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Contents

Preface

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We are pleased to present this report, created within a partnership between the World Economic Forum and the Ministry of Energy of Thailand, with the support of our project advisor, Accenture. The partnership was established to assist Thailand in assessing the performance of its existing energy system and in identifying options with which to strengthen it, to support economic growth, energy security and sustainability.

Now is a pertinent time to explore this topic. With the formation of the Association of Southeast Asian Nations (ASEAN) Economic Community in 2015, Thailand is preparing for the creation of more integrated energy architecture in the region. We hope that the insights provided in this report will enable Thailand and the wider ASEAN region to achieve this goal. The insights and recommendations provided stem from research and dialogue carried out among key stakeholders from business, government and civil society.

This research forms part of the World Economic Forum's New Energy Architecture initiative, which strives to understand better how decision-makers can respond to the changes underway in the world's energy architecture. Energy architecture is defined as the integrated system of energy sources, carriers and demand sectors shaped by business, government and civil society.

With the past decade reversing a 100-year decline in resource prices,[1] existing energy architecture has become increasingly expensive. It has a growing impact on the environment and remains highly dependent on fossil fuels, the combustion of which accounted for 84% of greenhouse gas emissions in 2009. Increasingly, energy architecture is under pressure from growing demand, especially in the developing world, which will account for 90% growth in the demand for energy, through to 2035.[2] In sum, meeting the challenges of the "energy triangle" – economic growth and development, environmental sustainability, and energy security and access – is ever more difficult.

A major transformation in the way energy is produced, delivered and consumed will be required if we are to respond to the emerging dynamics of energy poverty, climate change, and resource scarcity. Efforts to achieve this transition are inspired by new possibilities, including new alternative energy sources and technologies, which make more efficient use of existing energy sources.

Enabling this transition will not be easy, however. The energy sector poses a unique set of challenges due to its size, complexity, path dependency and reliance on long-lived assets. To help decision-makers bring about change effectively, the World Economic Forum created the New Energy Architecture methodology. Prior to the partnership with the Ministry of Energy of Thailand, this approach was applied to Japan and India.

We would like to thank the Ministry of Energy of Thailand for the partnership, as well as Accenture and all stakeholders who contributed to it. We recommend that stakeholders in Thailand review and prioritize the "actionable insights" highlighted in this study to develop strategies for strengthening Thailand's energy architecture and identifying how to bring about the solutions desired. The World Economic Forum will continue to seek to assist in this process.

[1] McKinsey Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.
[2] International Energy Agency, *World Energy Outlook 2011*.

Executive Summary

The year 2015 will bring about the formation of a united ASEAN Economic Community (AEC). The creation of a single market and production base will position its 10 member states well to accelerate their economic development. The AEC will catapult this bloc of countries, holding a combined gross domestic product (GDP) of US$ 1.9 trillion projected for 2020,[3] into the position of the eighth-largest economy worldwide.

The ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-15 covers the energy component of the Economic Community Blueprint 2015. It seeks primarily to create a solution to the energy "trilemma" – delivering on energy security and economic growth and development in an environmentally sustainable way. By tackling these challenges regionally, as opposed to unilaterally, the ASEAN countries will be able to draw on one another's strengths and to overcome their individual weaknesses.

Countries across the region are preparing themselves for the AEC and are excited at the prospect of increased opportunities. The pace of change will depend on the willingness of individual nations to reform and liberalize their energy sectors and to open themselves up to greater market competition. This is a considerable challenge for a sector often considered to be of unique strategic importance, paramount to national security.

This report aims to assess how Thailand can prepare for and promote the integration of ASEAN energy architecture. We explore how Thailand can create a New Energy Architecture to address the challenges of its current system and stave off competitive threats while drawing upon its strengths to accrue economic and energy security benefits from this integration. Our approach is based on the New Energy Architecture methodology, jointly developed by the World Economic Forum and Accenture through a multi-year partnership.

Current Challenges and a Vision for a New Energy Architecture in Thailand

Since the Ministry of Energy was established 10 years ago, significant progress has been made in Thailand's energy architecture. The country currently ranks 46th on the Energy Architecture Performance Index (EAPI) – a composite indicator that evaluates the performance of 105 nations across the energy triangle assessing whether their energy architecture supports economic growth and development, in an environmentally sustainable way, while providing energy access and security. Compared to its peers, Thailand has performed well. It is the highest scoring ASEAN nation, ranking 14th among non-Organisation for Economic Co-operation and Development (non-OECD) nations, and its performance improved over the five years for which data was collected. These improvements were driven by steps to create a sector that is more supportive of economic growth and development. In particular, Thailand's efforts to reform gasoline prices, by removing distorting subsidies and increasing taxes that promote efficient energy use, have had a positive effect.

Further improvements could be made, however. Continued economic growth has put pressure on energy security: over the last 25 years, energy consumption has grown at 6.2% a year, while, in contrast, Thailand's reserves of oil and gas have been declining.[4] Increases in energy consumption carry concomitant concerns about sustainability, as carbon emissions increase apace; they rose at 3% per year, in the period of 2004-2008.[5] Increasing challenges in securing supply (within Thailand and globally) and the need to promote more efficient energy use have driven up electricity and fuel prices.

Bearing these challenges in mind, a series of New Energy Architecture objectives has been created to inform the vision of how Thailand can create an energy architecture that better meets the goals of the energy triangle. This vision is based on three sources of input:

- The strengths and weaknesses of Thailand's current energy architecture, as identified through the EAPI
- A series of interviews and workshops held with stakeholders from across the energy value chain
- Existing targets and action plans, created by the Ministry of Energy[6]

[3] Accenture, *Destination South East Asia: A Joint Pathway to Future Growth? Opportunities for Regional Business Expansion*, 2011; Analysis of data from IHS Global Insights, 2011; World Economic Outlook Database; International Monetary Fund, 2010.

[4] APEC Peer Review on Low-Carbon Energies (PRLCE), *Background Information.*

[5] Accenture analysis of Energy Information Administration, *Annual Energy Outlook 2011.*

[6] See the 10-Year AEDP (2012-2021) and the 20-Year Energy Efficiency Development Plan (2011-30).

NEW ENERGY ARCHITECTURE OBJECTIVES

Diversification

The exploration of new and existing sources both in Thailand and abroad increases the diversity of the energy mix, leading to a rise in renewable energy consumption to 25% of the energy mix in 2021.

Efficiency

An energy literate population assists industry and government in creating a sustainable society built on energy efficiency and conservation programmes, leading to a reduction in energy intensity by 25% in 2030, equivalent to a reduction of final energy use by 20% (approximately 30,000 ktoe).

Integration

Thailand plays a leading role in building stronger links across the ASEAN region, both in terms of institutional and physical connectivity, driving energy integration as part of the formation of the ASEAN Economic Community and becoming a regional energy hub in areas where it has a competitive advantage.

ACHIEVING THESE OBJECTIVES…

New energy architecture objectives

- **Diversification**
- **Efficiency**
- **Integration**

…WILL ADDRESS CHALLENGES IN THAILAND'S CURRENT ENERGY ARCHITECTURE

Energy architecture challenges addressed

Economic growth and development

- High energy intensity
- Rising costs of energy imports

Environmental sustainability

- High carbon emissions
- Inefficient vehicle fleet
- Low integration of "new" renewable technologies

Energy access and security

- Import dependence
- Low fuel diversification in the power sector
- Quality of electricity supply

Features of an Enabling Environment

Based on discussions with stakeholders in Thailand, this report identifies a series of "actionable insights" that may help the country achieve its objectives and enable an effective transition to a more diversified, efficient and integrated energy architecture. The actions proposed are not exhaustive, but represent the insights gleaned during discussions held in Thailand. They offer stakeholders in the country options with which to explore, prioritize, and form working groups.

OVERVIEW OF ACTIONABLE INSIGHTS

1. Diversification

1.1 Build flexibility into the 10-year Alternative Energy Development Plan (AEDP) 2012-2021

1.2 More closely regulate small power providers (SPPs) and very small power providers (VSPPs), and consider alternative financing support mechanisms for new energy technologies

1.3 Set clear interconnection protocols, coordinate generation-to-transmission planning, and adopt supporting technologies for intermittent renewables integration

1.4 Promote the sustainable growth of the biofuels sector by creating a clear sustainability framework, increasing land productivity and supporting R&D for advanced biofuel technologies

1.5 Attract and support oil & gas independents to develop marginal and mature fields

1.6 Build on bilateral relationships with neighbours to open up new sources of supply

1.7 Focus on capacity building to lay the foundations of the nuclear sector

2. Efficiency

2.1 Develop more efficient production processes and increase product quality in the manufacturing sector

2.2 Focus on creating efficiency standards, adopting innovative financing mechanisms and government-led procurement initiatives, to increase the uptake of energy efficiency measures in residential and commercial buildings

2.3 Create a "smart" city roadmap for Bangkok

2.4 Create a more targeted programme of subsidies for the transportation sector

3. Integration

3.1 Take an inclusive view of connectivity that incorporates not just physical components, but also financial and human

3.2 Clarify Thailand's hub strategy, identifying best prospects and infrastructure requirements

4. In Focus: Energy Literacy – A Cross-objective Enabler

4.1 Foster understanding of energy issues

4.2 Create incentives and formal mechanisms to encourage change

4.3 Demonstrate and role model change through pilot programmes that bring local benefits

1. Diversity

In creating a diversified energy architecture, Thailand can take several steps to promote the expansion of home-grown renewables, supplies of hydrocarbons and the creation of a nuclear sector [which is included in the Power Development Plan 2010 of the Electricity Generating Authority of Thailand (EGAT)]. These steps include:

1.1 Build in flexibility to the 10-year Alternative Energy Development Plan (AEDP) 2012-2021:

The renewables sector has undergone extensive technological change in recent years. A doubling of installed capacity leads to unit cost reduction of around 20% for solar photovoltaic and around 10% for onshore and offshore wind, according to a 2007 review of historical technological improvement rates.[7] In future, the performance of clean energy technologies will continue to make substantial progress, thanks to improved production engineering. Thailand's AEDP will therefore need to be accommodating to technological advances and changing industry dynamics.

1.2 Regulate Small Power Providers (SPPs) and Very Small Power Providers (VSPPs) more closely and consider alternative financing support mechanisms for new energy technologies:

While a wide variety of policy initiatives exist for renewables, their success depends on their execution. Ambitious targets and policies do not necessarily generate success. As the execution of the power generation elements of the AEDP will fall predominantly on the private sector, a stronger regulatory body may be required to oversee their activities. Such regulatory control will prevent power purchase agreements (PPAs) from being awarded to companies with limited technical experience or to those seeking to resell PPAs on secondary markets, as has occurred in the past. The government should consider alternative approaches to the feed-in-tariff (FIT) "adder" premium payment that was introduced

[7] McKinsey Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.

in 2006. Because of the pace of technological change in the solar sector, the payment mechanism requires constant monitoring and repeated tariff adjustments. This generates instability for investors and poses the risk of developers being oversubsidized. To support the expansion of the solar and the broader renewables sector, Thailand should consider alternative approaches to FIT creation or examples of best practice, such as India's reverse auction approach.

1.3 Set clear interconnection protocols, coordinate generation-to-transmission planning and adopt supporting technologies for the integration of intermittent renewables:

Experience from Europe suggests that transparency and uniformity in interconnection rules are crucial factors for renewable energy developers. Ensuring these standards are enforced is EGAT's responsibility. Accordingly, EGAT has put in place a grid code to assign criteria, duty and responsibility related to the operation of the grid connection and to define regulations and technical specifications of the grid. Coordinated generation-transmission planning is also critical to the success of renewable energy expansion. This calls for detailed grid analysis, considering how a proactive approach can be applied to transmission expansion, based on resource availability, developer interest and project submissions. Supporting the implementation of the AEDP will require that EGAT consider implementing such an approach. As penetration rates of variable renewable generation increase, it can become increasingly difficult to ensure the reliable and stable management of the grid. Smart grids will support greater deployment of variable generation technologies by providing operators with real-time system information that enables them to manage generation, demand and power quality. In March 2011, the Provincial Electricity Authority (PEA) announced its smart grid development road map. While both the Metropolitan Electricity (MEA) and EGAT have adopted a series of policies and projects related to the efficiency and strengthening of the grid, neither organization has a clear smart grid strategy. A more unified approach will be required if Thailand is to succeed in delivering a smart grid.

1.4 Promote the sustainable growth of the biofuels sector by creating a clear sustainability framework, increasing land productivity and supporting research and development (R&D) for advanced biofuel technologies:

Biofuels production interacts with society and the environment in complex ways. Its impact on health, poverty and biodiversity can be positive or negative, depending on how projects are designed and implemented. To ensure that biofuels production based on current feedstocks is sustainable and does not impinge on food production, Thailand needs to: focus on creating clear sustainability frameworks and standards; increase land productivity, improving yields for current feedstocks; and promote advanced biofuel technologies. Since many biofuel technologies are in early stages of development, the government may need to play a role in bringing them to the market by offering direct support to R&D. In pursuing such an approach, Thailand should be mindful of where it has a competitive advantage, influencing where the country should be a "first mover" and where it should be a "fast follower".

