Journal of Sustainable Development; Vol. 6, No. 5; 2013
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Power Shift: Emerging Prospects for Easing Electricity Poverty in Myanmar With Distributed Low-Carbon Generation

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Received: March 8, 2013 Accepted: April 8, 2013 Online Published: April 16, 2013

doi:10.5539/jsd.v6n5p65 URL: http://dx.doi.org/10.5539/jsd.v6n5p65

Abstract

Myanmar is among the least electrified countries in the world. Prospects are examined to assess the opportunity for a paradigm shift to deliver rapid relief from electricity poverty and change the trajectory of national development. Expansion of electricity supply is currently planned around the model of large power plants and a national grid. Experience elsewhere suggests it will take several decades for this model to supply electricity to most of the population and come at considerable cost to environmental quality, particularly rivers. However, there are signs that a distributed generation model could be widely developed over several years. Already, local markets are supplying domestic electricity generation systems. In 2012 development partners identified opportunities for interventions to reduce electricity poverty. Several successful commercial models for supplying affordable electricity to poor people in neighbouring countries could be adapted to Myanmar. Furthermore, market and technological trends in distributed power generation are coherent with national policy goals of securing energy independence and increasing use of renewable sources. Given the scale of unmet demand and clean energy resources, particularly solar and biomass, an opportunity is open for alleviating electricity poverty in years, rather than decades. If a hybrid centralized-distributed power system emerges over the next few years Myanmar may be better placed to resist and adapt to climate change and global shifts in energy markets.

Keywords: Myanmar, electricity, poverty, distributed generation, solar photovoltaic, sustainable power

1. Introduction

In 2011 a marked break occurred in the politics of Myanmar. A civilian government took power, albeit with very close ties to the military which had held power continuously since the 1960s. Developed countries responded by relaxing or dropping sanctions and upgrading diplomatic relations and cooperation. International development agencies are now returning or expanding existing programs. Interest among foreign investors has risen considerably, an opportunity not lost on conference promoters and airlines around Asia. The sense of optimism in the public and private sectors over the future of Myanmar, which shows strong promise in agriculture, energy, minerals and tourism, has however to contend with a level of development on par with many of the poorer countries of Africa.

How development unfolds in Myanmar, particularly the elimination of poverty and adaptation to climate change, will be affected by the availability of electricity. The electricity situation and outlook for development have not been well documented because of the country's isolation. However, over the last year several initial assessments have been undertaken by international agencies. The findings are timely and valuable for two reasons. One, policy is at an early stage of reform which will shape the path taken to ubiquitous electricity. Two, trends in technology and climate are changing the conditions and opportunities for electricity and poverty. It is worthwhile therefore to review recent assessments and employ the findings in an evaluation of the opportunity for accelerated closure of the electricity supply gap by transferring sustainable solutions for electricity poverty from neighbouring countries.

Currently, 26% have access to electricity, mostly in towns and cities home to about 30% of the national population estimated at 60 million. Providing reliable grid electricity generated by central power plants, the mainstream model worldwide since the early 20th century, will take decades, exert a considerable strain on capital, and leave a heavy footprint on the environment. An alternative approach taking hold in neighbouring countries is generating locally, at the household or community scale. Deployment timeframes measure in days or weeks delivering power cheaper than typical monthly spending on candles and batteries, and with lower environmental impact. The opportunity for rapid reduction of electricity poverty is now a realistic one because of falling prices and the prospects for adapting innovative commercial models from Bangladesh and India. Prospects depend to a considerable degree on policy, the legal framework and investors' interest in an opportunity on the development and technology frontier. If the opportunity is realized then electricity in Myanmar will take a path leading towards the centralized-distributed hybrid models emerging in countries like China, Germany and the United States.

2. Status of Electricity Supply in Myanmar

Quantifying the electricity supply situation in Myanmar is difficult because consistent data is hard to come by. The Asian Development Bank, drawing on data from various ministries, reported a national connection rate of 26% in 2011, up from 16% in 2006 (Kim et al., 2012). In the countryside connections drop to 16%, which crudely suggests 33.6 million rural people live without electricity. They mostly use biomass for cooking and candles, torches and lamps for light.

