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**RAJAWALI FOUNDATION
INSTITUTE FOR ASIA**

Electricity in Myanmar: The Missing Prerequisite for Development

Prepared for

Proximity Designs | Myanmar

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About the author and the research partners

David Dapice is a professor at Tufts University and a leading expert on the economic development of Southeast Asia and has worked extensively in Indonesia, Thailand, Cambodia and Vietnam. He was principal advisor to the Indonesian Ministry of Finance when this country enjoyed its period of rapid growth. He has studied the Vietnamese economy since the late 1980s, with a particular emphasis on macroeconomic issues, public investment policy, and regional development. Professor Dapice is also the principal economist and researcher associated with the Ash Center's research paper series on Myanmar.



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The Ash Center at Harvard Kennedy School is dedicated to studying development and democratic governance in very different situations, including “hard countries” such as Vietnam, Indonesia, and Myanmar. The approach taken is to understand the political economy of reform, not just the technical economics, and to explore the connections between politics and institutional development to help address social and economic problems.

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Proximity Designs is a non-profit social enterprise operating in Myanmar designing, manufacturing, and marketing innovative products and services that improved the well-being of struggling rural families. Through its sales force in 9 states and divisions, across the Delta, Central Dry Zone, and Shan Hills, Proximity has excellent insight into local conditions, and experiments with participatory governance in the countryside. www.proximitydesigns.org

This combination of local knowledge at Proximity and on-the-ground economic and political analysis of the Ash Center has produced a series of studies that are deeper and more nuanced than many typically seen.

Introduction

Electricity is a fundamental input to every modern economy. Electricity consumption per capita in Myanmar is among the lowest in Asia and had been growing very slowly since the 1980's. It gently grew from 45 kWh per capita in 1987 to 99 kWh in 2008, a 3.8% annual growth rate.¹ However, since 2008, the production of electricity has jumped very quickly. The Central Statistical Organization (CSO) has published the following data:

Table 1: Electricity Production 2008-2011

	<u>2008/09</u>	<u>2009/10</u>	<u>2010/11</u>	<u>2011/12^{est*}</u>	<u>Annual Growth</u>
Electricity Production (Million kWh)	6,622	6,964	7,543	10,000	14.7%

*2011/12 is an estimate based on nine months data, from April-December 2011; Data are from Table 9, p. 28 of Selected Monthly Economic Indicators, December 2011. Earlier data are from Statistical Yearbooks.

This 50% jump in three years is about 15% per year, far higher than in the past. The CSO does not report any increase in installed capacity since 2009/10, so the existing system is being worked much more intensively. This creates problems, such as the risk of sudden outages from failures in generators. Indeed, there has been an increase in blackouts in the Yangon and Mandalay areas in the last year in spite of higher output – and even during the wet season. With increases in tourism, exports and overall economic activity, electricity demand will continue to soar. Even with 2011/12 output, estimated consumption in Myanmar is only about 160 kWh per capita, compared to 2009 consumption of over 250 kWh per capita in Bangladesh and nearly 600 in Indonesia. Vietnam had over 1000 kWh per capita in 2011. A recent presentation by the Ministry of Electric Power-2 stated that **supply was only about half of projected demand, even though less than a quarter of people had access to electricity in 2011.**² *There are no plans to invest enough to alleviate the blackouts from current deficits and growth in demand.*

Electricity is a prerequisite for growth and development. Yet the planned investments, mainly in hydroelectricity, over the next five years are only 617 MW (megawatts) of capacity, a growth rate of less than 5% a year. The demand growth – especially if people wanting and able to pay for connections are connected – is certainly double or triple this growth rate. The GDP growth-

¹ These data do not include self-generated power from diesel generators and some other home-made machines using rice husks.

² According to data from the Ministry of Electric Power (2), the 2011 connections amounted to 2.22 million or roughly a 22% connection rate. This is 253 thousand higher than in 2009.

driven 10-15% annual electricity demand growth ignores the existing shortage of supply for those who are already connected. Only the highly unsatisfactory use of diesel – expensive, polluting and complicated for smaller users – will allow any incremental power delivery. This is completely unacceptable.

If there is spare capacity in the existing gas generators, that would be the easiest way to quickly produce more power. This might not be cheap, especially if diesel or jet fuel (kerosene) had to be used. Prices in Myanmar in early 2012 for diesel were close to \$1 a liter and this works out to a fuel cost of 30 to 35 cents a kWh – five or six times the average price charged by the government utility for electricity. If natural gas is available at \$10-\$12 per million BTU, the fuel cost would be more like 10 cents per kWh.³ This is still a money losing deal for the electric company, but closer to breaking even. It is much cheaper than using diesel fueled generators.