1.5 Attract and support oil and gas independents to develop marginal and mature fields:

The oil and gas sector in Thailand is focusing on maximizing production in the Gulf of Thailand, which is beginning to plateau. A range of technical measures can be deployed to support the development of marginal and mature oil and gas fields. Many of these technologies have been adopted in the Gulf – the government's role should be to support continued investment through an appropriate policy framework and tailored fiscal regime, as took place in the United Kingdom and Norway. Access to infrastructure is also critical, as in most instances, marginal fields are unable to support their own infrastructure for off-taking oil and gas. Accordingly, Thailand should consider developing a voluntary code of infrastructure practice to guarantee new and smaller operators access to third-party infrastructure.

1.6 Build on bilateral relationships with neighbours to open up new sources of supply:

As the production of indigenous sources of gas is plateauing, Thailand will need to look increasingly towards international markets to secure its supplies. As with the rest of the energy sector, this will require a more diversified approach, in which hydrocarbons are sourced from multiple "hubs". The ASEAN region will remain a core hub, but Thailand will need to focus its efforts increasingly on accessing wider international markets. Supporting this approach will call for a clear understanding of market dynamics, such as the implications of shale gas production for Asian liquefied natural gas (LNG) prices.

1.7 Focus on capacity-building to lay the foundations of the nuclear sector:

In April 2011, the National Energy Policy Council (NEPC) postponed the development of nuclear power generation by three years in order to fill capacity gaps and promote public understanding. Capacity-building efforts should focus on establishing the sizeable support industries required for a robust nuclear sector. As the *New Energy Architecture: Japan* study demonstrated, countries that use nuclear power need to establish strong capabilities across the nuclear value chain, including managing cooling shutdown, storing spent fuel, disposing of contaminated water, and decommissioning. Appropriate organizational systems and oversight must also be put in place, embedding a culture of safety from project planning through to operation. Finally, Thailand should consider the recommendations made by the Fukushima Nuclear Accident Independent Investigation Commission (NAICC), with regard to the effective functioning of regulatory bodies.

2. Efficiency

In creating efficient energy architecture, Thailand could take a number of steps to conserve energy across key demand centres. These include industry, residential and commercial buildings, and transportation:

2.1 Develop more efficient production processes and improve product quality in the manufacturing sector:

Over the past decade, energy-intensive industrial sectors have been an important component of Thailand's economy. Manufacturing has, in particular, been an area of expanding economic activity and has contributed to high levels of energy intensity. Thailand will need to focus on developing more efficient production processes, improving product quality in the manufacturing sector and expanding into higher value-added activities. This will form an important component of achieving the objectives of the 11th National Economic and Social Development Plan, which aims to rebalance Thailand's economic structure to less energy-intensive, higher-value-added activities.

2.2 Focus on creating efficiency standards, adopting innovative financing mechanisms and government-led procurement initiatives, to increase the uptake of energy efficiency measures in residential and commercial buildings:

Since Thailand enjoys significantly more efficient technologies than were available to other countries which went through the same stage of development, there is the potential to embed more efficient consumption in Thailand's middle-class consumers. While more efficient technologies exist, however, there are a number of hurdles to driving up adoption rates, including principal-agent barriers and access to financing. Government efficiency standards can be an effective, low-cost means to overcome principal-agent barriers and coordinate a transition to more efficient products. Innovative financing mechanisms are needed to help overcome capital constraints. Examples include tying loan payments to a property or utility meter, instead of to the homeowner. To help address the risks inherent in technology and markets, the Thai government can also act as a lead customer of emerging technologies, through public-sector procurement.

2.3 Create a "smart" city road map for Bangkok:

Accommodating 7 million residents, Bangkok is Thailand's largest city and largest source of energy demand. Resulting challenges include growing congestion and CO_2 emissions. Social media, the Internet, "cloud" computing, embedded sensors and mobile phones are creating a smart or digital infrastructure that grows more powerful every year. Bangkok can draw upon these technological developments to become a smart city and meet its challenges using a strategic application of information communication technologies (ICTs). Bangkok has a climate change plan in place, however, in order to reap the many opportunities provided by ICTs, a clear smart city road map needs to be defined.

2.4 Create a more targeted programme of subsidies for the transportation sector:

Fossil fuel subsidies for consumers have been used by developing country governments as a means to alleviate energy poverty, redistribute national resource wealth and control inflation. While such subsidies may bring some social and economic benefits, they also come at a considerable cost, burdening public finances and increasing greenhouse gases (GHG) emissions and wasteful consumption. Although Thailand has made progress in its petroleum subsidy removal, public opposition has slowed it down. This resistance has harmed the government's ability to change fuel consumption patterns. In response, the government should look to adopt a more targeted approach to the use of subsidies in the transportation sector, one that will enable the gradual removal of support for low-priced petroleum products and the expansion of support for the use of gasohol.

3. Integration

To create regionally integrated energy architecture, Thailand should seek to improve its connectivity with other member states, while selectively pursuing opportunities that allow it to benefit from greater energy integration:

3.1 Adopt an inclusive view of connectivity, incorporating physical, institutional, financial and human components:

Stakeholders in the region have varying perspectives on the progress relating to the creation of regionally integrated energy architecture. While a number of connections between countries exist, they have been completed on a bilateral basis. Success at the multilateral level has been limited. During discussions held in Thailand, stakeholders emphasized that the region needed to adopt a broader understanding of connectivity. As defined in the *Master Plan on ASEAN Connectivity*, connectivity consists of three core components:[8] (1) institutional: developing institutional mechanisms to facilitate trade in goods and services, and the appropriate types of investment policies and legal frameworks to attract private investors; (2) human: developing initiatives that support human resource development, encourage innovation and entrepreneurship and build stronger socio-economic bonds; and (3) physical: developing an integrated and well-functioning energy network.

3.2 Clarify Thailand's hub strategy, identifying its best prospects and infrastructure requirements:

The formation of the AEC will change Thailand's energy sector significantly. Given its location in the region, the country is suited to becoming a central hub for energy trade in many sectors – including gas, electricity, ethanol and renewables components – and has identified this explicitly as an objective. During discussions, stakeholders emphasized that while Thailand has many of the ingredients needed for it to become a hub for energy trade, a robust strategy and strong leadership are required to ensure that the opportunity is reaped. Formulating this strategy calls for a sound understanding of: the attributes required to become a trading hub; the specific energy-related opportunities available and the viability of these options, based on how the country's strengths complement those of its neighbours.

4. Energy Literacy – A Cross-objective Enabler

Throughout discussions held in Thailand, stakeholders emphasized the importance of energy literacy as a cross-objective enabler. A lack of understanding of the energy sector has the potential to derail the three objectives outlined in this report. Energy literacy will therefore play an important role in creating a more informed debate about the future of energy policy. Three actionable insights may help Thailand achieve this:

4.1 Foster understanding about energy issues:

A number of traditional information programmes can be used to boost energy literacy, including energy labelling, energy academies and think tanks. Changes in technology and the move of consumers online are shifting traditional preferences as to how public discussions take place. The government and utility providers should draw upon new tools to take advantage of this shift, including apps, social media and gamification.

4.2 Create incentives and formal mechanisms to promote change:

Behavioural economists have found that diverse psychological or neurological biases motivate people to make choices. This idea has been developed, arguing that it is possible to nudge people towards better decision-making, by presenting the choices available

[8] ASEAN Secretariat, *Master Plan on ASEAN Connectivity*, Jakarta: ASEAN Secretariat, January 2011.

in different ways. [9] Such techniques can be used to change the way consumers interact with energy. For example, preliminary results suggest that when utilities give consumers monetary savings through dynamic pricing (varying according to the time of day and when peak demand occurs), consumers change how and when they use electricity. To that end, EGAT, MEA and PEA should collaboratively establish rates and tariffs that promote these behavioural shifts. EGAT, MEA and PEA can also draw upon partnerships to implement loyalty programmes, offering rebates or other rewards to consumers who purchase certain products or carry out specific actions. An alternative for lower-income groups is prepaid energy, which is present in many countries and targets disadvantaged consumers. By using prepaid energy, consumers become more aware of their consumption. This scenario offers utilities valuable insights into the broader scope of energy consumption.

4.3 Demonstrate and role model change through pilot programmes that bring local benefits:
The creation of energy cooperatives can teach communities about energy generation, while generating revenue for them. This results in a clear association of value between the two. The model has been adopted successfully in Thailand: the government is supporting the organization of villagers into community enterprises which allow them to buy and manage small-scale biofuel extraction facilities. However, the development of these projects was resource-intensive and requires increased private sector involvement to provide the management skills needed for running cooperatives and plants.

Potential Trade-offs and Risks in Achieving Thailand's New Energy Architecture Objectives

Managing the transition to a New Energy Architecture will not be easy. The imperatives of the energy triangle may reinforce or conflict with one another, forcing difficult trade-offs to be made and, in some cases, resulting in unintended consequences.

There are a number of potential trade-offs that Thailand may be making in creating a diversified, efficient and integrated New Energy Architecture. Efforts to bolster energy security through diversification may, for example, have negative implications for environmental sustainability. This can be seen in EGAT's Power Development Plan for 2010-30, which would result in the share of coal-fired generation in the nation's electricity supply doubling. Policies that support diversification may also carry considerable costs. The expansion of solar and wind, which has not yet reached grid parity and requires ongoing support from the FIT adder and other financial mechanisms, will come at a cost. This is likely to push up energy prices in the short term.

There is no "quick fix" solution to managing these trade-offs. What is required is rather an awareness that such trade-offs are being made. In response, decision-makers should ensure that they weigh up their choices carefully and create a portfolio of policies containing an energy mix that best balances the challenges inherent to the energy triangle.

[9] See Richard H. Thaler and Cass R. Sunstein, Nudge: *Improving decisions about health, happiness and wealth*, 2009.

The Role of Stakeholders in Implementing Enabling Environments

The creation of an enabling environment, one that is resilient to risk and responsive to the imperatives of the energy triangle, is beyond the scope of an individual corporation or government. Government, industry and civil society all have a role to play.

Orchestrating a broad-based, systemic transformation can be extremely challenging. Coalitions will be required to meet the New Energy Architecture challenge, with each stakeholder group channelling its own expertise within a common policy framework. By nature, ambitious transformation demands that stakeholders extend beyond their traditional roles and structures and collaborate in new ways.

During the discussions in Thailand, stakeholders depicted the state's "machinery" as decentralized and, at times, unnecessarily bureaucratic. A number of authorities and coordinating committees are involved in energy policy formation, but do not act across the value chain. Instead, regulatory responsibilities are spread between a set of institutions, with sometimes mismatching incentives. There is room to improve business-to-government dialogue and, according to some participants, transparency too. Interaction with non-governmental organizations (NGOs) could also be improved. Representatives from industry and government expressed their wariness of NGOs, with whom they have few formal lines of communication. Overall, decision-making processes, which are often top-down, need to evolve.

Based on the discussions, it is proposed that stakeholders in the country drive the transition to a New Energy Architecture, taking the following steps:

1) Take a more inclusive, collaborative approach…:
Thailand needs to create new institutional mindsets and mechanisms, so as to develop more coordinated approaches to its energy challenges. Policies should be built by coalitions of stakeholders and based on a collaborative approach incorporating perspectives from industry, society and academia. Promoting these exchanges will facilitate better informed decision-making. Accordingly, this will call for improved lines of communication between stakeholder groups, such as business and civil society, and stronger connections between those ministries and government agencies whose spheres of influence intersect.

2) …by creating a "single window" of oversight…:
For government to tackle conflicting policies, the formation of an individual institution or agency – a "single window" – is called for, one that drives the alignment process, setting common targets and incentives which are then monitored over time.

3)…and multistakeholder partnership platforms…:
Driving stronger alignment across stakeholder groups, not just 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 related to these priorities. By aligning and focusing stakeholder investments, programming and collaboration, this form of collaboration can accelerate progress towards shared goals.

4) …in order to build clear and consistent policies…:
A collaborative approach will facilitate consistent and predictable policies, potentially to eliminate the sometimes mixed messages which are currently conveyed to businesses and the public. This is evident, for instance, in the promotion of cheap energy for economic development, alongside energy efficiency measures.

5) …that are more effectively communicated to the public:
Once collaborative, clear and consistent policies are created, they need to be communicated effectively to the public and industry. Targets should be translated into accessible language, enabling the public to understand how their daily life will be affected.

A Closing Note on Next Steps

We recommend that stakeholders in Thailand review and prioritize the actionable insights highlighted in this study, in order to establish a road map for the creation of a New Energy Architecture for the country. In acting on this road map, stakeholders should form working groups and deliver on specific recommendations. The World Economic Forum will continue to provide its assistance in this process.

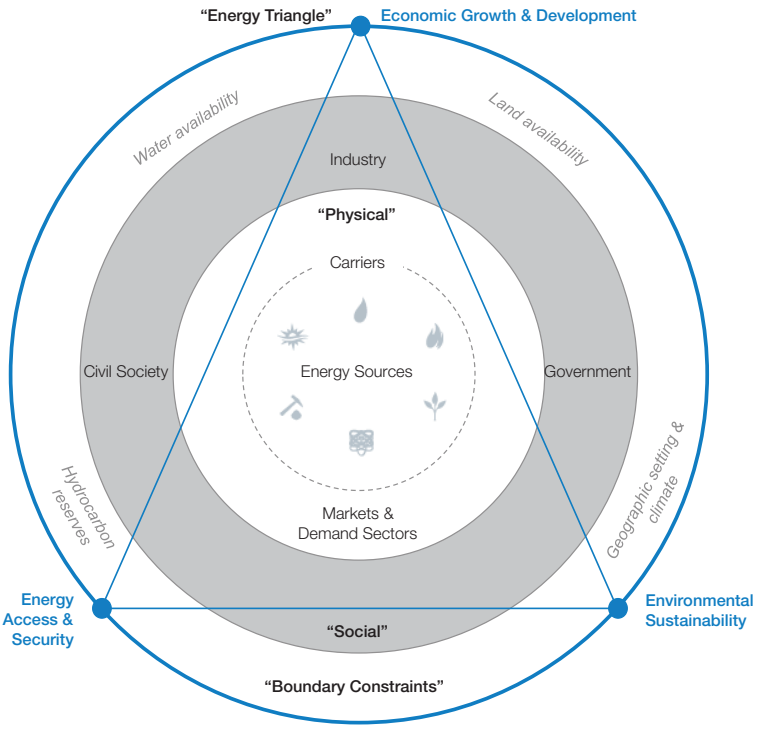
A Methodology for Managing Transition Effectiveness[10]

It has been common for some time to characterize the concerns surrounding energy 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, although delivery against each of them will inevitably be limited by "boundary constraints".[12]

[10] For a more detailed understanding of the New Energy Architecture methodology and conceptual framework, refer to: World Economic Forum, *New Energy Architecture: Enabling an Effective Transition*, 2012.
[11] This concept is commonly referred to by the IEA, among others, whose mandate has been broadened to incorporate the "Three Es" of balanced energy policy-making: energy security, economic development and environmental protection.
[12] Boundary constraints relate to both physical issues (such as hydrocarbon reserves) and social issues (such as the availability of human capital).

In this report, energy architecture is defined as the integrated physical system of energy sources, carriers and demand sectors shaped by government, industry and civil society (see Figure 1). While Figure 1 is a greatly simplified representation, it provides an overview of the complex interactions involved and emphasizes that a systems-based approach is needed to manage change.

Figure 1 – Energy Architecture Conceptual Framework



Definitions

Physical elements : Includes energy sources, their carriers and end markets.

Social elements : Includes political institutions, industry and civil society, which shape the physical elements.

The Energy Triangle : Ultimate objectives that the energy architecture is designed to support.

Boundary constraints : Factors limiting performance against the energy triangle, both physical and social.

In recent years, decision-makers have been grappling with how to navigate the transition to a more affordable, sustainable and secure New Energy Architecture. In response and to help them carry out this transition more successfully, we have developed the following, four-step methodology:

Step 1 – Assessing current energy architecture performance:
An assessment of current energy architecture performance is completed using EAPI; a composite indicator that evaluates economic development, energy security and environmental sustainability. This is intended to help countries monitor the progress of their transition and guide policy and investment decisions.

Step 2 – Creating new energy architecture objectives:
A vision for a more sustainable, secure and affordable New Energy Architecture is created. This is based on three inputs: the strengths and weaknesses of current energy architecture performance identified through the EAPI; a series of interviews and workshops with stakeholders from 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 that supports New Energy Architecture objectives needs to be designed. These enabling environments consist of four pillars: policy initiatives to establish 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 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 features of the environments that should be established and the suggestions are tested in multistakeholder workshops.

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

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

Figure 2 – New Energy Architecture Methodology

	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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Step 1: Assessing Current Energy Architecture Performance

Introduction to Thailand's Energy Architecture

In the following section, we provide a brief overview of Thailand's current energy architecture, considering the supply and demand perspectives.

Supply

- Thailand has indigenous reserves of oil, gas and coal. However, easily accessible supplies of oil and gas resources have been depleted in the face of growing demand and coal reserves are of low quality. This has caused import levels to rise.
- Although the renewables sector has grown rapidly in recent years, considerable room for expansion remains.
- Plans to create a nuclear sector have been delayed by safety concerns.

Hydrocarbons

Thailand has proven oil reserves of 345 million barrels and natural gas reserves of 0.3 trillion cubic metres. It currently produces 345,000 barrels of oil a day (0.3% of global supply) and 37 billion cubic metres of gas per day (1.1% of global supply).[13]

Of all oil and natural gas production in the country, 80% is from the Mergwi Basin in the Andaman Sea and the Gulf of Thailand. Future exploration and production projects are set to concentrate on the Khorat Plateau and the southern part of the Gulf of Thailand.[14] Black shale has been discovered in the Triassic Basin in north-eastern Thailand, although recoverable reserves are expected to be limited.[15]

Thailand's production of oil and gas is beginning to plateau. In 2011, the reserve-to-production ratio for oil was just 3.5 years and for natural gas, 7.6.[16] Thailand is therefore becoming increasingly dependent on imports: in 2011, 85% of crude oil, 67% of thermal coal and 26% of natural gas supplies were imported.[17] The Middle East and Myanmar are the primary sources for imports.

Thailand's total refining capacity stands at 1,298 kb/d, across seven refineries. The largest facilities are the Thai Oil Public Company Limited's 275 kb/d refinery and the IRPC's 215 kb/d refinery. PTT has major interests in five of the seven refineries.[18]

By the end of 2011, Thailand's recoverable coal reserves totalled 1,239 million tonnes and were concentrated in the Province of Lampang, in the north of the country.[19] Although sizeable, the use of these reserves is hampered by low public acceptance, because of a high sulphur content. Prospects for significantly increasing the production of high-quality coal in Thailand are limited, implying that the country's dependence on imports is likely to grow.

Renewables

In 2011, total electricity production in the country was 153,252 GWh, predominantly provided by natural gas (65.4%). Renewable electricity generation (excluding large hydro sources) accounted for 3.4% (3,925 GWh) of the electricity generated into the grid.[20] The majority of this generation comes from biomass, derived from agricultural waste (bagasse, rice husks, wood chips and biogas). Thailand has 1,700 small power plants that operate on biomass, predominantly in rural communities.[21] Significant potential exists for wind and solar power, and initiatives have been put in place to expand production from these sources. Thailand added its first 9.8 MW of solar thermal power capacity in 2011, while grid-connected PV capacity increased almost fivefold in 2011, to 140 MW. Most of this increase stemmed from MW-scale projects, as opposed to

[13] *BP Statistical Review of World Energy*, June 2012; Figures for oil production include crude oil, oil shale, oil sands and LNGs.
[14] Xue Li, *Energy development in ASEAN countries and Sino-ASEAN energy cooperation*, April 2009.
[15] Interview conducted in Thailand, April 2012.

[16] Reserves-to-production ratio: If the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last, if production were to continue at that rate. *BP Statistical Review of World Energy*, June 2012.
[17] Ministry of Energy of Thailand.
[18] *BP Statistical Review of World Energy*, June 2012.
[19] Ibid.
[20] APEC Peer Review on Low-Carbon Energies (PRLCE), *Background Information*.
[21] Written survey responses received from the NESDB.

domestic use.[22] The growth was driven by the completion of the first stage of the Lopburi solar power plant, which has a capacity of 73 MW.[23]

Thailand has a burgeoning biofuels sector. In 2011, the country was the tenth largest producer worldwide,[24] producing 1.1 billion litres. Sugar molasses and cassava are the main feedstocks for ethanol production. Fuel ethanol production was 509.61 million litres (ml) in 2011, with an average daily production of 1.4 ml/day, of which 167 ml were exported. Nineteen bioethanol plants were in operation with a total capacity of 3.065 ml per day. A further six plants are under construction, with a proposed capacity of 2.220 ml/day upon completion. The primary feedstocks for these plants will be cassava chips and tubers, not molasses.[25] The main feedstocks for B100 (unblended biodiesel) are crude palm oil (CPO) (72%), animal fat (24%) and, to a minor extent, waste cooking oil (4%).[26] B100 production was 630 ml in 2011. Thirteen active producers have a combined production capacity of 1,970 ml/y (5.4 ml/day). No new plants have been built since 2010.[27] Thailand does not export B100. Blended biodiesel, B5, has been compulsory since 1 January 2012.

Nuclear

Thailand currently has no nuclear plants in operation. The Electricity Generating Authority's Power Development Plan of 2010 called for the construction of five nuclear plants, each with a capacity of 1,000 MW. The first plant is due to be operational in 2020. However, in response to concerns raised by local communities and civil society groups, as well as the Fukushima incident, these plans have been revised significantly. They are yet to be finalized. The latest, revised version of the PDP 2010 includes only two 1,000 MW plants, planned to be operational in 2026 or 2027.[28]

[22] REN21, *Renewables 2012 Global Status Report*; Energy Policy and Planning Office, "Status of SPP and VSPP (September 2011)", at http://www.eppo.go.th/power/data/index.html.
[23] Boris Sullivan, "Thailand plans to Rev up Solar Power," *Thailand Business News*, 23 December 2011, at http://thailand-business-news.com/news/headline/34015-thailand-plans-to-rev-up-solarpower#.Tv4PJf7gt8c.
[24] The top 15 are: United States, Brazil, Germany, Argentina, France, China, Canada, Indonesia, Spain, Thailand, Belgium, The Netherlands, Italy, Colombia and Austria. REN21, *Renewables 2012 Global Status Report*.
[25] Department of Alternative Energy Development and Efficiency, *List of existing ethanol plants in Thailand*, February 2012, at http://www.dede.go.th/dede/images/stories/english/information/EthanolGasoholUpdateinFeb2012.xls.
[26] IEA, *Sustainable production of second-generation biofuels: Potential and perspectives in major economies and developing economies*, February 2010.
[27] USDA Foreign Agricultural Service, *Global Agricultural Information Network (GAIN) Report*, Thailand: Biofuels Annual 2012, 29 June 2011.
[28] Kalayanamitr Cherid, EGAT, *Status of Nuclear Energy in Thailand*, 21 March 2012.

Demand

- Thailand's primary energy demand was 106 million tonnes of oil equivalent (MTOE) in 2011; it is up by 1.6% from 2010 and by 53% from 2001, when demand stood at 69.1 MTOE.[29]
- The transportation and industrial sectors remain the predominant drivers of demand, accounting for over 70% of final energy consumption.
- Thailand's burgeoning middle class and urban population have become important drivers of the demand for energy, as disposable incomes have risen.

Transport

The transportation sector, responsible for a rapidly growing share of demand, accounts for more than one-third of final energy consumption. Road transport dominates the transport mode and contributes to three-quarters of energy consumption in the sector, while rail plays a very minor, declining role. In 2009, rail transport contributed to only 1.8% of modal shares of freight transport, in terms of ton-kilometre. This is in sharp contrast to countries like China (51%), Germany (21%) and the United States (45%), in which rail plays an important role in freight transport.[30]

Due to low taxes, fuel prices are relatively low, as compared to Japan and Western European countries. The estimated fuel efficiency of Thailand's passenger vehicle fleet is currently 25 to 30% below levels found in Japan and Western Europe.[31]

Almost half of transport energy use occurs around the Bangkok metropolitan region, where traffic congestion contributes significantly to the country's high transport energy intensity. Bangkok's car ownership rose from 4.2 million in 1999 to 6 million today.[32]

[29] *BP Statistical Review of World Energy*, June 2012.
[30] World Bank and NESDB, *Thailand: Clean Energy for Green Low-Carbon Growth*, 2011.
[31] World Bank, *Thailand: Making Transport More Energy Efficient*, 2009.
[32] World Bank and NESDB, *Thailand: Clean Energy for Green Low-Carbon Growth*, 2011.

Figure 3 – Energy Balance (KTOE) in Thailand, 2009

Source: IEA; Accenture analysis

Supply & consumption	Coal & Peat	Crude Oil	Oil Products	Gas	Hydro	Solar, wind etc.	Biomass & waste	Nuclear	Electricity	Heat	Total
Production	5,158	16,230	0	19,163	615	2	20,538	0	0	0	61,705
Imports	10,625	42,361	448	7,472	0	0	57	0	210	0	61,174
Exports	-17	-2,128	-11,500	0	0	0	-26	0	-134	0	-13,805
International marine bunkers	0	0	-1,481	0	0	0	0	0	0	0	-1,481
International aviation bunkers	0	0	-3,539	0	0	0	0	0	0	0	-3,539
Stock changes	-835	568	-505	0	0	0	34	0	0	0	-738
TPES	**14,931**	**57,031**	**-16,576**	**26,635**	**615**	**2**	**20,603**	**0**	**76**	**0**	**103,316**
% Share	14.5%	55.2%	-16.0%	25.8%	0.6%	0.0%	19.9%	0.0%	0.1%	0.0%	

Industry

Knowledge accumulation and capability development have allowed Thailand's economy to become more sophisticated. It is now competitively manufacturing and exporting complex machines and electronics and moving away from the predominantly agriculture-driven exports of the 1960s.[33] The manufacturing sector now accounts for over 30% of GDP, although growth is slowing as the services sector expands.[34] The growth of this sector has driven up the demand for industrial energy, which now accounts for 35.7% of overall demand (see Figure 4).