Affordability also appears low. A new connection costs 500,000 kyat, or $595 (Bodenbender, Messinger, & Ritter, 2012), compared with GDP per capita of $859 in a country where a quarter of the population lives below the poverty line (Park, Khan, & Vandenberg, 2012). Nevertheless, the jump in connections in the five years to 2011 suggests for some life is getting a little better, probably mostly in the cities, in an economy growing 6-7% annually. Once connected the power comes and goes. Brown-outs and black-outs from load shedding are common. In the 2011 dry season peak load of 1533 megawatts (MW) exceeded available generating capacity by about 500 MW despite total generating capacity of 3495 MW with 1957 MW of firm capacity (Kim et al., 2012). The Ministry of Electric Power has calculated supply is sufficient for half of expected demand (Dapice, 2012)-from the quarter of the population with a connection.

There are several explanations for supply falling short. One, output from hydro power plants, which account for about 70% of capacity, sags as the dry season advances only recovering after the monsoon arrives. Two, to compensate for falling output at some power plants others, including those burning gas, are run harder increasing wear and tear. Three, maintenance is poor. Four, about 25% of power is lost in transmission (Bodenbender et al., 2012) because the grid is dilapidated and overloaded.

3. Closing the Supply Gap-Estimates of Current Policies and Plans to Expand Electricity Supply

Existing customers might be in for some relief over the next few years. Supply is, on paper, going to rise. The centralized model of large power plants hooked up to a national grid is set to double or triple, according to the findings of the Asian Development Bank's preliminary assessment. By 2013 two coal power plants are due to add 870 MW to the system. Another 1720 MW could go online between 2013 and 2016 followed by 3732 MW thereafter (Kim et al., 2012). However, these plans might overstate ambitions. Dapice came up with a projected increase of only 617 MW by 2017 (Dapice, 2012). In any case not all the new power plants will be generating electricity solely for domestic demand because of export deals agreed with neighbours China and Thailand.

There are several reasons for treating current plans with caution. One, institutional constraints should not be underestimated. The government is underfunded, preoccupied with reorganization, and probably lacks enough staff and skills to oversee all the planned projects. Two, new laws and regulations cloud the picture. For example, the Environmental Conservation Law enacted in 2012 expands oversight and management of the environmental and social realms of development, including environmental impact assessment. Experience with such measures in either the public or private sector is understandably light. Moreover, civil society may turn to the law to curb developments imposing costly externalities, if the door to the tightly controlled courts is open.

Three, it is also conceivable skilled labour will be inadequate to implement all the projects on time. Training more engineers and technicians and expanding training capacity will itself take time and resources. Four, financing could be expensive because of the high risks investors associated with the poorest countries. Five, the emphasis on hydropower in current plans will not solve the seasonal variation in output. Six, the grid must be expanded and bottlenecks cleared.

Meanwhile, consumption will grow. Demand load for 2012-2013 is estimated at 2155 MW, against the 2011 dry season peak of 1533 MW, and projected to reach 6416 MW by 2021. Load increased around 8.8% annually between 2008 and 2011 (Kim et al., 2012). If that trend holds load doubles in eight years. The expected surge in demand from existing and new customers in areas served by the centralized grid, particularly major cities like Yangon and rising industrial zones, is going to test the efforts of the government, foreign partners and private investors.

In sum the prospects for stabilizing power supply and expanding availability are poor. Better planning and more capital could improve the outlook, at least for stabilizing the existing grid, if foreign technical assistance and finance can be brought to be bear. Slow progress is expected because legal foundations are weak and precedents to build confidence are few. In any case it is clear that fixing the existing system is going to cost a lot of money, much of which will be financed by credit one way or another, and preoccupy technical expertise and material resources for a long time.

It therefore is unlikely, even under the most optimistic scenario, that the electricity poverty affecting the homes and livelihoods of most of the population will be solved within a decade, perhaps two, if centralized generation is pursued as the sole strategy for expanding power supply.

4. Technological Change-The Opportunity for Policy

A solution to the speed and scale challenges of electricity poverty is to distribute the means of electricity generation widely across homes and communities. The distributed-generation approach, gathering momentum worldwide, uses local clean energy resources, such as farm waste or sunlight, to provide power at or near point of use. In richer countries distributed generation is beginning to reshape energy market economics and system structure. For example in Germany, the scale and speed of adoption of solar rooftop systems, plus other distributed energy systems, under the *energiewende* is such that the concept of the large power plant running constantly to support the base, or constant, electricity demand load is now in question. It is envisaged in 2022 Germany may only need large power plants able to come online in a few hours to fill transient supply gaps in power systems dominated by solar, wind and biomass (Baake, 2013). By 2030 simulations demonstrate a 100% renewable electricity system would be cheaper than the conventional hydrocarbon alternative and equally reliable in Australia (Elliston, MacGill, & Diesendorf, 2013).

As evidence from Germany and other countries, such as Australia and parts of the United States, suggests distributed generation can quickly change the supply and availability of electricity, with implications for market structure and consumer costs, in developed countries, and electricity poverty, in developing countries. While a 100% renewable electricity system, which avoids the seasonal and environmental drawbacks of dominance by hydropower, may not be immediately feasible in Myanmar, concurrent development of distributed power generation with centralized generation would accelerate reductions in electricity poverty by simultaneously tackling the problem at micro and macro scales. Moreover, the bottom-up approach of distributed generation can offset the requirement for power from topdown centralized generation thereby promising to release resources for spending on other critical priorities such as education, health and ecosystem services.

Distributed power using clean energy is well matched to remote or under-developed regions and countries for several reasons. One, expanding roll-out worldwide is driving costs down and innovation up. Two, systems can be rapidly commissioned, in weeks, even days. Three, small scale holds the potential for wide-scale deployment subject to capital availability. Four, clean power can tap abundant net zero carbon resources of solar, water, biomass and geothermal with minimal impacts on ecosystem services. Five, smaller projects may access wider sources of finance or aggregate to match the opportunity portfolio of local and foreign public or private investors, including reformed local banks and community funds (Sovacool, 2012) private equity and emerging crowd-funding models (Note 1).

Power development in Myanmar then is at an inflexion point. On the one hand electricity development could take the well-worn path building in dependence on the centralized model. On the other a thinking-forward path which balances centralized generation with the distributed model tuned to the low-carbon future. The first path will not do much for public welfare because much of society will wait years if not decades for electricity. The second path promises a better result for public welfare by delivering more electricity sooner for many. Moreover, more power for more people should spread prosperity further faster improving the quality and scale of development in Myanmar.

5. Affordability-Household Solar Photovoltaic Cells

Distributed power can draw on local energy resources of sunlight, wind, rivers, biomass and geothermal. Solar is seeing strong interest worldwide and appears to be leading development of distributed power because it is simple, flexible, abundant and increasingly affordable. It is therefore useful to take a closer look at the case of solar as a solution to electricity poverty in sun-drenched Myanmar.

If solar is going to be a commercially viable solution it has to provide a similar benefit within the budget of what people currently spend to obtain a little light or power. A team from the European Union Energy Initiative reported households around scenic Inle Lake in central Myanmar spending US$9.26 per month on candles and torches (Bodenbender et al., 2012). In the Irrawaddy Delta, which was hit hard by Cyclone Nargis in 2008, Mercy Corps found mean monthly household spending on candles and large batteries of about US$12 against mean monthly incomes of US$40-80 in the Irrawaddy Delta in 2011. The monthly energy budget buys 3.8 hours of light per night against demand estimated at 5 hours (Mercy Corps, 2011).

At these budgets solar is already competitive. Solar lanterns and solar-LED lighting systems cost US$10-86. In Myanmar a Chinese pico-hydro system or a 50 watt-peak (W_p) solar-home system cost US$397 and US$291 respectively and provide sufficient power to charge batteries for lights, phones and perhaps a small computer or flatscreen television. Entrepreneurs are already using such systems to sell power to light the homes of neighbours (Bodenbender et al., 2012). The Ministry of Energy and Yoma Bank have piloted a solar-charging station for batteries (Kim et al., 2012).