If there is further natural gas supply available for domestic use, the fastest way to put in new power supplies is to invest in single cycle gas generators. These are similar to jet engines and, as suggested above, can use liquid fuels or natural gas. If we assume natural gas is available and a natural gas price of \$10 per million BTU (the export price of gas to Thailand recently), the fuel cost for a new single stage generator would be about nine cents per kWh, while a more fuel efficient combined cycle gas system which uses the same generator but has its waste heat run through a steam cycle (and is more costly to buy and takes longer to install) would have a fuel cost of less than six cents per kWh. Total cost of production per kWh would have to include capital and maintenance costs⁴. These will depend in part on the interest rate and the intensity of utilization, but it is likely that total costs will fall in the range of 10-12 cents per kWh for the single stage natural gas turbine and 8-10 cents per kWh for the combined cycle. The single stage units can be installed in several months if other infrastructure (transmission lines and gas pipelines) are available, while the combined cycle plants normally take a few years to complete. Of course, if room were available, a single stage unit can be converted to a combined cycle unit later on. If natural gas prices were to fall or if domestic prices of natural gas were lower, then the cost of electricity would also be lower. But at current natural gas prices, existing electricity production costs are only about a third of diesel powered electricity. The delivered price of electricity has to include both the cost of production and the cost of delivery, normally adding a few cents per kilowatt hour to the final bill.

³ A recent gas field was discovered about 100 km south of the Shwe field and could use the Chinese gas pipeline to deliver gas to Mandalay. This would take some time, but would be a medium term solution.

⁴ In the US in 2010, the advanced single stage turbine had an estimated cost of \$665 per kilowatt and the advanced combined cycle plant had a cost of \$1000 per kilowatt. Maintenance would cost about 2 cents per kWh. See, "Updated Capital Cost Estimates for Electricity Generation Plants" by the Office of Energy Analysis, U.S. Department of Energy, November 2010.

Potential and Plans

There are 40,000 megawatts (MW) of potential hydroelectric capacity in Myanmar and only about 2560 MW has been developed. All other sources in 2011 amounted to only 900 MW, for a total of 3461 MW – and 100 MW of that is isolated and not connected to any large grid. It may be that some of these hydroelectric plants are mainly exporting electricity to China and are not owned by the Myanmar electric company or government, so not all capacity may be available for domestic use – this has to be clarified. Although there are variations, it is normal for a hydroelectric dam to have about 4000 hours a year worth of production in a monsoon climate. Gas generators can normally be used for more hours, although it might not be cost effective to do so unless they are combined cycle.

One trouble with hydroelectric capacity in a monsoon climate is that it has reduced or even zero capacity during the dry season, which normally runs from December through March. There are 8760 hours in a year and most hydroelectric plants can only be run from 3000 (if the dam is multi- purpose or if river flows are irregular) to 4500 hours a year. **The current plan is to rely almost entirely for hydroelectricity for base load – power that is used almost all the time.** Unless there are very large reservoirs or adequate dry season flows, this is a recipe for blackouts or having to rely on very expensive diesel power backup during the dry season. If a dam costs \$1500 a kilowatt and runs 3000 hours a year (the 2010 average) it will produce electricity costing only 5-6 cents per kWh. But if it is only 65% capable for four months a year, then there will be one-third of the year where diesel power must be used as backup or extra hydro will have to be built to ensure stable supplies – or blackouts will be common.

In 2010, there were 4627 megawatt-hours of hydroelectric output and 1600 MW of hydro capacity. This works out to only one-third of potential hydro output actually used. Given that hydroelectric capacity costs about \$1.5 million per MW (\$1500 per KW) to install, a complete reliance on hydroelectricity will cost billions of dollars more than gas for less reliable power. A mix of the two would cost less in terms of investment and reduce blackouts during the dry season. Most nations that have gas deposits do not rely exclusively on hydroelectricity for growth of base load due to these considerations.

