supplemented by gas during the dry season. However, U Aung Than Oo, former Deputy Minister for MOEP-2 and current Deputy Minister for the MOEP, noted combined hydro and gas capacity was at least 500 MW below electricity demand. Speaking at a May 2012 press conference, the Deputy Minister emphasized demand was expected to grow by 15 percent in 2012.

Up to 90 percent of electricity produced by certain joint venture operations, such as the China-funded Myitsone Hydroelectric Power project, are earmarked for export. This makes citizens skeptical of foreign investments in the sector. Riots broke out in 2012, and Myanmar citizens accused the government of diverting needed electricity to China. Several Chinese- and Thai-backed investments, including the Myitsone project, were interrupted due to citizen backlash<sup>103104</sup>.

In response, the government agreed to dedicate future natural gas finds to domestic use. While an expedient political move, this is problematic as capacity expansion is capital intensive and substantial investment will be required. A pipeline in the Southeast that brings gas from offshore fields to Yangon is reported to have corrosion problems that substantially decrease its capacity<sup>105</sup>. Other pipelines that bring gas to Yangon are already operating at capacity and would need to be upgraded. Without the hard currency revenues that can be generated through export sales, Myanmar may become overly dependent on debt and donor financing. It will also place the government under great pressure to subsidize domestic pricing. Another option is to install a modern combined cycle generator, which, according to David Dapice of Harvard University, would triple the amount of electricity produced using an equal amount of gas as the generators currently used in Myanmar.

**Electricity Grid:** Myanmar's national grid system connects major electric power stations—consisting of 20 hydropower plants, one coal-fired plant and ten gas-powered plants—to substations and end users using eight types of transmission and distribution lines<sup>106</sup>. The country has 4,793.24 miles of transmission lines, comprised of 39 230 kV, 37 132 kV and 117 66 kV lines.<sup>107</sup> There are 27 23 kV, 24 132 kV, and 108 66 kV substations with a total transformation capacity of 5,875.4 megavolt amperes. Transmission losses are high in Myanmar, estimated at 27 percent as of 2011, due to

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<sup>103</sup> [Burma to Halt Myitsone Dam Project: Media Reports](#), *Mizzima News*, September 30, 2011

<sup>104</sup> [Myanmar Scraps Coal-fired Power Plant at Dawei](#), *Reuters*, January 10, 2012

<sup>105</sup> David Dapice, *Electricity Demand and Supply in Myanmar*, Proximity Designs, December 2012

<sup>106</sup> Kan Zaw, *Challenges, Prospects and Strategies for CLMV Development: The Case of Myanmar in ERIA Research Project Research 2007 No.4: Development Strategy for CLMV in the Age of Economic integration* (Tokyo: IDE-JETRO, 2008)

<sup>107</sup> [The Republic of Union of Myanmar: Country Report](#), *op.cit.*

relatively low voltage and antiquated equipment<sup>108</sup>. This is down from about 30 percent between 2003-2009.

Adding to the problem, users sometimes use transmission line voltage regulators, or step-up transformers, which can create supply imbalances and blackouts. Beyond being uncompensated, this creates safety issues. More than one third of fires that broke out in Yangon in 2011 were reportedly caused by improper use of electrical appliances. Transformers are seen as a leading cause. This makes upgrading Myanmar's distribution system imperative.

Expanding the grid system can be the least expensive means to increase connectivity, which in Myanmar is at maximum 26 percent<sup>109</sup>. The government plans to build 36 additional substations with 5,675 MVA and 6,444 miles of transmission lines using four 500 kV, 41 230 kV, 8 132 kV, and 20 66 kV lines. It is likely most new transmission lines will bring power from northern hydropower and southern gas-fired power plants at 230 kV and 132 kV. One analyst estimated the capital cost could be between USD 13 billion to USD 18 billion.

In terms of rural electrification, simply extending distribution lines will not provide a short- to medium-term solution due to inadequate generation capacity. A 2003 report by Japan International Cooperation Agency estimates if rural electrification were improved 2 percent annually, an optimistic assumption, it would take more than 40 years for networks to reach the majority of Myanmar's towns and villages<sup>110</sup>.

#### (5) Distribution of electrification rate

According to MOEP data, electricity is distributed to 2,323,467 out of 8,905,674 families, or 26 percent. The electricity covers 220 out of 396 towns and approximately 1,600 of 6,774 villages in the current distribution network. Myanmar has a total 64,346 villages<sup>111</sup>.