Residential and Commercial Factors

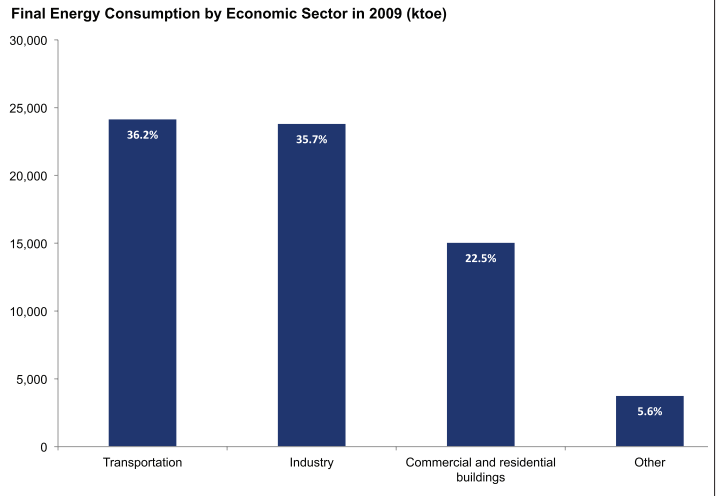
Over the past decade, Thailand has experienced substantial economic growth, moving it into the World Bank's upper-middle income bracket. The average annual household disposable income is expected to increase at a compound annual growth rate (CAGR) of 2.9% between 2000 and 2020, rising to well over US$ 10,000.[35]

Thailand's urban population has been growing rapidly; the proportion of the population living in urban areas rose from 18.5% in 2000 to 33.6% in 2009.[36] The urban population is expected to increase, too, by 14.6% between 2010 and 2020.[37] Above all, urbanization in Thailand has been characterized by the population growth and greater functional dominance of Bangkok. These two trends and the resulting urban middle class have driven up the demand for energy from residential consumers.

Agriculture

Thailand is traditionally an agriculture-based society. It produces a wide range of crops such as rice, sugar cane, rubber sheets, palm oil and cassava. Unlike many developing countries, the agricultural sector consumes a relatively small share of final energy demand, accounting for only 5% of the country's total energy consumption.[38]

Figure 4 – Energy Demand by Sector[39]



[33] R. Hausmann and C.A. Hidalgo et al., *The Atlas of Economic Complexity: Mapping Paths to Prosperity*, 2011.
[34] Written responses to author's interview questions received from the NEDSB.
[35] Accenture analysis of data from Euromonitor International and Emerging Market Consumer Survey, Credit Suisse, 2011.
[36] Thailand National Statistical Office, 2010.
[37] Accenture analysis of Euromonitor International, 2011, "Emerging focus: Rising middle class in emerging markets".
[38] Written survey responses received from the NESDB.
[39] Ministry of Energy, Thailand, 20-Year Energy Efficiency Development Plan, 2011-2030.

Industry Players and Governance

The two main regulatory authorities in Thailand are the Ministry of Energy and the Energy Regulatory Commission. The Ministry, which was established in 2002, is in charge of overall governmental energy policy. It works closely with other agencies and the energy industry in driving policy to implementation. The Energy Regulatory Commission is an independent agency that regulates the business practices of the electricity sector in terms of pricing, transmission expansion and the power plant development fund.

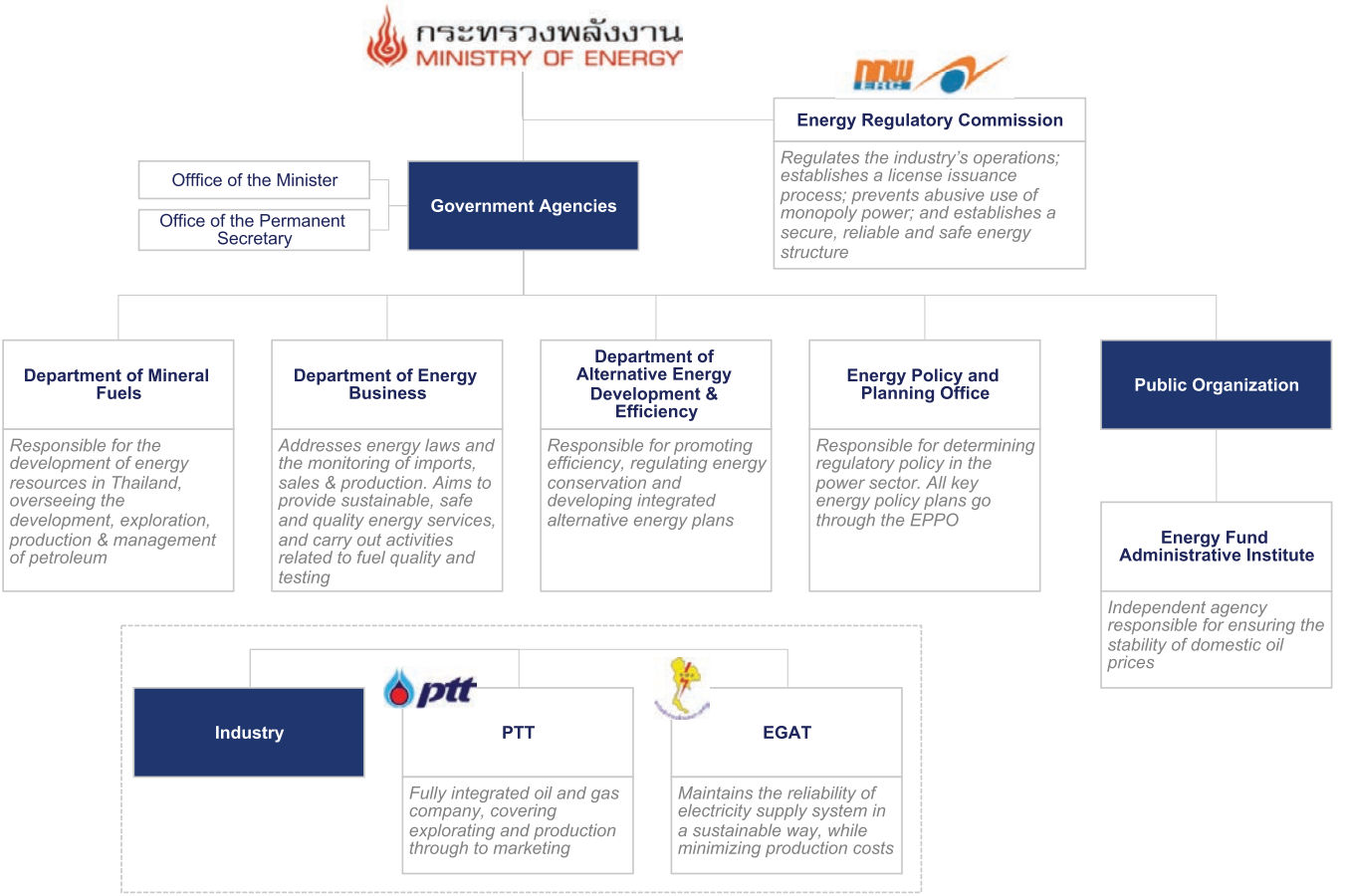
EGAT and PTT are responsible for the majority of the electricity and oil and gas industry value chains in Thailand. EGAT's objective is to maintain the electricity supply system sustainably, while minimizing production costs. It is responsible for nearly 48% of power generation and is wholly responsible for electricity transmission. EGAT has a commitment to purchasing output from independent power producers, providing them with access to the grid under the terms of PPAs.[40] This has led to the expansion of the number of organizations involved in the sector.

Distribution and retailing of electricity are the responsibility of the MEA and the PEA. The MEA is responsible for the distribution of electricity within the Bangkok metropolitan areas. The PEA is under the supervision of the Ministry of the Interior. Its main responsibilities are to produce, distribute and sell electricity to households, business and industrial sectors, and to the general public in the provinces of Thailand.

PTT is a fully integrated oil and gas company. It covers a range of activities, from exploration and production to the marketing of oil and gas. PTT operates the country's onshore and offshore pipeline system.

[40] APEC Peer Review on Low-Carbon Energies (PRLCE), *Background Information*.

Figure 5 – Energy Industry Stakeholder Map



Thailand's Current Energy Architecture Performance

In order to assess Thailand's current energy architecture performance, we have used the EAPI. The EAPI is a composite indicator used to evaluate a nation's performance across the energy triangle, and to assess whether its energy architecture supports economic growth and development, in an environmentally sustainable way, while providing energy access and security.

Thailand currently ranks 46th on the index out of the 105 nations covered (see Figure 6 for a complete overview of performance). In comparison to its peers, its performance is strong. As the highest scoring ASEAN nation, Thailand ranks 14th among non-OECD nations.

The country has gradually improved its performance over the five years for which data has been collected. These improvements have been driven by steps to create a sector more supportive of economic growth and development. In particular, efforts to reform gasoline prices, by removing distorting subsidies and increasing taxes that promote efficient use, have had a positive effect.

In the following section of this report, we explore more thoroughly Thailand's performance across the three elements of the index.

Economic Growth and Development

Over the past decade, Thailand's significant economic growth has pushed it into the World Bank's upper middle-income bracket, where it ranks 38th on the World Economic Forum's Competitiveness Index.[41] The country's economy is expected to grow at 4.5% a year between 2010 and 2020.

Knowledge accumulation and capability development have allowed Thailand to develop an increasingly complex economy which competitively manufactures and exports complex machines and electronics, indicating a shift away from the predominantly agriculture-driven exports of the 1960s.[42] The manufacturing sector now accounts for more than 30% of GDP.

Growth in the manufacturing sector carries its own challenges. Despite policy frameworks and financing mechanisms installed by the government to promote energy efficiency, energy intensity has not changed significantly over the last decade. Thailand's rank on the EAPI for energy intensity has, in fact, since declined from 69th to 72nd. While the country's energy intensity has declined only slightly over that time period, that of its peers has declined at a sharper rate. This is largely due to the increasing share of energy-intensive industries in the economic structure and inefficiencies in the transport sector, due to high levels of motorization, heavy dependence on road transport and a lack of fuel economy standards.[43]

[41] World Economic Forum, *Global Competitiveness Report 2012-13*.
[42] R. Hausmann and C.A. Hidalgo et al. *The Atlas of Economic Complexity: Mapping Paths to Prosperity*, 2011.
[43] Fuel economy refers to the fuel efficiency relationship between distance travelled by a vehicle and the amount of fuel consumed. Thailand has been working on a set of standards based on Japan's Top Runner approach (see Sophie Punse, *Fuel Economy Standards in Asia*, ADB Transport Development Forum, 26 May 2010).

Thailand's increasing reliance on imports – particularly of petroleum products in a time of volatile pricing – may put pressure on and potentially dampen economic growth. The country ranks in the bottom quartile of the EAPI for this measure, highlighting that as a fundamental weakness. Rising commodity prices increase the input cost of manufacturers and reduce the discretionary consumption of households in commodity-importing countries. The price inflation linked to these higher commodity prices could also trigger a rise in interest rates, as the central bank of Thailand seeks to maintain official inflation targets. Tighter monetary policy could then further dampen short-run growth.

As previously highlighted, a positive aspect of Thailand's energy architecture performance, from an economic growth and development perspective, has been the government's efforts to reduce price distortion of gasoline and diesel, by removing subsidies.

Summary of key challenges:

- *High energy intensity, which has failed to decline with economic development*
- *Rising costs of energy imports*

Environmental Sustainability

Despite significant efforts from the Department of Alternative Energy Development and Efficiency (DEDE), environmental sustainability remains a fundamental weakness in Thailand's energy architecture. While the share of renewables in total primary energy supply has risen, this has not significantly affected emissions. The energy sector is the country's leading contributor to GHG emissions. According to the Energy Information Administration, Thailand's energy sector emitted 254 million tons of CO_2 in 2008, thus ranking 20th in the world and fifth in East Asia (after China, Japan, South Korea and Indonesia). Due to its continued economic growth, Thailand's GHG emissions increased steadily at 3% per year from 2004 to 2008. While the country's per capita energy-related CO_2 emissions are approximately 30% of the average level indicated by the OECD, it has the second-highest levels of carbon emissions in ASEAN, accounting for 24% of the regional emissions.[44]

At the city level, CO_2 emissions per capita in Bangkok are high, as compared to leading cities worldwide, and several times higher than the national average. The city's relatively high emissions result from an urban form with low population density and short public transit networks, which result in high personal energy use.[45]

Emissions of NO_2 and SO_2, from power plants have been declining. However, particulate levels remain high, due to the expansion of the vehicle fleet.

Thailand's performance across the emissions indicators can be explained, in part, by the considerable share of biomass within alternative energy use. While many forms of biomass make a lower contribution to emissions than hydrocarbons on a life-cycle analysis basis do, they are far from emission-free. When biomass is removed from Thailand's share of alternative and nuclear energy in total primary energy supplies, the biomass share declines to less than 1%.

Summary of key challenges:

- *High carbon emissions*
- *Inefficient vehicle fleet*
- *Low levels of "new" renewable technologies in power generation, such as solar and wind*

[44] Accenture analysis of Energy Information Administration, *Annual Energy Outlook 2011*; World Bank and NESDB, *Thailand: Clean Energy for Green Low-Carbon Growth*, 2011.
[45] Economist Intelligence Unit, *Asian Green City Index*, 2011.

Energy Access and Security

Thailand is heavily dependent on fossil fuels, as petroleum products make up more than 45% of total energy supply. However, the country has limited indigenous resources and a rapidly growing demand: an average of 6% growth in energy demand and 9% in electricity consumption per year, over the past 25 years. This has led to greater dependence on energy imports. In 2011, the country imported energy equivalent of 87% of total domestic production of primary energy – crude oil accounted for 61% of these imports. Such high levels of imports come at a cost: in 2011, Thailand imported 847 thousand million baht of energy, an increase of 26.2% from 2010.[46]

As a consequence of its rising import dependence, Thailand's performance on energy access and security has deteriorated. The country has dropped from its former ranking of 39th to 54th.

In response to energy security concerns, Thailand is seeking to diversify its energy mix. Considerable progress has been made, with the country ranking in the top quartile for this indicator. Despite this, individual sectors, most notably power generation in which natural gas takes up 65-70% of the mix, are overly dependent on one type of fuel. The country is also in the process of increasing its strategic petroleum reserve from 36 to 90 days, in line with IEA guidelines.

From an access perspective, Thailand performs relatively well. The PEA has expanded electricity supply to 73 provinces, covering 510,000 km^2 and servicing 99% of the country's total area.

Summary of key challenges:

- *Growing import dependence due to the decline of domestic oil and gas production*
- *Lack of fuel diversification in the power sector*
- *Decline in quality of electricity supply due to increased pressure on the grid*

[46] APEC Peer Review on Low-Carbon Energies (PRLCE), *Background Information*.

Figure 6 – An overview of Thailand's performance on the Energy Architecture Performance Index[47]

		2007	2008	2009	2010	2011	Trend
EAPI 2012	Rank (1-105)	43	44	52	44	**46**	
	Score (0-1)	0.45	0.46	0.48	0.51	**0.50**	
Economic Growth and Development	Rank (1-105)	45	43	55	42	**43**	
	Score (0-1)	0.41	0.43	0.49	0.54	**0.54**	
GDP per unit of energy use	Rank (1-105)	69	73	73	72	**72**	
	Score (0-1)	0.28	0.28	0.30	0.30	**0.30**	
	Actual (PPP $ per kg of oil equivalent)	5.11	5.15	5.27	5.27	**5.27**	
Fuel Imports	Rank (1-105)	89	94	92	88	**88**	
	Score (0-1)	0.41	0.23	0.47	0.44	**0.44**	
	Actual (% GDP, adjusted for LCU)	0.10	0.14	0.09	0.10	**0.10**	
Fuel Exports	Rank (1-105)	43	40	41	43	**43**	
	Score (0-1)	0.05	0.08	0.06	0.06	**0.07**	
	Actual (% GDP)	0.03	0.04	0.03	0.03	**0.04**	
Super Gasoline - Level of price distortion through subsidy or tax	Rank (1-105)	77	63	63	7	**7**	
	Score (0-1)	0.5	0.7	0.7	1.0	**1.0**	
	Actual (Index 0 -1)	0.54	0.73	0.73	0.97	**0.97**	
Diesel - Level of price distortion through subsidy or tax	Rank (1-105)	67	84	84	54	**54**	
	Score (0-1)	0.57	0.49	0.49	0.70	**0.70**	
	Actual (Index 0 -1)	0.57	0.50	0.50	0.70	**0.70**	
Electricity prices for Industry	Rank (1-105)	9	8	15	15	**15**	
	Score (0-1)	0.6	0.7	0.8	0.8	**0.8**	
	Actual (U.S. Dollars per Kilowatthour)	0.1	0.1	0.1	0.1	**0.1**	
Environmental Sustainability	Rank (1-105)	75	75	76	73	**73**	
	Score (0-1)	0.25	0.25	0.25	0.27	**0.27**	
Alternative and nuclear energy	Rank (1-105)	57	57	61	60	**60**	
	Score (0-1)	0.19	0.19	0.20	0.20	**0.20**	
	Actual (% of total energy use, incl. Biomass)	0.19	0.19	0.20	0.20	**0.20**	
Nitrous oxide emissions in energy sector	Rank (1-105)	26	26	26	26	**26**	
	Score (0-1)	0.18	0.18	0.18	0.18	**0.18**	
	Actual ('000 metric tons CO2 equivalent/capita)	6.55E-05	6.55E-05	6.55E-05	6.55E-05	**6.55E-05**	
CO2 emissions from electricity and heat production, total	Rank (1-105)	60	62	62	62	**62**	
	Score (0-1)	0.47	0.46	0.46	0.46	**0.46**	
	Actual (% of total fuel combustion)	40.63	41.10	41.10	41.10	**41.10**	
PM10, country level	Rank (1-105)	83	81	79	79	**79**	
	Score (0-1)	0	0	0	0	**0**	
	Actual (micrograms per cubic meter)	55.63	54.33	52.62	52.62	**52.62**	
Average fuel economy for passenger cars	Rank (1-105)	86	86	87	86	**86**	
	Score (0-1)	0.42	0.42	0.40	0.50	**0.50**	
	Actual (l/100km)	11.77	11.75	11.89	10.65	**10.65**	
Energy Access and Security	Rank (1-105)	39	41	51	52	**54**	
	Score (0-1)	0.70	0.70	0.70	0.71	**0.70**	
Electrification rate	Rank (1-105)	28	28	59	59	**59**	
	Score (0-1)	0.99	0.99	0.99	0.99	**0.99**	
	Actual (%)	99.00	99.00	99.30	99.30	**99.30**	
Quality of electricity supply	Rank (1-105)	33	39	37	38	**46**	
	Score (0-1)	0.77	0.75	0.75	0.78	**0.74**	
	Actual (0-7)	5.64	5.48	5.51	5.69	**5.46**	
Percentage of population using solid fuels for cooking	Rank (1-105)	74	74	74	74	**74**	
	Score (0-1)	0.78	0.78	0.78	0.78	**0.78**	
	Actual (%)	25.00	25.00	25.00	25.00	**25.00**	
Energy imports, net	Rank (1-105)	62	61	64	64	**64**	
	Score (0-1)	0.08	0.08	0.08	0.09	**0.09**	
	Actual (% of energy use)	41.33	39.43	40.28	40.28	**40.28**	
Diversity of TPES	Rank (1-105)	26	23	26	24	**24**	
	Score (0-1)	0.88	0.89	0.89	0.89	**0.89**	
	Actual (Herfindahl index)	0.19	0.18	0.18	0.18	**0.18**	

[47] The EAPI is produced by the World Economic Forum and represents the major analytical tool of the New Energy Architecture initiative. The first edition of the EAPI will be launched in December 2012. The results published in this report may therefore be subject to change. They should therefore only be considered as being indicative of performance. Further details can be found at www.weforum.org/energy.

Thailand in the ASEAN Context

The 10 countries of ASEAN make up one of the world's most dynamic and diverse regions. With a nominal GDP exceeding US$ 1.8 trillion and a growth rate expected to exceed 5% in 2012, the region has escaped the worst of the global recession. By 2020, ASEAN will be the world's eighth-largest economy, with the world's third-largest population, following China and India.[48]

Continued growth, industrialization and urbanization have led to increased energy consumption from a comparatively low per-capita level, which is set to prevail. According to the Institute of Energy Economics, Japan, ASEAN's final energy consumption will grow at an average annual rate of 4.4% from 375 MTOE to 1,018 MTOE, in a business-as-usual scenario.[49]

[48] Accenture, *Capturing the ASEAN Wave*, Outlook, 2012, Issue 1.
[49] IEEJ, *ASEAN Energy Demand Outlook 2011*.

Southeast Asia's energy resources – including about 10.3 billion barrels of proven oil reserves, 6.6 trillion cubic meters of proven gas reserves, 12.5 billion tonnes of proven coal reserves and abundant hydropower – are relatively meagre, as compared with the growing scale of demand.[50] While ASEAN remains a net energy exporter, this situation may change in the future.

Although ASEAN was once a prominent exporter of oil, since the late 1980s, the region has become increasingly dependent on imports. It remains a net exporter of natural gas, due largely to Brunei, Malaysia and Indonesia, which are amongst the world's top 10 suppliers of LNG. Similarly, it is home to some major producers and exporters of steam coal, in particular, Indonesia and Vietnam. While parts of Southeast Asia have relatively abundant sources of renewable energy, certain physical and economic factors have left a significant share of it as yet untapped.

Due to its complex geography, the region's resources are unevenly distributed among member states. All, with the exception of Vietnam, depend on imports of at least one fossil fuel.

For ASEAN to meet its growing energy demand in the face of dwindling supplies will require huge investment in expanding regional energy infrastructure. Everything, from power generation to pipelines and grids, will need to be expanded and strengthened. The International Energy Agency estimates that this investment will need to reach US$ 1.1 trillion by 2030. This expansion of energy supply infrastructure will come at economic and environmental costs. If current trends continue to 2030, ASEAN's share of global energy-related, CO_2 emissions may reach 5%, up from its current share of 3.5%.[51]

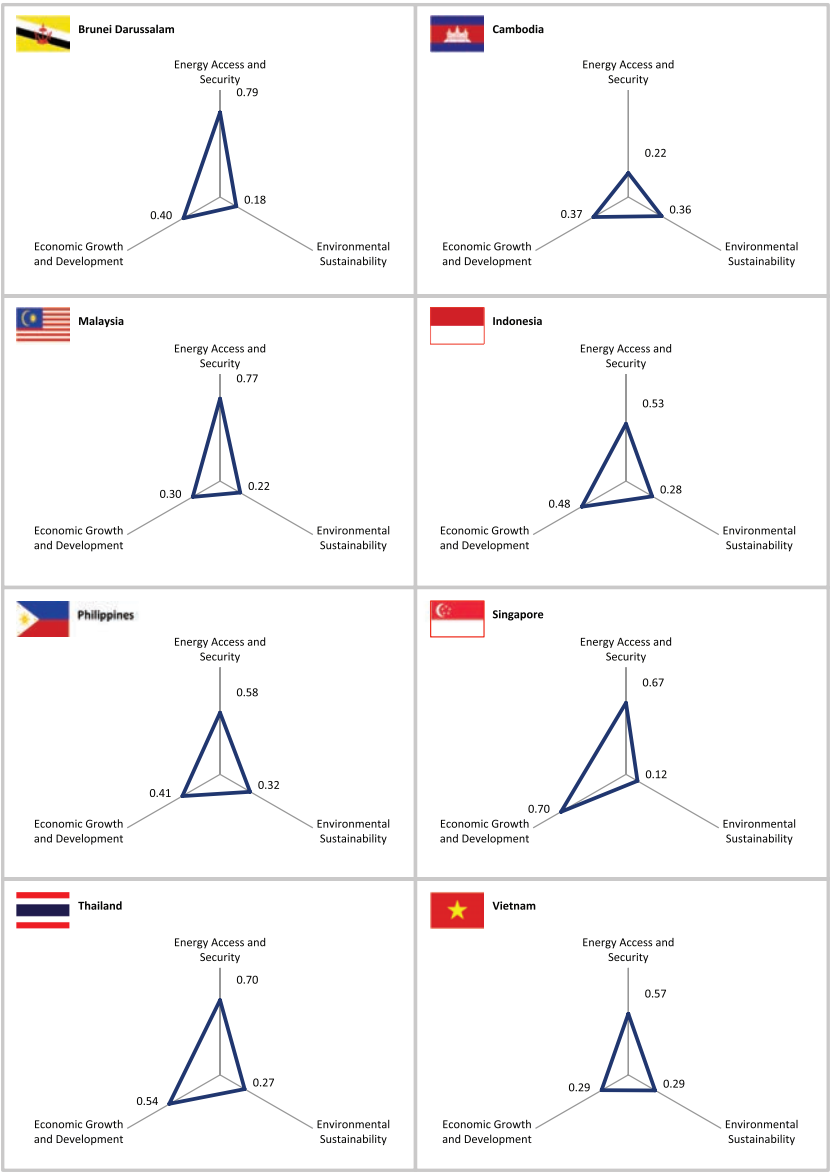
A review of ASEAN's performance on the EAPI underlines the diverse set of challenges present in the region (see Figure 7). Perhaps unsurprisingly, the less developed nations in the region – Cambodia and Vietnam – underperform their peers. Because of a lack of data availability, the two least developed nations in the region – Laos and Myanmar – do not feature on the EAPI. A key task for the more developed ASEAN-6 would therefore be to support capacity development for their neighbours.

One feature is common across ASEAN: countries have focused on affordability and security, at the expense of sustainability. The region will need to address this aspect of the triangle, if it is to bring balance to its energy architectures in future.

[50] IEA, *World Energy Outlook 2009*.

[51] ibid.

Figure 7 – An overview of ASEAN performance on the Energy Architecture Performance Index



ASEAN Energy Integration

From the onset, economic integration and, in particular, regional trade liberalization, have been key elements of the ASEAN strategy. This culminated in the agreement on the AEC, which is to be established by 2015.The AEC Blueprint adopted in 2007 provides a master plan for building an economic community, characterized by a competitive single market and production base. This master plan seeks to promote the equitable economic development of members and to facilitate their integration within the global economy. Figure 8 provides an overview of the components of the AEC Blueprint.

The APAEC, 2010-15 covers the energy component of the Economic Community Blueprint 2015. It outlines the implementation of seven programme areas, as illustrated in Figure 9.

Figure 8 – Four Central Components of the AEC Blueprint

I. Single market and production base

5 core elements:

	Liberalization	Facilitation
Free flow of goods	▪ Tariff and NTB elimination ▪ Synchronized external tariff alignment	▪ Customs integration ▪ Standards and technical barriers to trade
Free flow of services	▪ Full market access and national treatment ▪ Remove substantially all restrictions on trade in services	▪ Mutual Recognition Arrangements (MRAs) on professional services; professional exchange
Free flow of investment	▪ All industries and services incidental to these industries to ASEAN investors	▪ Transparency ▪ Streamlined procedures ▪ Avoidance of double taxation ▪ Joint promotion
Freer flow of capital	▪ Relax capital control measures on intra-ASEAN portfolio investments	▪ Harmonize capital market-standards ▪ Facilitate market driven efforts to establish exchange and debt market linkages
Free flow of skilled labour	▪ Remove discrimination on employment	▪ Harmonization of standards in education and training ▪ MRA on vocational training

II. Competitive Economic Region

Consisting of the following elements:

- Develop a competition policy
- Strengthen consumer protection
- Regional cooperation in intellectual property rights
- Regional cooperation in infrastructure development
- Complete network of bilateral agreements on avoidance of double taxation
- Promote e-commerce

III. Equitable Economic Development

Consisting of the following elements:

- Accelerate the development of small and medium-sized enterprises
- Enhance the Initiative for ASEAN Integration to narrow development gaps between countries

IV. Integration into the Global Economy

Consisting of the following elements:

- Achieve a coherent approach towards external economic relations, including its negotiations for free trade area and comprehensive economic partnership agreements
- Enhance participation in global supply networks

Figure 9 – The seven programme areas of the ASEAN Plan of Action for Energy Cooperation (APAEC), 2010-15[52]

Program Area	Strategies	Ownership
ASEAN Power Grid	▪ Accelerate the development of the ASEAN Power Grid Interconnection projects ▪ Optimize the generation sector vis-à-vis the available indigenous energy resources in the region ▪ Encourage and optimize the utilization of ASEAN resources, such as: funding; expertise and products to develop the generation, transmission and distribution sectors	▪ HAPUA
Trans-ASEAN Gas Pipeline	▪ Collectively implement the ASEAN MOU on TAGP by ASCOPE members ▪ PERTAMINA and PSC partners to undertake detailed feasibility study for East Natuna Gas Field Development ▪ Implement the approved roadmap for TAGP by respective ASCOPE Members ▪ Implement the approved 5-year ASCOPE Gas Centre Work Program	▪ ASCOPE
Coal and Clean Coal Technology	▪ Strengthen institutional and policy framework and build an ASEAN coal image ▪ Promote coal and clean coal technologies ▪ Promote intra-ASEAN coal trade and investment ▪ Enhance environmental planning and assessment of coal projects	▪ AFOC (ACE as Secretariat)
Energy Efficiency and Conservation	▪ Develop energy efficiency policy and build capacity ▪ Enhance awareness raising and dissemination of information ▪ Promote good energy management practices, especially for commercial and industrial sectors ▪ Facilitate energy efficiency financing	▪ EE&C-SSN (ACE as Secretariat)
Renewable Energy	▪ Increase the development and utilization of RE sources to meet 15% target share in power generation ▪ Enhance awareness and information sharing and strengthen networks ▪ Promote intra-ASEAN cooperation on ASEAN-made products and services ▪ Promote renewable energy financing scheme ▪ Promote the commercial development and utilization of biofuels ▪ Develop ASEAN as a hub for renewable energy	▪ RE-SSN (ACE as Secretariat)
Regional Energy Policy and Planning	▪ Enhance energy policy and supply security information sharing network ▪ Conduct capacity building in energy and environmental policy planning and energy supply security assessment ▪ Prepare regional energy outlooks and conducting ASEAN policy reviews and analysis series ▪ Strengthen collaboration and dialogues with ASEAN partners and with national, regional and global institutions ▪ Monitor and evaluate the progress of APAEC programs	▪ REPP-SSN (ACE as Secretariat)
Civilian Nuclear Energy	▪ Conduct capacity building among ASEAN member states ▪ Strengthen public information and public education on nuclear power generation ▪ Strengthen institutional, legal and regulatory capabilities on nuclear energy for power generation	▪ ACE as Secretariat

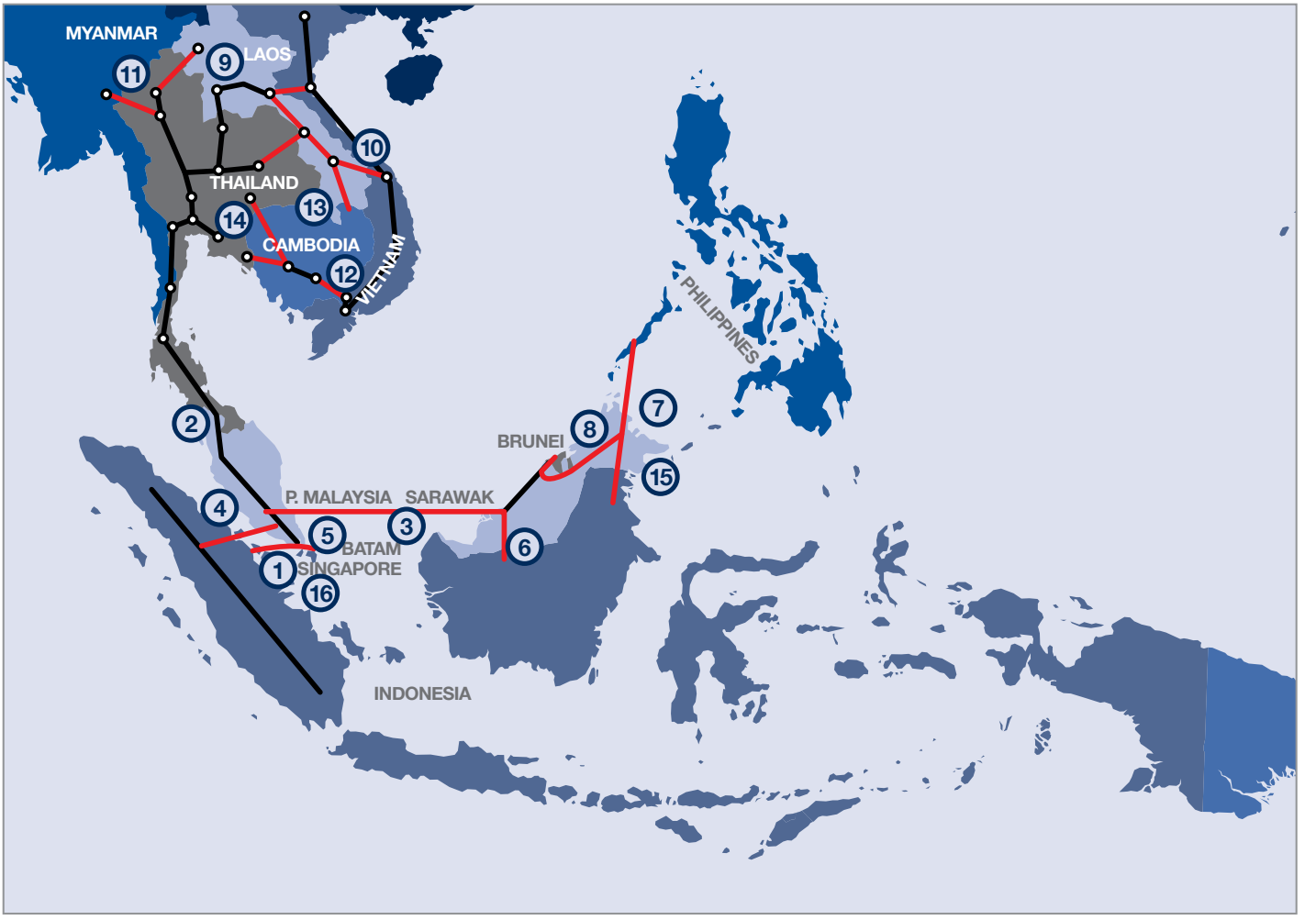
Core features of the APAEC are:

– The ASEAN Power Grid (APG): APG is a flagship programme which was mandated in 1997 by the ASEAN heads of states/ governments. It incorporated 15 grid interconnection projects, initially on cross-border bilateral terms, before being expanded to a subregional basis and finally, to a totally integrated Southeast Asian power system. The investment requirement for the APG was estimated at US$ 5.9 billion.[53]

– The Trans-ASEAN Gas Pipeline (TAGP): TAGP aims to interconnect the gas pipeline infrastructure of ASEAN member states and to enable gas to be transported across their borders. The TAGP involves the construction of 4,500 km of pipelines (mainly under the sea), requiring an investment of US$ 7 billion.[54] These pipelines would link Thailand, Malaysia, Indonesia, Java, Brunei, Malaysia and the Philippines and would originate from the Indonesian offshore gas field, Natuna D-Alpha, which is yet to be developed.

[52] ASEAN, *2010 ASEAN Plan of Energy Co-operation 2010-2015, Bringing Policies to Actions*, Adopted by Energy Ministers in Mandalay, Myanmar, 29 July 2009.
[53] ibid.
[54] ibid.

Figure 10 – Current status of the ASEAN Power Grid[55]

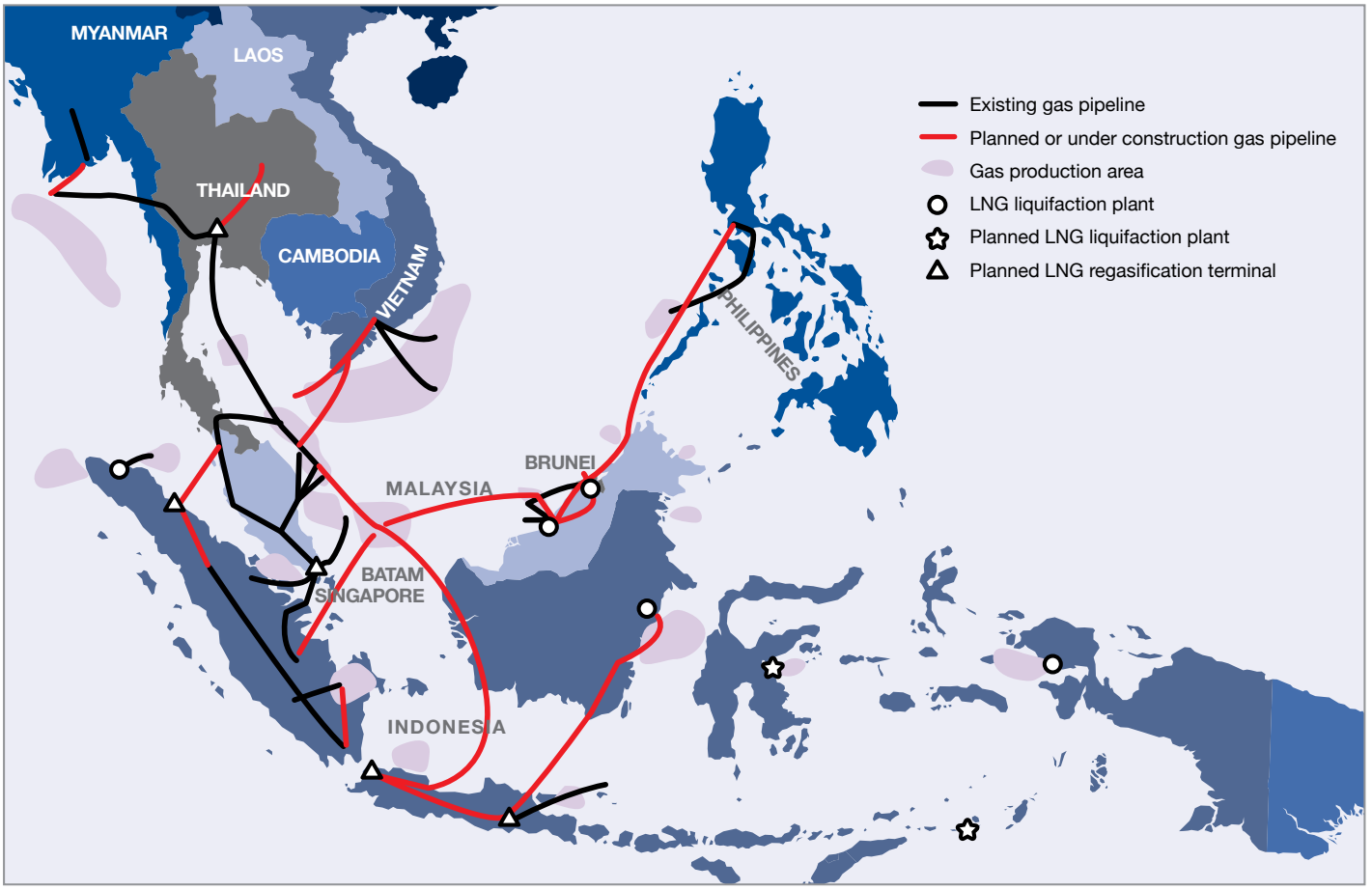


		Revised earliest COD
1)	P.Malaysia - Singapore (New)	2018
2)	Thailand - P.Malaysia	
	• Sadao - Bukit Keteri	Existing
	• Khlong Ngae - Gurun	Existing
	• Su Ngai Kolok - Rantau Panjang	Newly Proposed
	• Khlong Ngae - Gurun (additional)	2016
3)	Sarawak - P. Malaysia	2015-2021
4)	P.Malaysia - Sumatra	2017
5)	Batam - Singapore	2015-2017
6)	Sarawak - West Kalimantan	2015
7)	Philippines - Sabah	2020
8)	Sarawak - Sabah - Brunei	
	• Sarawak - Sabah	2020
	• Sabah - Brunei	Not Selected
	• Sarawak - Brunei	2012-2016

		Revised earliest COD
9)	Thailand - Lao PDR	
	• Roi Et 2 - Nam Theun 2	Existing
	• Sakon Nakhon 2 - Thakhek - Then Hinboun (Exp.)	2012
	• Mae Moh 3 - Nan - Hong Sa	2015
	• Udon Thani 3- Nabong (converted to 500KV)	2017
	• Ubon Ratchathani 3 - Pakse - Xe Pian Xe Namnoy	2018
	• Khon Kaen 4 - Loei 2 - Xayaburi	2019
	• Thailand - Lao PDR (New)	2015-2023
10)	Lao PDR - Vietnam	2011-2016
11)	Thailand - Myanmar	2016-2025
12)	Vietnam - Cambodia (New)	2016
13)	Lao PDR - Cambodia	2011
14)	Thailand - Cambodia (New)	2015-2017
15)	East Sabah - East Kalimantan	Newly Proposed
16)	Singapore - Sumatra	2020

[55] Accenture analysis of Bambang Hermawantao, Chairman, ASEAN Power Grid Consultative Committee, Report of the 8th meeting of APGCC.

Figure 11 – Current status of the Trans-ASEAN Gas Pipeline[56]



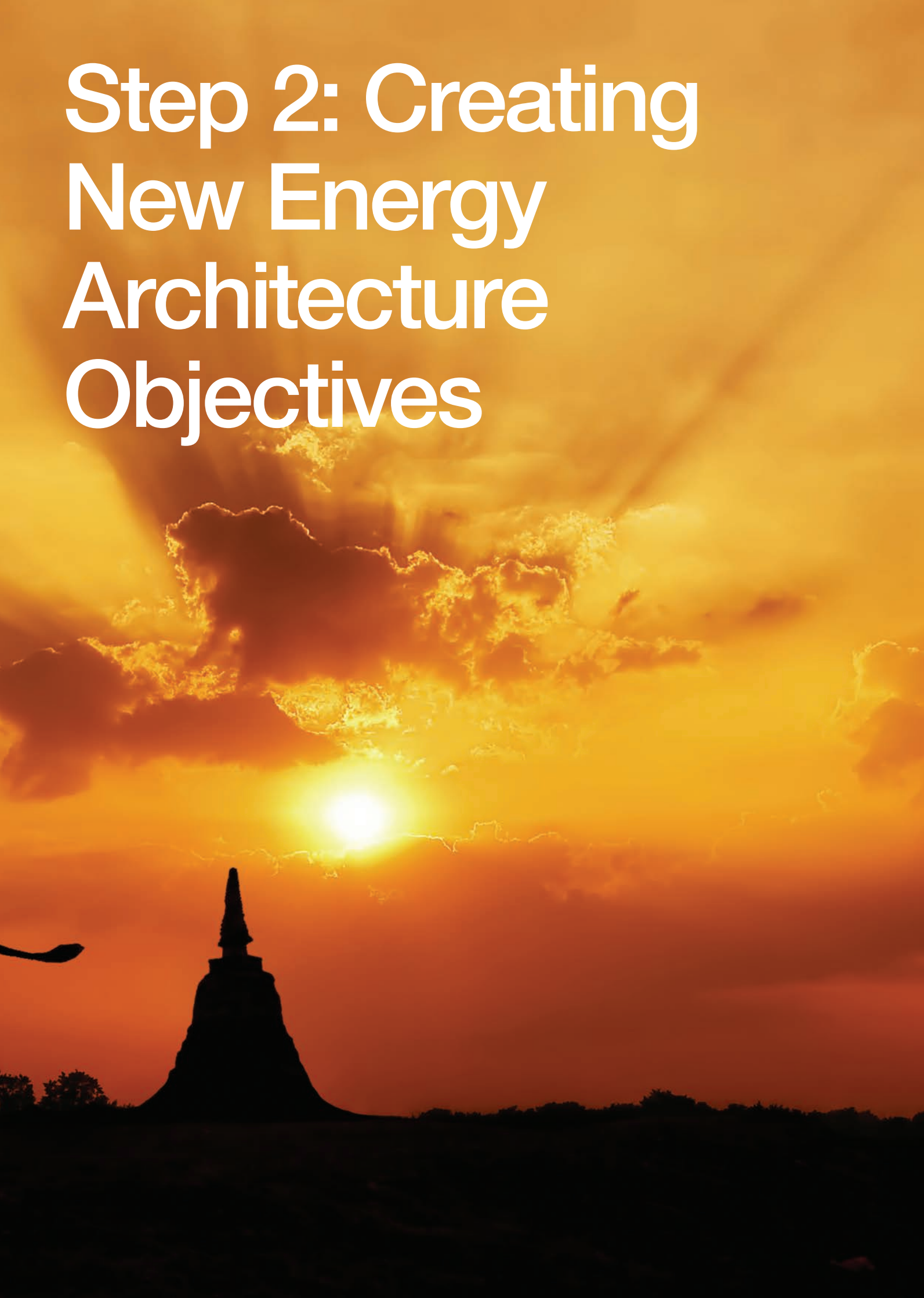
Thailand's Current Role in Energy Integration

From a Thai perspective, as with other member states, activities have largely been conducted bilaterally in the Greater Mekong Subregion, predominantly with Laos and Myanmar. Thailand currently receives approximately 9.8 bcm/year from the Yadana and Yedagun fields, located in the Andaman Sea off the coast of Myanmar, which arrives via a pipeline of 670 km.[57] Since 1996, Thailand has benefited from interconnection with Laos to import hydro-produced electricity and thereby bridge the gap between demand and insufficient domestic power supply.

As indicated in the next section of this report, a core future objective will be expanding Thailand's role in regional energy integration.

[56] Accenture analysis of International Energy Agency, *World Energy Outlook 2009*.
[57] IEA, *World Energy Outlook 2009*.

Step 2: Creating New Energy Architecture Objectives



Since the Ministry of Energy was established 10 years ago, significant progress has been made in Thailand's energy architecture. With its energy master plan and targets in place, it is ahead of many countries in the region. However, our analysis of its current energy architecture performance shows that opportunities for improving this performance exist.

Consequently, we have created a series of New Energy Architecture objectives, forming a vision of how Thailand can set up an energy architecture to better achieve the goals of the energy triangle. This vision is based on three factors:

- The strengths and weaknesses of Thailand's current energy architecture, as identified through the EAPI
- A series of interviews and workshops with stakeholders from across the energy value chain
- Existing targets and action plans, created by the Ministry of Energy[58]

[58] See the 10-Year AEDP (2012-2021) and the 20-Year Energy Efficiency Development Plan (2011-30).

NEW ENERGY ARCHITECTURE OBJECTIVES

Diversification

The exploration of new and existing sources both in Thailand and abroad increases the diversity of the energy mix, leading to a rise in renewable energy consumption to 25% of the energy mix in 2021.

Efficiency

An energy literate population assists industry and government in creating a sustainable society built on energy efficiency and conservation programmes, leading to a reduction in energy intensity by 25% in 2030, equivalent to a reduction of final energy use by 20% (approximately 30,000 ktoe).

Integration

Thailand plays a leading role in building stronger links across the ASEAN region, both in terms of institutional and physical connectivity, driving energy integration as part of the formation of the ASEAN Economic Community and becoming a regional energy hub in areas where it has a competitive advantage.

ACHIEVING THESE OBJECTIVES…

New energy architecture objectives

- **Diversification**
- **Efficiency**
- **Integration**

…WILL ADDRESS CHALLENGES IN THAILAND'S CURRENT ENERGY ARCHITECTURE

Energy architecture challenges addressed

Economic growth and development

- High energy intensity
- Rising costs of energy imports

Environmental sustainability

- High carbon emissions
- Inefficient vehicle fleet
- Low integration of "new" renewable technologies

Energy access and security

- Import dependence
- Low fuel diversification in the power sector
- Quality of electricity supply

Step 3: Defining the Enabling Environment

Based on discussions held with stakeholders in Thailand, we have identified a series of actionable insights that may help the country transition effectively to a more diversified, efficient and integrated energy architecture. These actions, which represent insights gained during the discussions, are not exhaustive and are explored in detail in the sections that follow.

An Overview of Actionable Insights

OVERVIEW OF ACTIONABLE INSIGHTS

1. Diversification

1.1 Build flexibility into the 10-year Alternative Energy Development Plan (AEDP) 2012-2021

1.2 More closely regulate small power providers (SPPs) and very small power providers (VSPPs), and consider alternative financing support mechanisms for new energy technologies

1.3 Set clear interconnection protocols, coordinate generation-to-transmission planning, and adopt supporting technologies for intermittent renewables integration

1.4 Promote the sustainable growth of the biofuels sector by creating a clear sustainability framework, increasing land productivity and supporting R&D for advanced biofuel technologies

1.5 Attract and support oil & gas independents to develop marginal and mature fields

1.6 Build on bilateral relationships with neighbours to open up new sources of supply

1.7 Focus on capacity building to lay the foundations of the nuclear sector

2. Efficiency

2.1 Develop more efficient production processes and increase product quality in the manufacturing sector

2.2 Focus on creating efficiency standards, adopting innovative financing mechanisms and government-led procurement initiatives, to increase the uptake of energy efficiency measures in residential and commercial buildings

2.3 Create a “smart” city roadmap for Bangkok

2.4 Create a more targeted programme of subsidies for the transportation sector

3. Integration

3.1 Take an inclusive view of connectivity that incorporates not just physical components, but also financial and human

3.2 Clarify Thailand’s hub strategy, identifying best prospects and infrastructure requirements

4. In Focus: Energy Literacy – A Cross-objective Enabler

4.1 Foster understanding of energy issues

4.2 Create incentives and formal mechanisms to encourage change

4.3 Demonstrate and role model change through pilot programmes that bring local benefits

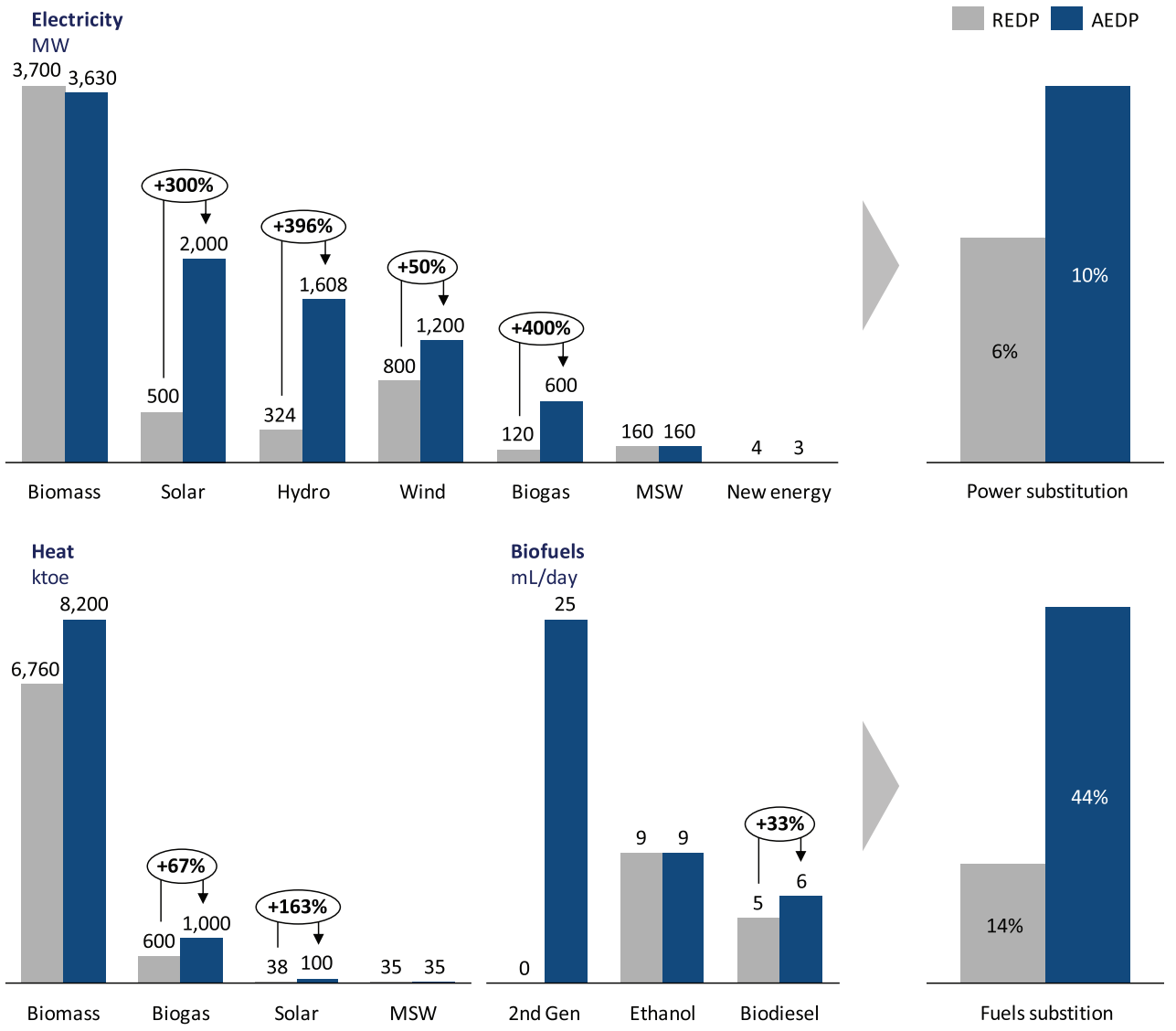
1. Diversification

Actionable insight 1.1: Build in flexibility to the 10-year Alternative Energy Development Plan (AEDP), 2012-21

Through the 10-Year AEDP, 2012-2021, the Ministry of Energy has created a strong road map for the development of the renewables sector, advanced in its thinking in comparison with other nations in the region.

As highlighted in Figure 12, the AEDP marks a significant break from its previous incarnation, the 15-Year Renewable Energy Development Plan (REDP), 2008-2022. Both the power and fuel substitution targets are significantly more aggressive, built on large expansions of a number of technologies, most notably solar and advanced biofuels. The changes reflect a desire, given the growing volatility of pricing, to reduce reliance on oil and gas imports. Under the AEDP, renewable energy will account for 25% of final energy consumption, as compared to 12% for the REDP (when natural gas vehicles (NGV) targets are excluded).

Figure 12 – Comparing the AEDP with the REDP[59]



[59] APEC Review on Low-carbon Energies (PRLCE), *Background Information*.

The shift between the REDP and AEDP underlines the challenges associated with constructing energy policy for what is a rapidly changing sector. Across clean energy technologies, a doubling of installed capacity leads to unit cost reductions of around 20% for solar photovoltaic and around 10% for onshore and offshore wind, according to a 2007 review of historical technological improvement rates.[60] The medium-term yield performance of clean energy technologies is likely to continue improving substantially, owing to improved production engineering and technology (e.g. software and hardware integration that allows for much greater energy capture). As highlighted during the discussions in Thailand, policy will need to be accommodating to technological advances and changing industry dynamics. This calls for a portfolio approach that provides stability for investors. Building such flexibility into the policy framework constitutes one of five elements of the "SHIFT" framework for policy-making pertaining to effective renewable energy.

In Focus: "SHIFT" Renewables Policy-making

Drawing on our experience of applying the New Energy Architecture methodology to a number of countries, we have identified a set of principles for decision-makers to follow when creating policies to support renewable energy deployment. The "SHIFT" policy framework outlines attributes that decision-makers should consider building into their policies:

Stable: Without consistency in government policy, private companies may be unwilling to cover the high capital costs involved in pursuing utilities-scale renewables projects. Renewable energy policies should furthermore be consistent with the overarching energy policy framework.

Holistic: Large-scale penetration of renewable energy technologies can have an impact on the cost efficiency and reliability of the system. Policy decisions must be made taking social, economic and security effects into consideration and creating a balance for consumers between sustainability and price implications.

In-tune: To allow a smooth transition towards mass market integration of renewables, technology-specific support should be applied, to foster renewable energy technologies according to their level of maturity. This will create a more level playing field, for the parties concerned. Technologies that are most mature and closest to market competitiveness can compete. Less mature technologies can be proven and established in more "protected" market niches. Support for these technologies can be provided by targeted R&D, demonstration incentives or market-based mechanisms, depending on their innovation stage.

Flexible: Disruptive technology will continue to have an impact on the energy sector. Flexible policies will be needed to respond to shifting dynamics.

Tailored: A country's physical boundary constraints – ranging from water and land availability to climatic conditions – will affect the suitability of specific supply sources and technologies. Countries should draw advantageously on their strengths, identifying in which situations they should take the lead in technology development and in which they should rather be "fast followers".

[60] McKinsey Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.

Actionable insight 1.2: More closely regulate Small Power Providers (SPPs) and Very Small Power Providers (VSPPs), and consider alternative financing support mechanisms for new energy technologies

While a wide variety of policy initiatives exist for renewables, their success depends on their execution. Ambitious targets and policies do not necessarily lead to success. In accordance with its Power Development Plan, EGAT's focus for power generation build-out planned for 2030 will emphasize traditional fossil fuel coal and gas-fired plants. In the renewables sector, it will focus primarily on pumped storage facilities.[61] The execution of the power generation elements of the AEDP will therefore fall predominantly on the private sector, namely as independent power producers.

Policies to accommodate the grid interconnection of customer-owned renewable energy in Thailand were initiated in 1992 with the SPP programme, which included standardized interconnection and PPAs for generators up to 90 MW. In 2002, the country adopted VSPP regulations, further streamlining utility interconnection requirements for generators of up to 1 MW.

To further support SPPs and VSPPs, in 2006, Thailand introduced a FIT[62] premium payment. This provides an adder to be paid in addition to utility-avoided costs, differentiated by technology type and generator size, and guaranteed for 7 to 10 years. Additional per-kilowatt hour subsidies are provided for projects that offset diesel use in remote areas (on mini-grid systems) and utilities are granted incentives to accommodate VSPPs. Although incremental costs have been passed through to consumers, thus far, they have been minimal.[63] In response to the FIT adder, the online capacity of renewable energy increased sharply, from 992 MW in February 2007 to 1,364 MW by March 2010.[64]

Despite the considerable progress achieved by streamlining grid interconnection access and implementing the feed-in premium, challenges in its execution prevail.

Firstly, as pointed out by stakeholders during interviews held in Bangkok, in some instances PPAs have been awarded either to companies with limited technical experience or to those that are not solar producers, but are looking to resell to developers on secondary markets. The government has responded by calling for a reimbursable bid bond for projects of over 100 kW and by requiring that projects produce power within a year of the scheduled date of commissioning, to receive their subsidies.[65] The government may wish to consider further strategies to improve execution rates, including: tightening evaluation criteria to filter out SVPs or VSPPs lacking in demonstrated technical experience and financial capacity; and providing technical assistance and advisory services to VSPPs to help render their investments operational. Furthermore, the proliferation of SPPs and VSPPs which is likely to accompany AEDP, may call for a stronger regulatory body to oversee activities.

Secondly, the adder provided to SPPs and VSPPs was set too high for certain technologies, most notably solar. The solar adder was initially set at 8 baht/kWh. As this led to over-demand, it has been reduced to 3.5 baht/kWh. Given the pace of technological change in the solar sector, the current system requires constant monitoring and repeated adjustments to the tariff. This generates instability for investors and poses the risk of developers being oversubsidized.

There are, however, solutions to this pricing challenge. An alternative approach would be to make use of a reverse auction FIT, which inverts the normal buyer-seller relationship. Renewable providers (solar power producers) have to compete to provide a service to utilities – with a minimum price for that service assured under the FIT. Under a reverse auction solar project, developers submit bids for the tariff they wish to access, with the knowledge that the regulator will choose the lowest bidders. This competitive process keeps costs down and theoretically provides effective price discovery by ensuring that bidders submit requests at the level required to render them commercially viable, but not at a level that would result it excessive profits.[66] This practice has been implemented effectively in India, which has used a multi-year programme of reverse auctions to obtain the best possible vintage of renewable energy technology. To support the further expansion of the solar and the broader renewables sector, Thailand should consider such alternative approaches to FIT creation. Additional features of best-practice FITs are highlighted in "In Focus: Best FITs".

[61] Analysis of Dr Suthep Chimklai, *Thailand Power Development Plan (PDP2010) and Perspective*, 15 February 2012.
[62] At the most basic level, a feed-in tariff (FIT) pays renewable energy producers a set rate (tariff) for each unit of electricity fed into the grid.
[63] In 2010, the additional burden associated with the FIT was US$ 0.001/kWh (or approximately US$ 2.78/GJ). Electricity is subsidized for small consumers (<150 kWh/month or <540 MJ/month) such that they pay less marginal cost and are not negatively affected by the FIT.
[64] EPPO, VSPP (As of April 2007). Energy Policy and Planning Office (EPPO), Ministry of Energy, Thailand; EPPO (2010c). สถานภาพการรับซื้อไฟฟ้าจาก VSPP จำแนกตามประเภทเชื้อเพลิง (ณ วันที่24 มีนาคม 2553. (Electricity purchased from VSPP by fuel type, as of 24 March 2010). Energy Policy and Planning Office (EPPO), Ministry of Energy, Thailand.
[65] J. Tongsopit, *Thailand's VSPP Program. Technical Visit of the Delegation from the United Republic of Tanzania to Thailand regarding Thailand's Very Small Power Producer (VSPP) Program*, 2010.
[66] In some instances, reverse auctions attract "suicide bids" from developers with limited experience in the solar sector and which are willing to fund projects on their balance sheets, in order to "get their foot in the door" of the sector. This can be countered by requiring that each developer pay a bond when they submit a bid, which is only refunded upon completion of a project. See DECC, Scaling up solar in India through public-private action: Status update from the Capital Markets Climate Initiative, at http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/international-climate-change/4174-scaling-up-solar-india.pdf.

In Focus: Best FITs

There are two predominant forms of FITs:

- Fixed payment sets a fixed price that is independent of electricity market prices, varying by technology per unit and delivered over a specified number of years. This model is used in Germany and Greece. These FITs normally ensure connection to the grid at a pre-agreed price, guaranteeing the purchase of all electricity that is generated. A set price, independent of the electricity price, combined with a guaranteed connection and purchase, leads to an almost risk-free contract from the perspective of generators.

- Premium payment guarantees that renewable energy supplies will receive an additional payment, in addition to the market price for electricity. This model is used in Denmark, the Netherlands and Thailand. Premiums can be set price adders or fluctuate, based on electricity price developments, which result in a reduced risk of overcompensation. As producers are exposed to changes in the electricity price, these FITs result in a higher risk for generators, which in turn implies a higher cost of capital. The advantage of premium payments is that generators are incentivized to produce electricity when the market needs it most.

A number of countries have implemented FITs, to varying degrees of success. According to research conducted by the World Economic Forum's Green Growth Platforms Initiative, the Intergovernmental Panel on Climate Change (IPCC) and the National Renewable Energy Laboratory in the USA, the most effective and efficient policies comprise most or all of these following elements:[67]

- Tariffs based on the cost of generation and differentiated by technology type and project size, with carefully calculated starting values: By introducing a high degree of demarcation in setting payment levels, a jurisdiction can ensure that diverse renewable energy investments are fostered. For dispatchable resources, an additional option is to differentiate by time of delivery, thereby incentivizing that generation matches demand more closely.

- Tariffs guaranteed for a long enough time period to ensure an adequate rate of return: The stability of the framework makes it more likely for traditionally risk-averse investors to provide debt financing for projects and helps manufacturers develop longer planning horizons. A lesson learned from Spain, where over-capacity prompted a drastic change to the policy framework,[68] is that sudden and unpredictable changes in policy design can undermine investor confidence. FIT policies must therefore incorporate a long-term perspective, with policy adjustments occurring gradually.

- Regular long-term design evaluations and short-term payment level adjustments to reflect technological change: FIT payment levels should seek to track the actual technological costs. