WORLD ECONOMIC FORUM

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Industry Agenda

New Energy Architecture: Myanmar

Prepared in collaboration with Accenture and the Asian Development Bank

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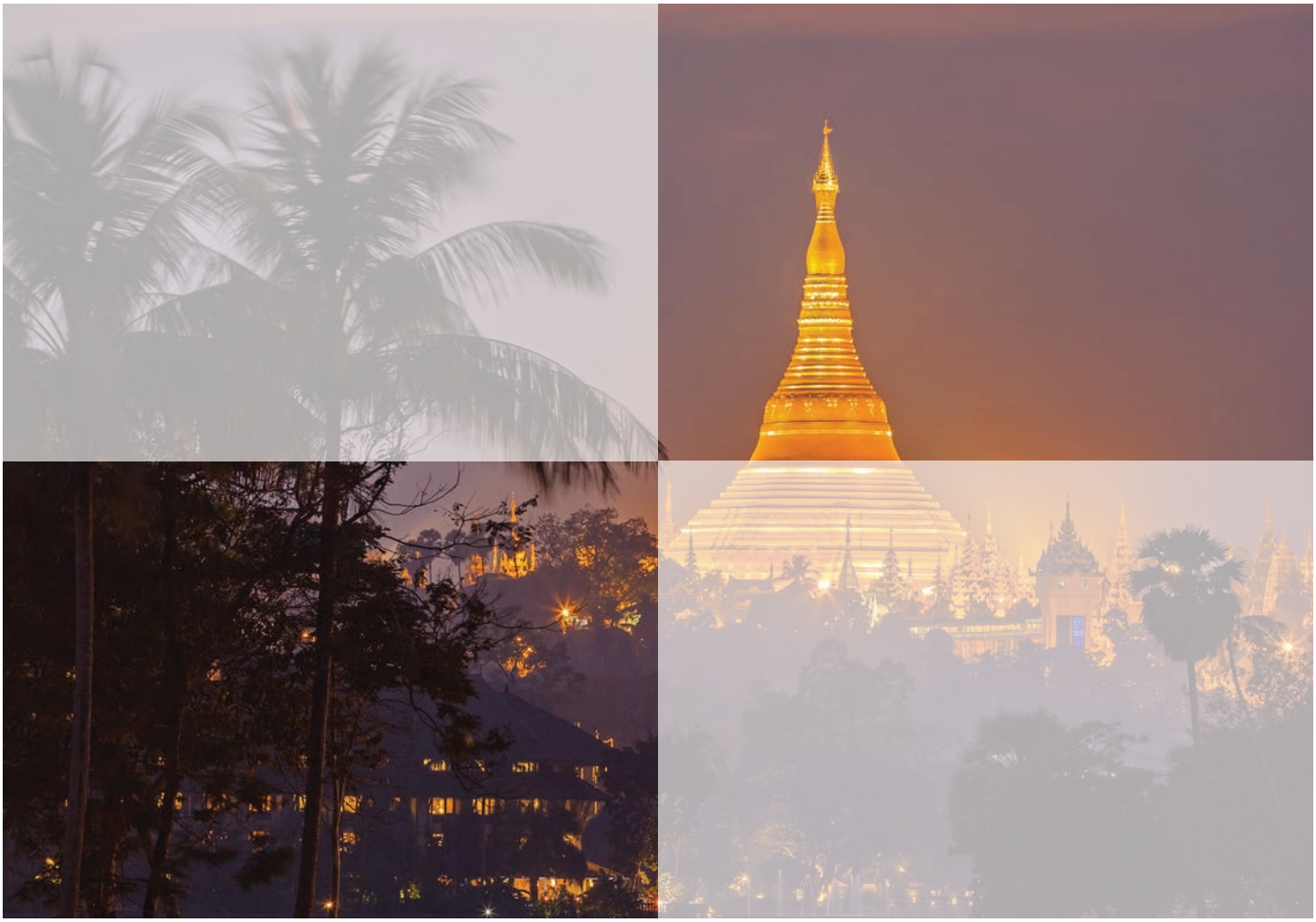

About the Asian Development Bank (ADB)

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member-countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.7 billion people who live on less than US$ 2 a day, with 828 million struggling on less than US$ 1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

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Accenture is a global management consulting, technology services and outsourcing company, with approximately 261,000 people serving clients in more than 120 countries. Combining unparalleled experience, comprehensive capabilities across all industries and business functions, and extensive research on the world's most successful companies, Accenture collaborates with clients to help them become high-performance businesses and governments. The company generated net revenues of US$ 27.9 billion for the fiscal year ended Aug. 31 2012. Its home page is www.accenture.com.

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Foreword

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Myanmar is resource-rich and strategically located between the People's Republic of China (PRC) and India, at the crossroads between East and South Asia. It has always had overwhelming potential for rapid economic development. Yet, today, 74% of its roughly 60 million people lack access to power and endure basic infrastructure. Myanmar has spent 50 years in isolation from the global economy. But now, after decades in the shadows, an ambitious programme of reforms is seeing the country emerge from isolation, committed to integrating once more with the global economy.

Accordingly, Myanmar needs an energy sector that can power its economic and political reforms. Myanmar's energy sector must attain a position of sound institutional governance. It needs to deliver comprehensive energy access to its people and fuel the engines of commerce and industry. It should be developed and planned in conjunction with external stakeholders who offer experience, advanced technologies, new markets and investment.

With its abundant resources, Myanmar is on the brink of an exciting transformation that has the potential to see it carve its own niche in the global economy, and in history. Myanmar's energy architecture is pivotal to its transformation, and now is a critical time to craft its design.

The World Economic Forum, in collaboration with Accenture and the Asian Development Bank (ADB), is pleased to present this report on a New Energy Architecture for Myanmar. The report is the result of a consultative process engaging with the government, local and foreign businesses, and civil society. The consultations that led to this report had one main goal: to bring together the principal actors in this energy architecture – the public sector, the private sector and civil society – to deliver concrete insights to assist Myanmar in its transition towards a new energy architecture. The report offers clear support for the development of national strategies and policy frameworks to help Myanmar achieve and balance the goals of economic growth, sustainability, and energy access and security. This consultation process forms part of the New Energy Architecture Initiative, a collaboration between the World Economic Forum and Accenture to address and accelerate the ongoing global energy transition in an effective manner.

The World Economic Forum and Accenture partnered with the ADB in this consultation process because although the latter had not extended loans or technical assistance to Myanmar since the late 1980s – just like other development partners – it had maintained some involvement with the government through the Greater Mekong Subregion (GMS) Programme of Economic Cooperation, the energy component of which has provided fragmented information on Myanmar's energy system. This involvement led to it preparing the energy sector initial assessment in 2012. That continues to be the most authoritative source of technical information on the sector, and ADB has taken a lead among donors and development partners in the energy sector.

Introduction by His Excellency U Than Htay, Union Minister of Energy of Myanmar

It is my greatest pleasure and honour to offer a few introductory words to this report on *New Energy Architecture: Myanmar*.

At the World Economic Forum on East Asia held in Bangkok, Thailand, in 2012, the World Economic Forum proposed to assist Myanmar through participation in the New Energy Architecture Initiative. Since that meeting, the Ministry of Energy of Myanmar has laid much emphasis on ensuring a workable and sound New Energy Architecture suitable for Myanmar, with the participation of all stakeholders from the government, industry and civil society.

Myanmar is very much aware and recognizes the need to respond to the changing dynamics in economic growth, environmental sustainability and energy security that is the result of global transition, as well as the importance of the combined goals to have energy security and access, sustainability, economic growth and development.

However, during the previous Government, the energy sector of Myanmar was diversified with many Government entities vested with the responsibilities of each and every energy sub-sector. Implementation was conducted on ad-hoc basis without proper plan or strategy, which made energy sector consolidation very difficult.

With the new civilian Government taking office as of March 2011, the need to integrate all energy sub-sectors under one umbrella was recognized and given priority, and the initiative to form a National Energy Management Committee (NEMC) and an Energy Development Committee (EDC) was expedited, bringing forth together all energy-related Government entities and private institutions, propelled and managed by a single national committee and supported by a development committee.

The two bodies have many challenges to overcome in order to create an integrated energy policy including a plan and a strategy for the short, medium and long term, with a view to supporting Myanmar's transformation into a developed nation – democratically, economically and socially.

By establishing a partnership with the World Economic Forum and with the support and collaboration of Accenture, as well as the Asian Development Bank, the New Energy Architecture Initiative for Myanmar is on course for success, as witnessed by this report's outcomes.

This comprehensive and informative study showcases the endeavours and emphasis expedited by the World Economic Forum together with Accenture and the Asian Development Bank. It also reveals the true sincerity and goodwill of the Forum towards the betterment and overall development of Myanmar and especially its energy sector.

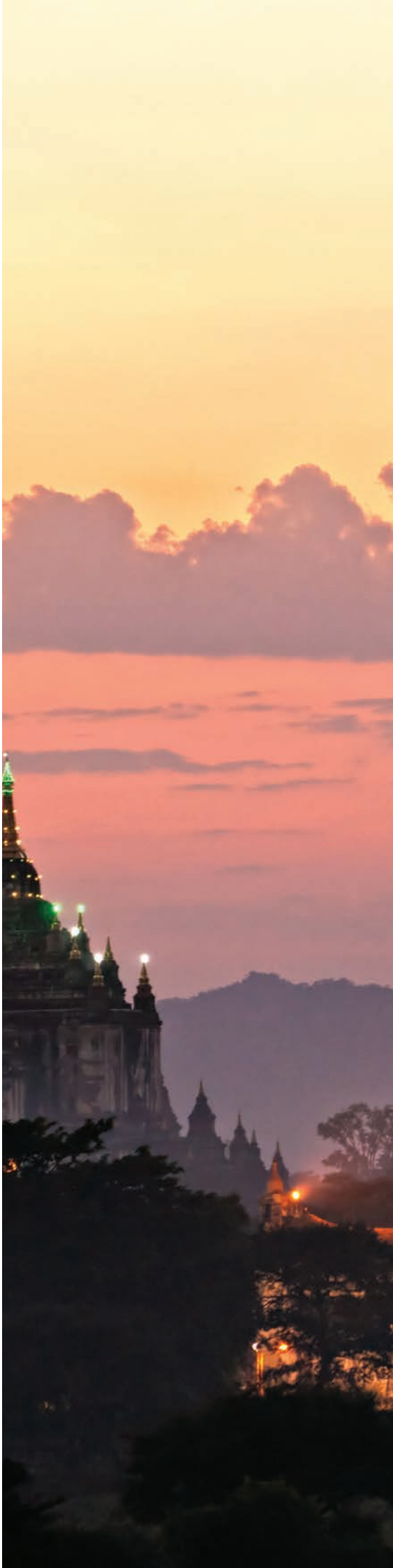
Last but not least, I would like to express my deepest gratitude for the Forum's diligent efforts to expedite this New Energy Architecture Study, which Myanmar truly needs in the reform process currently taking place in Myanmar in the political, economic and social spheres.

My profound thanks to all relevant Government, industry and civil society stakeholders for their active and diligent participation by providing views, comments, ideas and suggestions towards the successful completion of this report.

My hearty wishes for the success of the World Economic Forum on East Asia to be held in Nay Pyi Taw, Myanmar, on 5-7 June 2013.

Best wishes to you all.

Than Htay
Union Minister
Minister of Energy of Myanmar



Executive Summary

Introduction

A global transition towards a new energy architecture is under way, driven by countries' need to respond to the changing dynamics of economic growth, environmental sustainability and energy security. The World Economic Forum, in collaboration with Accenture, has created the New Energy Architecture Initiative to address and accelerate this transition. The Initiative supports the development of national strategies and policy frameworks as countries seek to achieve the combined goals of energy security and access, sustainability, and economic growth and development.

The World Economic Forum has formed a partnership with the Ministry of Energy of Myanmar to help apply the Initiative's approach to this developing and resource-rich nation. The Asian Development Bank and the World Economic Forum's Project Adviser, Accenture, have collaborated with the Forum on this consultation process, and have been supported by relevant government, industry and civil society stakeholders.

The consultation process aims to understand the nation's current energy architecture challenges and provide an overview of a path to a New Energy Architecture through a series of insights. These insights could form the basis for a long-term multistakeholder roadmap to build Myanmar's energy sector in a way that is secure and sustainable, and promotes economic growth as the country makes its democratic transition. While not all recommendations can be implemented in the near term, they do provide options for creating a prioritized roadmap for Myanmar's energy transition.

This report is the culmination of a nine-month multistakeholder process investigating Myanmar's energy architecture. Over the course of many visits to the country, the team has conducted numerous interviews, multistakeholder workshops, and learning and data-gathering exercises to ensure a comprehensive range of information and views. The team has also engaged with a variety of stakeholders to better inform their findings, which have come from national and international public and private sectors and from civil society.

This report is structured as follows. First, the New Energy Architecture methodology is outlined. In Step 1, the performance of the country's current energy architecture is assessed. Step 2 describes the setting of the objectives of the New Energy Architecture. Step 3 outlines insights to support the development of a New Energy Architecture, and highlights potential risks in achieving this. Step 4 then discusses the need for leadership and multistakeholder partnerships to support the implementation of a New Energy Architecture in Myanmar.

Current Energy Architecture

Myanmar's present energy architecture faces many challenges and opportunities as the country makes its transition to democracy. Myanmar faces significant energy access and security challenges. Only 26% of the population has access to electricity,[1] and 70% of the population lives in rural areas.[2] Myanmar relies heavily on traditional biomass for its energy needs, getting approximately 75% of its total primary energy supply from that source, mainly fuel wood from natural forests.[3] For those who do have access to power, supply is intermittent at best due to the seasonality of hydropower production and inadequate transmission and distribution infrastructure. Even if electricity output doubled every five years, it would take five years just to meet today's needs. In that time, demand would have grown by 12% a year.[4]

Natural gas poses a similar problem. Myanmar's proven natural gas reserves of 7.8 trillion cubic feet[5] are significant and are an important source of government revenue. However, there is insufficient supply to meet local demand. One of the principal reasons for this local shortfall is that the pre-2011 government had limited avenues for raising finance while international sanctions were in place. To raise finance, it entered into contracts for the export of natural gas to Thailand and the PRC, limiting the amount available for domestic use. Combined with historically poor maintenance and a lack of compression in gas pipelines, the existing gas-powered plants are old and operate at a significantly lower plant capacity and efficiency. The country's three ageing oil refineries, with utilization rates as low as 41%, need urgent rehabilitation as well as technical upgrades to handle heavier crude oil.

Since the reform process began in 2011, however, Myanmar's energy architecture has seen many positive developments. In early 2013, the government formed the National Energy Management Committee to oversee the sector. It had earlier set in motion a series of reforms – including the initiation of new laws and institutional arrangements to improve decision-making, enhance human capacity and increase levels of private investment – in order to help Myanmar transition to democracy and integrate with the global economy. Additionally, the government is beginning to take a more integrated approach to policymaking across the various energy value chains to improve overall supply and demand.

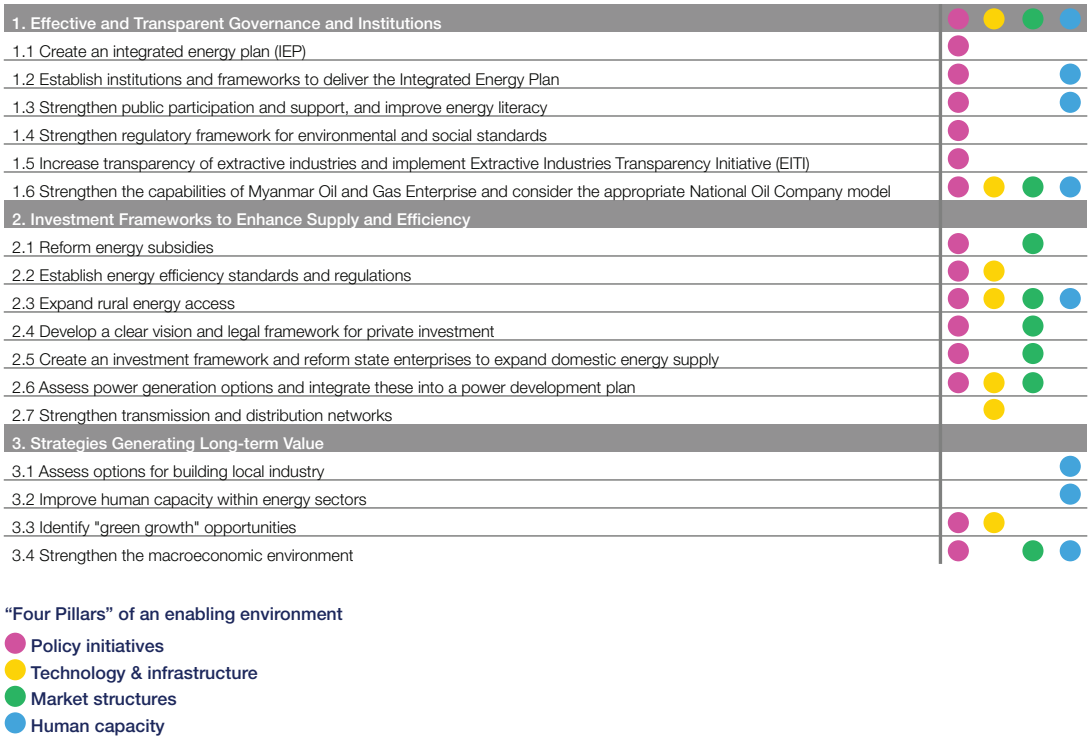
A Vision for the Future

If the country continues its political and economic reforms, Myanmar has the potential to emerge as South-East Asia's next frontier. The country's growth prospects are already enhanced by a number of valuable assets: a large and young population numbering some 60 million,[6] a vital geostrategic location between India and the PRC, and sizeable untapped resources. The government is targeting an average annual GDP growth rate of 7.7%.[7] If that is achieved, GDP per capita could reach US$ 2,000-3,000 by 2030, more than three times the current level, propelling Myanmar into the ranks of middle-income countries.[8] As was the case under military rule, the energy sector will continue to play a pivotal role in enabling development. The energy sector's centrality is clearly demonstrated by the fact that natural gas is by far the most important source of income for Myanmar.

The Required Enabling Environment

Based on an assessment of Myanmar's current energy challenges, a series of New Energy Architecture insights have been drawn. These offer a vision for how Myanmar can deliver on its objective of crafting an energy architecture that better meets the goals of the "energy triangle": achieving economic growth and development to provide energy access and security in an environmentally sustainable fashion.

Figure 1: Overview of insights mapped to the New Energy Architecture's four pillars of an enabling environment



In formulating these insights, some urgent short-term needs are apparent:

1. The creation of a governance structure that underpins the long-term development of the sector in line with appropriate energy sector reforms and a roadmap for the same.
2. The provision of energy to supply essential goods and services to rural communities, turn the wheels of commerce and industry, and ignite the economy by ensuring energy efficiency and expanding energy supplies. This should be done by constructing new sources of generation, transmission and distribution networks, and large-scale infrastructure to improve power supply to metropolitan areas. For rural areas, small-scale hybrid renewable systems and off-grid renewable systems should be constructed.
3. The development of an energy sector that supports Myanmar's long-term growth.

The Role of Stakeholders in Creating Enabling Environments

The creation of an enabling environment that is resilient to risk and responsive to the imperatives of the energy triangle is beyond the scope of an individual corporation or government. Research on New Energy Architecture has shown that five key groups of stakeholders have a role to play:

1. Government, to create a stable policy and regulatory framework to facilitate change
2. Industry, to drive implementation through innovation and investment
3. Small-scale and local private sector, to provide goods and services and empower rural communities
4. Civil society, to build greater transparency and public support into the system
5. Donor and development partner institutions, to provide technical expertise, comparative experience and finance

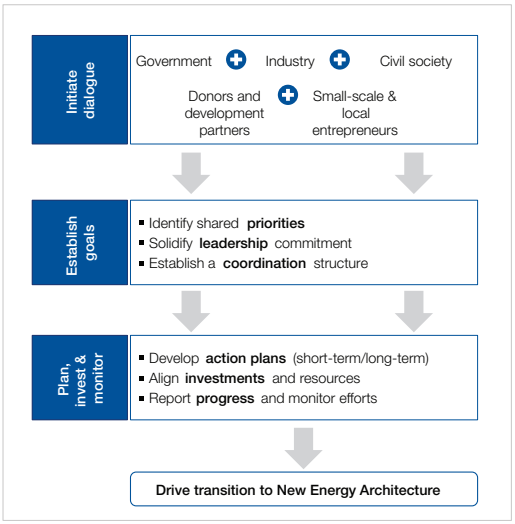
Orchestrating a broad-based, systemic transformation can be extremely challenging. By definition, an ambitious transformation requires stakeholders to go beyond business as usual, acting outside of traditional roles and structures and collaborating in new ways to create coalitions to meet the New Energy Architecture challenge.

Different bodies should therefore work together to create integrated resource plans. Where this does not take place, conflicting objectives and interests among policymakers, unclear ministerial responsibilities and insufficient coordination between the institutions involved can result in delays in the transition to a New Energy Architecture.

Based on discussions in Myanmar, stakeholders should seek to take the following steps to drive the transition to a New Energy Architecture:

- Take a more inclusive, collaborative approach
- Establish multistakeholder partnership platforms
- Build clear and consistent policies
- Communicate effectively with the public

Figure 2: New Energy Architecture partnership platforms[9]



Principles

- Dialogue is facilitated by a neutral body
- Each stage in the platform is multi-stakeholder
- Platforms are led by local champions

Next Steps

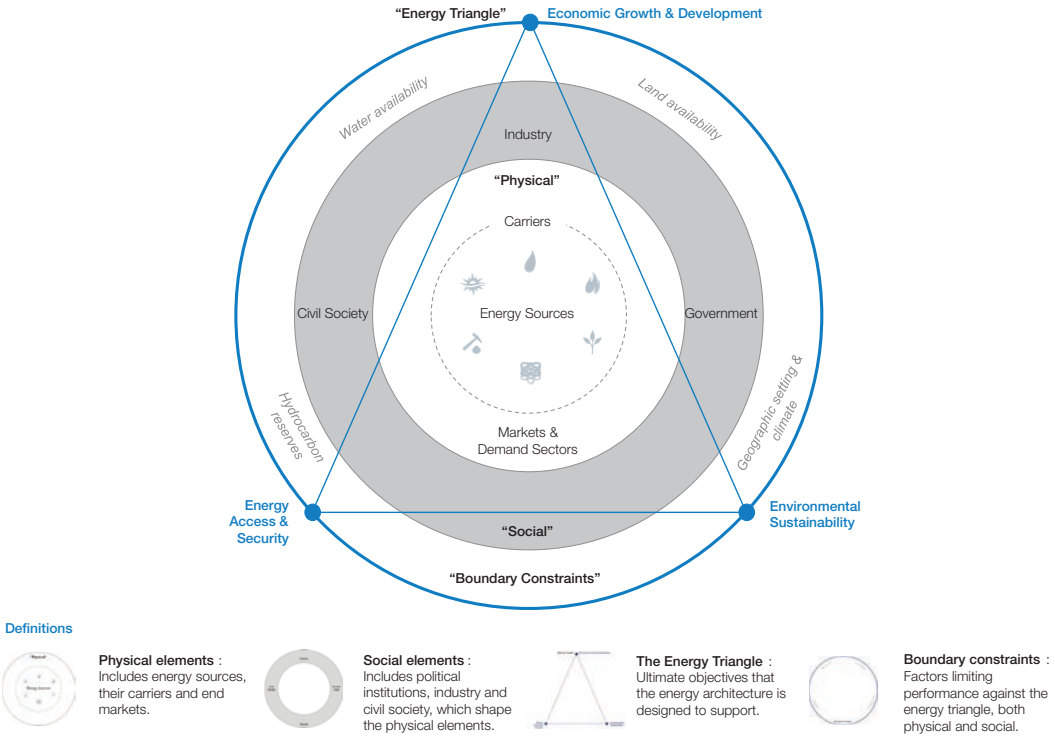
This report recommends that stakeholders in Myanmar review the highlighted insights in order to lay out a prioritized roadmap for the creation of a New Energy Architecture. To execute this roadmap, stakeholders need to demonstrate leadership to implement these insights and, where appropriate, form multistakeholder working groups to maintain the momentum of the government's reform agenda. The World Economic Forum, the ADB and Accenture will continue to seek to assist in this process

A Methodology for Managing an Effective Transition[10]

Energy concerns are sometimes described as a "triangle" of imperatives relating to the economy, the environment and energy security.[11] To be effective, energy architecture should be designed with these imperatives in mind, but a set of "boundary constraints" may limit their full achievement.[12]

Energy architecture is defined as the integrated physical system of energy sources, carriers and demand factors shaped by government, industry and civil society. Figure 3 provides an overview of the complex interactions involved. The implication is that a systems-based approach should be taken to manage change in the energy system.

Figure 3: Energy architecture conceptual framework



In recent years, decision-makers have been grappling with the transition to a more affordable, sustainable and secure New Energy Architecture. In response, the World Economic Forum and Accenture have developed a methodology to help manage this transition more effectively. The methodology consists of four steps:

Step 1 – Assessing current energy architecture performance: This assessment is completed using the Energy Architecture Performance Index (EAPI),[13] a composite indicator that considers economic development, energy security and environmental sustainability. This assessment is intended to help countries monitor the progress of their transition, and guide policy and investment decisions.

Step 2 – Setting new energy architecture objectives: A vision for a more sustainable, secure and affordable New Energy Architecture is based on three inputs – the strengths and weaknesses of the current energy architecture performance identified through the EAPI; a series of interviews and workshops with stakeholders across the energy value chain; and existing targets and action plans created by the relevant national authorities.

Step 3 – Defining the enabling environment: An enabling environment consists of four pillars – policy initiatives to put in place the rules, price signals and risk-return incentives that attract investors and facilitate development; technology and infrastructure to address specific challenges in a country or at a stage of the value chain; market structures enabling producers to meet consumers' needs efficiently; and human capacity to drive change and develop solutions. Interviews are used to identify the enabling environments that should be put in place, with the suggestions further tested through multistakeholder workshops.

Step 4 – Introducing areas of leadership: The ultimate output is the creation of an action plan that details the relative roles of government, industry and civil society in creating an enabling environment for the transition.

Figure 4: Introducing areas of leadership: The ultimate output is the creation of an action plan that details the relative roles of government, industry and civil society in creating an enabling environment for the transition.

	1. Assessing current energy architecture performance	2. Creating New Energy Architecture objectives	3. Defining the enabling environment	4. Defining areas of leadership
	The Energy Architecture Performance Index	An archetype approach	The four pillars of an enabling environment	Key considerations for stakeholders
Key question	• How is energy architecture currently performing?	• What are the objectives for a New Energy Architecture?	• What enabling environment will achieve transition objectives?	• Who is responsible for implementing enabling environments?
Activity	a) Understand current energy architecture b) Select KPIs to assess current and historic performance	a) Highlight energy architecture challenges b) Identify New Energy Architecture objectives	a) Create an enabler "toolkit" that highlights the potential actions that can be taken to accelerate the transition b) Map enablers to transition objectives	a) Develop high-level action plan for steps to be taken by government, industry, the finance community and civil society to shape the transition

In the sections that follow, this four-step process is applied to Myanmar.

Step 1: Assessing Current Energy Architecture

1. Introduction

The following section analyses the current make-up of the country's energy architecture, along with the impact of increasing ASEAN integration, taking the supply and demand perspectives.[14]

Institutional structure and governance

The Ministry of Energy is principally responsible for the oil and gas sector. It has oversight of three state-owned enterprises:

- Myanmar Oil and Gas Enterprise (MOGE): Created in 1963, it is responsible for oil and gas exploration and production, as well as domestic gas transmission through a 2,488 km onshore pipeline network.
- Myanmar Petrochemical Enterprise (MPE): It operates three refineries, five urea fertilizer plants and a number of other processing plants.
- Myanmar Petroleum Products Enterprise (MPPE): It is responsible for retail and wholesale distribution of petroleum products.

The other ministries involved in the energy sector are:

- Ministry of Electric Power (MOEP), which is responsible for hydropower, thermal power, and transmission and distribution. These areas of responsibility were previously split between two ministries, which merged in 2012. Within MOEP, there are three operational entities – the Myanmar Electric Power Enterprise (MEPE), which is responsible for the transmission network and gas-fired power plants; the Yangon City Electricity Supply Board (YESB), which is responsible for the supply of electricity to consumers in Yangon; and the Electric Supply Enterprise (ESE), which is responsible for the supply of electricity to consumers in the rest of Myanmar.
- Ministry of Environmental Conservation and Forestry (MOECAF), which is responsible for fuel wood, climate change, and environmental standards and safeguard requirements but not social ones.
- Ministry of Agriculture and Irrigation (MOAI), responsible for biofuels and micro-hydropower for irrigation purposes.
- Ministry of Science and Technology (MOST), responsible for research and development related to renewable energy technologies.
- Ministry of Mines (MOM), responsible for coal production.
- Ministry of Industry (MOI), responsible for energy efficiency and off-grid rural energy access (it contains the Rural Energy Supporting Development Committee), as well as approving electrical connections for businesses and industries (this may change with the approval of the new Electricity Law).

A National Energy Management Committee (NEMC) and an Energy Development Committee (EDC) were also created in early January 2013 to strengthen coordination and planning among the energy sector's institutions. The NEMC is a minister-level committee and sits under the Vice-President No. 2. It is responsible for formulating energy policy and plans in coordination with other key energy-related ministries. The EDC, composed primarily of deputy ministers, is broadly responsible for implementing the policies and plans of the NEMC. The NEMC Secretariat is composed of staff seconded from the energy-related ministries, and the office functions under the Ministry of Energy. Currently, the Deputy Minister for Energy is supervising its daily schedule.

Figure 5: Ministry of Energy institutions[15]

Source: Ministry of Energy

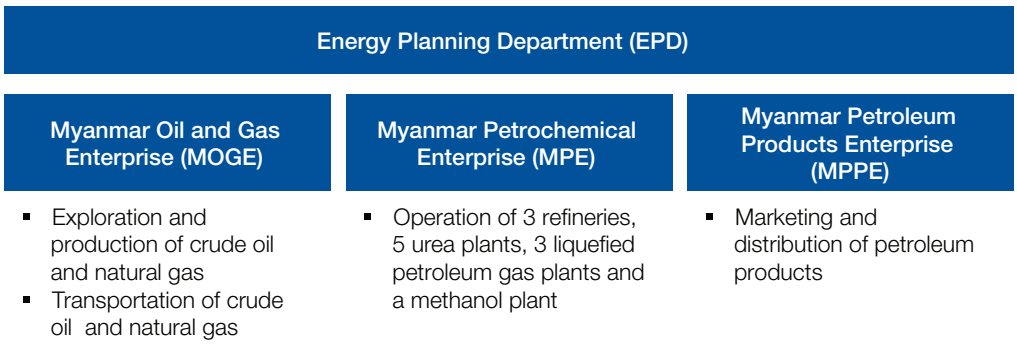
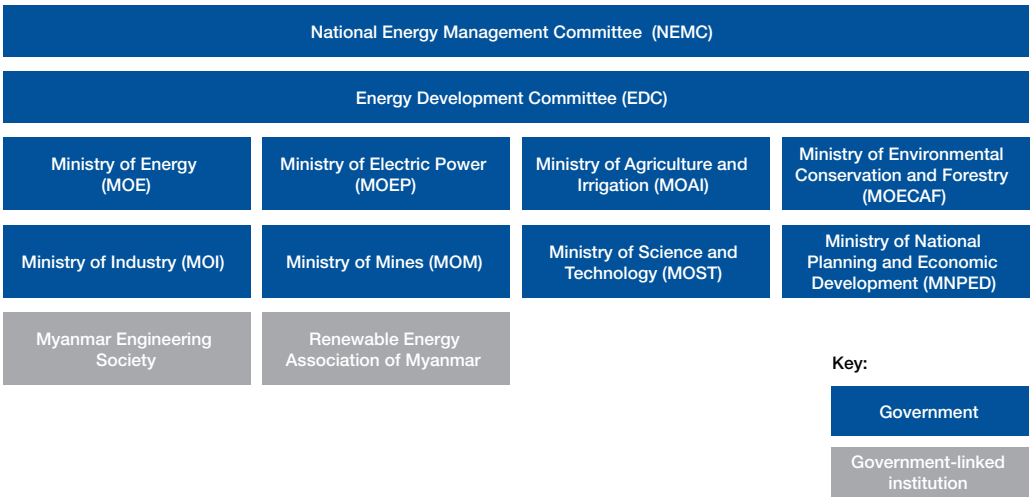


Figure 6: Wider energy-related government institutions[16]

Source: Myanmar Government notification 12/2013 dated 9 January 2013



Energy Supply

Key Points

- Traditional biomass meets 75% of Myanmar's primary energy supply, followed by gas (10%) and crude oil (6%).
- Fuel wood harvested from natural forests makes up 90% of traditional biomass and this poses a threat to environmental sustainability.
- Myanmar holds natural gas reserves of 7.8 trillion cubic feet, and current gas production is centred on the Yadana and Yetagun fields.
- Foreign companies are increasingly taking an interest in oil operations, with 75 expressions of interest received for tenders released in January and April 2013.
- Coal production has risen significantly, with 0.065 million metric tons (approximately) being produced in 1998 and 1.4 million tons in 2011.
- Wind, solar and biomass energy hold great potential, but only hydropower is being commercially exploited at present. The Ministry of Electric Power has identified 300 potential hydropower projects with a combined capacity of 46,331 megawatts.
- Total power consumption in Myanmar was 6,312 gigawatt-hours in 2011, with coal and gas plants running far below full capacity owing to poor infrastructure and maintenance.

Figure 7: Myanmar's total primary energy supply, 2010[17]

Source: Accenture Analysis, IEA

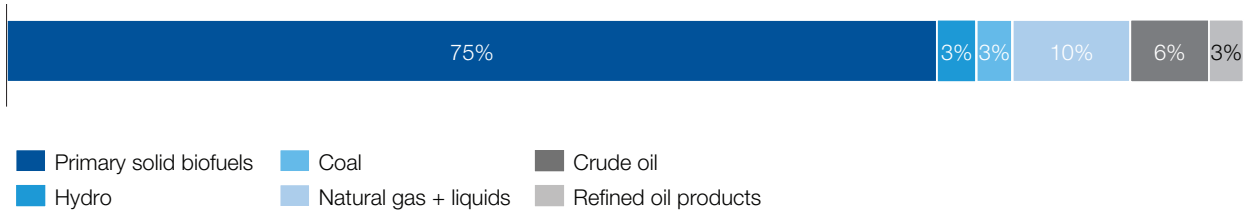


Figure 8: Energy balance in thousand tons of oil equivalent (KTOE), 2010[18]

Source: Accenture Analysis, IEA

Flow	Primary solid biofuels	Hydro	Coal	Natural gas + liquids	Crude oil	Gasoline (all types)	Jet fuel/ Kerosene	Gas/ Diesel oil	Fuel oil	Petroleum coke	Other oil products	Total
Production	10535	439	409	10219	927	0	0	0	0	0	0	22530
Imports	0	0	0	0	0	57	33	149	0	0	0	239
Exports	0	0	0	-8879	0	0	0	0	0	0	0	-8879
International marine bunkers	0	0	0	0	0	0	0	-3	0	0	0	-3
International aviation bunkers	0	0	0	0	0	0	-19	0	0	0	0	-19
Stock changes	0	0	0	0	-43	34	15	113	8	2	3	130
TPES	10535	439	409	1340	884	91	29	259	8	2	3	13997

TPES: Total Primary Energy Supply

Biomass

Myanmar has a biomass-centred energy architecture. Wood alone met 62% of all primary energy consumption needs in 2008,[19] more than five times the second most significant source, crude oil and petroleum products. Biomass accounts for approximately 75% of total primary energy supply. This dependence on biomass is largely because approximately 70% of the population lives in rural areas.[20] Households receive about three-quarters of national energy supply (76%), followed by transport (10%), industry (8.3%) and agriculture (2%).[21]

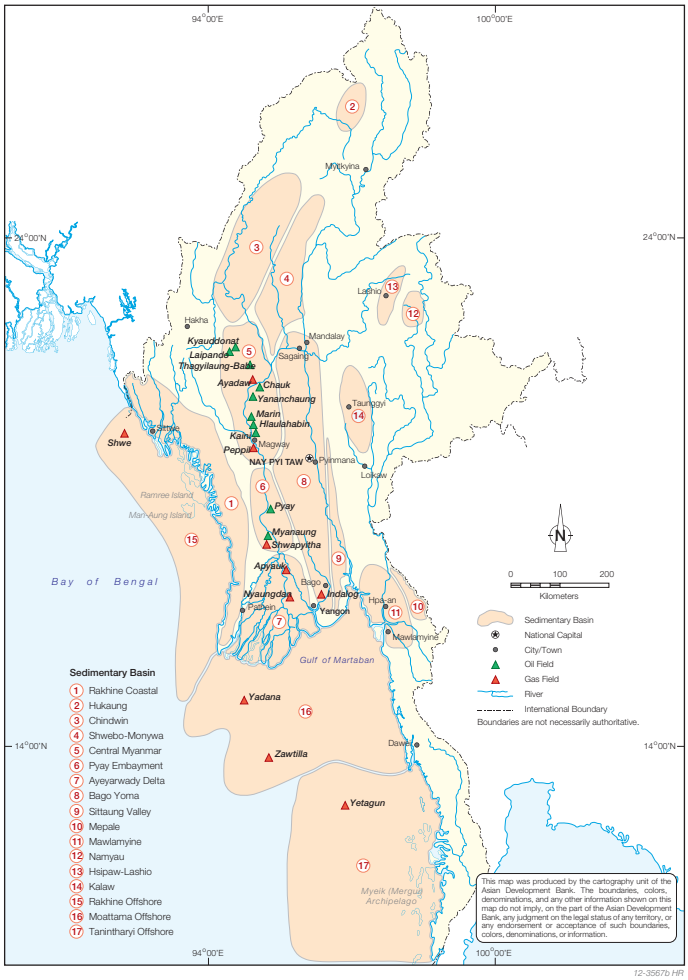
Of the total biomass-sourced energy, over 90% is fuel wood, most of which is harvested from natural forests. As a result, threats to Myanmar's environment have already emerged, despite relatively low economic growth rates of the past. Although deforestation is primarily driven by unsustainable harvesting, illegal logging and the export of timber, fuel wood is still a significant factor contributing to deforestation. The 2012 National Environmental Performance Report produced by the ADB reveals the acceleration of forest destruction since 1990, averaging around 400,000 hectares annually.[22] The scale of dependence on biomass is therefore not only an energy access issue, but also raises concerns about widespread environmental degradation.

Hydrocarbons – Upstream

Myanmar is one of the world's oldest oil producers, having exported its first barrel in 1853. Today, 16 foreign companies are working on 17 onshore blocks and 15 foreign companies are involved in exploration or production on 20 existing offshore blocks, all in partnership with the state-owned Myanmar Oil and Gas Enterprise (MOGE). The foreign companies include Total and Chevron, who cooperated in a venture that pre-dated western sanctions in the early 2000s and which gave rise to further agreements.

In 2011, the MOE offered 18 onshore blocks for bidding and awarded eight of these to foreign firms. In January 2013, the MOE put up a further 18 onshore blocks for tender, and another 30 offshore blocks in April 2013.[23] The rounds have attracted significant interest, with over 75 letters of interest submitted for the onshore blocks. Competitive bidding is expected to stimulate an even higher level of interest in the offshore blocks before 14 June 2013. Initially, the government planned to offer these rounds in September 2012 but they were delayed to ensure that the tendering of exploration contracts was transparent and up to international standards. The government expects at least another 20 offshore blocks to be offered by the end of 2013.

Figure 9: Overview of Myanmar's oil & gas blocks and infrastructure



Myanmar's oil production is limited to onshore production and is estimated to have reached a crude and natural gas liquid (NGL) production of 935 kilotons of oil equivalent (KTOE) in 2010.[24] The majority of this production is from fields based in the Salin sub-basin, specifically the Mann field operated by MPRL. As part of the wider reform process, Myanmar is hoping to boost oil production to meet growing demand.

Hydrocarbons – Downstream

The Myanmar Petrochemical Enterprise (MPE) runs the country's three oil refineries in Chauk (6,000 barrels per day, or BD), Thanbayagan (25,000 BD) and Thanlyin (20,000 BD), with a total nameplate capacity of 50,000 BD.[25] However, the refineries are old and average utilization rates are low at 41%. During interviews, stakeholders highlighted that the government is considering a joint venture with a foreign company for the Thanlyin refinery in a bid to improve operations. MOE will also build a new refinery near Mandalay with a capacity of 20,000 BD to process crude oil from the Myanmar-PRC oil pipeline in 2014. Other downstream facilities include five urea fertilizer factories using natural gas with a total capacity of over 2,000 metric tons per day and three liquefied petroleum gas (LPG) plants with a total capacity of 42-50 million cubic feet per day (mmcfd).

The abundance of Myanmar's hydrocarbon resources has made it a significant regional supplier of energy, (mainly to Thailand and the PRC, but current decisions will limit the expansion of its regional role to existing contracts as discussed further below). The country has proven natural gas reserves of 7.8 trillion cubic feet (TCF),[26] and exports totalled 303 billion cubic feet (BCF) in 2011. The majority of Myanmar's production is accounted for by two offshore fields: Yadana (5.7 TCF) and Yetagun (3.16 TCF), which were the source of 95% of Myanmar's total gas production in 2011.[27] Both fields have

been supplying natural gas to Thailand since 2000, with 755 mmcfd coming from Yadana and 424 mmcfd from Yetagun.

In 2004, Daewoo announced the discovery of the Shwe gas field, off the coast of Rakhine state. Purchasing rights were awarded to the PRC in June 2008, under an agreement to export 6.5 TCF over 30 years. These supplies will be moved overland to Southwest PRC via an 870 km gas pipeline running from Kyaukphu to Muse in Myanmar before entering the PRC at the border city of Ruili in Yunnan Province. The pipeline is scheduled for completion in late 2013 at an estimated cost of US$ 2.01 billion. South-East Asia Pipeline (SEAP) Company Limited, a Hong Kong-registered entity created by China National Petroleum Company (CNPC), and the Shwe Consortium members are in charge of constructing and operating this onshore pipeline.

PRC's CNPC will construct a crude oil pipeline parallel to the gas pipeline at a cost of US$ 2.25 billion,[28] which should be complete by the end of 2013. The crude oil pipeline will be 771 km and will stretch into Yunnan and eventually into Chongqing in PRC. The pipeline will transport oil from the Middle East and Africa to south-western PRC. The project also involves the construction of a new deep-water crude unloading port and oil storage facilities on Myanmar's Maday Island. CNPC controls a 50.9% stake in the pipeline through its wholly-owned subsidiary, SEAP. MOGE controls the remaining 49.1%. SEAP will be responsible for the construction and operation of the pipeline, while Myanmar's government will provide security.[29]

The Ministry of Mines has identified 33 major coal deposits with estimated reserves of some 488.7 million tons although only 1% of this has been confirmed. Coal production has increased significantly over the past 15 years, with approximately 0.065 million metric tons being produced in 1998 and 1.4 million tons in 2011.[30] This growth is set to continue given the country's large potential reserves and increasing demand for coal, primarily for export to neighbouring countries such as PRC. However, coal demand is unlikely to increase domestically as new coal plants are expected to use imported coal, because other than coal located near the Bangladesh border; Myanmar coal tends to be of an inferior quality. Mines are open-cast, and environmental issues would need to be addressed.

Renewables

Myanmar has significant renewable energy potential from hydropower, modern biomass, wind and solar power. At present, however, only hydropower is being commercially exploited while other forms of renewable energy remain at the research and development or pilot stages. In 2010, total net generation of renewable electricity was 5.054 billion kilowatt-hours.[31]

The MOEP estimates Myanmar's hydropower potential from the four main river basins – the Ayeyawaddy, Chindwin, Sittaung and Thanlwin – at more than 100,000 megawatts (MW),[32] of which the MOEP has identified over 300 large-scale hydropower project locations with an estimated capacity of approximately 46,331 MW.[33] In contrast, Myanmar's installed hydropower capacity is only 2,520 MW.[34] Myanmar's monsoon climate creates a problem for its hydroelectric power: energy capacity is significantly reduced or even eliminated altogether during the dry season, which normally runs for four months from December through March.

MOAI is considering the production of biofuels as a substitute for gasoline and diesel consumption. This consideration is given even after the unsuccessful Jatropha Plantation Project, in which jatropha plantations failed due to low yields and weak implementation. The Myanmar Chemical Engineers' Group has constructed four biofuel plants with a total annual production of 1.95 million gallons. In addition, the Myanmar Economic Cooperation has supervised the commercial operation of two plants since 2008 with a combined capacity of 1.8 million gallons per year. In determining the role for biofuels, Myanmar's policymakers must consider the possibility of biofuels competing with food production and ensure there is no conflict with food if biofuels are pursued.

Wind and solar energy are in the early stages of research, development and experimentation. At least three wind projects are currently operating, while two Chinese companies undertook feasibility studies in 2011 to conduct further investigation into the potential development of 4,032 MW of wind energy. Pilot projects have been run for solar energy, and the MOST has helped to ensure that research continues into harnessing solar energy in rural areas without access to the national grid system. Solar energy is being introduced in a limited way through photovoltaic cells which are used for battery-charging stations and water pumping.

Geothermal energy has considerable potential for commercial development in Myanmar. A total of 93 sites have been identified, with 43 having been tested. Moreover, in 2007, a tidal power plant was installed, in a barrage style, and a similar project was subsequently implemented.

ADB has identified the following barriers to future development of renewable energy resources: (i) absence of a transparent institutional and legal framework for exploration, development and deployment; (ii) limited financial capacity to support research and development (R&D), market-based investment and physical infrastructure; (iii) lack of human resource capacity; and (iv) subsidized power and petroleum prices.

Power generation

Myanmar's total electricity consumption was 6,312 gigawatt-hours (GWh) in 2011. In theory, the country has more than adequate capacity to deal with peak loads. However, inadequate maintenance, lack of investment to upgrade gas and coal power plants, and poor compression in gas pipelines has meant that gas and coal-fired plants are operating at a significantly lower level than their potential capacity. Hydropower plants suffer similar limitations. During the dry season from December to March, they receive insufficient water to generate at full capacity. The grid, therefore, experiences significant load shedding of up to 500 MW during the dry season. If no new generation capacity is added in 2013, load shedding may need to increase to between 800 MW and 1000 MW in 2014. The network also suffers from high transmission and distribution (T&D) losses, and conductors and transformers are overloaded, resulting in high system losses (27%). This is largely due to poor maintenance of the T&D systems and extensive theft.

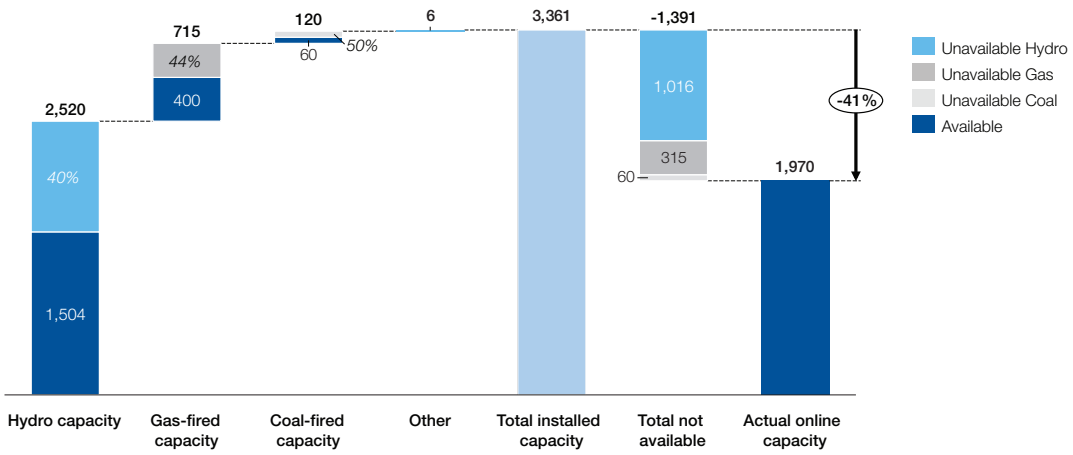
Figure 10: Hydropower resources in Myanmar[35]

Source: Ministry of Electric Power

Capacity	Number of Potential Sites	Potential Capacity (MW)
Less than 10 MW	210	231.25
Between 10 MW and 50 MW	32	806.30
More than 50 MW	60	45293.00
Total	302	46330.55

Figure 11: Total installed and available generation capacity (in MW) [44]

Source: Myanmar Energy Sector Initial assessment. Asian Development Bank. 2012, ADB estimates



Energy demand

Key Points

- 70% of Myanmar's 60 million population live in rural areas and 74% lack access to energy. Yangon is by far the largest city, with 4.6 million inhabitants; of these, only 67% are connected to the grid.
- The road network covers 130,000 km, and is the primary mode of transport. However, there are only 18 vehicles per 1,000 people in Myanmar, compared with 480 in Vietnam and 350 in Thailand.
- The railway network has grown very slowly in the last decade and suffers from historical underinvestment.
- Industrial activity constitutes 26% of GDP, double the level in 1965. The contribution of services has dropped from 52% in 1965 to 38% in 2010. These rates are very low and will need to be increased to create economic growth.
- Agriculture constitutes 36% of GDP, and is the source of 25-30% of export value.

Households

Myanmar has a population of 60 million, of which 70% live in rural areas where average electrification rates are 16%.[45] The two largest cities, Yangon and Mandalay, have a combined population of 5.6 million, of which 4.6 million reside in Yangon. Average electrification rates are 67% in Yangon and 31% in Mandalay. Population figures, however, are estimates, and there has been no official census for the last two decades. The United Nations Population Fund (UNFPA) is supporting Myanmar to conduct a population and housing census according to international standards, which has been proposed for 2014. However, the estimated rates of electrification are a clear illustration not only of how limited electricity access in Myanmar is, but also of the disparity between rural and urban communities.

Transport

Myanmar's total road network of 130,000 km is the primary mode of transport for the country. There are only 18 vehicles per 1,000 people in the country, compared with 250 in Indonesia and 370 in Thailand.[46] The density of the road network also lags behind regional neighbours, at 40 km per 1,000 km compared with 480 in Vietnam, 350 in Thailand, 200 in Cambodia and 60 in Laos People's Democratic Republic. In light of recent reforms, there has been a boom in car ownership. This boom will have an impact on the demand for petroleum products, which are mainly imported from countries such as Singapore.

The railway network has significant room for improvement. With limited expansion in the 12 years up to 2010, growing from 2,000 km to 3,500 km of track, the network suffers from historical underinvestment. And despite a significant increase in the total volume of freight, the railways carried the same volume – around 3 million tons – in 2011 as in 1993.

The port in Yangon and eight coastal city ports – four on the west and four on the south-east coast – are all under the supervision of the Myanmar Port Authority. The facilities at the eight ports are basic, mostly pontoon-based, and there are no mechanized handling facilities.[47]

Industry

As industrial development in Myanmar is limited, industrial demand for energy is relatively low. In 2010, industrial activity contributed 26% of GDP, double the level in 1965. The government's goal in its Fifth Five-Year plan is to increase this to 32% by 2015. In the same period, the contribution of services dropped from 52% to 38%.[48] Without higher levels of domestic energy demand from these sectors, the country will struggle to build an integrated and expanded energy plan.

Heavy industry and construction are relatively small sectors of the economy and have experienced a lack of investment. However, Myanmar's abundance of relatively cheap labour holds out the prospect of growth in some aspects of manufacturing. The bulk of manufacturing is connected with processing of agricultural crops, timber and other commodities. However, the garment industry is already well-developed and contributed to 17% of export revenue in 2000 prior to the imposition of US sanctions.[49] It could offer initial gains in employment, per capita income and revenue from export to the nearby markets of PRC, Thailand and India while other areas of industry undergo longer, more capital-intensive development.

Agriculture

The agricultural sector is a key segment of Myanmar's economy, accounting for 36% of output, the majority of the country's employment, and 25-30% of exports by value. In 1965, agriculture contributed 35% of GDP, a level that was relatively unchanged in 2010 at 36%.[50]

Production from areas under rice, beans, sesame seed and vegetables has increased significantly between 1990 and 2010. Encouragingly, some crops saw production increase faster than the area planted, pointing to enhanced yields. The area under rice, for example, nearly doubled in this period, while production nearly tripled.[51]The slow but steady rise in productivity towards the levels seen in Vietnam, despite challenges including a lack of irrigation facilities, points to considerable potential for future growth.

Livestock production is largely carried out by small households rather than in commercial operations. It contributes around 7.5% to GDP, and includes the rearing of cattle, buffaloes, pigs and poultry. It also offers significant potential for expansion.

2. Myanmar's Current Energy Architecture Performance

The principal analytical tools of the New Energy Architecture Initiative are the Energy Architecture Performance Index (EAPI), quantitative data gathering exercises, interviews and multistakeholder dialogues as well as research. Myanmar was not included in the EAPI 2013 because of a lack of quantitative data. Thus, the following analysis of its performance across the energy triangle is primarily based on a qualitative investigation.

Economic growth and development

The true size of the Myanmar economy is unknown, but reasonable estimates indicate that it remains very small in the global context. The IMF's 2013 forecast estimate places GDP at US$ 57.4 billion.[52]

Myanmar's population is far less prosperous than its regional counterparts. In 2011, annual income per head (at market exchange rates) was approximately US$ 900, a figure that compares unfavourably with US$ 5,000 in Thailand, US$ 1,400 in Vietnam and US$ 5,300 in PRC.[53] Although these official levels may not fully account for real purchasing power given the considerable role of an informal business sector operating outside an institutionalized framework, the size of the discrepancy is a clear indicator of Myanmar's relative poverty. Moreover, utility subsidies have inhibited the growth of the energy sector by keeping prices below the cost of production.[54] Slow growth in energy production and distribution is bound to negative affect the growth of other areas of the economy.

The ADB, however, is optimistic about Myanmar's prospects for growth. It has estimated that if Myanmar is able to follow the same development path as its neighbours, the country could grow at 7-8% per year every year for an extended period. The government is also targeting an average annual GDP growth rate of 7.7%.[55] At these growth rates, GDP per capita could reach US$ 2,000-3,000 by 2030, more than three times the current level, propelling Myanmar into the ranks of middle-income countries.[56] Indeed, since the reforms were initiated, GDP growth has accelerated to an estimated 6.3% in the financial year 2012 (ended 31 March 2013) compared with an average of 5% in the previous five years.[57]

The energy sector will be a key enabler for wider economic development. According to the Statistical Yearbook 2011 of the Ministry of National Planning and Economic Development, a total of 104 investment enterprises have been approved by the Myanmar Investment Commission for the oil and gas sector as of 31 March 2011, totalling US$ 13.8 billion in investment. Natural gas became the top export item in 2001 and has accounted for approximately 40% of the total exports in recent years. During 2013, two large gas fields, Shwe and Zawtika, are expected to come online and will double existing levels of production, raising exports to the PRC and Thailand. Although these are significant developments, very limited value-adding activity is associated with these industries. A lack of infrastructure, limited processing facilities and the inadequate presence of heavy industries mean that foreign direct investment (FDI) into the oil and gas sector is of little consequence to employment.

Environmental sustainability

A country endowed with natural and energy resources, Myanmar is in an optimal position for green, resilient, and environmentally-sustainable development.[58] The country is located within the Indo-Burma biodiversity hotspot and the Greater Mekong Subregion, considered to be one of the world's richest reservoirs of plant and animal life.[59] Natural energy resources are among Myanmar's most important assets, and are viable sources of growth for the country if properly and sustainably managed.[60]

However, Myanmar's current demographic and economic growth pattern presents enormous challenges, among which include large population growth, rapid industrialisation, increasing consumption and demand for natural resources for the production of food, trade and energy.[61] These economic pressures also continue to challenge the integrity of Myanmar's physical environment and availability of natural resources, resulting in land degradation, dwindling forest resources, threats to biodiversity, poor management of water and energy resources, poor waste management, and air pollution from mobile sources.[62]

For example, deforestation is exacerbated because a large number of Myanmar's population rely on traditional biomass for their energy, although key drivers are sustainable harvesting and illegal logging for timber export. The 2012 ADB national environmental performance report shows that since 1990, Myanmar has lost about 400,000 hectares of forest a year.[63] Thus, Myanmar's dependence on traditional biomass is an issue for energy access while also being a contributor to environmental degradation. Oil and gas extraction is highly sensitive from the environment point of view – construction of pipelines through pristine ecosystems can cause irreparable damage. Hydropower facilities have also been criticized for the environmental impacts of damming large reservoirs, inundating ecosystems and affecting the wildlife or endangered species. The construction of all forms of power plants has environmental impacts, and use of fossil fuels is a major factor for climate change.

Challenges affecting one resource are interlinked with negative externalities for other resources. In Myanmar, land-water linkages have a deep impact on the energy sector. Soil susceptibility to erosion (caused by deforestation and slash-and-burn cultivation near watersheds) appears to be the single largest factor in land degradation,[64] which affects availability and access to source biomass, biofuels and fuel wood. Sedimentation associated with rapid deforestation,[65] annual precipitation, and available water resources affect efficient hydropower development.

Worth adding to this list of environmental challenges are the irreversible impacts of climate change. Myanmar's low adaptive capacity and vulnerability to environmental shocks such as droughts, floods and extreme weather conditions are expected to increase in frequency and intensity as a result of climate change.[66] The Berlin-based climate watchdog, Germanwatch, ranked Myanmar as the second-worst country affected by extreme weather events caused by climate change from 1990 to 2008.[67] The report also ranked Myanmar as the globe's worst-hit country in 2008 – in early May of that year Cyclone Nagris devastated the Irrawaddy delta and resulted in deaths of more than 130,000 people and economic damage estimated at US$ 4.1 billion.[68] The 2009 monsoon in Myanmar was reportedly shorter than usual, bringing lower than average rainfall in central regions, but torrential rain and severe localized flooding in the southern parts of the country.[69] A global vulnerability index marks Myanmar among the top 30 countries at "extreme risk" of climate change impact when considering constant exposure to climate-related natural disasters, sea level rise, human sensitivity, available infrastructure and the adaptive capacity of the government.[70]

Although there is currently no national policy target for climate change measures, Myanmar has made international commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the related Kyoto Protocol, which Myanmar ratified in 2003. However, without adequate environmental and social safeguards, climate change mitigation and adaption policies, and energy efficiency regulations, Myanmar's power and energy sector will continue to be vulnerable to environmental challenges.

Energy access and security

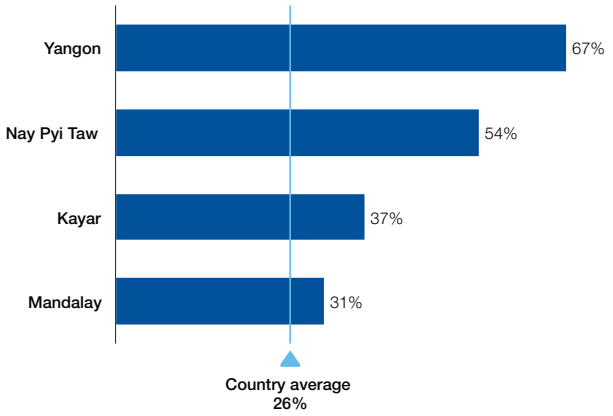
In 2011, approximately 26% of the population had access to grid-connected electricity while a corresponding 74% did not. Myanmar had the ignoble distinction of having the largest percentage of

population without access to electricity in Asia.[71] However, large differences exist in the electrification rates between income groups and across states. In 2011, Yangon had the highest electrification rate of 67%, followed by Nay Pyi Taw (54%), Kayar (37%) and Mandalay (31%).

However, with rural electrification rates averaging 16%, the challenge of supplying electricity is huge. People in these areas rely on off-grid sources such as fuel wood and kerosene. In such areas, off-grid mini and micro hydropower, wind and solar energy systems could help meet basic energy needs while reducing traditional biomass usage, thereby enabling access to new forms of services and technologies to enhance people's well-being.

Figure 12: Myanmar's electrification rates [72]

Source: Myanmar Energy Sector Initial assessment. Asian Development Bank. 2012



Of those with access to power, supply is intermittent at best. During the dry season, neighbourhoods in the lower socioeconomic areas of Yangon receive as little as one hour of power per day, while those in wealthier districts receive six hours followed by 12 hours off. Over the last four years, electricity production has increased at an annual growth rate of 14.7%, from 6,622 million kilowatt-hours (kWh) in 2008-09 to an estimated 10,000 kWh in 2011-12. However, despite the higher 2011-12 output, estimated consumption in Myanmar is only about 160 kWh per capita, compared with 250 kWh per capita in Bangladesh (in 2009).[73]

Planned investments focusing primarily on hydroelectricity will only add 617 MW of capacity, amounting to a growth rate of less than 5% per year. Growth in demand, however, is expected to be double or triple this rate, pointing to a severe deficit in production. Even if electricity output doubled every five years (a 15% annual rate, similar to Vietnam's), it would take five years just to meet today's needs. In that time, demand would have grown by 12% a year.[74]

A similar problem exists with respect to natural gas. In the financial year 2011, domestic gas demand was 400 mmcfd and expected to increase to 700 mmcfd by 2013. Supplies in the current period are expected to be 300 mmcfd short, meaning that less than half the domestic demand for gas is being met. The gas currently produced is used for 10 gas-fired electricity plants (60%), fertilizer manufacture (12%) and production of compressed natural gas (10%).[75] In the future, Myanmar could undertake a gas rationalization plan based on what new gas resources are likely to come on-stream and prioritize the use of gas domestically. In addition, appropriate gas pricing could also be introduced to reflect the true cost of supply.

3. Myanmar in the Regional Context

Myanmar has significant internal energy access challenges. Yet it plays an important role in regional energy security. This contradiction provides an example of the choices that have to be made between the three components of the energy triangle. The prior military government made decisions that prioritized government revenue from oil and gas notionally for economic growth and development, at the expense of providing energy access and security for vast numbers of its people. This extreme export-oriented energy strategy left many Myanmar people literally in the dark due to a lack of natural gas for domestic purposes. The prior government pursued this policy to earn much-needed foreign exchange, which it could not obtain elsewhere on account of the economic and trade embargo. The current government has changed this emphasis and export is not expected to be a priority beyond existing contracts. Going forward, Myanmar will be exploring ways and means to add value prior to any export of gas. For oil, if the private sector handles the rehabilitation of the refineries, domestic crude could be put through them to produce petroleum products.

Most notably, Myanmar currently affords the PRC the opportunity to transport oil and gas by pipeline, thereby bypassing the sea route via the Malacca Strait. Located between the two economic giants of the PRC and India, which are together home to 2.5 billion people, Myanmar acts as a land bridge between South and East Asia. The Myanmar-PRC gas and oil pipeline projects are therefore very important. Saudi Aramco has signed a Memorandum of Understanding (MOU) with CNPC to supply crude oil through this pipeline. In addition to the existing pipelines, these two pipelines that the CNPC is constructing will open another route for the PRC's oil and gas imports – adding to the existing Malacca Strait ocean shipments and the Sino-Kazakhstan, Sino-Pakistan and Sino-Russian pipelines. This project is expected to transfer 22 million tons of crude oil annually through the pipeline, accounting for approximately 10% of the PRC's total oil import in 2010.

The Myanmar-PRC pipeline is expected to generate a significant amount of revenue for Myanmar. In accordance with international practice, a 16% value added tax will be levied on the crude oil transported through the pipeline, raising US$ 900 million (excluding the transport tariff) in foreign exchange earnings each year. A further US$ 900 million annually is expected to arise from the sale of natural gas to the PRC over the next 30 years, bringing the total revenue generated by the project to US$ 1.8 billion each year.[76]

Myanmar is also playing an important role as a source of natural gas to Thailand. Myanmar exports approximately 1,205 mmcfd of natural gas from the Yadana and Yedagun fields to Thailand via a 670 km pipeline. The Zawtika field, expected to start producing gas at the end of 2013, will add an additional 240 mmcfd of export volume to Thailand.[77]

Lastly, Myanmar is indicating it will play an important role in the ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-15. Myanmar will take over the ASEAN Chairmanship in 2014, which will require it to play a particularly important role in leading ASEAN towards the ASEAN Economic Community (AEC) due to be established by 2015.[78] The key energy component of the AEC is the ASEAN power grid and the ASEAN gas pipeline, each of which seeks to connect all 10 ASEAN countries through infrastructure. The current Myanmar government has stated that "it will give priority to building infrastructure projects that will fill the missing links identified in the Master Plan of ASEAN connectivity."[79]

In focus: Regional power trade in the Greater Mekong Subregion (GMS)

Energy cooperation in the Greater Mekong Subregion (GMS) began as part of the ADB's GMS Economic Cooperation Programme (GMS Programme) launched in 1992. The GMS aggregates Cambodia, Laos People's Democratic Republic (Laos), Myanmar, Thailand, Vietnam, and the Guangxhi Zhuang Autonomous Region and the Yunnan Province of the PRC. It aims at fostering regional cooperation to contribute to growth and poverty reduction and to address the provision of public goods. Energy was identified at the inception of the GMS programme as one of nine areas of subregional cooperation.

The subregion is well endowed with energy resources, including 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. But these energy resources are unevenly distributed throughout the GMS. In view of sharing the benefits of the subregion's diverse energy resources and of optimizing supply to meet varying demand profiles across the region, GMS energy cooperation has been focused on regional power trade and grid interconnections from the beginning.

Since their 1999 Policy Statement on Regional Power Trade, the GMS members have consistently affirmed the principles of cooperation, gradualism and respect for the environment. All of them recognize that regional power trade will develop in phases and that a regional market will need to evolve through institutional strengthening of reforms and infrastructure development that is conscious of energy security and sustainable environmental and social impacts. Therefore, the framework for developing the GMS power market has taken a phased approach, building on cross-border interconnections associated with power exports and bilateral power purchase agreements.

Prior to 1992 and the existence of the GMS Programme, the only significant cross-border power transmission in the subregion existed to export hydropower from Laos to Thailand. Some low voltage lines also connected certain areas in Laos to Thailand and separately to Cambodia, distributing power to remote border regions. In 2010, total electricity trade in the GMS was approximately 34,139 gigawatt-hours (GWh). Thailand is the largest importer at 6,938 GWh, comprising hydropower purchased from Laos. Laos, Myanmar and the PRC are the region's net exporters, with Laos exporting the largest volume and offering the most competitive price. Competitively priced electricity from Laos and PRC has helped Thailand and Vietnam meet their large and rapidly growing demand. Likewise, Cambodia can access more affordable electricity (given its own higher production costs) from its GMS neighbours. Moreover, remote border regions of Cambodia, Laos and Vietnam have benefitted from accessing cross-border power supply from neighbouring countries. Overall, electricity access has roughly doubled from about 37% on average in 1994 to around 69% in 2009, mostly benefiting remote rural populations.

Major institutional milestones are expected in moving forward with regional power trade in the near future. At the 19th GMS Ministerial Conference (MC), four members signed an MOU for the establishment of a Regional Power Coordination Centre (RPCC), and other two countries are expected to sign it soon. Previously received bids for hosting the RPCC headquarters will be opened for consideration shortly, while the Articles of Association are continuously discussed. The RPCC will be an independent, neutral organization with a legal personality that will oversee the efforts to harmonize power programmes, system operations and regulatory frameworks in the GMS towards a well-coordinated regional power market. Simultaneously, the pipeline of regional energy cooperation projects, having undergone several review sessions throughout 2013, will be endorsed at the 19th MC for implementation under the new GMS Strategic Framework (2012-2022) to build more blocks for the regional grid while enhancing modern energy access to remote areas. The reopening of Myanmar, which has a large potential for hydropower and natural gas production would provide another opportunity for promoting regional power trade in the subregion.

Significant progress has been made for GMS regional power trade through a two-pronged approach to developing the market, comprising a policy and institutional framework and physical interconnections. However, more efforts should be made by the GMS members themselves to realize the full benefits of synchronous operations for individual countries and the entire GMS subregion. There is a need to (i) reduce national investments in the power reserves maintained to meet peak demand; (ii) provide a more reliable supply of electricity, including from an interconnected network in case of power failure; (iii) reduce operational costs; (iv) reduce greenhouse gas (GHG) emissions and other pollutants; and (v) increase consumer access to the cheapest and most environmentally-sustainable source of electricity in the subregion.

The ADB serves as the secretariat for the GMS Programme and actively supports regional power trade and efforts to establish a regional coordination centre. GMS energy cooperation benefits highly from the participation of other international agencies and bilateral donors, including the World Bank, the Swedish International Development Agency, the Australian Agency for International Development, and Agence Française de Développement.

Step 2: Setting New Energy Architecture Objectives

Based on the assessment of Myanmar's current energy architecture challenges outlined in Step 1, the following New Energy Architecture objectives have been set to form a vision of how Myanmar can create an energy architecture that better meets the goals of the energy triangle:

1. Effective and transparent governance of institutions
2. Investment frameworks to enhance energy efficiency and supply
3. Strategies for generating long-term value

In formulating these insights, some urgent short-term needs have been kept in mind:

1. The creation of a governance structure that underpins the long-term development of the sector in line with appropriate energy sector reforms
2. The provision of energy to ensure access to essential needs and services to rural communities, as also to turn the wheels of commerce and industry and ignite the economy while ensuring energy efficiency and greater energy supplies. This should be done by constructing new sources of generation, transmission and distribution networks, and large-scale infrastructure to focus on metropolitan areas. For rural areas, small-scale hybrid and off-grid renewable systems should be built
3. The development of a sector that supports Myanmar's long-term growth

Achieving the wider aims of the energy triangle is by no means straightforward. The government and key stakeholders must be prepared to take tough decisions as outcomes are traded off against each other. The important challenges this paper brings to the fore follow.

Renewable energy – Investing in renewable energy is vital to ensure Myanmar develops a sustainable and environmentally clean energy system. It should be a top priority even though investment in renewables may provide less electricity in the short term than the development of hydrocarbon resources. Myanmar has significant potential for the development of hydropower, biofuels, solar and wind power, but these are currently at an early stage of development. Renewable energy projects have relatively high upfront costs but low operational costs because the fuel is free. The government will have to seek out strategic public-private partnerships with the private sector, civil society, NGOs and other entities that have greater experience and superior technologies.

Energy access – Investing in energy access solutions is vital to ensuring development in Myanmar. With 74% of the population without access to energy, and the overwhelming majority of these people living in rural areas, the delivery of energy services to them will require a focused and sustained commitment by the government. While some increase in energy access is likely when supplies are expanded and large-scale T&D infrastructure is built, the government should seek out innovative and strategic off-grid solutions for this primarily rural problem through partnerships with firms, civil society, multilateral organizations and other entities.

Increasing the proportion of energy production dedicated to domestic use – Ensuring that Myanmar obtains an adequate proportion of its natural gas, oil and hydropower to satisfy domestic demand is essential. Domestic demand for energy is not currently being met by supply, both because of limited access to electricity in rural areas and because poor maintenance means many plants are running under capacity. However, expanding domestic provisions may mean that the country must forgo some export revenue. In addition, financing the development of domestic infrastructure will require a deep initial investment, necessitating public-private partnerships.

Removing subsidies – Myanmar should move towards a gradual removal of energy subsidies, which mainly take the form of electricity and utility subsidies. Not only do these comprise considerable government expenditure, they also contribute to the failure to incentivize the development of a leaner energy sector. Removing subsidies would encourage companies to produce, develop and distribute energy in a more efficient way. However, prices will rise as a result, and the government will be faced anew with the challenge of protecting the poorest in society against unaffordable energy costs and securing their access to electricity. The removal of subsidies is also likely to provoke a political reaction among citizens. Thus, the government needs to prepare for slow and sequenced removal of indirect subsidies, together with a clear, transparent and well-reasoned public explanation of why the subsidies need to be removed. It must invite public consultation in advance of the removal of any subsidies.

Liberalizing the energy market and promoting PPPs – Myanmar should allow foreign companies entry into Myanmar and offer appropriate terms and conditions for business to ensure incentives for investment, while also meeting Myanmar's development needs. To ensure a level playing field, a crucial part of inviting foreign investment is the development of a transparent legal system while ensuring that the terms and conditions embedded in any contract offered to private investors are of mutual benefit. Thus, foreign companies will introduce new technologies into Myanmar and invest in long-term projects. In time, foreign investment will help bridge the gap between domestic supply and demand, will allow competition to drive down prices and will afford the government a steady stream of revenue. However, this must be traded against a considerable degree of cultural and political adjustment, which the government is already starting to make.

Figure 13: Overview of insights mapped to the New Energy Architecture's four pillars of an enabling environment:

	Policy initiatives	Technology & infrastructure	Market structures	Human capacity
1. Effective and Transparent Governance and Institutions	●	●	●	●
1.1 Create an integrated energy plan (IEP)	●			
1.2 Establish institutions and frameworks to deliver the Integrated Energy Plan	●			●
1.3 Strengthen public participation and support, and improve energy literacy	●			●
1.4 Strengthen regulatory framework for environmental and social standards	●			
1.5 Increase transparency of extractive industries and implement Extractive Industries Transparency Initiative (EITI)	●			
1.6 Strengthen the capabilities of Myanmar Oil and Gas Enterprise and consider the appropriate National Oil Company model	●	●	●	●
2. Investment Frameworks to Enhance Supply and Efficiency				
2.1 Reform energy subsidies	●		●	
2.2 Establish energy efficiency standards and regulations	●	●		
2.3 Expand rural energy access	●	●	●	●
2.4 Develop a clear vision and legal framework for private investment	●		●	
2.5 Create an investment framework and reform state enterprises to expand domestic energy supply	●		●	
2.6 Assess power generation options and integrate these into a power development plan	●	●	●	
2.7 Strengthen transmission and distribution networks		●		
3. Strategies Generating Long-term Value				
3.1 Assess options for building local industry				●
3.2 Improve human capacity within energy sectors				●
3.3 Identify "green growth" opportunities	●	●		
3.4 Strengthen the macroeconomic environment	●		●	●

"Four Pillars" of an enabling environment

- **Policy initiatives**
- **Technology & infrastructure**
- **Market structures**
- **Human capacity**

Step 3: Defining the Enabling Environment

The following insights may help Myanmar chart an effective transition to a more diversified, efficient and integrated energy architecture. Although by no means exhaustive, these recommendations are explored in more detail below.

1. Effective and Transparent Governance and Institutions

Insight 1.1: Create an integrated energy plan

Myanmar should immediately establish a comprehensive integrated energy plan (IEP) to guide expansion and development of the sector. A number of people spoken to expressed their belief that the rather ad hoc management of the wave of change that the reform process is creating needs replacing with a clearer prioritization and sequencing of reforms. The Myanmar energy sector has weak institutional capacity and a lack of reliable data, making comprehensive planning difficult. Myanmar needs to develop an IEP in collaboration with all stakeholders to provide a clear vision and send the appropriate signals to investors and civil society of the government's intentions and resolve. Assuming the reform process continues successfully and GDP growth is maintained at 7-8%, an IEP will also help the government address key development challenges, including the question of the appropriate energy mix to satisfy Myanmar's increasing demand for energy.

The IEP should be developed following a further consultative process with all stakeholders similar to that initiated in the production of this report. However, based on the work thus far, the following elements could be included as a starting point for further discussion.

Overview
- Energy sector contribution to Myanmar's overall national development policy and plan
- Vision for a sustainable energy sector (Myanmar's energy sector vision is to develop a sustainable energy sector that would ensure secure, affordable and reliable supply of high-quality energy services for urban and rural homes, businesses, industries and the transport sector, while contributing to Myanmar's export earnings.)
- Overall energy sector targets (namely universal service by 2050, energy efficiency target, renewable energy target)

Myanmar's Energy System
- A framework for a National Energy Policy
- Myanmar's energy needs (an overview of energy needs of end-users – urban and rural households, commerce and industry – identified through a consultative process
- Current energy scenario in Myanmar
- Future energy trends and challenges (including short-, medium- and long-term supply and demand forecasts for each energy source)

Myanmar's Energy Sector Platform
- Institutional and sector governance
- Energy subsidy policy
- Energy efficiency and conservation policy (by sector)
- Renewable energy and waste policy
- Rural electrification
- Power sub-sector policy
- Petroleum sub-sector policy
- Natural gas sub-sector policy
- Coal sub-sector policy
- Energy and environment sub-sector policy

Myanmar's Cross-cutting Energy Sector Implementation Strategies
- Environmental and social safeguards
- Capacity development
- Multistakeholder consultation and engagement
- Ethnic minority consultation
- Public-private sector partnerships
- Regional cooperation and integration

Each energy sector policy could include: targets, goals, development plans and outlooks for each energy source; an overview of the institutional and regulatory environment across the value chain; an overview of legislative reforms; and an outline of key programmes, projects, strategic plans and implementation.

For the power sector, the IEP should adopt an integrated resource planning approach. The government should consider the combined development of supply- and demand-side efficiency options to provide energy services at a minimum cost, including environmental and social costs. It could do this by evaluating energy efficiency options on equal terms with supply-side options, building environmental and social costs into the energy roadmap, and factoring in risks and probabilities. Planning involves stakeholder consultation and hence encourages a more rigorous process. An important component of the plan is its flexibility, ensuring it can adapt to unforeseen circumstances and external factors. In order to meet this need, the government should ensure a system-wide plan that incorporates a number of factors including long-term supply and demand forecasting for energy sources and sets of development options and scenarios. Although initial electricity forecasts have been updated in the last year, there are no long-term forecasts available for other energy sources such as oil and gas, nor are there any consumer studies to understand the end use of energy. These will be issues that depend on, among other things, the effective collection of data.

Indeed, long-term planning requires relevant, reliable and timely information. While the Ministry of Energy and others involved in the energy sector do have the capacity to develop quantitative data about the energy sector, statistics are not produced in line with internationally accepted standards and methodologies, leading to

an inability to measure baselines and improvements. To produce an IEP, statistical capabilities across ministries would therefore need to be bolstered. In addition to devising an IEP that includes a full spectrum of measures and tools, the NEMC should use the opportunity of the upcoming census to ensure that steps are taken to collect more detailed data on energy consumption and usage. These actions will enable the government to create a portfolio of relevant indicators to monitor the current situation, prioritize areas for improvement, and monitor the success or failure of their actions.

Insight 1.2: Establish institutions and frameworks to deliver the Integrated Energy Plan

Myanmar should establish an appropriate legislative and institutional framework to deliver on the IEP. This will require updated and revised versions of the Electricity Act and the Petroleum Act, a new Energy Act, new rules and guidelines on social and environmental impact assessments, as well as environmental quality standards issued under the new Environmental Conservation Law of 2012.

As of March 2013, the NEMC has asked every relevant energy ministry to develop new laws, rules and regulations to update and modernize the country's current legal framework. The NEMC intends these laws to be integrated into a new overarching Energy Act. Additionally, ADB is currently working with the MOEP on revising a new Electricity Act. Institutional changes, however, may be more challenging to effect, and will require action in three different areas:

1. Streamlining the ministries involved in the energy sector and clarifying their respective roles
2. Educating and empowering civil servants at all levels
3. Improving coordination between central and regional governments

1. Streamlining the ministries involved in the energy sector and clarifying their respective roles

Seven ministries are currently involved in the energy sector (see Step 1) and in several subsectors it is unclear which ministry has overall responsibility. Energy efficiency and renewable energy are two such areas, and unsurprisingly, limited progress has been made in these.

To tackle these issues, the government could define the scope of each ministry's responsibilities and ensure that effective lines of communication exist between them. In addition, the government could establish dedicated bodies to deal with specific sub-sector issues, such as renewable energy expansion and energy efficiency. Here, it could take the lead from the Ministry of Energy of Thailand, which created a Department of Alternative Energy Development and Efficiency, or the Government of Indonesia, which established a Directorate General of New and Renewable Energy.

2. Educating and empowering civil servants at all levels

Energy sector governance is currently limited by the bureaucracy, which has installed a rigid hierarchy. Lower levels of administration are not afforded the opportunity to take initiative on matters of energy policy. At the same time, when the senior leadership communicates policies, subordinates may not fully understand, and may not seek clarification. This creates a state of bureaucratic inertia, which is a common problem during times of major policy change.

The limitations of the hierarchical system have been further reinforced by the custom of "a-na-de": the unwillingness to embarrass the leadership by bringing bad news, or causing someone to be uncomfortable. As long as the administration refuses to be proactive in carrying out organizational change, tangible results from reforms will remain elusive. Firstly, organizational restructuring will require the careful assessment of existing regulations, procedural audits to identify and remove red tape, and the adoption of new methods to streamline processes. Secondly, technical assistance and training programmes for civil servants would be needed to empower civil servants and improve decision-making within the government.

3. Improving coordination between central and regional governments

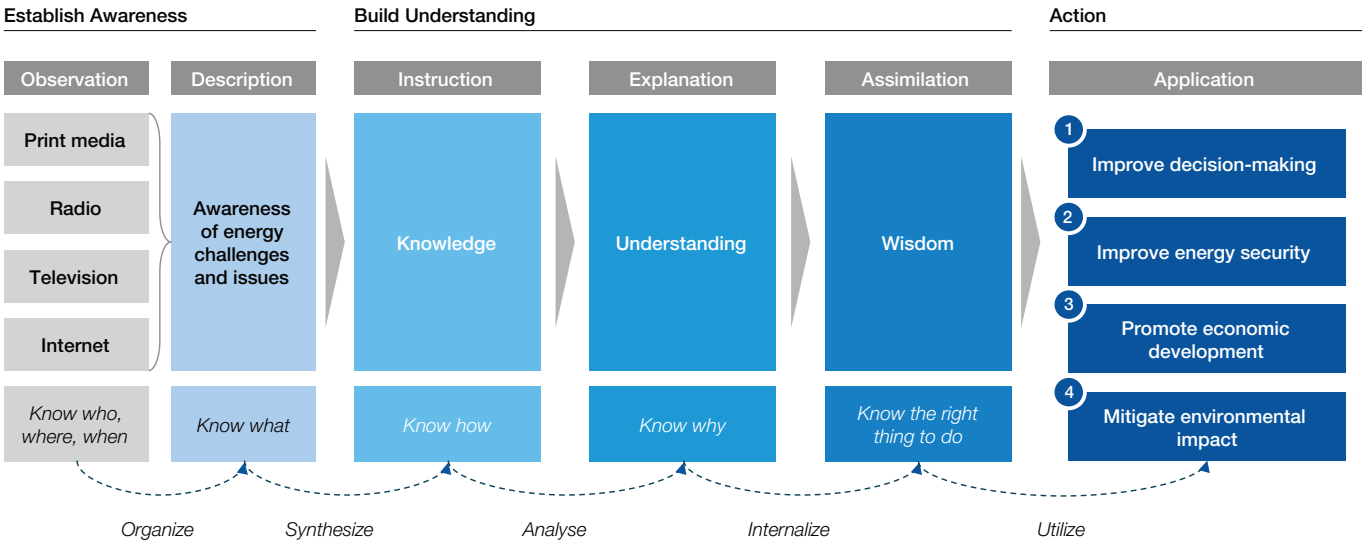
The states and regional governments have a degree of autonomy from the central government and are permitted to put forward potential projects. The national government then determines whether they require technical assistance, and whether the projects need to be financed by aid, grant or loan. As part of this process, the MOE has been advising the local and regional governments on creating sectoral development plans, which can then be built up to a national development plan. At present, however, it is unclear whether this process is functioning, and a number of stakeholders have expressed concerns that regional governments simply do not have the capabilities to deliver even in consideration of their newly-created budgets.

Insight 1.3: Strengthen public participation and support, and improve energy literacy

A pivotal aspect of the energy reforms will be the improvement of energy literacy throughout Myanmar and the development of a clear consultation and communications strategy. Stakeholders should be consulted and empowered to participate in key processes surrounding energy sector decision-making, including development of the IEP and related legislation. Some stakeholders have cautioned that garnering the understanding and support of the public could be a long drawn-out process, since the general public are new to the idea of democracy. Nevertheless, ensuring democratization of energy sector decision-making by providing sufficient information to the public and consulting them in advance of any major decisions is a task of utmost importance. Moreover, actually consulting with energy users on all aspects of the energy sector, in particular in relation to rural energy, will be key to ensuring that new projects and developments serve their needs. Effective government leadership and suitable energy literacy campaigns could mobilize changes in behaviour across government, the private sector and civil society.

A useful framework to help understand the need and to plan for a clear consultation and communication strategy is the "hierarchy of knowledge". The government needs to act as a catalyst to take the general public from a simple awareness of energy-related issues, through gaining an understanding of the key energy challenges and opportunities the country faces, to acting upon their understanding, expressing their views and participating in the decision-making process, as well as changing their behaviour.

Figure 14: Energy literacy and the hierarchy of knowledge[80]



Two policy areas that would benefit greatly from improved energy literacy among the public are the current electricity subsidies and the development of energy-efficiency measures.

1. Electricity subsidy regime: Stakeholders have commented that the current government is wary of removing blanket electricity subsidies. It fears the public would respond with the same political unrest that occurred when it liberalized petroleum products and removed their subsidies. This is a common worry among government ministers, but is an issue that could be mitigated by an effective consultation and communications strategy. A clear energy literacy campaign could inform decision-makers about the public's greatest concerns so that they can design the withdrawal of subsidies accordingly and educate the public on the benefits of the withdrawal, which include the increased availability of funds to relieve the burden on the poorest sections of society. It is hoped that such a campaign could help to roll out the phased withdrawal of subsidies in the long term.

2. Energy efficiency: There is a need to change the general public's energy use by instilling the recognition that energy is a scarce, valuable resource. Again, a clear communication strategy and campaign to promote energy literacy and opportunities to save energy will help change behaviour. That, in turn, will help minimize the imbalance between supply and demand through improved demand management and will build efficiency into the design of Myanmar's new energy architecture.

Insight 1.4: Strengthen regulatory framework for environmental and social standards

As Myanmar continues to open up, a remarkable opportunity exists to use domestic energy resources to power the country's development, but it is essential that strong, enforceable environmental and social standards and safeguards are established.

Developing strong standards for environmental and social impact assessments (EIA and SIA) of energy projects and institutionalizing the consultation and approval process will be very important for Myanmar for several reasons. First, it will give the government, local communities and the broader civil society effective tools and better information on crucial impacts of energy sector projects and hence an improved basis for decisions. Second, it will give investors more clarity on what environmental and social dimensions need to be considered and addressed for large-scale energy projects. Third, it will streamline the process and likely lead to higher public acceptance of projects while reducing process-related costs for all stakeholders. Standards can build on international best practices.

Currently the ADB and the Japan International Cooperation Agency (JICA) are supporting development of environmental safeguards and standards which are not, however, addressing indigenous peoples and involuntary resettlement.

Mitigating negative environmental impacts, clear local benefits and community involvement in the development of large-scale energy infrastructure is of central importance to the successful delivery of such projects. Community involvement should not stop simply at the public's awareness of these projects, but should extend to their part in decision-making. President U. Thein Sein recently elaborated on this objective when he called for the public to act "as a driver, as opposed to a group that is just consulted".[81] The government's commitment to a "people-centred approach" points to the need for a greater understanding of the social and environmental impact of energy infrastructure projects.

In 2012, Myanmar passed a very broad environmental framework law, the Environmental Conservation Law, prepared by the Ministry of Environmental Conservation and Forestry (MOECAF). The law is ambitious in stipulating that every company doing business in Myanmar must carry out an EIA and an SIA, but does not give details of the standards to be used as a measure of these assessments. Nor does it outline the process for consultation and approval. Rules and regulations for EIA and SIA must therefore be developed. However, while environmental assessments are the responsibility MOECAF, the new law also refers to the need to conduct social assessments, and it is unclear which ministry should assume responsibility for establishing those standards. Thus, while ADB is currently working with MOECAF to develop new EIA procedures, guidelines and related environmental quality standards, work on social standards and assessments, which may apply to indigenous peoples and to any project-related resettlement, has not yet started.

The responsibility of drafting the environmental procedures that govern how the assessments will be implemented lies with the MOECAF, which will be supported by the ADB through the Greater Mekong Subregion Environment Operations Centre (EOC). Together, they will work to ensure that the finalized rules are consistent with the Environmental Conservation Law. The Environmental Conservation Rules, which the ADB and the EOC helped finalize, were submitted to the Office of the President in early March 2013. EIA procedures prepared by the EOC are currently being finalized to incorporate feedback from a just-completed inter-ministerial review. Until the new laws are approved, interim EIA and SIA policies and regulations, as well as capacity-building measures to implement them, will be necessary as FDI in Myanmar continues to rise.

The new Law of Foreign Investment also sets the requirement for EIAs for most development activities, not just large-scale or environmentally sensitive projects, and will need to be visited with the same scrutiny. This requirement should also be linked to the rules currently under way.

The importance of completing SIAs and EIAs was brought into sharp focus when President U. Thein Sein suspended work on the Myitsone hydropower dam following public protests. The US$ 3.6 billion Myitsone project, which was being constructed by a Chinese company, had been the subject of widespread protests in Kachin state as well as across Myanmar when work was ordered to stop on 30 September 2011, pending the result of the 2015 elections. The decision was conveyed in a letter read out in the upper and lower houses of the legislature in which the President cited "public concern" as the reason for suspending the project. The Myitsone incident highlights not only the strength of views among different sections of society within Myanmar, but also exposes the absence of an effective means for the government to assess civil society reaction to the impacts of infrastructure projects.

Insight 1.5: Increase transparency of extractive industries and implement Extractive Industries Transparency Initiative (EITI)

An essential requirement for the transition to democracy is the need to increase transparency across all industries. Enhancing transparency reduces the risk of corruption, improves the flow of business information and restores trust among stakeholders – whether government, private businesses, NGOs or civil society. Indeed, various private sector stakeholders have commented that improved transparency would enable them to make better decisions and increase the likelihood of investment. One potential foreign investor said they felt they were "operating with a blindfold on" when evaluating investment in the country and that it is very difficult to know how decisions are made or what the evaluation criteria for tenders are.[82] Given this, it is unsurprising that Myanmar currently ranks 172nd out of 176 countries on Transparency International's Corruption Perception Index.[83]

One clear example of the urgent need to improve transparency comes from the oil and gas sector. Gas sales from the Yadana and Yetagun fields earn the government US$ 2 billion annually, a figure that had been driven by the government's expressed need to raise finances while sanctions were in place.[84] However, the manner in which those revenues have been transferred and used remains unclear. While the international oil companies (IOCs) involved deposited their profit-sharing payments into a government account in Thailand, the flow of money from there is unknown to external stakeholders.

The government can take a positive step to address the issue of transparency in the extractive industries including oil, gas and mining by signing up to the Extractive Industries Transparency Initiative (EITI), a process that is currently under way. The World Bank and the Government of Australia are helping Myanmar prepare to meet EITI standards through aid programmes. The government has stated that it hopes to submit an application by the end of 2013 and the President is said to be personally very committed to EITI.[85]

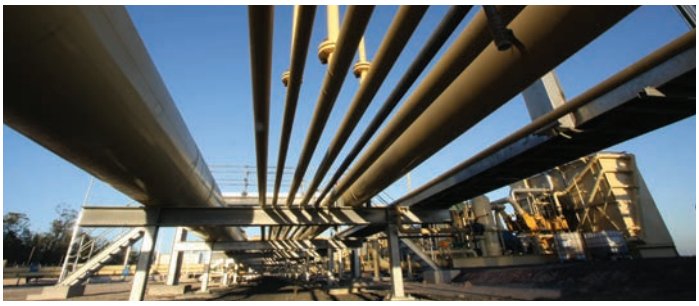
Several issues surrounding the implementation of EITI are still outstanding in spite of the government's commitment. Some local stakeholders have commented that movement on the initiative is slow. There is also a lack of clarity of what the government intends to submit by the end of the year, including details as to which industries will be covered by EITI and what groups and parties will form a multistakeholder group to oversee implementation of the initiative. Government sources confirmed that the country would enter into EITI but also commented that the process would take time as the government wanted to take care to implement the initiative properly.

In focus: Signing up to EITI[86]

As outlined in the EITI Rules, a country applying for EITI Candidate status must meet the following five sign-up requirements:

1. The government must issue an unequivocal public statement of its intention to implement EITI.
2. The government must commit to work with civil society and the private sector to implement EITI.
3. The government must appoint a senior individual to lead on implementation of EITI.
4. The government must establish a multistakeholder group to oversee implementation of EITI.
5. The multistakeholder group, in consultation with key EITI stakeholders, must agree on and publish a fully-costed work plan, containing measurable targets, a time frame for implementation and an assessment of capacity constraints.

When a country considers it has met these five requirements, it may submit a candidature application to the EITI Board. If the board finds that the requirements have been successfully met, the country will become an EITI Candidate country.



Insight 1.6: Strengthen the capabilities of Myanmar Oil and Gas Enterprise (MOGE) and consider the appropriate National Oil Company (NOC) model

The energy sector, arguably Myanmar's most valuable asset, and in particular MOGE, the national oil and gas company, will be a primary test case for increasing transparency. MOGE's expertise lies in onshore operations, which are run by its own technical staff. It has limited experience of offshore operations, and, according to some stakeholders, lacks the technical capabilities required to review the field development plans drawn up by IOCs. MOGE was described as capable and even "extremely innovative" in running its onshore fields, given the challenges it faces, of which three were consistently highlighted:

1. Lack of financing: MOGE faces considerable capital constraints, making it increasingly difficult for it to take on the operatorship of new blocks.
2. Poor technical equipment: MOGE's capital constraints mean that its equipment, ranging from seismic surveying to drilling and lifting, is largely substandard. Substandard equipment often results in drilling programmes taking longer than they should, becoming uneconomical in the process.
3. Lack of human capacity: MOGE struggles to retain its experienced people, since its salaries are low in comparison with those offered by service providers and IOCs. This brain drain is difficult to avert since MOGE must be run in accordance with the MOE wage structure.
4. Positive steps have already been taken to tackle these challenges. This year, for the first time, MOGE created its own budget and this should provide it with greater control over financial decision-making, despite the Ministry of Finance remaining responsible for making budget allocations. The NEMC and MOE should further consider what the most appropriate NOC model for MOGE is to make it a stronger driver of economic growth for the country.

In focus: How have NOCs evolved to meet pressure from governments, global commodity markets and rising consumption levels, and what lessons can MOGE learn from this?

Summary

To meet growing pressures for change, MOGE's model must evolve by:

- Defining its commercial and political objectives separately and building a governance structure around those objectives
- Building strategic alliances to harness the capabilities of IOCs and other NOCs, and promoting transparency to attract FDI
- Investing for the long term in Myanmar's legal and financial institutions and providing education within the country
- Becoming more autonomous and financially strong over time

Introduction

Over the last 50 years, NOCs have dominated the global control and supply of oil and gas. Typically, NOCs have been owned by national governments, very responsive to political policies and focused on domestic operations. These characteristics have presented unique challenges in recent decades as NOCs have come under growing pressure to respond to:

- Rapidly increasing domestic and global demands for oil and gas
- Global price volatility, which has encouraged commercial development but has potential negative effects on export markets
- Pressure from governments seeking to extend control over other commercial entities via NOCs and to promote higher rent-collecting
- Geopolitical motivations to extend political influence or form strategic political alignments
- Environmental pressure to extract, refine and use resources sustainably

These factors have driven many NOCs to evolve in three main ways: by addressing the governance structures of NOCs, including reshaping their overall objectives and channels of communication between management and stakeholders; by developing partnerships with IOCs in order to gain access to new technology and markets in pursuit of commercial viability; and by seeking to address their roles as custodians of national resources and contributing to the sustainable economic development of their home countries. The entirely state-owned Malaysian NOC, Petronas, provides one example of a company that has addressed all of these issues in the course of its successful evolution and can offer insights to MOGE as it sets out on its next phase of development.

This is how it may do so:

a. Optimize Governance Structures

As state-owned enterprises, NOCs maintain two potentially conflicting aims: to meet political needs and develop commercial viability. They have developed three main tactics to better serve both of these ends:

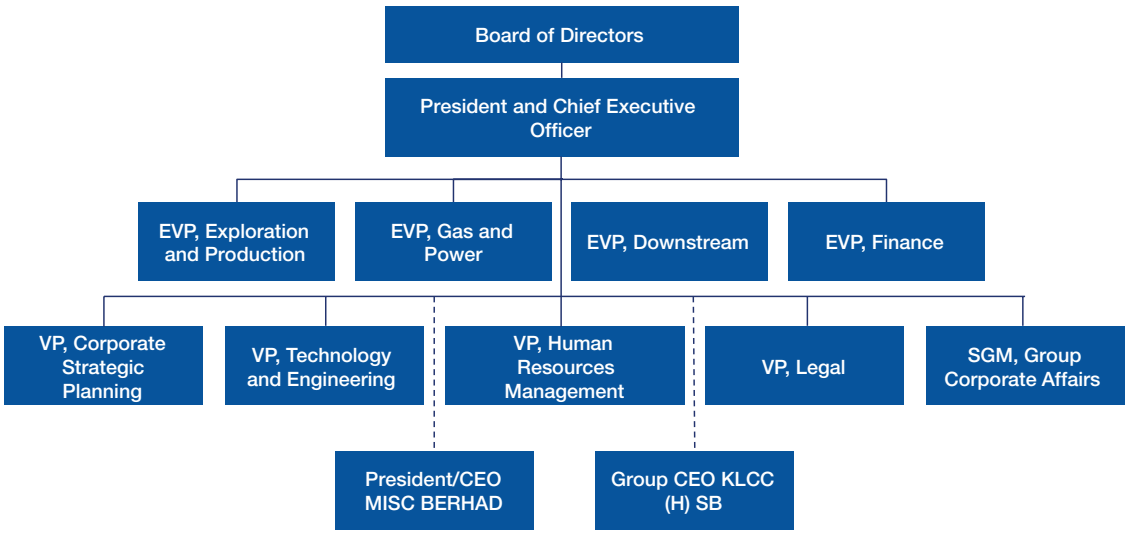
1. Clearly defining political and commercial objectives and the scope of each objective
2. Incorporating the political and commercial perspectives into the organizational structure
3. Clearly spelling out the scope of responsibilities between management structures and the channels of communication between them

Petronas is one example of a company that has developed its commercial and political objectives and offers a full policy statement in its annual reports. Its governance structure has been developed to represent these two-fold aims, with a mixed Board of Directors and a Chairman that reports directly to the Prime Minister (see Figure 15). These open lines of communication have helped Petronas overcome the problems of lengthy decision-making processes associated with traditional NOCs. MOGE could learn from this structure, with the NEMC responsible for steering and advising on a national resource strategy through seats on the board of directors.

Figure 15: Petronas corporate structure

Notes:
Executive Committee comprises the President and Chief Executive Officer and the four Executive Vice-Presidents
EVP – Executive Vice-President
VP – Vice-President
SGM – Senior General Manager
MISC BERHAD - Malaysia International Shipping Corporation Berhad
KLCC (H) SB - Kuala Lumpur City Centre Holdings

Source: Petronas Annual Report 2011



The top tier of management in Petronas also controls the corporate strategy to be pursued by its four main business units (Exploration and Production, Gas and Power, Downstream and Finance). In this way, centralized governance ensures that international and operational expansion does not dilute the company's political mission.

b. Develop Commercial Viability

The nationalized model has presented a number of limitations to NOCs' commercial pursuits. As state-owned entities, they have traditionally been reluctant to take on the risks associated with specialized extractive operations such as deep-water drilling. Underdeveloped private finance markets in countries like Myanmar have made it difficult to overcome this limitation. Nevertheless, the pressure to supply growing demand by increasing depletion rates, extracting new resources and raising revenue by establishing control throughout the value chain has prompted NOCs to evolve in the following ways:

1. Developing transparency in accounting and in the organizational structure to bolster investor confidence
2. Seeking out strategic partnerships with IOCs or foreign NOCs
3. Revamping the salary structure of the organization

Petronas has demonstrated transparency in its accounting by publishing full annual reports and highlighting its fiscal contributions – actions that MOGE does not currently take.

International expansion has contributed enormously to revenue growth in NOCs. Petronas' foreign operations (it is active in over 35 countries) have consistently contributed the largest portion of revenue growth by geographic segment. NOCs have pursued international expansion via joint ventures, partnerships and merger and acquisition (M&A) deals with IOCs or other NOCs. MOGE has also embarked on a joint venture with CNPC of the PRC for the construction of an oil pipeline on Myanmar's Maday Island, and could benefit from further strategic alliances. Alliances and competition from other players will also encourage leaner operations and improved pricing to help MOGE professionalize.

If MOGE is corporatized and allowed to retain part of its earnings for its operations as well as for its staff salaries – as is being done by Petronas in Malaysia, PetroVietnam in Vietnam, PTT in Thailand and Pertamina in Indonesia – it will help retain qualified personnel as they will see a future within the new corporate entity not only in terms of job security but also for training to improve their skills.

c. Develop capacity to meet local demands

Many NOCs are entrusted with the responsibility to act as national stewards in their management of natural resources. Their responsibilities have enlarged in response to population increases and resulting rises in domestic energy consumption, discrepancies in regional and rural/urban energy infrastructure, and political agendas addressing socio-economic concerns. NOCs have typically evolved by:

1. Investing in rural infrastructure
2. Investing in education and training programmes for personnel
3. Engaging with international environmental agencies to promote sustainable development

These points are of particular importance to Myanmar, where rural electrification is poor, especially when compared with its neighbours. By expanding access to energy, Petronas has helped spur development in other sectors of the economy. Petronas has also adopted a number of educational initiatives, including the establishment of a high-tech university to train engineers. With its low production-per-employee ratio and the pool of young workforce to choose from, MOGE could benefit from long-term investment in education.

2. Investment Frameworks to Enhance Supply and Efficiency

Insight 2.1: Reform energy subsidies

The government should aim at a blanket removal of subsidies, particularly for electricity, and the redirection of funds in favour of those in need. This action should be sequenced, and should be taken in conjunction with Insight 1.5: Increase transparency of extractive industries and implement Extractive Industries Transparency Initiative. Together, these actions will enhance the credibility of the budgets of state enterprises, especially of those that are exposed to political pressures owing to the extent to which they rely on subsidies.

Recent data has illuminated the extent to which energy prices have been distorted by subsidies in Myanmar. In 2011, official electricity charges in Yangon were 12 cents per kWh for foreigners and 75 kyat (9 cents) for offices; however, the average price actually paid by the end of the year was only 5 cents/kWh, or 35 kyat.[87] These prices fall far below the cost of producing electricity: a recent study assessed the possibility of producing more electricity from both natural gas and diesel and estimated the cost of each kWh to fall between 9 and 35 cents/kWh.[88]

However, according to those interviewed for this report, many residential entities and commercial enterprises would be prepared to pay more if they were provided with a more reliable supply of power. For example, in Kachin state, independent power producers (IPPs) currently charge more for a higher quality product, a system that works very successfully there. A recent study has estimated the cost from gas generators to be between six and nine cents, but 30-35 cents when diesel is used.[89] These figures and interviews suggest not only that more companies and individuals would be willing to pay a higher price for power, but that those costs would still be very attractive compared to the alternative of using diesel to expand power supplies in the short term.

The objective of offering energy subsidies is to ensure that the poorest in society have access to gas and electricity. However, the government should consider other, more effective ways of doing this. These include direct cash transfer or the provision of energy coupons. This is similar to the way in which poor households are already identified for benefits such as food distribution, education support and medical treatment. The ADB has elaborated on how this scheme might work, suggesting that a cash payment could be scaled to the level of energy used by a typical energy-poor household rather than to each household's actual energy consumption.[90] Such a scheme would extend access without encouraging wasteful behaviour. Myanmar can also look to other countries to find successful examples of how subsidies have been removed and support has been extended to the poor. Indonesia, for example, is currently planning to establish a national security system in 2014 through which the government will pay insurance premiums for poor families. Discussion is under way to use the new social security system to target energy subsidy transfers to the poor.[91]

In addition, funds from the removal of subsidies could be used to improve the financial health of state energy enterprises. In the course of research for this report, participants commented that electricity subsidies are a significant factor for the low revenues of the state electricity companies and that, in turn, helps explain why they find it immensely difficult to make investments either on their own or in partnership with foreign builders of IPP power plants, as so many other countries have done when developing new capacity. Myanmar will not succeed in fulfilling the aims of its energy triangle if it cannot make domestic energy supplies more sustainable. Gradual removal of subsidies, regular revision of electricity tariffs and the rationalization of natural gas prices will be central to a balanced energy triangle.

External perspective: Fossil fuel subsidies – an inefficient and ineffective means of supporting the poor

Dr. Fatih Birol, Chief Economist, International Energy Agency; Chair, World Economic Forum Energy Advisory Board

Developments in energy pricing will be a critical driver of future energy trends by affecting the amount and type of energy that is consumed and the effort that is put into improving energy efficiency and developing cleaner-energy technologies. A key issue in this respect is how quickly fossil-fuel subsidies, which still remain substantial and commonplace in many countries, will be phased out.

The International Energy Agency (IEA) has been focusing attention on fossil fuel subsidies for well over a decade in the context of its World Energy Outlook publication. The work is primarily aimed at raising awareness about the magnitude and incidence of fossil-fuel use and its impact, an essential step in building momentum for global fossil-fuel subsidy reforms.

The IEA's latest estimates indicate that fossil-fuel consumption subsidies worldwide amounted to US$ 523 billion in 2011, up almost 30% from 2010 and six times more than the subsidies to renewables. These subsidies were most prevalent in the Middle East, amounting to 34% of the global total. These estimates capture the value of subsidies that reduce end-user prices below those that would prevail in an open and competitive market. Such subsidization occurs whether energy is imported at world prices and then sold domestically at lower, regulated prices, or, in the case of countries that are net exporters of a given product, where domestic energy is priced below international market levels.

In many cases, fossil-fuel subsidies were introduced with the well-intentioned objective of improving access to modern energy services for the poor. While making electricity and clean cooking facilities available to the poor is of vital importance, studies have found that fossil-fuel subsidies as presently constituted tend to be regressive, disproportionately benefitting higher-income groups that can afford higher levels of fuel consumption. Indeed, recent analysis in the World Energy Outlook indicates that only 8% of fossil-fuel subsidies typically reach the poorest income group (the bottom quintile). This finding reflects the fact that poor households may not have access to subsidized energy directly, since they may lack a connection to electricity or natural gas and own no vehicle. It also demonstrates that subsidies are an inefficient means of assisting the poor; other direct forms of welfare support would cost much less.

Although low-income households only benefit from a small proportion of energy subsidies, they are still likely to be disproportionately affected by their removal as they spend a higher percentage of their household income on energy. Therefore, any moves to phase out subsidies must be carefully designed so as not to restrict access to essential energy services or increase poverty. In undertaking major changes, assessments should be made regarding the extent to which the economy and society can absorb the impacts of reforms. Financial support for economic restructuring or poverty alleviation will often be essential. In most successful cases of energy-subsidy reform, support has been well-targeted, temporary and transparent.

As has been seen in, for example in Myanmar, subsidy reform is difficult as the short-term costs imposed on certain groups of society can be very burdensome and induce fierce opposition. Nonetheless, globally we are seeing some encouraging signs of progress. G20 and APEC (Asia-Pacific Economic Cooperation) member economies have made commitments in recent years to phase out inefficient fossil-fuel subsidies and many are now moving ahead with implementation, including the PRC, India, Russia and Indonesia, to name just a few. Many countries outside these groupings have also committed to subsidy reform. In net-importing countries, reforms have been closely linked to persistently high energy prices, which have made subsidies an unsustainable financial burden. Even some net-exporting countries have taken steps as they have realized that artificially low prices are eroding export availability and reducing foreign currency earnings.

While these efforts indicate growing momentum to phase out subsidies, the reality is that energy resources are still significantly underpriced in many parts of the world. The countries involved face a momentous choice between pursuing the hard but necessary reforms and continuing with the status quo. If they make the right decision, I am convinced they will reap long-term benefits for their own economies, while also making an important contribution towards putting the global energy system on a more sustainable path.

Insight 2.2: Establish energy efficiency standards and regulations

The formation of the NEMC could be used to drive the development of appropriate energy efficiency standards and regulations across the key ministries responsible for energy. To support this, a separate energy efficiency law could be instituted. The government should also consider signing up to the en.lighten initiative (see Case Study). This is a responsibility that will be especially important both for meeting the objectives of the energy triangle and for securing the long-term integration of Myanmar into the global economy. Higher standards of energy efficiency will support demand-management and mitigate the problem of inadequate supply throughout the country. They will also help avoid the potential dumping of poor quality and inefficient products, an issue that may be of increasing concern to consumers in the face of rapid economic growth. Lastly, lower energy consumption reduces emissions and supports environmental sustainability.

Progress is already being made to drive forward energy efficiency at the local and national levels. The Yangon Master Plan, supported by JICA, looks at incorporating energy efficiency measures through building standards and codes. At the national level, the Ministry of Industry and Trade has indicated that it is currently developing energy efficiency standards. Areas for further consideration are summarized in the IEA's 25 Energy Efficiency Policy Recommendations.[92]

Japan offers an exemplary model of implementing energy efficiency standards, thanks to which the country charts very low levels of energy intensity. Japan has worked hard to improve its economic output per unit of energy. In 1979 it introduced standards and regulations in the Law Concerning the Rational Use of Energy. This law set out energy efficiency standards for buildings, appliances and other equipment. In addition, the Japanese support energy efficiency through a variety of budgetary, tax and financial incentives. As a result, Japan's energy intensity in 2010 was 25% lower than in 1980.[93] Korea has also reduced its energy consumption significantly in the last 10 years through efficient labelling, energy efficiency standards and improved industry processes that have saved US$ 6 billion for the Government of Korea. Thailand too has taken important steps in this regard.

External perspective: Benefits for Myanmar in applying international standards in energy – The International Electrotechnical Commission's (IEC) perspective

Gabriel Barta, Head of Technical Coordination, International Electrotechnical Commission

What makes an appliance energy-efficient, or how long a micro-generating station continues to function successfully, depends on the laws of physics and how the device is designed and maintained, not on whether it is situated in Myanmar or another country. In keeping with this perspective, the IEC develops international standards for the various characteristics of electrical appliances and many other products. If you have assurance that a product conforms to IEC standards, you can depend on its safety, quality, energy efficiency and other attributes. However, to apply the standards, or even to decide whether conforming to them should be required, a given level of technical preparation is needed. It is also likely that a conforming product will cost more to manufacture. These aspects sometimes present a barrier even when the advantages of conforming to international standards are recognized.

Where the cost-benefit question is particularly acute because some of the basic capacity to use standards is not yet in place, the most important criterion is that of public policy. At the two extremes, one may distinguish a policy to maximize immediate production or import by minimizing cost, and a policy to be "best-in-class" even if this involves a high cost. For Myanmar, the second possibility is probably too costly; the first, however, runs the risk of making Myanmar a dumping ground for substandard products, and even of causing extra costs in the longer term through waste and other externalities. Perhaps a policy to minimize long-term cost, in terms of energy use, replacement or repair cost, human effects and technology ramp-up, holds the most promise.

Such a policy could consist of a judicious choice of products and installations, and the relevant standards (where they exist) that would be required to show conformity in order to enter the market. The energy-related characteristics would include energy efficiency, power consumption, standby power requirement and environmentally-conscious design (including the energy needed for manufacture). For electrical infrastructure, including rural electrification with mini-grids, the criteria include quality, maintainability, interoperability and control as well as efficiency. In all these cases, requiring conformity to international standards means that products and installations made for and sold in Myanmar would be the same as those for other markets. This implies economies of scale in production, and Myanmar's participation in international trade on level terms.

Two further aspects deserve consideration. First, it is possible that only some of the international standards which Myanmar may wish to depend on are already published. Others may be in development, and yet others waiting for proposals from and involvement of stakeholders, including developing countries, in order to be launched. Whether to participate or contribute to standards when the required ones are not yet available is a policy decision, as is whether to specify standards other than international ones, if they exist.

Finally, when it has been decided to require conformity to standards, the question of how exactly conformity should be demonstrated – by the market actors trying to satisfy regulations – is another area where cost-benefit trade-offs are crucial. If local testing is required, imported products which have almost certainly been tested already will suffer a price penalty through the cost of repeated testing. In addition, such imposed local testing can be regarded as an unjustified technical barrier to trade. However, if testing in another country or the supplier's declaration of conformity is deemed to suffice, how can Myanmar authorities be certain that the test results are reliable? A danger of dumping will remain, similar to the situation where no standards at all are required. A mutual-recognition arrangement among certification bodies, such as the conformity assessment systems operated by the IEC, can help ensure that only one set of tests is required while simultaneously providing assurance of true conformity to international standards.

External perspective: Working towards a bright urban future – Reducing electricity consumption and enhancing urban living in Yangon

Eric Rondolat, Chief Executive Officer, Lighting, Philips

The time is now. The time to lead by example and to create a lasting impact.

Following a series of substantive economic and political reforms, Myanmar is on a steady path towards economic reawakening. And Yangon will be the epicentre of new growth attracting a large number of people to live and work in the city. Currently, there are an estimated 5 million people who call Yangon home and the city anticipates 100,000 new inhabitants every year. The need to build infrastructure and basic services is evident. Yet catering to these elementary requirements alone will not be enough.

The people of Yangon want to live, work and enjoy their free time in a safe, attractive, vibrant and environmentally-sound city. The growing urban population offers great opportunities for economic and social development, but at the same time presents enormous challenges.

Among the most pressing challenges in Yangon is energy. The city is exposed to electricity shortages and the demand far outpaces current supply. Today, Yangon consumes 45% of Myanmar's electricity supply, a figure that will only increase over time. But merely increasing power supply cannot be the answer – not from the economic point of view and not from an environmental point of view. It is imperative that we also make use of energy-efficient solutions to achieve significant savings and meaningfully bring electricity demand and supply into balance.

Globally, lighting accounts for 19% of total electricity consumption. Significant savings are possible – on average 40% and up to 80% for individual applications – simply by switching to energy-efficient lighting technologies such as Light-Emitting Diode (LED) bulbs. In Myanmar these savings would amount to an estimated US$ 9.7 million in reduced electricity costs and 45 kilotons of CO2 annually; half of these savings can be achieved in Yangon alone.

Furthermore, lighting has an important role to play in expressing a city's unique identity, thereby attracting tourism and business. This aspect is of particular relevance for Yangon, which boasts of some of South-East Asia's richest historical and architectural sites, including colonial-era heritage buildings and the magnificent Shwedagon Pagoda – one of the most important and beautiful sacred sites in South-East Asia. Through the late 19th and early 20th centuries, Yangon was a crucial port city for the world – the diversity of its population and trade was unparalleled, its academic institutions and reputation unmatched. Conservation-led development and properly highlighted heritage sites will contribute to Yangon once more assuming its role as one of Asia's most liveable and important commercial capitals.

Recognizing the short- and long-term electricity savings potential in Yangon, Philips has worked with the Yangon City Development Committee (YCDC) to provide inspirational and practical ideas on how lighting can play a key role in realizing significant energy savings and in making Yangon a more liveable city, by featuring its architectural treasure and heritage in the best possible light.

Public space and street lighting accounts for about 15% of a city's total electricity consumption. Working together with YCDC, Philips is also piloting upgrades of Yangon's street lighting with LED technology that has been proven to deliver savings of up to 60% of electricity consumption. The pilot measurably demonstrates how electricity consumption decreases while quality and intensity of street lighting increases. It will thereby serve as a reference point for a sustainable and responsible application of LED technology in the country and is expected to inspire broader policies to accelerate the adoption of energy-efficient technologies, innovative project financing and comprehensive approaches to urban planning.

The opportunity that energy-efficient lighting solutions hold does not stop at the city borders of Yangon. Of the nearly 60 million people living in the country, three out of four are without reliable access to electricity. While connecting people and businesses to a reliable electricity grid is undoubtedly critical for Myanmar, the lack of transmission infrastructure in rural areas makes off-grid solutions an attractive option. These solutions, which make 100% use of renewable energy and come with a low installation cost and no energy bills, can present a cost-effective and impactful alternative to establishing a vast network of transmission lines.

Myanmar has the opportunity to embrace existing off-grid lighting solutions as a gateway to better education, healthcare and livelihoods in rural communities. Globally, in both emerging and mature markets, Philips has gained experience in working together with different communities to use state-of-the-art solar-powered LED lighting as an alternative to grid-connected lighting. These solutions have transformed lives in communities by enabling various activities after dark that contribute to economic and social development. Reliable lighting provided at places where it was previously impossible enables a community to perform agriculture-related tasks like rice threshing after nightfall, helps children study and allows social get-togethers.

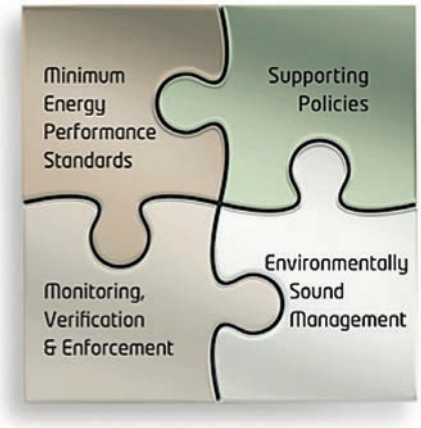
Both the public and the private sector have an important role to play. With a shared vision and with commitment, we can make it happen. Together.

In focus: What is the en.lighten initiative?

The United Nations Environment Programme (UNEP), with funding from the Global Environment Facility, established the en.lighten initiative to accelerate a global market transformation to environmentally sustainable, energy-efficient lighting technologies. The aim is to rapidly reduce GHG emissions and the release of mercury from fossil fuel combustion.

To date, 47 countries spanning Africa, Asia, Europe, Latin America, the Caribbean and the Middle East have joined the en.lighten initiative's Global Partnership Programme. As a first step to transition to high-efficiency lighting, they have agreed to phase out inefficient incandescent lamps by the end of 2016.

The en.lighten initiative promotes an integrated policy approach to ensure that all pertinent aspects are considered as each developing country creates its National Efficient Lighting Strategy. Elements include: minimum energy performance standards; supporting policies; monitoring, verification and enforcement; and environmentally sound management. This approach can successfully overcome economic, technical and policy barriers, thus facilitating a sustainable transition with concomitant financial, energy and environmental benefits.



en.lighten in the South-East Asia Region

At an en.lighten workshop organized by the UNEP and the Global Environment Facility (GEF) in Singapore in November 2011, government representatives from 18 countries in South-East Asia voiced their support for the phasing out of incandescent lamps. Participants included representatives from ministries of energy and environment, national utilities, manufac¬turing sector, international organizations and civil society. They unanimously agreed that the phase-out of incandescent lamps is one of the easiest ways to reduce CO2 emissions and achieve significant energy and financial savings.

The Philippines: A case study

The Philippines became one of the first Asian countries to transition to efficient lighting. In 2005, the Philippine Efficient Lighting Market Transformation Project integrated various energy efficient lighting programmes and practices into standards, labelling programmes and promotional activities. The project concluded in 2011, having met its objectives on energy savings (7,366 GWh equivalent) and emissions reduction (3.98 million tonnes of CO_2).

The en.lighten initiative estimates that a continued transition to energy efficient lighting in the on-grid residential, commercial, industrial and outdoor sectors for all major lamp types would save 3.5 terawatt-hours (TWh) in annual electricity consumption, equivalent to 6.3% of total national electricity consumption and 42.1% of electricity consumption for lighting. The on-grid efficient lighting transition would also save 761 million US dollars annually, and avoid 1.7 million tonnes of CO_2 emissions annually. For off-grid, the Philippines' transition to energy-efficient lighting could save US$ 270 million annually, the equivalent of 221 million litres of kerosene, 121 million candles and 30 million batteries.

In consultation with the Department of Energy and the UNEP, Philippines stakeholders aim to develop a new generation of high-efficiency lighting activities, focusing on increased laboratory-testing capacity for emerging technologies such as LED, controls and off-grid lighting.

What does en.lighten offer to countries?

- *Global Partnership Programme:* Policy advice to national regulators and regional bodies on the development of policies, strategies and actions for the phase-out of inefficient incandescent lamps.
- *Technical support:* Policy guidance and technical expertise offered both remotely and in-person using a comprehensive best practice guide, "Achieving the Global Transition to Energy Efficient Lighting Toolkit."
- *Country lighting assessments:* Tangible information for decision-makers about the significant energy and financial savings and climate change mitigation benefits that could be achieved from a transition to efficient lighting, on-grid and off-grid.
- *Global policy map:* A global interactive tool that allows tracking and benchmarking of progress towards efficient lighting.
- *Efficient lighting forecast tool:* An online modelling tool that forecasts electrical energy and CO_2 emission savings potentials of efficient lighting regulations relative to a business-as-usual scenario in any given country or region.
- *en.lightened learning online portal and webinars:* Country-specific case studies and increased communication and awareness with governments and key stakeholders.

Insight 2.3: Expand rural energy access

As outlined in the overview of Myanmar's current energy architecture performance, the country faces tremendous energy access challenges, with about three-quarters of the population still without access to electricity or modern forms of fuel. Electrification rates range from 67% in Yangon to as little as 16% in rural areas, where around 40 million people reside. Without broadening access to modern energy, development will be slow at best. The national grid has limited scope, so that while the major cities are connected to power supplies, most rural areas have little or no infrastructure to support access. Many communities therefore rely on a "wax economy" and kerosene for their lighting needs, and the collection of fuel wood for cooking purposes.

As Myanmar is building the nation's electricity infrastructure from scratch, it can learn from other developing countries' experience. As pointed out in the perspective by Andy Schroeter, Laos provides one such example.

While no one ministry is tasked with tackling rural energy access, the MOST has been working on R&D for hybrid renewable systems based on biogas and small-scale solar, and with a capacity of around 30 kW. Recently, the government announced that it is planning to draft a "new energy policy based on the current Japanese model" and the Japanese Ministry of Economy, Trade and Industry is supporting the Myanmar's Ministry of Industry with a feasibility study.[94] The policy announcement elaborated on the government's focus on supplying rural areas with off-grid electricity from biogas, hydropower or solar power.

The ADB is also considering providing financial and technical assistance to the Rural Energy Supporting Development Committee. This committee falls within the Ministry of Industry and is responsible for coordinating and implementing rural energy access programmes. Furthermore, Myanmar recently received a technical assistance grant from the Government of Norway – channelled through the ADB – to help update its 1984 Electricity Law so that it reflects current international standards, including supporting the goal of expanding rural electrification and promoting off-grid solutions.

These developments should contribute to some progress on tackling Myanmar's tremendous energy access challenge, while more efforts are clearly needed for creating enabling policies and establishing public- private partnerships to overcome hurdles. Some key dimensions that need to be addressed properly are:

- The need to ensure closer consultation with end-users in advance of project planning (whether large- or small-scale) to ensure that their energy needs are met
- The lack of a clear legislative framework to support off-grid solutions, such as power purchase agreements (PPAs) for very small power producers (VSPPs)
- The lack of technical expertise, both in terms of the technology required for setting up hybrid village-level systems, and for the operation and maintenance of both hybrid and home systems
- The prevalence of low-quality solar home systems and solar lamps in the marketplace, which leads to poor user experience and thus low levels of trust and adoption
- The continued presence of non-market based initiatives in which products are distributed for free, or below the cost of production, thereby cannibalizing the sales of market-based schemes
- The lack of access to capital and, in particular, the low availability of microfinance
- The need to ensure capacity-building, particularly for proper operation and maintenance of systems by local people and communities to help create longer-lasting off-grid energy solutions and more holistic development
- Limited LPG supplies for use in efficient cook stoves, which is a consequence of the export-driven strategy for natural gas production while LPG plants in Myanmar are running at 10% capacity

External perspective: Looking to Laos as a model for off-grid renewable energy

Andy Schroeter, Co-Founder and Chief Executive Officer, Sunlabob Renewable Energy

Simon Henschel, Chief Operating Officer, Sunlabob Renewable Energy

Considering lessons learned from national rural electrification efforts in Laos

Today, Myanmar has an electrification rate hovering just above 25%. In rural areas, where 40 million people reside, energy access drops to barely more than 15%.

Fortunately, Myanmar is in an opportune position; all signs point to a robust energy transformation in the near future. The Government of Myanmar is, in principal, building the nation's electricity infrastructure from the ground up, which opens up the opportunity to leverage lessons previously learned by other developing countries in similar situations.

Laos, for example, had an electrification rate hovering just above 30% in 2000. Nearly 70% of the population lives in rural areas. To supplement its national grid extension efforts, the Government of Laos and its public and private sector partners (including Sunlabob Renewable Energy) put an emphasis on off-grid renewable energy expansion; more than 10,000 solar home systems were deployed and numerous village mini-grids utilizing solar, small-hydro and biomass energy sources were established.

Today, after little more than a decade, more than 7 in 10 Laotians have access to electricity.

How can Myanmar make a similarly impressive leap in energy provision? While on-grid electrification in Myanmar will likely come from large-scale hydropower, natural gas and coal-fired plants in the long-term, the case is strong for off-grid renewable energy solutions in the short-term, particularly because two-thirds of the population lives in rural areas. In contrast to comparatively slow-moving national grid extension, off-grid solutions – particularly village mini-grids – offer the opportunity for fast, flexible, expandable and cost-effective energy access.

While its population is only one-tenth that of Myanmar's, Laos's experience can act as an indicative case study for the Government of Myanmar as it develops its off-grid electrification strategy. Key takeaways include:

- Renewable energy mini-grid systems, compared with solar home systems, are longer-lasting, have greater "add-on" flexibility and can be easily connected once the national grid reaches a community.
- Closer consultation with end-users must take place in advance of the planning and design phases to ensure energy needs are met. Surveying individual user needs is critical to effectively reducing energy poverty.
- Hands-on training that empowers end-users with the skills and knowhow to properly maintain off-grid systems is a core element to ensure long-lasting, self-sustaining energy access. Using a community-based approach that provides training and direct income generation for local technicians, and helps create a local governance group (what we at Sunlabob call Village Energy Technicians and Village Energy Committees), Myanmar can use micro-entrepreneurship to simultaneously electrify the nation and help lift its people out of poverty.
- Energy efficiency education and implementation should be integrated into off-grid electrification programmes. The promotion of energy efficient technologies (i.e. lighting and appliances) and habits inevitably makes energy access more impactful and longer-lasting.
- Empowering the domestic private sector to be a key stakeholder in and driver of implementation is a critical aspect of successful, widespread off-grid electrification. Local businesses must be contributors to on-the-ground progress.
- Catalysing public-private partnerships to more efficiently maximize the resources of the public sector and on-the-ground expertise of the private sector is invaluable. Creative approaches, innovative financing and collaborative solutions are essential when trying to provide high-quality, long-lasting energy access to millions of people in some of the most remote, rural areas of the world.

President Thein Sein has explicitly stated that the government will take a "people-centred" approach to the country's growth and development. If Myanmar is going to hold true to this promise, off-grid renewable energy needs to have a significant place in the national electrification strategy so that the 74% of the population currently without electricity (particularly those in rural areas), can begin to be lifted out of energy poverty in a timely and effective manner.

With smart planning, an ambitious approach and consideration of the lessons learned by Laos and its other developing neighbours, Myanmar can use off-grid renewable energy to begin making meaningful, long-lasting energy progress now.

External perspective: Energy access for development in Myanmar

Neal Keny-Guyer, Chief Executive Officer, Mercy Corps

The challenge

Energy access

Access to modern energy services is central to alleviating poverty and creating the foundation for economic growth. In recent years, Mercy Corps has transitioned from post-Nargis disaster recovery efforts to implementing programmes aimed at increasing food security and helping build resilience to external shocks. Increasing access to energy is central to this and will not only expand economic opportunities in off-grid areas but will also allow individuals to invest more in other necessities, such as health, education and agricultural productivity.

Assessments carried out in 2012 in three states (Mandalay, Chin and Rakine) clearly demonstrate the extent to which existing energy practices place a significant burden on household expenditure. Half the households surveyed reported total annual expenditure of less than US$ 700, around 30% of which was spent on ineffective and damaging energy sources. Households that regularly purchased firewood for cooking spent around US$ 160 annually, while the average rural household spent US$ 29 each year on the primary lighting source, usually kerosene. This considerable burden is only expected to increase with the adoption of new power-hungry technologies, particularly mobile phones.

The high level of fuel wood consumption by households is recognized as an associated development challenge. Mercy Corps' assessments in the Delta and Dry Zone (Mandalay state) identify fuel wood collection as a significant contributing factor to the degradation of forest resources. Tree-based resources are vital to protecting coastlines in the Delta, and for limiting soil erosion and desertification in the Dry Zone, where shifting rainfall patterns are already exacerbating the negative impact of soil loss on agriculture. Evidence from the global health community and Mercy Corps' own surveys suggests that the dominant use of open fires for cooking and kerosene for lighting is linked to chronic illnesses, particularly among already-disadvantaged women and young children. The 2010 WHO Global Burden of Disease report has listed open-fire cooking as the fourth biggest cause of premature death, a ranking that illustrates the urgent need to provide cleaner sources of fuel.

Opportunities

Cook stoves and wood lots

Successful programmes in the region that address the broad impacts of poor cooking practices have focused on stimulating market systems to scale up the adoption of clean cooking technology. These programmes have created direct opportunities through cost-savings, health benefits and prospects for entrepreneurial initiatives via local stove manufacturing, assembly and/or distribution. Improved Cook Stoves (ICSs) offer a clean cooking solution to deprived rural areas. ICSs have experienced a rapid uptake in India and Cambodia, where they have benefited from public-private partnerships that offer private companies access to emerging-market growth opportunities.

Availability of good-quality ICSs is limited in Myanmar at present, but Mercy Corps' experience from the Nargis recovery effort in the Delta and in neighbouring countries has demonstrated the potential benefits of introducing ICSs both through the market system and through community-managed wood-lot development. Efforts to introduce managed resources through agro-forestry could help alleviate environmental damage.

Micro-grids and lighting options

Technological advancements have helped to redirect attention away from the traditional concern of extending the national grid infrastructure and towards cheaper, small-scale and replicable community-based solutions. Solutions range in size from low-cost solar lanterns and phone chargers to community-wide micro-grids employing a single renewable source or a hybrid of local and renewable energy sources. These appliances offer enhanced energy provision and reduce reliance on more dangerous or sporadically available fuels. The challenge is to ensure they can be distributed to remote rural areas. Micro-grids are especially useful, offering longer-term access that can be expanded on a modular basis with the prospect of linking to the national grid. Experience so far has suggested that fee-based revenues from micro-grids are sufficient to cover maintenance and management costs, although covering initial investment costs is difficult. This is certainly an area where the development sector is well-placed to support experimentation and help stimulate future investment.

Barriers

Although opportunities exist, there are many challenges to harnessing them effectively. A functioning market system for affordable energy products would provide the appropriate forum for manufacturing and distribution to take hold. This in turn relies on broader enabling factors, including access to micro-finance and other nascent private-sector services; government support for NGOs engaging in market-based programmes by allowing imports of particular high-quality technologies; and a willingness to move beyond ineffective free-distribution models that undermine market-based systems.

Market systems are widely seen to be a successful way to create sustainable access to energy products and services. However, Mercy Corps' research in Myanmar and elsewhere indicates that although a significant proportion of low-income households are sufficiently incentivized to adopt appropriate products or services once access barriers are removed, a substantial number of households still have no ability to pay. These vulnerable households have the most to gain from access to clean, reliable energy. A pertinent question remains, then, as to how these households can be engaged in clean energy programmes without undermining efforts to build the sector as a whole.

Insight 2.4: Develop a clear vision and legal framework for private investment

Myanmar must ensure appropriate levels of private and foreign investment as vital steps for the development of its energy sector. To attract and manage that investment, Myanmar needs to define a clear vision for investment and create a transparent legal framework that investors can trust. This is a perennial issue for foreign investors and the problems are well-known, such as fear of shifting rules, lack of efficient arbitration of contracts and an uncertain tax regime.

The government has already moved to tackle this problem through the New Foreign Investment Law of November 2012, which replaced the previous law of 1988. The new law offers greater incentives to foreign investors: local enterprises can be up to 100% foreign-owned; the amount of time that foreign investors can lease land for has been increased from 30 to 50 years, with the possibility of two further extensions of 10 years; foreign investors are entitled to a five-year tax holiday, up from three years previously; and the government has moved towards protecting foreign-owned enterprises from nationalization, although this is conditional upon obtaining the relevant permit from the Myanmar Investment Corporation (MIC).[95]

This is welcome news for the energy sector, not only because of the enhanced terms of investment outlined above, but also in light of some of the principles the government has put forward as a legitimate basis for investment. The law specifically outlines the importance of expanding the energy sector, promoting advanced technologies, encouraging exports and driving energy efficiency in the sector.[96] In terms of securing a long-term vision for Myanmar's energy development, the law also recommends foreign investment in renewable sources of energy and energy-saving technologies.

One key area this will impact is the transport sector, which is pivotal to the energy sector. Clear planning and legal frameworks to incentivize private investment in sustainable modes of transport is essential. Given Myanmar's current stage of development, it has the opportunity to benefit from the experiences of its neighbours to avoid the traffic congestion and pollution that is typical of Asian developing countries. It can do this by undertaking overarching, comprehensive planning of the transport system, which includes population projections, zoning of commercial and industrial centres, appropriate planning of pedestrian paths, roads and highways, as well as railways and light rail systems that would lead to a sustainable transport system from the start of this development process.

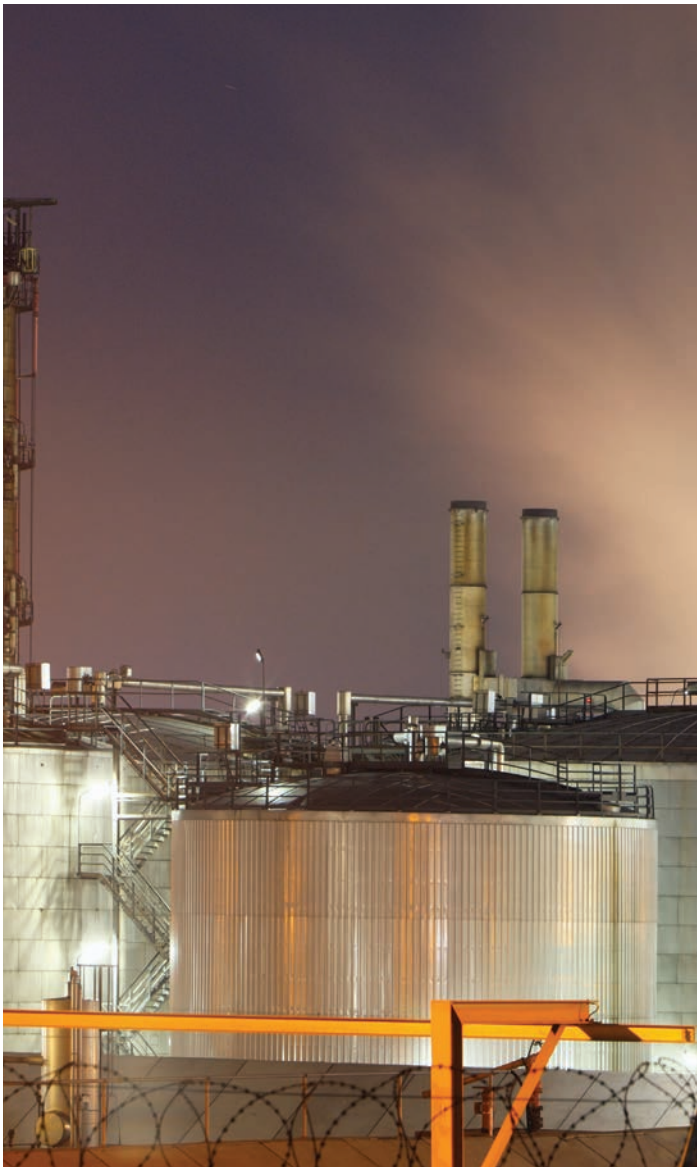
There is still much to do. While the new law promotes the export of goods and services, it also champions investment that promotes import substitution by stimulating the domestic production of goods that would otherwise be imported. The hierarchy of these principles is not made clear, but it is just one of many instances where the investment environment for foreign companies is not altogether transparent and should be further developed. In relation to energy, given the current supply shortfall, the government will most likely welcome projects that are designed to meet domestic demand.

In addition, negotiations for new foreign investments are still dealt with on a case-by-case basis. The government has declared its intention to reform this by, among other measures, merging the foreign investment law with the citizen investment law before the formation of the ASEAN Economic Community (AEC) in 2015. Such measures will increase the business community's confidence, but investors will remain cautious as the new investment environment in Myanmar unfolds over the next few years.

Insight 2.5: Create an investment framework and reform state enterprises to expand domestic energy supply

Ultimately, any expansion of power generation requires a switch from an export-oriented natural gas strategy to a focus on supplying the local market. Accordingly, the MOE has made it clear that the government's policy is to prioritize all future supplies of natural gas for domestic use, with any surplus to be used for the manufacture of value-added products (thereby eventually stemming the export of "raw" supplies). However, opportunities for the development of value-added, gas-based petrochemicals seem limited, as Myanmar's natural gas so far has been "dry" with no ethane or propane content. Indeed, even Zawtika (M9), the next offshore gas field targeted to come online in 2013, consists of dry gas.

Nevertheless, if the policy of focusing on supplying the local market is to be successful, the government must create an attractive framework for sellers. As one stakeholder commented: "The rules of the road are pretty clear: there needs to be demand, and you need to be able to sell your product at a competitive rate to make a return on your investment."[97] The government must therefore ensure that there are adequate offtake opportunities for domestic supplies of natural gas, through the expansion of heavy industry, industrial zones, power generation, fertilizer plants and so on. Secondly, the government needs to ensure a fair and equitable price for the seller, and put in place proper mechanisms for completing sales. This will support the development of the energy sector in conjunction with local industry.



In focus: PTT Exploration and Production Public Company's (PTTEP) M3 block and the development of local demand in Myanmar

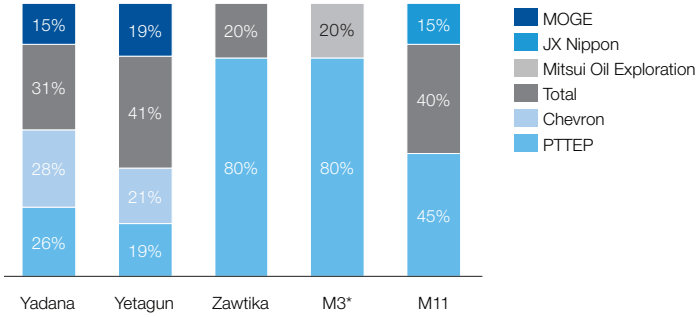
PTTEP Myanmar operations overview

PTTEP has done business with Myanmar for over 20 years. In 2011, Myanmar accounted for 8% of PTTEP's sales and 30% of its reserves.[98]

Figure 16: PTTEP offshore gas interests in Myanmar

Notes: 20% stake subject to Government of Myanmar approval

Source: Credit Suisse



M3 and M11 potential and the local gas market

Given the block's proximity to land, M3 gas would be sold to the domestic market in Myanmar. Due to the shallow water and shorter distance to shore, PTTEP estimates that the project would be economical with a reserve size of 1.5 trillion cubic feet (TCF) or more, assuming 200 mmcfd volume over 20 years.[99] If the exploration outcome is positive, first gas is expected between 2016 and 2018. Another block in which PTTEP has an interest is the offshore M11 block, for which it signed a production-sharing contract (PSC) in 2005. This block, located in the Gulf of Moattama, is a deepwater block.

Given M3's location and the government's "domestic first" policy, PTTEP selling new gas in the domestic market faces higher risks arising from a variety of factors, including the current infrastructure challenges, lack of demand, and pricing and subsidy regimes. To help mitigate risk exposure, PTTEP has brought in additional partners to both the M3 and M11. The key challenge, however, for any future Gas Sales Agreements (GSA) is to consider how the local demand for natural gas develops over the next few years. This is especially true for the development of the M11 block and the significant additional costs associated with deepwater exploration and development.

Institutional reform and the corporatization of state-owned enterprises could be an important part of the energy reforms. The government has stated that it will "continue implementing the process of State Owned Enterprise reforms, from corporatization to privatization, in a transparent and efficient manner".[100] Indeed, power sector enterprise reform – such as the separation of maintenance and operation functions from the government's policy and regulation functions – is imperative for efficient and effective governance. Ultimately, establishment of an independent regulator, creation of an internal regulatory department, and separation of sector segments along functional lines (generation, transmission and distribution) would be an important interim step.

The provision of investment for reliable power supply also requires a stable fiscal and institutional environment. This process will also help create a stable fiscal regime and incentivize investment that is adequately controlled through the relevant processes and rules. As part of this process, the government could also consider adopting rules for captive power plants, and perhaps even let them connect to the grid, something that might help address the challenges that large energy companies face when seeking routes to investment. This is a course that requires some caution, however. Several states in India have taken such action, but there have been instances in which captive power plants have made it easier for the wealthiest customers to exit the grid.

External perspective: Energy infrastructure development to power Myanmar's growth

John G. Rice, Vice-Chairman of GE and President and Chief Executive Officer of GE Global Growth and Operations

Myanmar has made enormous strides to integrate into the global community and promote economic development. The government is focused on sustaining that momentum, but significant challenges remain. Most pressingly, the country must develop its infrastructure and increase its power-generation capacity to continue its growth. Infrastructure investment – especially in the energy sector – is key to the development of a stable and prosperous economy, with improved standards of living for all. The World Bank estimates that an additional 1% of world GDP spent on infrastructure would increase global GDP by 2% and GDP in developing countries by almost 7%.

Without electricity, developing countries like Myanmar have no chance of providing basic requirements for health, job creation and sustainable development. Per capita electricity consumption in Myanmar is among the lowest in Asia, with an electrification rate of only 27%. The rate is much lower in most rural areas. As Myanmar's leaders have acknowledged, shortages of electricity are a major hindrance to economic development. The costs are profound – in terms of investments never made, businesses never established and jobs never created.

Myanmar has an opportunity to invest in its energy infrastructure and build a framework for growth. It is looking to develop a comprehensive energy framework that will make the best use of its resources. GE looks forward to helping Myanmar expand its supply of reliable electric power. Interestingly, Myanmar's own energy development potential reflects at least three significant global trends: the significant growth of power generation based on natural gas, a fuel with which Myanmar is richly endowed; the modernization of transmission and distribution (and eventually, the so-called Smart Grid); and the growth of distributed power or the creation of off-grid solutions that are particularly important for rural areas. GE has invested heavily in related technologies.

Yet technology alone will not solve Myanmar's energy needs. Good government policy – policy that enables and attracts effective cooperation with the private sector – is also critical. Based on GE's experience, at least four critical elements are needed to create a strong enabling environment for infrastructure development: (1) a clear and durable political commitment; (2) regulation that is transparent, reasonable and speedy; (3) good, transparent procurement processes; and (4) worker education and training. A focus on these areas will lead to more investment and long-term commitments from GE and other companies.

GE has a long history of investing in and supporting responsible growth in the ASEAN region. For over a century, GE has worked with ASEAN governments to develop local capability, because investing in human capacity is essential to long-term success. Today, GE employs 7,500 people across nine countries including Myanmar and has invested or announced commitments of over US$ 250 million since 2010.

GE looks forward to partnering with Myanmar to develop infrastructure that will promote growth and improve the quality of life for its citizens.

Insight 2.6: Assess power generation options and integrate them into a power development plan

The government has made expanding energy supplies a priority, with an immediate focus on increasing power supply to metropolitan areas. This focus will be a significant undertaking as ministers must look to overcome the large divergence between demand and supply in these areas. Short-term measures have been put in place, including the shipping of 13 sets of 1 MW diesel-engine power generation systems by Mitsubishi to the YESB.[101] These were provided as the first tranche of emergency grant aid from Japan and will be installed in Yangon. While such measures are undoubtedly welcome, the urgent need to bridge the demand and supply gap across the country in the medium and long term persists.

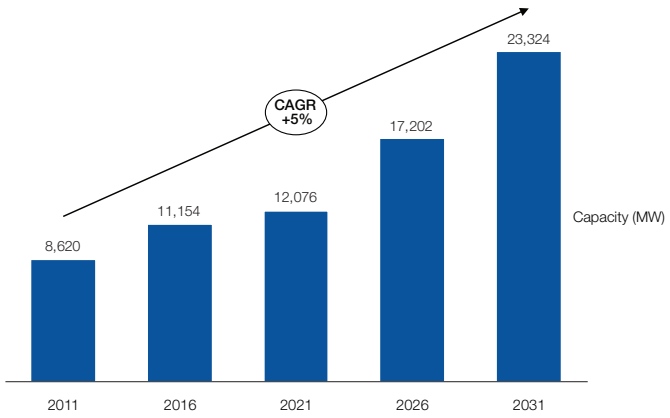
A first step towards addressing power supply gaps would be the completion of a cost-benefit analysis of the power generation options available to Myanmar. The ADB and JICA are lending support to develop a least-cost generation and transmission plan, although more detailed assessment will be needed for hydropower including a detailed river basin analysis and cumulative impact assessment. Together, the overall power development plan should include an assessment of supply- and demand-side efficiency options as a first priority, and then incorporate the long-term environmental effects of any choice, combining the results into an integrated power resources development plan. The government has said it will produce 5-, 10- and 30-year plans. This report recommends that these plans be realistic and embedded into the country's integrated energy plan.

At present much of the data pointing to long-term generation capacity is aspirational, with underestimated expected demand and overestimated supply growth. For example, during interviews officials expressed the hope of adding 10,000 MW by 2020 – 40% from hydropower, 30% from wind and 30% from gas. These figures are very optimistic. A 10,000 MW addition in installed capacity is a rapid increase in a short period of time. Moreover, the estimate for renewable energy supplies is doubtful given the scanty technical and financial infrastructure available and the time it may take to develop fully-operational facilities. A new Renewable Energy Law could help accelerate the uptake of renewables.

Lastly, the projections for future energy supplies do not appear to have taken into account the fact that much of that future capacity has already been earmarked for export. However, demand-side predictions are also notorious for being overestimates, as evident from several decades of predictions in Thailand. It may take some time for a clear picture of supply and demand to emerge.

Figure 17: Ministry of Electric Power generation forecast

Source: Ministry of Electric Power



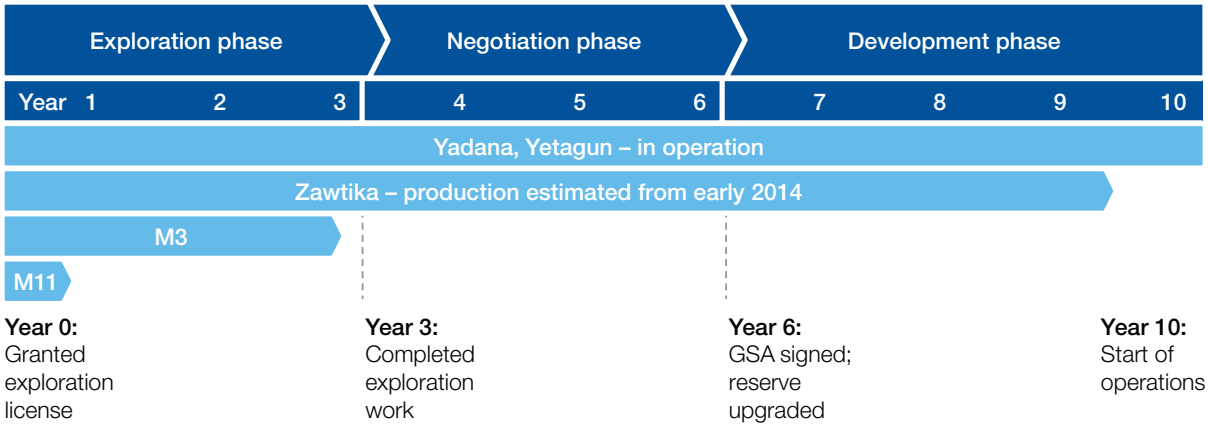
It is likely that much of the short-term demand for energy will be met by gas-fired plants and coal could be a medium-term solution, considering the 8-10 year construction period. The MOEP has signed MOUs to develop six hydropower projects on the Salween River in Shan, Kayah and Karen states. Nevertheless, the high costs associated with large-scale renewables, as well as the recent controversies surrounding the construction of large hydropower projects (as well as Yangon's distance from potential sites), all suggest that traditional hydrocarbons will provide the most immediate source of energy to meet Myanmar's short- and medium-term needs.

While these options appear to be viable short-term and medium-term solutions, a great deal of uncertainty still surrounds the balancing of gas for export versus domestic use. The government is said to be renegotiating with existing natural gas exporters to make more natural gas available for domestic users, but the outcome of these discussions is unknown. If unsuccessful, a second consideration is that it takes a long time to monetize natural gas reserves. The first three deals involving PTTEP have taken up to 10 years from the start to reach the monetization stage. Similarly, over the course of this consultation process, the government has indicated that it expects new projects to take five years for exploration and a further five for development.

Figure 18: Natural gas project development timeline

Source: Accenture Analysis, Government stakeholders interviews

GSA: Gas Sale Agreement



Coal-fired generation is more likely to yield results in the medium term. MOEP has identified potential sites for private sector development in the next few years, but it is unclear if this will be by competitive tender or direct negotiation.[102] Given the high emissions cost associated with coal-fired power generation, if the government were to take this route, it would do well to upgrade its technological capabilities to balance trade-offs between energy access and security on the one hand and environmental costs of increased emissions on the other. Specifically, it would need to ensure investment either in supercritical boilers, which have efficiencies of above 40%, or ultra-supercritical boilers, which promise even higher levels of efficiency and lower emissions.

Government representatives have explained that they were considering the construction of a new coal-fired power plant near the Thilawa (Yangon) special economic zone, similar to the Maizuru power plant in Japan (two units of 900 MW).This power plant would consist of 2,400 MW (two units of 1,200 MW each) with ultra-supercritical boiler technology using coal imported from Indonesia. The government has indicated they hope this would be constructed by 2017.

In conjunction with its support for the development of new gas and coal plants, the government should seek to develop a sound regulatory framework for independent power producers (IPPs) and public-private partnerships. This might enable more power to be produced more efficiently through a combination of small IPP projects and the rehabilitation of existing facilities, rather than the large, potentially unrealistic, developments the government has in mind. The obvious advantage of IPPs is the opportunity they offer for private sector players to have a market presence at lower risk. In addition, the proper rehabilitation of existing facilities would improve efficiency and create a win-win situation in which, for example, less natural gas would be used to create more electricity.

Insight 2.7: Strengthen transmission and distribution networks

In recent years, the MOEP has focused more on expanding power generation than on the need to expand and strengthen the T&D network. This has given rise to many situations in which operational plants cannot fully evacuate their power. The lack of an integrated approach to the expansion of the power sector has also resulted in areas of new economic activity being deprived of power. Indeed, one interviewee highlighted how the government had promoted the creation of a new beach resort, but had failed to coordinate with the MOEP about its development. As a result, no transmission lines were run to the area, leaving hotels and residents reliant on diesel generators.

Alongside the problems associated with an uncoordinated approach to generation-transmission planning, Myanmar also suffers from high T&D losses due to a combination of ageing and poorly maintained equipment. The long distances over which power is transmitted and extensive theft from the distribution system are two other issues that have exacerbated losses.

The MEPE, with the assistance of multilateral financial institutions and development agencies, is in the process of making extensive upgrades to the transmission system. Its five-year expansion plan (2011-2016) envisages building a total of 44 new transmission lines and introducing a 500 kV system to reduce voltage drop.[103] Government interviewees also indicated that they are looking at T&D joint ventures, whereas previously joint ventures were limited to generation. The government should now look further to focus on taking a more proactive approach to generation-transmission planning, based on resource availability, developer interest and project submissions to prevent the occurrence of further stranded assets.

The ESE is also working on expanding the distribution network and substation capacity, as well as completing improvement works. This has resulted in a significant reduction in the levels of technical and non-technical losses, from approximately 30% in 2003-2009 to 25% in 2011.[104] However, there is still room for significant progress (see Figure 5). In particular, the YESB and the ESE should consider taking steps to reduce the prevalence of illegal hook-ups through the use of public information campaigns, while simultaneously providing new avenues for those currently connected illegally to obtain access.

Figure 19: Distribution system in downtown Yangon[105]

3. Strategies Generating Long-term Value

Insight 3.1: Assess options for building local industry

Through the NEMC, Myanmar should conduct a review of existing practices of local content regimes within the region and elsewhere to assess their advantages and disadvantages prior to implementing future local content mandates. This review will enable the implementation of clear policies and regulations that strike a balance between developing local industry and encouraging foreign investment. These policies and regulations can also take the form of appropriate incentives instead of simply listing requirements.

To date, the government has taken a pragmatic approach to reviewing leading practices for implementing future local content requirements. This has been well demonstrated in recent rounds of oil and gas bidding. International operators are required to incorporate local firms, other than MOGE, into their upstream activities for onshore and shallow water but not for deep water projects. This is sensible, as experienced local industry players have the capacity and skills to collaborate on onshore and shallow water projects, but not for deep-water projects that require additional skills and financing.

However, much more can be done to increase the focus of the energy industry on local needs. At present, the new foreign investment law has ambitious and simplified local content requirements. It mandates that foreign investors "shall appoint, when appointing citizen skilled workers, technicians and staff, at least 25% of citizen within first 2 years from the commencement date, at least 50% within second two years, at least 75% within third 2 years however in complex projects the time limit may be extended as the Commission considers necessary (*sic*)."[106] Few potential private sector foreign investors spoken to believe there is sufficient local capacity in place to support these broad requirements, and while a few companies have received high praise from a number of quarters, the issues of inadequate financing and a lack of skilled labour still represent major limitations.

Moreover, a range of local companies active in the oilfield services sector have made it clear that while they recognize their immediate capacity and capability constraints, in the longer term they would like to see stronger government backing of local content requirements for upstream and midstream activities. This would enable local firms to move beyond their current role of "bean counters and brokers" towards playing a more active role in the industry. Some members of the legislature also echo this sentiment. While many of the international operators present in Myanmar have extensive corporate social responsibility schemes in place, it is clear that at this time of extensive reform, they must continue to be agents of economic growth for local populations. In some instances this amounts simply to highlighting the good work already being done on the ground.

External perspective: Foreign investment and local content – Striking a balance

David G. Victor, Professor, University of California San Diego

The massive political changes within Myanmar in recent years have set the stage for the country to play a pivotal role in Asia's energy future. The key to that future is investment – especially by foreign firms that can help bring capital and expertise, as many already have through the development of Myanmar's massive natural gas resources.

Striking the right relationship with foreign investors is a perennial question in the energy business. In light of all the political changes under way within Myanmar today, three elements of that relationship are particularly important. First is clarity about goals. The new National Energy Management Committee (NEMC) can play a major role in herding the interests of the six ministries and three state energy companies that presently dominate the country's energy policy and investment system. Myanmar and foreign investors, alike, should expect that these goals will shift a lot as the country opens up and as the economy grows, creating new opportunities for the population to move from traditional agriculture to higher value-added activities. Shifting goals are not new; making those shifts predictable so that foreign investors can anticipate and adjust is crucial.

Second is the need to separate goals and means. One of Myanmar's central goals is the creation of national industries, such as those that use the country's huge potential supplies of natural gas. Many other countries have had similar goals, and one lesson from the experiences worldwide is that requiring foreign investors to play central roles in building national industries is usually inefficient. Let the foreign investors do what they do best – such as find and produce natural gas, oil and other hydrocarbons – and create separate enterprises to deliver other goals.

Instead of requiring local content and linkages upstream and downstream to local industries, a better approach may be to set aside revenues from new investment in hydrocarbons to finance national economic development. A national development authority – focused on goals such as local content and value added – would be better placed than foreign investors to actually deliver these goals. That authority might create special export zones and invest in infrastructure needed to support clusters of related industries, much as the PRC and Korea did in the early stages of their economic development. The government of Myanmar would be wise, as well, to resist the temptation to require investors in oil, gas, electricity and coal to shunt some of their production into local industries and perhaps even ban exports. That approach is often self-defeating over the long term since it creates industries that depend too much on cheap energy and are not competitive globally; it also reduces potential revenues from sales that could be channelled back into national development.

Third, it is hard to make any surge in investment in the country's energy infrastructure sustainable unless energy prices start to reflect market realities. Today, Myanmar faces a problem similar to that of many countries: energy prices are kept low, a policy that is politically attractive and thus hard to modify. But the spiral of low prices has impoverished the state and especially the electricity companies that face massive underinvestment in new supplies and grid infrastructure. The country will not take off economically if it does not have a reliable energy supply system. My sense is that the government thinks electricity subsidies (and other subsidies as well, such as for motor fuels) are politically untouchable. That might be right. If so, there are ways to keep the subsidy in place without causing much financial harm to the country's vital electricity system. Examples might include the creation of separate accounts that compensate electricity suppliers for revenues lost due to a subsidy, as some states in India have done quite successfully.

Insight 3.2: Improve human capacity within energy sectors

Healthy, skilled and knowledgeable workers are essential to the development of the energy sector as well as the wider economy. Under the previous regime, public expenditures on education and healthcare were low. Indeed, Myanmar is the only developing Asian country with a defence budget that is greater than the education and health budgets combined. Vulnerability to malaria, tuberculosis, HIV/AIDS and other diseases remains higher in Myanmar than in its regional neighbours, while net enrolment estimates for secondary education range from 53-58%.[107]

Chronic underinvestment in the education sector has created a legacy of low technical expertise at almost all levels. The civil service and state firms have been further weakened by successive governments' preference for a military background over technocratic capability. This restrictive environment has encouraged a brain drain of talent, with the best qualified citizens often leaving to work overseas. While estimates vary, there are believed to be 3-6 million Myanmar workers abroad, accounting for 10-20% of the total domestic workforce.[108]

An immediate focus is the need for improved technical skills applicable to energy sectors such as power and oil and gas. This will enable Myanmar to take advantage of its youthful, low-cost labour force – the 13 million people aged 15-28 years who account for nearly 40% of the working population.[109] IOCs active in Myanmar run extensive training programmes for the local population; the vast majority of Total's staff, for example, is indigenous. Stakeholders have suggested that further capacity-building could be achieved through MOGE, which could set up a certification programme focused on the development of workers for the oil and gas sector. In relation to this, there have been discussions of assistance from Thailand, Norway and India to improve human capacity within the oil and gas sector. More pressingly, the national education programme requires major reform in order to create higher education institutes and universities with internationally recognized academic standards.

Insight 3.3: Identify "green growth" opportunities

Myanmar relies heavily on natural resources for its main exports, and on industries such as agriculture and tourism, which makes it essential that its growth pattern be environmentally sustainable. In this context, Myanmar can take advantage of the global move to "green growth", which entails decoupling economic growth from further increases in GHG emissions and resource degradation. However, the government has no targets and could begin by setting a government target of renewable energy share in total energy consumption.

From a green growth perspective, modern biomass is seen to have the greatest commercial potential due to the strength of the agricultural sector, with biofuels playing an important role in reducing foreign currency expenditure by reducing petroleum import needs. There is a need to shift away from traditional biomass, such as fuel wood from natural forests – currently a prime energy source – and into new forms of biomass that are cleaner. A range of feedstocks are being considered, including rice husk, sugarcane and cassava. A project on Jatropha has been implemented, but has not yielded positive results due to high picking costs and a low price point. This underlines the need for an initial focus on early stage R&D to improve feedstock yields, and promoting technology transfer with other producers in the region such as Thailand. In pursuing such a policy, Myanmar will need to be mindful of the potential sustainability challenges associated with biofuels production and ensuring that production does not compete with food.

Solar power has great development potential in the central areas of the mainland. A few pilot projects have already been trialled, although solar power is still very much in an R&D phase. In some rural areas, photovoltaic cells have been installed to generate electricity for charging batteries and pumping water for irrigation.[110]

Both wind and geothermal energy are also in R&D phases, though both hold significant potential in Myanmar. Partnerships with foreign institutions have afforded Myanmar access to advanced technologies in these fields, with Japan's NEDO installing data-gathering equipment for wind projects and two Chinese companies undertaking feasibility studies for the development of a 4,032 MW wind farm in 2011.[111] In total, 93 locations suitable for the development of geothermal energy have been identified, 43 of which are being tested by MOGE in cooperation with Japanese and US stakeholders.

It is now time to move away from research and into actual implementation either by the government or the private sector. Myanmar's abundant potential for the development of renewable energy sources stands in marked contrast to how little has been done to harness them. This points to some clear underlying weaknesses in the institutional environment in which energy partners may be expected to operate. First, external partners require a fully transparent legal framework to support lengthy and expensive exploration projects, and a more developed financial sector to help finance project development. Along these lines, it is important that the subsidies attached to petroleum products are lifted to remove the relative price-disadvantage of renewable energy. Second, the government should aim to commission large-scale data-gathering expeditions to ensure that information about the scope of opportunities in the country is available to potential investors. There is an urgent need to have actual ground station measurements of solar irradiation and wind. Satellite-generated data is not very accurate as there is a 15% margin of error. Hence, reliable ground-level measurements of 2-3 years would be very helpful. The ADB is in discussion with the government to undertake such measurements under upcoming technical assistance programmes. Third, the government should aim to develop more partnerships with the private sector and other governments to take advantage of more efficient technologies. These are just a few initial but significant measures that should be considered in order to expand energy access in rural areas, develop a more sustainable and efficient energy system, and allow Myanmar to establish a more robust and lasting energy architecture.

Insight 3.4: Strengthen the macroeconomic environment

The greatest challenges faced by private investors wishing to enter and operate in Myanmar are its weak macroeconomic management and the lack of development of its financial sector. These challenges were persistently highlighted in interviews and other stakeholder interactions, suggesting that a number of steps need to be taken to provide greater macroeconomic stability and promote a greater sense of certainty among potential investors. While it is not the purpose of this report to make detailed recommendations with regard to economic policy, potential steps include: strengthening the bond function in the Ministry of Finance and Revenue; creating a more autonomous central bank that adopts a reserve targeting monetary framework; developing a functional inter-bank market; and creating an efficient, equitable and transparent tax system.

Many of these changes are under way and the government's Framework for Economic and Social Reforms document "recognizes that maintaining a stable macroeconomic framework is the first order of reforms essential for achieving the overall reform agenda". Indeed the government is consulting closely with the IMF on currency unification and other issues, and listening carefully to the recommendations of private economists and think-tanks. A recent Credit Suisse report on Myanmar commented that the government "gets it" on the economy.[112]

Even when these changes are implemented, risks will remain – the Asian Financial crisis of 1997-98 highlighted the risk of financial liberalization when macroeconomic management and regulatory capacity are weak. As Myanmar further integrates into the global economy, it will face a number of potential risks that require careful fiscal management, including high inflation, exchange rate instability and the potential for credit bubbles as financial deregulation proceeds.[113] Success in attracting foreign investment poses perhaps the greatest risk to sustainable growth. The 2006 bubble in Vietnam highlights the dangers of large increases in capital inflows to emerging economies with weak infrastructure and financial systems. The inflows led to property bubbles, misallocated resources and an overvalued currency. Similarly, in Myanmar the rapid reform process and potential influx of foreign investment could lead to a destabilizing boom and bust cycle.

To add to this, Myanmar faces the standard problem of resource-rich countries: when natural resource prices are high, foreign exchange flows in and drives up the exchange rate, making it difficult for both factories and farmers to compete with foreign imports. Indeed, signs of "Dutch Disease" have already begun to emerge. Because of rising natural resource exports, capital inflows, remittances and other factors, a flood of dollars and other foreign currencies has come into Myanmar, while import licensing and other taxes and restrictions have impeded imports. The result has been a real exchange rate appreciation of the kyat by 200% from 2006 to 2011 (relative to the US dollar).[114]

Ultimately, in this transition from a managed to a market economy, Myanmar cannot completely escape the potential for economic shocks. The PRC may provide an instructive example of how gradual and cautious approaches to liberalizing the financial sector can help maintain stability when the economy is not fully adapted to market mechanisms and market functions are impaired by a lack of transparency.

4. Potential Risks in Achieving Myanmar's New Energy Architecture Objectives

Managing the transition to a New Energy Architecture is not easy. The imperatives of the energy triangle may reinforce or act in tension with one another, forcing difficult trade-offs, and, in some cases, may mean that decisions have unintended consequences. Additionally, energy reforms are an integral part of the wider political transition now under way in Myanmar. This transition will directly affect what types and forms of energy architecture change are feasible and how current challenges can be overcome.

Two years into the new semi-civilian government, Myanmar has implemented a wide-ranging set of reforms as it seeks to integrate into the global economy. Support for the reforms is genuine. Participants from government expressed a distinct and deep-felt commitment to democratic governance. There is, however, much more to be done. The pace of change so far has been dramatic, but the challenges are complex and numerous. In particular, there are seven key risks that may affect the government's ambitious agenda to overhaul the country's energy sector and balance the imperatives of the energy triangle.

1. Pace of reform and international integration

The political will to implement reforms is laudable; however, the speed and depth of change has raised questions about how fast the reforms can advance. There are two major concerns at present. First, that limited institutional and technical capacity could prevent the comprehensive implementation of new policies. Second, that the rapid opening of the economy without reforms being completed exposes Myanmar to the overbearing interest of foreign stakeholders. National institutions are spending a great deal of time negotiating deals with foreign companies at the expense of implementing internal reforms. The government of Myanmar will need to strike a balance between advancing energy reforms and attracting energy investments. One stakeholder interviewed commented that the "change is great; however, I wish it could happen at a slower pace so we could understand the consequences of decisions and plan better." Contrary to this stakeholder's aspiration, the interest from abroad is only going to intensify over the next two years as Myanmar hosts the Southeast Asian Games, stages a major telecom bidding round in 2013 and takes over the chairmanship of ASEAN in 2014.

2. Political developments

Myanmar has made encouraging progress in the arena of political reform since 2011, but as the 2015 general election draws nearer, there are doubts over continuity. Linked to this parliament is review of the 2008 Constitution. Indeed, the ruling Union Solidarity and Development party has suggested that the review might pave the way for greater rights for ethnic minorities by granting them the right to elect their own state-level representatives.[115]

The prospect of sanctions being lifted altogether has sparked a great deal of interest from investors. Indeed, a sense of renewed international confidence in Myanmar is suggested by the recent moves by US authorities to reopen business between the two nations. Although there remains scope for the renewed imposition of sanctions, these changes send important signals to international investors taking a fresh interest in the country. Other encouraging signs have emerged as countries including Canada, Australia and Japan have lifted or suspended sanctions. The European Union also moved in April 2013 to permanently remove all economic, trade and individual sanctions against Myanmar, barring the arms embargo. Despite strong interest and foreign investments increasing, long-term stability and continued reforms will be important for the global business community to substantially increase investments in Myanmar.

3. Social unrest and ethnic groups

The representation of ethnic minorities and management of social unrest present another set of significant challenges to the government. A quick examination of the ethnic make-up of the country hints at the extent of this challenge: only 68% of the population are Burman, the remainder are made up of Shan, Kachin, Karenni, Wa and Royhinga, among others. Although progress is being made with the armed ethnic groups, there are still serious clashes with the Kachin Independence Organisation. The transition to democracy has also resulted in a greater degree of personal and social freedom in Myanmar, a development that has driven the re-emergence of local conflicts.

Bringing peace to the ethnic regions and managing social tensions will be critical to avoiding significant damage to the reform process. However, it is a considerable task and will be a formidable challenge to expanding energy access. This is especially true with regard to the energy sector, since the site of many resources – hydropower dams, coal reserves and pipeline developments – lies close to or on the route to ethnic borderlands.

4. Human capital deficit

A crucial component of modern economic development is the availability of human capital. As a result of its historical development, Myanmar lacks the necessary level of education and professional and technical skills to support its economic ambitions. Even now, the government spends only 1.3% of GDP on education, compared with 8% in Malaysia and 5% in Thailand. The poor state of universities also means that the majority of those achieving advanced levels are over 50 years of age.[116] This is an untenable situation for any nation looking to develop economically or socially, and will severely curtail Myanmar's potential to grow if the country fails to address it in a radical and comprehensive manner.

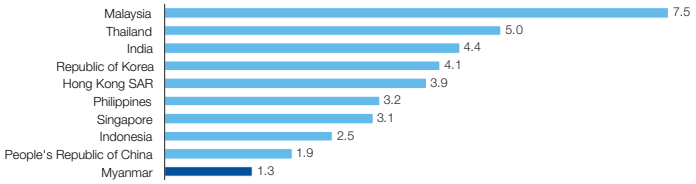
Figure 20: Ethnicity population breakdown

Source: Centrtal Intelligence Agency, (Accessed: 26/04/2013)

Note: Groups not mentioned by name are included in the "Other" category

Figure 21: Public expenditure on education as a percentage of GDP

Source: Credit Suisse, World Bank
Note: All data for 2001 with the exception of People's Republic of China (1999) and India (2000)



5. Overvalued currency

The government took positive steps to improve its monetary policy by unifying its multiple exchange rates. However, the excessive strength of the currency remains a significant problem. The market rate of the kyat has been pushed up significantly by the sale of state assets, receipts from gas exports and high local interest rates.[117] While this may indicate confidence in Myanmar, the strong kyat threatens to hamper export markets in what is commonly known as the "Dutch Disease". The export of natural gas could play a major part in this development, as soaring revenues from gas sales continue to put upward pressure on the currency, making other exports, notably the successful export of beans and pulses to India, increasingly unattractive.

6. Starting from a low base

Although the government's continued commitment to democratic progress and ambitions for economic prosperity are encouraging signs of Myanmar's potential for growth, the country is still in its infancy with regard to some of the most basic inputs for development. It is the second-poorest country in Asia after Afghanistan and has an economy that is only 14% the size of Thailand's.[118] Generating a cycle of supply and demand in its domestic market is challenging when purchasing power is incredibly low, pointing to the need for investment in rural infrastructure and education concurrently with investment in industrial activity. Indeed, the current, basic communications network and frequent blackouts are indicators of the scale of work required to create an infrastructure that can support economic expansion. In addition, the inward-looking nature of the regime over the last five decades has impeded the development of an entrepreneurial class with access to international or even regional exchanges of knowledge, technology and human capital. These factors set Myanmar apart from its regional neighbours, but also present the opportunity for comprehensive development across all sectors through greater international cooperation.

7. Development driven by global liquidity

It comes as no surprise that investors have taken a great deal of interest in Myanmar as a country with strong potential for growth. However, lingering perceptions of political and economic risk mean that investor activity in this relatively young market is especially sensitive to global liquidity issues. If wider events cause investors to seek a haven in secure places, then Myanmar may become a centre of volatility as capital flows out of the country in times of heightened global uncertainty. This issue can be mitigated to some extent by creating a sound legal and financial framework for investment, and assuring new entrants to the market of Myanmar's commitment to continued reform.

In focus: Natural riches? Perspectives on natural resource development in conflict-affected countries

Myanmar's opening up to foreign investors presents great opportunities for the country to maximize its economic potential, bring increased wealth to its population, promote long-term stability and reduce the risks associated with extraction of natural resources, including armed conflict.

The Network of Global Agenda Councils of the World Economic Forum collaborated throughout 2012-2013 to develop a *Check-List for Managing Natural Resources in Conflict-Affected Nations*. Their collaboration offers high-level guidance on how natural resource wealth can be responsibly developed for the benefit of nations that face the challenges of violent conflict. Myanmar – a resource-rich country which has recently embarked on a political transition – can ensure its natural resources are a force for peace.

Many of the world's remaining natural resources are in harder-to-reach places such as under deep oceans, in the frozen Arctic, and often close to indigenous communities or in proximity to conflict zones. The opportunities offered by natural resources are extraordinary for this fragile developing country facing high poverty levels, a growing population with high expectations, low levels of revenue base and a sluggish economy with weak institutions. The exploitation of these resources will present a relatively quicker and simpler avenue to secure revenues that can be used to mitigate poverty, build and modernize infrastructure, and otherwise develop the country.

However, experience from a range of very different countries shows that it is not straightforward to reap the benefits of natural resource development. Indeed, the exploitation of mineral wealth is all too often associated with increased conflict risk, corruption and an arbitrary and unstable system of government. The United Nations estimates that 40% of intra-state conflicts are related to natural resource exploitation. Resource-rich nations are 50% more likely to relapse into violence. Thus, responsible resource development can play a vital role in building a strong, stable nation and a prosperous society, especially in fragile states.

Myanmar has embarked on a promising transition, with the potential to resolve long-standing violent conflicts. As a nation, Myanmar possesses a wealth of assets including natural endowments of tin, antimony, zinc, copper, tungsten and lead as well as petroleum, timber, coal, marble, limestone, gemstones, natural gas and hydropower. These resources can be extremely lucrative and transformative. Maximizing the potential of these assets for Myanmar's citizens will require careful attention to vital, interconnected elements of responsible natural resource management.

A basic check-list for responsible management of natural resources in conflict-affected countries includes the following elements:

- A national development policy to frame activities in the natural resource sector
- Legal and regulatory frameworks for natural resource development
- Best practices for contract design
- Laws regarding transparency of payments and revenue management
- Frameworks to address human rights in natural resource development
- Governmental and civil society institutions to support natural resource development
- Community engagement and environmental management policies
- Investment in local development through capacity-building and local content

Step 4: Introducing Areas of Leadership

Creating Multistakeholder Partnerships

Creating an enabling environment that is resilient to risk and responsive to the imperatives of the energy triangle is beyond the scope of an individual corporation or government. Our research on New Energy Architecture has shown that five key groups of stakeholders have a role to play:

Government – Creating a stable and transparent policy platform to facilitate change
- Clear and sustained government policy support is an essential prerequisite for an effective transition.
- Once a clear policy platform has been created, policymakers should look to support capacity-building, including centralized support for R&D programmes and skill development for new and emerging industries.

Industry – Driving implementation through innovation and investment
- Industry should build on the government's lead, driving implementation through innovation.
- Increased levels of inter-industry collaboration will be vital to ensure continued innovation as energy firms look to leverage each other's knowledge and experience, access new markets and gain additional funding for highly capital-intensive projects.

Small-scale and local private sector – Driving rural access
- The private sector can provide energy services to meet end-user needs.
- Small-scale and local businesses can create employment opportunities, thereby raising the rural standard of living.

Civil society – Building greater transparency and public support into the system
- Making changes to energy architecture requires building support among all stakeholders in civil society.
- Enhancing public involvement in shaping the future of the sector is essential to build trust and ensure broad support.

Donor and development partner institutions – Providing technical expertise, comparative experience and finance
- They bring international experience and technical expertise, including comparative experience from other similarly situated countries.
- The finance they bring is necessary for change.
- They support multistakeholder interaction.

Orchestrating a broad-based, systemic transformation can be extremely challenging. By definition, an ambitious transformation requires stakeholders to go beyond business as usual, acting outside of traditional roles and structures and collaborating in new ways to create coalitions to meet the New Energy Architecture challenge.

The strong inter-linkages that now exist across resources and geographies, as illustrated in Step 1 by ASEAN regional energy integration efforts, further underlines the importance of building a multistakeholder environment. This requires different bodies to work together to create integrated resource plans. Without these, conflicting objectives and interests between policymakers, unclear ministerial responsibilities and insufficient coordination between the institutions involved will result in delays to the transition to a New Energy Architecture.

The Current Stakeholder Environment in Myanmar

Figure 22: Key energy stakeholders and institutions acting within Myanmar

Non-exhaustive

Initiating Dialogue and Collaboration to Drive the Transition to a New Energy Architecture

Based on discussions in Myanmar to drive the transition to a New Energy Architecture, stakeholders should seek to take the following steps:

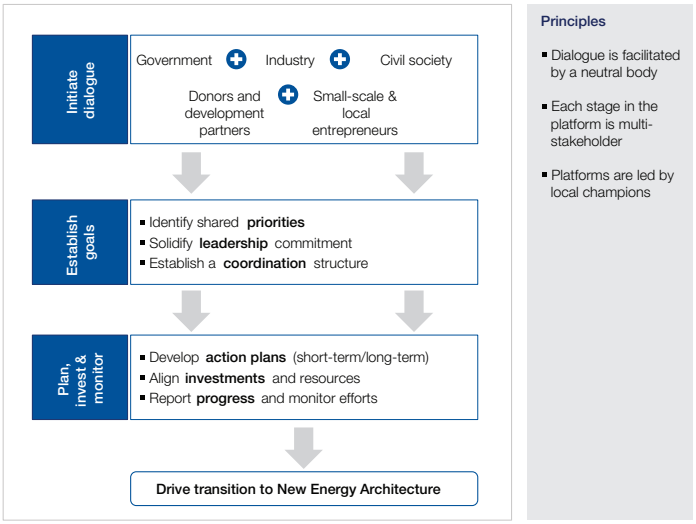
a) Take a more inclusive, collaborative approach: Myanmar needs to create new institutional mindsets and mechanisms that can develop more coordinated approaches to its energy challenges. Policies should be built by coalitions of stakeholders based on a collaborative approach that incorporates perspectives from industry, society and academia. Promoting these exchanges will enable informed decision-making. This requires improved lines of communication between stakeholder groups such as business and civil society, and stronger connections between ministries and government agencies whose spheres of influence intersect.

b) Form multistakeholder partnership platforms: Driving stronger alignment across stakeholder groups, and not simply within government, calls for the formation of partnership platforms. Through a process of facilitated dialogue, stakeholders can discover their common interests, build trust and identify where government priorities and business interests overlap. The group can then establish a structure for collaboration – such as a task force or council – to coordinate efforts around these priorities. This form of collaboration will accelerate progress towards shared goals by aligning and focusing stakeholder investments, programming and collaboration.

c) Build clear and consistent policies: A collaborative approach will help facilitate consistent and predictable policies, eliminating the sometimes mixed messages currently sent to businesses and the public at large.

d) Communicate effectively to the public: Once collaborative, clear and consistent policies are created, they need to be effectively communicated to the public and industry. Targets should be translated into a language that the public can understand, clarifying how policies will affect everyday life.

Figure 23: New Energy Architecture Partnership Platforms[119]



Next Steps

This report recommends that stakeholders in Myanmar review the insights it highlights to lay out a prioritized and sequenced roadmap for the creation of a New Energy Architecture. To execute this roadmap, the stakeholders need to show leadership in its implementation and, where appropriate, form multistakeholder working groups to maintain the momentum of the government's reform agenda. The World Economic Forum, the Asian Development Bank and Accenture will continue to provide assistance in this process.

Appendix

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Abbreviations

ADB	Asian Development Bank
AEC	ASEAN Economic Community
APAEC	ASEAN Plan of Action for Energy Cooperation
APEC	Asia-Pacific Economic Cooperation
APG	ASEAN Power Grid
ASEAN	Association of Southeast Asian Nations
CNPC	China National Petroleum Corporation
DEP	Department of Electric Power
DICA	Directorate of Investment and Company Administration
EAPI	Energy Architecture Performance Index
EDC	Energy Development Committee
EIA	Environmental Impact Assessment
EITI	Extractive Industries Transparency Initiative
EOC	Greater Mekong Subregion Environment Operations Centre
ESE	Electric Supply Enterprise
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GMS	Greater Mekong Subregion
IEA	International Energy Agency
IEP	Integrated Energy Plan
IOC	International Oil Company
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
LED	Light-Emitting Diode
LPG	Liquefied Petroleum Gas
MEPE	Myanmar Electric Power Enterprise
MIC	Myanmar Investment Commission
MOAI	Ministry of Agriculture and Irrigation
MOE	Ministry of Energy
MOECAF	Ministry of Environmental Conservation and Forestry
MOEP	Ministry of Electric Power
MOGE	Myanmar Oil and Gas Enterprise
MOI	Ministry of Industry
MOM	Ministry of Mines
MOST	Ministry of Science and Technology
MOU	Memorandum of Understanding
MPE	Myanmar Petrochemical Enterprise
MPPE	Myanmar Petroleum Products Enterprise
NEA	New Energy Architecture
NEDO	New Energy and Industrial Technology Development Organisation
NEMC	National Energy Management Committee
NOC	National Oil Company
PPA	Power Purchase Agreement
PRC	People's Republic of China
PSC	Production Sharing Contract
PTTEP	PTT Exploration and Production Public Company
RPCC	Regional Power Coordination Centre
SEACOP	South-East Asia Crude Oil Pipeline
SEAP	South-East Asia Pipeline
SIA	Social Impact Assessment
TAGP	Trans-ASEAN Gas Pipeline
TPES	Total Primary Energy Supply
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
VSPP	Very Small Power Producer
YESB	Yangon City Electricity Supply Board
YCDC	Yangon City Development Committee

Weights and Measures

BCF	billion cubic feet
BD	barrels per day
GW	gigawatt
GWh	gigawatt-hour
Ha	hectare
Hz	hertz
Km	kilometre
km2	square kilometre
KTOE	kiloton of oil equivalent
kV	kilovolt
kVA	kilovolt ampere
kW	kilowatt
kWh	kilowatt-hour
MCF	thousand cubic feet
MMbbl	million barrels
MMCFD	million cubic feet per day
MTOE	million tons of oil equivalent
MW	megawatt
MWh	megawatt-hour
MVA	million volt-amperes
TCF	trillion cubic feet
TWh	terawatt-hour

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