World Bank data, however, from 2009 states only 13 percent of Myanmar's population had access to electricity. Based on that rate, a 2012 presentation by the National Energy Institute at the National University of Singapore, says 19 percent of urban and 10 percent of rural populations are connected to the grid<sup>112</sup>. The Integrated

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<sup>108</sup> Asian Development Bank, Myanmar Energy Sector Assessment, *op.cit.*

<sup>109</sup> [Addressing the Electricity Access Gap](#), Background Paper for the World Bank Group Energy Sector Strategy, The World Bank Group, June 2010

<sup>110</sup> [The Study on Introduction of Renewable Energy Sources in Myanmar](#), Japan International Cooperation Agency, September 2003

<sup>111</sup> [Electricity Prices to Be Doubled](#), *op.cit.*

<sup>112</sup> S.K. Chou, [Overview of ASEAN's Energy Needs and Challenges](#), Presented at Energy Policy Roundtable 2012, Todai Policy Alternatives Research Institute, The University of Tokyo, April 20, 2012

Household Living Conditions Survey 2009-10, however, carried out jointly by UNDP and the Myanmar Ministry of National Planning and Economic Development, states overall access to electricity increased from 38 percent to 48 percent in 2005-2010. As emphasized in a strategy paper on Rural Development and Poverty Reduction in Myanmar, large differences exist between the poor, with a 28 percent access rate – up from 20 percent in 2005 – and the non-poor, with 55 percent<sup>113</sup>. The figures stand at 34 percent for rural and 89 percent for urban dwellers.

The discrepancy in data may result from World Bank statistics measuring access to national grid, with UNDP measuring availability from all sources, including generators and independent projects. Typically households in Myanmar derive electricity from car batteries, chargers, and inverters—commonly used to convert direct to alternating current—or purchase power from independent generators.

Small independent producers play a key but difficult to measure role in rural environments. For example, a *Reuters* article described an individual in Kya-oh, who provides energy to households using a private generator. The individual charges 3,000 kyat a month per household for 2.5 hours of electricity a night, and an extra 1,500 kyat for a television – nearly a week's income for some villagers<sup>114</sup>.

Rakhine State fared among the worst in a UNDP study concerning electricity and household, water, and sanitation conditions. Access to electricity stood at 26 percent in Rakhine, 30 percent in Ayeyarwaddy, 31 percent in Magwe and 32 percent in Bago<sup>115</sup>. Rakhine State is plagued by ongoing violence and was the site of an uprising that led Myanmar to declare a state of emergency in 2012. Although urban electrification is relatively easier, the government, in its attempt to build a more representative democracy, is becoming more dependent on political buy-in from traditionally marginalized and remote populations. Rural electrification, in addition to helping the country develop and industrialize, is one means of building broader support.

In pursuing rural electrification, the government must balance between connecting rural populations to the national grid and satisfying increased urban and industrial demand. Villagers, understanding the difficulties of relying on government projects, have begun implementing schemes on a self-help basis. In some cases this is done with support of NGOs, donors and SMEs, in parallel with government initiatives. Proximity Designs, for example, a Yangon-based social enterprise, introduced a solar-powered lantern that sells for about USD 11, compared to a USD 60 Chinese model.<sup>116</sup> A Thai

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<sup>113</sup> Dr. Dolly Kyaw, Proposal for Rural Development and Poverty Reduction in Myanmar

<sup>114</sup> [Myanmar's Power Struggle Endangers Economic Boom](#), *Reuters*, April 16, 2012

<sup>115</sup> [Integrated Household Living Conditions Survey in Myanmar 2009-2010](#), Poverty Profile Report, UNDP Myanmar, June 2011

<sup>116</sup> Winn, *op.cit.*



solar power company, SPCG, is also planning to enter Myanmar, with initial plans to establish 2 MW of solar power capacity<sup>117</sup>.

Although admirable in providing a short-term solution, the sustainability of reliable decentralized power is questionable. Isolated power systems tend to use small-scale renewable sources, including hydroelectricity, as well as biofuel, solar and wind. Isolated systems are suitable options where demand density is low. They do not require large-scale investment or hard currency. While operating and maintenance costs are also low compared to projects involving the national grid, administrative and management costs by donors and other institutions seeking to develop numerous sites can be onerous. That is because individual small projects lack the scale that allows effective amortization in comparison with larger ones.

SMEs that try to deliver to rural areas also face many difficulties, including customers unable or unwilling to purchase or install electrification capacity. Marketing to the rural poor is also a challenge<sup>118</sup>. Myanmar's SMEs face numerous additional problems, including a scarcity of capital, obsolete equipment and machinery, a shortage of adequate physical and human resources, an absence of current information on technical, market and legal issues, and a lack of support from the state, especially in technology transfer, credit guarantees and loans. This is an area in which donor assistance or public-private partnerships could prove vital.

**Electricity Cost:** The need for outside financing is especially apparent when one considers the losses sustained by government through subsidies. Myanmar's electricity prices are the cheapest among 15 countries in the region, according to Deputy Minister U Aung Than Oo, but vary widely. Costs for electricity from the national grid range from 35 kyat per kWh in Myanmar's capital to 12 times that in Sittwe, the capital of Rakhine State<sup>119</sup>.