One alternative would be to have natural gas fired turbines as backup instead of diesel. That would cost less in fuel but more in capital, and the turbines (and perhaps the producing facilities for natural gas) would not be used for much of the rest of the time.⁵ Another

⁵ Relying on natural gas for peaking capacity is currently planned but this depends on private companies being willing to develop an expensive gas field for part-time use. Unless this gas surplus could be exported when not needed in Myanmar, it is unlikely that peaking demand alone is sufficient to support gas field development.

alternative would be to build significant excess hydro capacity so even the reduced flows were adequate for normal demand. But this would necessitate large idle capacity or exports in the wet season, and exports do not normally fetch very high prices. (But see the text box on the following page.) A combined cycle natural gas plant or a coal plant would have the capacity for base load operation and have costs competitive with or lower than hydro +diesel. A coal plant with imported coal would have fuel costs of about 5 cents per kWh and other costs of about the same amount. A combined cycle natural gas plant would also total about 10 cents/kWh.

There is also the question of how quickly new supplies could be brought in. The “high” demand case from 2010 to 2020 has only 10% - 11% a year for demand growth, even though recent supply growth has been 15% a year – as blackouts have been increasing. Yet the Ministry of Electric Power states that current supply is only about half of projected demand, and demand is growing 1.5 to 2 times as fast as GDP – and real GDP growth is now projected at 6-7% a year. In addition, new connections will surely be coming on stream – the connection rate in Myanmar was only about half that of Cambodia, one of the least connected nations in Asia. Even if electricity output doubled every five years (a 15% annual rate, similar to Vietnam’s), *it would take five years just to catch up to today’s existing demand*. In that period, demand would have grown by 12% a year. To the extent that new connections are additional, demand growth would be even higher. In short, a massive increase in electricity generation and transmission is needed very quickly. Growth rates doubling electricity output every four to five years are probably needed for a decade. These would require major investments in hydroelectricity and in gas and possibly coal plants. Some of this could come from foreign investors, some from aid and some from commercial credits – IF electricity prices are high enough to recover the cost of generating and delivering new electricity.

Box 1: Export Hydro-Electricity in the Wet Season, Use Locally in the Dry Season?

There are several hydroelectric sites in Myanmar that are of interest to foreign investors. Recent contracts provided for a foreign, usually Chinese, company to come in and build the project at their own expense and supply a fraction (about 10%) of the hydroelectric output to Myanmar. The Myitsone project has been suspended due to a variety of concerns about the environment, displacement of local people and adequacy and fairness of contract terms. It may be useful to compare any revised terms with the Nam Theun hydro project in Laos, as these terms were agreed to in a transparent manner. If revised terms can be agreed to, one possibility is for Myanmar to export power to China in the wet season when there could be a surplus but keep most or all of the project’s power for local use in the dry season. The large amount of coal power in China and its integrated grid would allow them to rely on coal-fired power in the dry season, while Myanmar could get the full benefit of “foreign” dams in Myanmar in its dry season. This might allow a very rapid expansion of electricity output and help utilize hydropower without suffering the cost of high cost diesel backup. If China or Thailand were willing, there might even be sales of electricity to Myanmar when needed. However, the prices of electricity imports and exports should be close to each other. Foreign hydro projects might be the only way to rapidly expand Myanmar’s power supplies since rapid expansion in both hydroelectric and thermal generation will be needed.

Electricity Pricing: No power is as expensive as no power!

The price of electricity has recently been raised to more nearly reflect its cost. Recent data suggest charges per kWh were 12-13 cents (in US\$) for foreigners and 75 kyat (about 9 cents) for offices, both in Yangon. However, average charges in December 2011 were less than 40 kyat per kWh or only 5 cents. A common mistake many developing countries make is to equate a low price of electricity with cheap electricity. The low price normally puts a great strain on the electricity company and government budget and this causes a slow growth in investment and capacity. The power may be low priced but blackouts are frequent. Those who can (some businesses and wealthy households) buy generators as a backup but this is many times more costly; others sit in the dark. Is electricity cheap when it is not available? The best policy is to charge what it costs (and should cost – electricity should not cost much more in Myanmar than in Thailand, where it is less than ten cents per kWh) and supply enough so that blackouts are uncommon and more people can be connected. This is what Thailand and Vietnam do.

There is often a complaint that raising electricity prices will hurt “the poor” – although 78% of homes do not even get any electricity, and most of those who are connected are not poor compared to those who are not connected. If this is a compelling political argument, it is possible to charge a low “lifeline rate” for a low amount of energy per month. If a household uses, for example, less than one kilowatt-hour a day (enough for a few lights, a fan and perhaps a television) then a lower price could be charged. If monthly consumption is over 30 kWh, then the household or business should pay what it costs to produce and deliver the electricity. If diesel power is excluded, this should be between ten and fifteen cents per kWh. In practice, anyone with a low-capacity connection would get the subsidized rate for the first thirty kWh, but those with a higher capacity connection would pay the full price for all power used.

The public is never happy with more expensive electricity, so a gradual phase-in and simultaneous improvements in reliability may make this policy easier to explain and accept. Fortunately, the price of electricity to larger private homes and businesses is not far short of where it needs to be and only gradual steps are needed to reach a price that will cover the full costs of providing the electricity. The more difficult problem may lie with very low rates charged to state and military consumers.

Going Forward

Electricity is required for economic growth. Myanmar’s electricity use and connection rate are among the lowest in Asia. (In 2009, Afghanistan and Nepal had higher connection rates.) Its plans for increasing capacity are too little and bet essentially everything on hydroelectricity – a

type of power that takes years to complete and suffers from dry season shortages which are expensive to back up. A more rapid and more balanced expansion path is needed, using natural gas and perhaps imported coal as well as hydro.

One major policy decision is what domestic natural gas should cost. It might be priced at the same level as exported gas to China or Thailand, or it might be set at a lower price. If domestic gas were sold at a lower price than exported gas, this would allow electricity prices to be set lower but still recover the cost of production. On the other hand, many companies would want to drill for export gas and fewer for domestic gas! An export tax could be imposed on new gas developments and this could be figured into revised contract terms. For example, a 20% export tax would make a company indifferent between exporting gas at \$10 per million BTU and selling domestically at \$8. If \$8 per million BTU were charged to the electric company, the fuel cost of gas would be only five cents per kWh in an efficient combined cycle generator. Capital, operating and delivery costs would raise the final cost, but it should allow costs close to current private rate charges. *However, most costs of power are essentially dollar based – both the cost of capital and the cost of fuel. If the kyat were to depreciate, this would mean that electricity prices would have to rise to offset the unchanged dollar but higher kyat cost per kWh.*

The major constraint right now is the availability of finance to build generators and transmission and distribution lines. If this can be overcome by opening up aid and commercial lending, the availability of natural gas for domestic use would be the next constraint. It might take several years to develop a new gas field and deliver the gas close to Yangon for a combined cycle generating plant. The plant itself could be built in a few years and larger hydroelectric dams take at least five years, and often more. Arranging the financing, planning and executing these investments will be one of the determinants of future industrial and GDP growth of Myanmar.

If Myanmar targeted adding 700 megawatts of base load power **a year** over the next five years, it would cost \$1000 a kilowatt or \$700 million a year for gas-fired electricity. (It is not clear that sufficient gas is or would be available for this much gas-fired power in five years.) If it were hydroelectricity, it would be \$1500 a kilowatt for full (wet season) capacity, but much more for reliable and year-round power. Transmission and distribution lines would add to the total investment cost. Possible agreements with China for dry season power from purchases or from mainly export-oriented dams could make hydroelectricity more attractive as part of the solution. Finding a solution for doubling power is critical to fostering rapid growth of incomes.

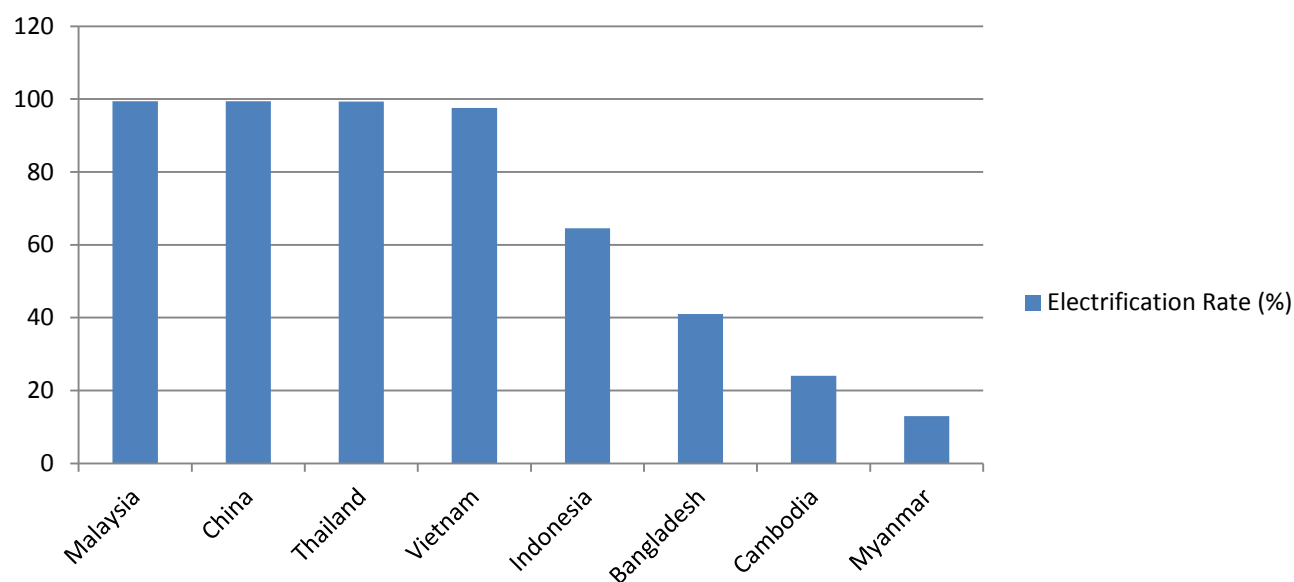
Appendix: Electricity Connectivity and Consumption in Some Asian Nations

Table 2: Electricity Connectivity and Consumption (2009) in Selected Asian Nations

	<u>Electrification Rate</u>	<u>Millions without Power</u>	<u>Consumption (kWh/person)</u>
Bangladesh	41.0%	96	252
China	99.4%	8	2631
Cambodia	24.0%	11	131
Indonesia	64.5%	82	590
Malaysia	99.4%	0.2	3614
Thailand	99.3%	0.5	2045
Vietnam	97.6%	2.1	918
Myanmar	13.0%	44	104

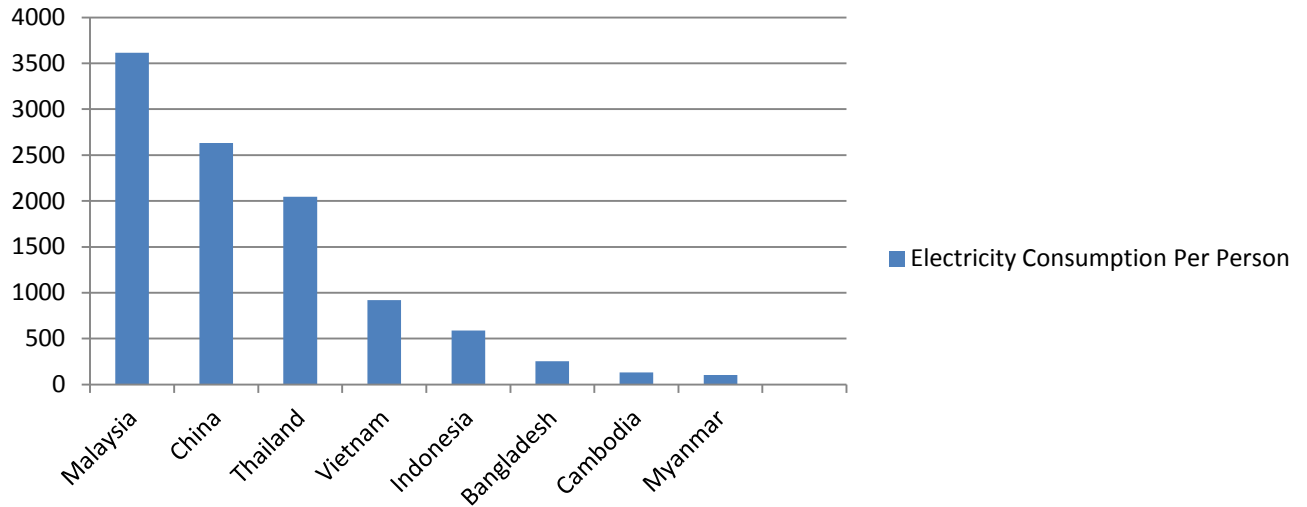
Source: Connectivity from the International Energy Agency; Electricity consumption per capita from the World Bank data web site. 2009 is the most recent year available for all nations.

Graph 1: Electrification Rate in 2009 (%)



Source: Connectivity from the International Energy Agency; Reports are that by 2011, Myanmar's connectivity rose to 22%.

Graph 2: Electricity Consumption per Person in 2009



Note: The per capita electricity numbers for Cambodia and Myanmar in this graph are for 2011, not for 2009.

Source: World Bank data web site. 2009 is the most recent year available for all nations. Myanmar for 2011 is from the December 2011 Monthly Bulletin. Cambodia is from newspaper reports.