Upfront spending is the biggest barrier to solar in Myanmar. The barrier could be removed if lanterns or solar home systems were sold on credit to households. Repayments could be financed from money saved as a result of solar systems eliminating the need for candles and batteries. Moreover, solar would insulate them from inflation affecting consumables like candles and batteries. If credit were charged at 15% per year-a common, even low, rate for microcredit-the system could be paid off after five years, assuming income was not affected by bad harvests or disasters. Thereafter the household would be in pocket to the tune of what would otherwise be spent on candles, batteries or perhaps hydrocarbons. Conceptually, this approach is no different from the savings-as-revenue model used successfully in the energy-efficiency retrofit programs worldwide.

6. Learning and Scaling-Domestic and International Experience

In addition to local traders selling solar lanterns, solar home systems and pico-hydro kits (Bodenbender et al., 2012) several pilot projects have tested distributed approaches in homes and villages. Yangon Technological University investigated village solar electrification. Japan's New Energy and Industrial Technology Development Organization has with the Ministry of Electric Power conducted demonstration research for a solar power plant (Kim et al., 2012). The pilots as well as community initiatives and firms already at work in Myanmar are just the beginning however. What comes next depends on policy clearing the way and aid partners, entrepreneurs and investors providing knowledge and capital to complement local expertise. The results could be striking given progress in neighbouring Laos, Bangladesh and India.

Sunlabob began a decade ago in Laos, a country as poor as Myanmar, renting solar lanterns and expanded into mobile-phone charging systems, micro-hydro and expanding recently to Africa (Sunlabob, 2013). In Bangladesh each day a thousand solar home systems are installed by Grameen Shakti. Last November total installations surpassed a million homes (Grameen Shakti, 2012). That scale in Myanmar equates to about 4-5 million people, or over 10% of the rural population without electricity. In Bangladesh the program is financed to the tune of US$370 million by a coalition of international, bilateral and domestic partners led by World Bank (World Bank, 2009).

In Uttar Pradesh, where less than one-in-five rural households have grid power, Mera Gao Power is building village micro-grids powered by four solar panels. Output is sufficient for villagers to buy enough power for lighting and mobile phone charging at home (Mera Gao Power, 2012). The model is promising enough that in 2011 it won a grant of US$300,000 to scale up to 40 villages during 2013 from USAID's Development Innovation Ventures (USAID, 2011).

Simpa Networks, Omnigrid Micropower and Gram Power have taken the pay-as-you-go model of mobile phones. Payments match the ups-and-downs of spending on candles, batteries and kerosene. Simpa users in Karnataka pay what they can by sending a text message to unlock the solar home system for a period of time correlating to the sum paid. Once payments equal total cost the system unlocks permanently and the user takes ownership (Simpa Networks, 2012).

Omnigrid Micropower goes a step further with a flexible micropower system exploiting solar, wind or farm wastes. Long-term supply contracts for off-grid cellphone towers, currently powered by diesel generators, offsets development costs. The system is designed to scale as demand expands from light to television and then machinery like water pumps (Omnigrid Micropower, 2012). The capability of the microgrid to respond to expanding demand conceivably removes one barrier to developing local industries such as agricultural processing and packaging or factories engage in light production such as footwear and apparel.

Gram Power is another startup focused on microgrids. The first microgrid went online providing around the clock power in a remote village in Rajasthan with up to 80 planned under contract with the state government. Lighting and cellphone charging using electricity from Gram costs villagers about US$1.37 a month, against the incumbent options of kerosene and cellphone-charging services costing US$3.66 a month. Gram was supported with seed capital from Alibaba.com, Intel and the University of California Berkeley. A Swiss firm invested US$1 million after meeting Gram at the LAUNCH energy challenge in November 2011 (Abrar, 2012).

Development is not only happening in rural settings. In Gandhinagar, the capital of Gujarat, two firms won tenders to each develop 2.5 MWp of rooftop solar. The International Finance Corporation provided technical assistance for the pilot project and is now advising on similar projects in five cities across the state. Power from the cells will reduce the city's carbon emissions and ease strain on the grid during the day when demand spikes as air-con and fans are turned up while offices and factories are busy at work (IFC, 2012).

Conditions in Myanmar are not so different from Gujarat suggesting the model could be transferred to the rooftops wherever demand is sufficient and solar competitive at the socket given the alternative of inadequate grid power or diesel generators. On a per unit basis the European Union Energy Initiative calculated solar is increasingly competitive with diesel generators, estimated at 420 kyat/kWh or about US$0.57, in places unlikely to receive reliable central grid supply for years (Bodenbender et al., 2012). In cities rooftop solar might displace diesel during the day when grid supply fades or fails and charge batteries to power lighting and computers in the evening.

7. Discussion

The range of approaches to solving the problem of electricity poverty for the poor illustrate the potential of the opportunity innovation in technology and business models is opening up. The direct benefits in terms of savings for households and higher power quality are readily apparent.

However, ramping up solar and other local clean energy resources for power generation however offers several additional benefits for health and environment which directly or indirectly affect economic well-being. They may not be considered in policy development because of the limits to standard market-valuation techniques and the common problem of externalizing environmental impacts from markets, if they exist. Failure to recognize and value such benefits is detrimental to human health and economic well-being in the long run. Even in Myanmar which despite a relatively low level of development is at risk from weak environmental and energy security (Sovacool, Mukherjee, Drupady, & D'Agostino, 2011).

Solar cells on rooftops, for example, are positive for food security because they do not compete with crops for land. Biomass systems convert agricultural waste to energy and fertilizer reducing pollution and generating power with little or even zero net-carbon emissions. Pico-to-small hydro power systems can be sited and designed for minimal impact on environmental quality and maintenance of ecosystem services critical to food security. Whereas large hydro-power dams because of scale and structure are associated with irreversible damage to ecosystem services, particularly in tropical riparian ecosystems characterized by high biodiversity, underpinning food security and damage to climate stability through methane emissions (Fearnside & Pueyo, 2012; Fearnside, 2012; Orr, Pittock, Chapagain, & Dumaresq, 2012; World Commission on Dams, 2000).

Air and noise pollution from diesel generators or heavy-metal contamination of soil, water and food by disposable batteries should fall after introducing clean energy systems, which themselves stand a better chance of being recycled because residual value makes for attractive scrap.

Environmental benefits could be felt at larger scales and through time if as has been seen elsewhere the culture of energy changes. Generating a limited amount of clean power locally can incept users with a different outlook on energy to people drawing seemingly unlimited power from the grid (Devine-Wright, 2006; Pasqualetti, 2000). Devine-Wright (2005) found interest rises in how energy is used to produce power and the accompanying costs and benefits when people stand to gain direct access or share in the profits or ownership of clean energy schemes larger than the house roof. Consumer power generation raises the prospect of an energy citizenship emerging in which people actively participate with the state in the responsibility for co-producing energy security (Devine-Wright, 2006; Sauter & Watson, 2007). An energy culture of active engagement with devices producing a little power may make for parsimonious users who place greater value on highly-efficient products. Energy efficiency for them may be second nature. That could help infuse a culture of energy efficiency, an opportunity of increasing importance worldwide for carbon mitigation.

Developing interest and participation of households in power generation at this stage in Myanmar's development could prime the country for relatively early adoption of changes reshaping the structure and market for electricity. Firstly, the consequences of distributed generation for electricity supply and market structure are as previously mentioned beginning to appear in Germany (Baake, 2013). If Myanmar's power system was structured around distributed clean energy, helped by policy directing private investment, capital expenditure on large power plants might be less than the conventional centralized approach. Secondly, households generating power and plugged into microgrids will be in an advantageous position to adopt peer-to-peer power trading technology currently under development (Lasseter, 2011; Patterson, 2012). Technical developments enabling peer-to-peer power trading promise improvements in efficiency and reliability for consumers and strengthen energy security for society. They may also reduce financial leakages from communities in the form of power bill payments to central utilities.

While expanding access to electricity has considerable benefits for households, the economy and the environment costs emerge in due course. For example, access to electricity could increase disposable income in two ways. One, as mentioned costs are lower relative to existing sources of lighting. Two, with more and better quality power and light households might develop additional income opportunities. Conceivably, consumption could increase generating more municipal solid waste.

In Laos, during nationwide field work in 2011 it was common to see municipal waste dumped along the roads outside villages or down ravines into water courses, something not noted during similar field work in 2007. During the intervening years the economy had changed markedly owing to the cumulative effects of foreign investment, increased trade, including rising imports of consumer goods and processed foods from China and Thailand, and expanding access to electricity. It is hypothesized that the increase in quantity and change in quality of waste is a function of economic development, including electricity access, and the inability of policy and public services to prepare and respond. Given similarities between Laos and Myanmar similar problems could emerge in Myanmar as electricity and the economy develop.

Another example of an unintended consequence also concerns the environment. If solar, or other distributed generation, is put to work powering pumps drawing water up from wells several risks may emerge. One, withdrawal over a wide area could, in the absence of effective common-pool management institutions, exceed the recharge rate of an aquifer, exacerbating any pre-existing water stress and fomenting social discord which may not be tolerated well in areas already suffering religious or ethnic tensions. Two, depending upon the hydrological conditions fields may suffer salinization causing reductions in productivity with implications for household economic and food security.

Of course problems like these are not inevitable. However, if they are to be avoided and the benefits of electricity maximized policy, administration and communities should assess their respective situations and prepare mitigation in good time, not least because the challenges for budgets and capacity could be considerable.

8. Conclusion

Electricity is a prerequisite for developing the benefits and well-being associated with modern life. Without it the prospects for millions of people to develop their well-being will be held back, particularly in education and health. A great number of people could well wait a generation for electricity if the problem is dealt with solely by expanding and extending the centralized grid. This is unnecessary. Proven technologies and business models have shown that the potential exists for distributed power to solve the problem in a few years. Widespread deployment of distributed power drawing on clean energy could furthermore make an important contribution to the goals of energy policy set out by the government.

Society also stands to gain from the collateral or indirect benefits of distributed power. One, an expansion of distributed power holds potential to reduce the scale of the centralized power system leaving more funds and resources for other productive purposes. Two, a smaller centralized power system should leave a smaller impact in terms of irreversible damage for environment and ecosystem services which underpin food and material security. Three, greater diversity in energy resources and power production will strengthen energy security. Four, the state of forestry and agriculture could improve because of positive spill-over effects (Sovacool, 2012). Five, a stimulus for local firms and jobs drawing on existing capacity to implement and market clean energy systems (Bodenbender et al., 2012; Sovacool, 2012). Six, prepare society for early adoption of peer-to-peer power trading.

The legal and policy context is however underdeveloped and at risk of instability and implementation failure given inadequate administrative and technical capacity plus the strains of economic and political change. The challenges are therefore considerable. That said there are reasons for cautious optimism. First, the policy context appears positive. Clean local energy can help achieve the government’s energy policy goals of independence, new and renewable sources, efficiency and conservation, and alternative fuels for households (Kim et al., 2012). Second, there is a pool of local knowledge, albeit limited, welling up from existing small-scale deployments of various technologies under less than ideal circumstances. Third, expanding deployments in neighbouring countries and elsewhere offer models and know-how for replication and modification. However, as briefly highlighted expanded access to electricity may also have negative consequences for the environment if it is not possible to adopt a precautionary position on mitigation.

Myanmar may not have to deal with the challenges alone. Recent reforms have been widely welcomed around the world and many countries are stepping forward to offer support and cooperation in tackling the problems of underdevelopment including energy and power. Reports from the European Union Energy Initiative (Bodenbender et al., 2012) and the United Nations Development Programme (Sovacool, 2012) during 2012 suggest international support may be forthcoming. The Asian Development Bank and Norway are helping the government to revise the electricity law which among other things give legal standing to off-grid power (Asian Development Bank, 2012).

The prospects for distributed power in Myanmar are therefore promising. Powerful global trends intersect with urgent local needs. If policy tackles the regulatory and investment challenges then electricity poverty could be eased considerably which may improve prospects for alleviating other development issues.

Acknowledgements

I am grateful to the anonymous reviewers, the editor and Benjamin Sovacool for comments and suggestions, as well as Peter Antonioni, Mark Brimblecombe, Charles Ferguson and Conor Greene for material support.

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Note

Note 1. For example Mosaic and Everybody Solar in California