In 2012, MOEP-2 was buying hydroelectricity from MOEP-1 at a rate of 20 kyat per kWh and spending 127 kyat per kWh to generate electricity with gas turbines<sup>120</sup>. The deputy minister said the ministry was spending more than 60 kyat to distribute one kWh of electricity, but charging 37.40 kyat per kWh, losing over 20 kyat for every unit sold.

The cost of distributing electricity at a loss will total 249.8 billion kyat (roughly USD285.3 million) in 2013. This creates a quandary when attempting to balance the critical upgrades required to accumulate more users and expand the infrastructure needed to promote development and industrialization, with the need to generate hard currency and raise prices to market rates. This problem is likely to be further compounded by

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<sup>117</sup> Mridul Chadha, [Off-Grid Solar Power Projects For Myanmar](#), Clean Technica, January 13, 2013

<sup>118</sup> [Entrepreneurship Development in Solar Energy Sector for Rural Area in Myanmar](#), ARTES/SESAM Alumni Regional Level Workshop, May 2008

<sup>119</sup> [Myanmar's Power Struggle Endangers Economic Boom](#), *op.cit.*

<sup>120</sup> [Electricity Prices to Be Doubled](#), *op.cit.*

government pledges to reserve future natural gas finds for domestic use. It will be difficult to finance new development, processing, and distribution if the output is then subsidized and sold at a loss.

Overcoming this constraint will not be easy. Since revenues gained from resource extraction were used in the past to enrich a narrow group of elites and select institutions, the public is now pushing for Myanmar's energy to be used for the public good, while market pricing and mechanisms, as well as the insidious role of subsidies—are not well understood. In particular, gradual subsidy removal to ensure sustainability of socio-political and national economic growth will be paramount.

One analyst interviewed noted he had been told industrial users and foreigners in Yangon are presently being charged for electricity in dollars, rather than kyats. Asking export-oriented consumers of electricity to make payments in foreign currency is a model that could enable both generation of foreign exchange and industrial development. It could fund industrial park development and other facilities where output is export-oriented. This would allow hard currency funding as well as partial subsidization of distribution, deemed a necessary public good.

The government increased electricity rates in 2012—from 25 to 35 kyat per unit for home use and 50 to 75 kyat per unit for industrial use—with the long-term hope of equalizing costs and revenues. This will enable the country to focus on regularizing electricity supply, maintenance and expansion of new cable lines. According to Harvard's Dapice, cited above, the cost of electricity should be closer to 90 to 100 kyat per kWh, with subsidies covering only the very poor, most of which do not currently have access to electricity<sup>121</sup>.

## (6) Major energy policies

To meet its goal of tripling per capita GDP in five years and expand national electrification to satisfy growing demand, Myanmar has adopted a diversification strategy to meet both domestic needs and export requirements.

On a political and regulatory level, substantial work must be done to transform resource extraction from an industry that lacks transparency and which enriches only a small elite, to one that addresses a full range of environmental and social concerns and which has all the nation's citizens' best interests in mind.

**Institutions of Policy:** The Ministry of Energy and Ministry of Electric Power are the two main entities tasked with oversight. Oil and gas management falls under Ministry of Energy and MOGE; coal business under the Ministry of Mines; biofuels and micro-hydro (for irrigation use) under Ministry of Agriculture and Irrigation; fuelwood, climate change and environmental safeguards under Ministry of Environmental Conservation and Forestry; renewable energy under Ministry of Science and Technology; and energy efficiency under Ministry of Industry.

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<sup>121</sup> David Dapice, *Electricity Demand and Supply in Myanmar*, *op.cit.*



To fulfill the people's need to systematically manage the linkage of Energy and Electrical Sectors, **National Energy Management Committee (NEMC)** and **Energy Development Committee (EDC)** was formed according to the Notification No.(12/2013) dated 9<sup>th</sup> January, 2013 issued by the President Office. For the time being 1<sup>st</sup> Draft of Energy Policy has already drawn up for short-term and long-term plans.

The Ministry of Education, responsible for vocational and technical training, and the Ministry of Co-operatives, which also has a hand in vocational skills training as well as developing mineral production and electrical goods production under the cooperative sector, also play a role in Myanmar's energy policy.

**Basic Policy:** The Ministry of Energy's current policy priorities are: To fulfill Domestic Energy Requirement as Priority; To Implement the Status of Sustainable Energy Development; To promote Wider Use of New and Renewable Sources of Energy; To promote Energy Efficiency and Conservation; To promote Use of Alternative Fuels in Household; To Implement Effective Utilization of Discovered Crude Oil and Natural Gas Resources in the Interest of the Entire Nation including the Regions where the Discovery was made; and to promote more Private Participation in Energy Sector. Given Myanmar's power sector is starting from such an underdeveloped state, the country has a great opportunity to create and adopt efficient and sustainable energy policies. With its current energy mix, Myanmar produces 0.04 percent of global greenhouse gas emissions, compared to 0.9 percent in Thailand and 25.55 percent in China<sup>122</sup>.

Carbon dioxide emissions for each kW of electricity produced from coal and oil are twice that from natural gas, according to British Nuclear Industries Forum. Although hydropower schemes emit very little carbon dioxide, methane emissions do rise from rotting vegetation in reservoirs. Hydropower is said to contribute only 4 percent to global warming<sup>123</sup>. Black carbon emissions from burning biomass in open fields are the third largest contributor to global warming<sup>124</sup>.

In 1997, the government adopted the Myanmar Agenda 21 to integrate sustainability into everyday considerations of individuals, households, communities, corporations and government. It seeks to increase efficiency, reduce waste and promote recycling, encourage new and renewable sources of energy, utilize environmentally sound technologies for sustainable production, decrease wasteful consumption, and raise awareness of sustainability measures.

While Myanmar plans to increase its reliance on hydropower, hydropower production is centered in more remote and mountainous areas such as Kachin and Karen States. These areas have historically been troubled by ethnic tensions and are located far

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<sup>122</sup> [Carbon Dioxide Emissions \(CO2\), Thousand Metric Tons of CO2](#), Millennium Development Goals Indicators, United Nations

<sup>123</sup> [Greenhouse Gas Emissions from Dams FAQ](#), International Rivers, May 1, 2007

<sup>124</sup> For more information on the carbon footprint of electricity generation, see: <http://www.parliament.uk/documents/post/postpn268.pdf>

from population centers where demand is focused. This presents a challenge of efficiently transporting the electricity generated.

Myanmar's Ministry of Energy also has plans to address its energy pricing system, which presently operates with subsidies. The Ministry intends to introduce a pricing mechanism to not only enhance competitiveness of certain resources, such as coal, but also to increase awareness of energy use with an eye toward promoting efficiency and conservation.

The GOM, in partnership with Japan, has also launched feasibility studies for energy conservation.<sup>125</sup> The government enacted a conservation initiative for government entities, under which government buildings must use daylight for illumination during office hours as much as possible and government vehicles, except those on duty and emergency vehicles, were required to observe two dry days a month. Compliance was monitored by an inspection team.<sup>126</sup>

The government also engages in partnerships with the private sector, foreign countries and regional agencies, as well as universities. Recent partners include Thailand's Chiang Mai University, which supported a rural electrification project in 2008, and Japan's New Energy and Industrial Technology Development Organization (NEDO), with which the Myanmar government recently signed an agreement on renewable energy and conservation technologies.<sup>127128</sup>

**Additional Policy Concerns:** Myanmar needs to carefully consider its options as it determines future policies and plans to plug the "electricity deficit" while balancing a mix of reliable and sustainable energy sources. It must also address the perceived inequity of many energy transactions, as well as environmental consequences beyond carbon emissions. All of this is compounded by the newfound ability of citizen's in Myanmar to exercise their democratic right of protest. Two large-scale power projects—the Myitsone dam and Dawei coal-fired plant—have been interrupted since the fall of 2011.

A survey published on *MyanmarAffairs.com* found that 90 percent of 1,059 people interviewed opposed the Myitsone dam for environmental, socioeconomic and cultural reasons.<sup>129</sup> Importantly, the vast majority—up to 90 percent according to some reports—of electricity generated by the project was slated for export to China. The project had

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<sup>125</sup> [Burma Infrastructure > Energy](#), Asia Trade Hub, accessed: June 29, 2012

<sup>126</sup> [ASEAN Countries' Presentation on Renewable Energy Projects and Business Opportunities \(Myanmar\)](#), *op.cit.*

<sup>127</sup> Than Htike Oo, [Villages Near Twante See the Light](#), *The Myanmar Times*, January 14-20, 2008

<sup>128</sup> [NEDO and the Government of Myanmar Conclude Letter of Intent for Introduction of Renewable Energy and Energy Conservation Technologies in Myanmar](#), New Energy and Industrial Technology Development Organization, January 17, 2012

<sup>129</sup> [Opinion Poll on Ayeyawady Myitsone Hydropower Project](#), MyanmarAffairs.com, accessed June 28, 2012

initially been given the go ahead without public consultation, despite estimates that 15,000 locals would be displaced.

Hydropower on a large-scale can also threaten ecosystems and local livelihoods, including farming and fishing. Due to a lack of resources, the government has not adequately surveyed dam sites for biodiversity or formalized regulations requiring environmental impact assessments of energy projects. In the case of Myitsone dam, a USD 1.25 million environmental impact assessment that was carried was a source of controversy<sup>130</sup>.

As coal is the most carbon-rich fossil fuel, villagers near coal sites suffer from pollution as well as noise hazards. For example, an estimated 12,000 people living within a five-mile radius of Myanmar's largest coal mine, Tigyit, are said to be affected with health problems and breathing difficulties as a result of the mine.<sup>131</sup> Water contamination also threatens agriculture and ecosystems, while waste can encroach on villages, causing massive mudslides.

Though it burns cleaner than coal, natural gas production and transport carry risks of leakage and gas blowouts. Pipeline routes in Myanmar are highly protected due to so-called "pipeline security operations," with 8,500 soldiers said to be stationed along the Yetagun and Yadana pipeline route. Petroleum Operations in both Onshore and Offshore areas, after signing of Production Sharing Contract and / or Improved Petroleum Recovery, the Contractor have to conduct Environmental Impact Assessment (EIA), Social Impact Assessment (SIA) and Environmental Management Plan (EMP) reports for MIC's approval during the Preparation Period.

Biomass and other renewable sources bring their own problems, including soil erosion, loss of biodiversity, and deforestation. When burned indoors using certain stoves, biofuels contribute to indoor air pollution and respiratory disease. Production can also divert land from agricultural use, impacting food security.

There are minimal laws regulating energy projects in Myanmar and provisions of international treaties, such as the Convention on Biological Diversity, to which Myanmar is a party, have yet to be codified into domestic legislation.

The government, however, has already taken steps to join the Extractives Industries Transparency Initiative (EITI) through a group created under direction of Myanmar's president to oversee implementation in December 2012. Myanmar's government is expected to submit an application by the end of 2013.<sup>132</sup>

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<sup>130</sup> [TheMyitsone Dam on the Irrawaddy River: A Briefing](#), International Rivers, September 28, 2011

<sup>131</sup> *Poison Clouds, op.cit.*

<sup>132</sup> [US official sees 'real commitment' in Myanmar's EITI efforts](#), *Myanmar Times*, March 4, 2013

Accomplishing its new energy policy objectives will also require a repositioning of Myanmar's human resource capacity and expertise, and a clarification of the roles of ministries involved in energy policy implementation. The country is fortunate to have significant resources and several options, as outlined in Table 6-8.

**Table 6-8: Energy Development Strategy for Myanmar**

Short-term:	<ul style="list-style-type: none"> <li>• Subject to cost, maintain power plants and distribution system that are already installed</li> <li>• Subsidize diesel for high-speed diesel captive-power in exchange for a percentage of supply to the grid / or consumers</li> <li>• Renegotiate Chinese, Thai and other electricity export contracts to divert higher percentage for national supply</li> <li>• Rent gas (CNG) or marine fuel-oil (MFO) fired reciprocating engines for decentralized power (note these have higher efficiency than gas turbines (GT) and require less infrastructure)</li> <li>• Where gas is available, rent trailer-mounted aero-gas (GT) turbines</li> <li>• Promote energy conservation (e.g. compact fluorescent light bulbs)</li> </ul>
Medium-term:	<ul style="list-style-type: none"> <li>• Install open-cycle GTs</li> <li>• Install mini-hydro in rural areas</li> <li>• Install high-voltage transmission to urban and industrial centers</li> <li>• Encourage industry to invest in efficient / reciprocating captive-power plant with a percentage for domestic consumers</li> </ul>
Long-term:	<ul style="list-style-type: none"> <li>• Maximize hydropower and coal reserves for base-load</li> <li>• Develop gas pipelines</li> <li>• Optimize use of natural gas resources, primarily for peak-logging during maximum demand</li> <li>• Minimize imported oil and coal</li> <li>• Evaluate the geothermal opportunity</li> <li>• Promote biofuels and other cost-effective renewables</li> </ul>

*Source:* ERIA.

There are a number of drivers that will influence the way forward. These include availability of project finance, project lead-time, expectations, economic growth requirements, environmental and sociopolitical impact, reliability and supply.

It is important that Myanmar overcome critical short-term demands and plan for the future using medium- and long-term solutions.

## **2.2. Policy Implications**

### **(1) Directions for future energy policy developments**

In the course of our research and discussions, we have generally agreed on several important energy policy concerns and issues that should be tackled in the future. These include:

- Recognizing essential importance of formulating an Integrated Energy Policy. Establishment of Energy Management Committee chaired by the Vice President marks definitive progress;
- Initiating comprehensive medium/long-term energy policy planning;
- Enhancing coordination between ministries. For example, optimizing natural gas allocation and development of power generation at political and ministerial level;
- Maximizing human resource development. Capacity building and training also needed.
- Evaluating and optimizing energy prices, tariffs and use of subsidies;
- Developing a framework for public-private partnerships in the electricity sector
- Developing more comprehensive energy statistics immediately. Rectifying inconsistencies in statistical data among the ministries;
- Integrating parallel focus on off-grid areas into policy dialogue and development efforts;
  
- Introducing additional transparency into policymaking procedures and process;
- Improving potential for expansion and rehabilitation of transmission lines through measures that can better attract necessary investment; and
- Recognizing continuing importance of forestry in energy mix as traditional biofuels remain essential primary energy source.

### **(2) Three Policy Themes**

Better energy access helps to provide the underlying fundamentals that lead to poverty eradication, economic development and political stability. As emphasized throughout this project to facilitate development of an Integrated Energy Strategy in Myanmar, huge additional investments of time, capital and other resources are necessary to suggest mechanisms to improve, rehabilitate and expand Myanmar's existing energy infrastructure and electricity in particular. This is necessary to provide better access to power in backbone areas including Yangon, Mandalay and Nay Pyi Taw. In addition, as emphasized throughout our first stakeholder's meeting, many other initiatives are needed to address power access in areas that extend beyond the grid, both in the short run until 2015 and longer term. Therefore, while current policy discussion is largely focused on strengthening the main grid to increase power generation, these measures alone cannot achieve broader access. Even if the grid infrastructure were totally renovated and upgraded there would still be a serious lack of transmission and distribution to major

portions of the country. For this reason, the following three policy themes have been highlighted as mechanisms that can facilitate broader access to power in Myanmar.

### **Grid Extension**

The first theme is strengthening, extending and expanding the main grid. This strategy is the most efficient on both an economic and technical basis. With economies of scale, the generation cost per unit can be reduced within a larger energy system that has an ability to draw, and integrate distribution, from a range of energy sources. At the same time, this strategy will require massive investment if it is to fulfill the requirements of the nation as a whole. Examined purely on an economic basis, investors are likely to choose urban centers, industrial zones and other areas where demand is high and incomes sufficient to allow positive returns on a commercial basis. This is, however, not likely to improve access in peripheral regions, at least, at the present time. Additionally, from the standpoint of energy security, a centralized energy system could prove problematic in Myanmar, given many energy and natural resources are located in rural areas with long histories of ethnic strife and conflict. This necessitates the introduction of safeguards against possible disruptions that could potentially hamper energy transmission, adversely impacting the entire energy system.

### **Regional Integration and International Cooperation**

The second theme is enhanced cooperation with bordering nations as well as countries around the world that can provide essential capital, technology and other goods and services. Luckily, Myanmar has substantial energy resources including thermal, hydro, oil, gas and biofuel. This provides the potential to transform the nation into both a valued supplier as well as a consumer of energy products in the region. For example, along the Chinese border, vast potential exists for hydroelectric power, which can flow in both directions. Additionally, along its border with India, there are a number of mining sites including coal. There is also biofuel potential in Myanmar's agricultural heartland and substantial potential for offshore oil and gas development in coastal areas. If these resources are developed for generation and supply, both domestically and for export, this cross-border energy flow is beneficial for Myanmar's neighboring countries and the region. Further, electricity from Myanmar's neighbors is available in certain border towns, but strict regulations hinder its use on the Myanmar side. As noted in the strategic paper, "Border Area Development Strategy," making this electricity available legally and regularly will attract foreign factories to the Myanmar side of the border where international firms can take advantage of Myanmar's competitive wages. The country can also take advantage of capital, technologies and other inputs from its more advanced neighbors<sup>133</sup>. In this regard, special attention will be paid to border cities – such as Muse and Myawaddy – which have the potential to serve as major conduits to enhance regional integration and Myanmar's trade and economic relations with ASEAN and other neighbors as well as the world at large.

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<sup>133</sup> Kitti Limskul, Toshihiro Kudo, and Hiroyuki Taguchi, Border Area Development Strategy, Myanmar Comprehensive Development Vision Strategy Paper presented March 25, 2013

## **Rural Energy Access**

The third theme is driven by the realization it will not be possible to electrify Myanmar as a whole on an economic basis. Some areas, particularly in remote regions will lag behind, and by necessity will have to rely largely on self-help approaches and stand-alone systems if they are to gain access to electricity and power over the short- and possibly intermediate-term. For these areas, we will examine the potential for alternative energy systems such as oil products like LPG, traditional biomass, and mini/pico hydropower systems on an off-grid and/or mini-grid basis. By utilizing intermediate technologies and interim solutions, it is believed these least developed regions can begin to move forward. This could mean a steady step for modernization in these regions—without unnecessarily drawing resources away, and detracting from priority projects and initiatives. By minimizing any potential for diversion, this will also serve to provide more adequate supply and capacity to the urban and industrial areas that will drive Myanmar's economic development. It will also allow demonstrable progress in more remote areas, which can ultimately enhance long-term development in these regions.

These three core themes will be examined through fieldwork, simulation and comparative research in Myanmar and from the viewpoint of neighboring countries and the overall global energy environment. The examinations will lead to the development of actionable strategies and policy recommendations, which will then be fine-tuned through additional stakeholders meetings and an ongoing dialogue with the GOM. This will lead to the formulation of scenarios and policy recommendations and options for the GOM that will provide support for development of a comprehensive integrated energy strategy beyond 2015.

## References

- ADB (2012), *Myanmar Energy Sector Assessment*, Manila: ADB.
- Aschauer, D. A. (1990) *Public Investment and Private Sector Growth*. Washington D.C.: Economic Policy Institute.
- Black, N. M. (2009), *The Myanmar Oil and Gas Industry, in Blood Money: A Grounded Theory of Corporate Citizenship: Myanmar (Burma) as a Case in Point*, Ph.D. University of Waikato.
- Chadha, M. (2013), 'Off-Grid Solar Power Projects For Myanmar', *Clean Technica*, 13 January 2013. Available from: <http://cleantechnica.com/2013/01/13/off-grid-solar-power-projects-for-myanmar>
- Chou, S. K. (2012), 'Overview of ASEAN's Energy Needs and Challenges,' Presented at *Energy Policy Roundtable 2012*, Tokyo, 21 February 2012. Todai Policy Alternatives Research Institute, The University of Tokyo.
- Chowdhury, S., F. Yamauchi and R. Dewina (2009), 'Governance Decentralization and Local Infrastructure Provision in Indonesia', IFPRI Discussion Paper 00902. Washington, D. C.: IFPRI.
- Dapice, D. (2012), 'Electricity Demand and Supply in Myanmar, Proximity Designs', Research Paper, ASH Center for Democratic Governance and Innovation, Harvard-Kenedy school and Rajawali Foundation Institute for Asia.
- Dapice, D. (2012), 'Electricity in Myanmar: The Missing Prerequisite to Development', Research Paper, ASH Center for Democratic Governance and Innovation, Harvard-Kenedy school and Rajawali Foundation Institute for Asia.
- Wah Wah Thaung, Daw (2013), 'Oil and Gas Sector in Myanmar: The energy related issues and challenges from the perspective of Ministry of Energy', Myanmar Oil and Gas Enterprise, Ministry of Energy, Republic of the Union of Myanmar.
- ERIA (2009), *Mekong-India Economic Corridor Development*, ERIA Research Project Report 2008-4-2. Jakarta: ERIA.
- ERIA (2010), *The Comprehensive Asia Development Plan*, ERIA Research Project Report 2009 no.7-1, Jakarta: ERIA.
- Isono, I., S. Kumagai and F. Kimura (2012), 'Agglomeration and Dispersion in China and ASEAN: a Geographical Simulation Analysis', ERIA Discussion Paper Series-2012-02, Jakarta: ERIA.
- Japan International Cooperation Agency (2003), 'The Study on Introduction of Renewable Energy Sources in Myanmar'.
- Kan Zaw (2008), 'Challenges, Prospects and Strategies for CLMV Development: The Case of Myanmar', in Sotharith, C. (ed.), *Development Strategy for CLMV in the Age of Economic Integration*, ERIA Research Project Report 2007-4, Chiba: IDE-JETRO, pp.443-496.
- Kudo, T., T. Gokan and I. Kuroiwa (2012), 'Distribution of Myanmar Rice Mills in the Age of Economic Integration, in Kuroiwa, I. (ed.), *Economic Integration and the Location of Industries: The Case of Less Developed East Asian Countries*. Great Britain: Palgrave Macmillan.
- Murwito, I. S., B. Rheza, S. Mulyati, E. Karlinda, and R. Mulyanto (2012), 'Infrastructure Quality, Local Government Spending and Corruption', *Research Report #1*.



- Jakarta: Regional Autonomy Watch. Available from <http://www.kppod.org/datapdf/laporan/research-report-1.pdf>
- Myat Mon Swe (2008), 'Entrepreneurship Development in Solar Energy Sector for Rural Area in Myanmar', ARTES/SESAM Alumni Regional Level Workshop, *Renewable Energy for the Sustainable Development*, Katmandu and Pohara, 15-23 May 2008.
- New Energy and Industrial Technology Development Organization (2012), 'NEDO and the Government of Myanmar Conclude Letter of Intent for Introduction of Renewable Energy and Energy Conservation Technologies in Myanmar', 17 January 2012. Kawasaki: NEDO. Available from [http://www.nedo.go.jp/english/whatsnew\\_20120117\\_index.html](http://www.nedo.go.jp/english/whatsnew_20120117_index.html)
- Okamoto, M. (2012), 'Gyakukosu wo ayumu Indonesia no Chihojichi', (in Japanese), in Funatsu, T. and F. Nagai (eds.), *Kawariyuku Tonanajia no Chihojichi*, IDE-JETRO.
- Sombilla, M. A., U. S. Malik, A. K. Mahfuz Ahmed, and S. L. Cueno (2009), *Integrating Biofuel and Rural Renewable Energy Production in Agriculture for Poverty Reduction in the Greater Mekong Subregion*, Manila: Asian Development Bank.
- The Republic of Union of Myanmar (2011), 'Country Report', Myanmar Ministry of Agriculture and Irrigation.
- The World Bank Group (2010), *Addressing the Electricity Access Gap, Background Paper for the World Bank Group Energy Sector Strategy*, Washington, D. C.: World Bank.
- UNDP Myanmar (2011), *Integrated Household Living Conditions Survey in Myanmar 2009-2010, Poverty Profile Report*.
- UNESCAP (2012) *Economic and Social Survey of Asia and the Pacific 2012*, United Nations publication, Bangkok

### ***News and Articles from Newspapers and Journals***

- ASEAN Countries' Presentation on Renewable Energy Projects and Business Opportunities (Myanmar), Myanmar Engineering Society.
- Burma Eyes Private Power Producer, Nation (Bangkok), February 13, 1996.
- Burma to Halt Myitsone Dam Project: Media Reports, Mizzima News, September 30, 2011.
- Daniel Ten Kate, Myanmar Oil Veteran Rebuffs Suu Kyi a Shell, Chevron Weigh Bids, Bloomberg, Sept. 18, 2012.
- Delta Holds Great Potential for Tidal Power Generation, Voice Weekly, February 13, 2006.
- Electricity in Myanmar, Thura Swiss Research, April 12, 2012.
- Foreign oil companies ink exploration deals, Agence France Presse, June 21, 2012.
- Government Will Prioritize Hydropower Projects Over Gas, The Myanmar Times, July 10, 2006.
- Greenhouse Gas Emissions from Dams FAQ, International Rivers, May 1, 2007.
- Harnessing Energy from the Clouds, The Myanmar Times, August 20-26, 2007.
- Jacob Gronholt-Pedersen, Myanmar to Launch Offshore Oil, Gas Bidding Round in April, Dow Jones, Mar. 4, 2013.
- Myanmar Gas Export May Touch \$ 4bn, *Natural Gas Asia*, March 27, 2013.

- Myanmar open to foreign energy bids, *Bangkok Post*, March 6, 2013.
- Myanmar opens keenly awaited oil and gas auction, *Agence France Presse*, April 10, 2013.
- Myanmar Scraps Coal-fired Power Plant at Dawei, *Reuters*, January 10, 2012
- Myanmar Set for Economic Takeoff With Right Policies, *IMF Growth Survey*, May 7, 2012.
- Myanmar's Electric Power Generating Capacity Reaches 2,256 mw, *Xinhua*, January 1, 2001.
- Myanmar's Power Struggle Endangers Economic Boom, *Reuters*, April 16, 2012.
- Myitsone Dam Study Should Be Made Public: Dr. Htin Hla, *Mizzima News*, September 26, 2011.
- Opinion Poll on Ayeyawady Myitsone Hydropower Project, *MyanmarAffairs.com*, accessed June 28, 2012.
- Patrick Winn, Myanmar's Real Power Struggle? Keeping on the Lights, *Global Post*, June 23, 2012.
- Thailand to Supply More Gas to Meet High Demand in Myanmar, *Arakon Oil Watch*, June 21, 2012.
- Than Htike Oo, Villages Near Twante See the Light, *The Myanmar Times*, January 14-20, 2008.
- The Myitsone Dam on the Irrawaddy River: A Briefing, *International Rivers*, September 28, 2011.
- US official sees 'real commitment' in Myanmar's EITI efforts, *Myanmar Times*, March 4, 2013.

***Internet Access (Statistics)***

- Electricity Production from Hydroelectric Sources (% of total), The World Bank Group, accessed: June 29, 2012.
- Electricity Production from Oil, Gas and Coal Sources (% of total), The World Bank Group, accessed: June 29, 2012.
- Electricity Production from Oil Sources (% of total), The World Bank Group, accessed: June 29, 2012.
- Burma, The World Factbook, Central Intelligence Agency, accessed: June 29, 2012.
- Renewable Energy Sector, Myanmar Ministry of Energy, accessed: June 29, 2012.
- Electric Industry in Burma/Myanmar, Online Compendium, Burma Library, accessed: June 28, 2012.
- Country Analysis Brief: Myanmar (Burma), U.S. Energy Information Administration.
- Electric Power Consumption (kWh per capita), The World Bank Group, accessed: June 29, 2012.
- International Energy Statistics, U.S. Energy Information Agency.
- Carbon Dioxide Emissions (CO<sub>2</sub>), Thousand Metric Tons of CO<sub>2</sub>, Millennium Development Goals Indicators, United Nations.
- Burma Infrastructure > Energy, Asia Trade Hub, accessed: June 29, 2012.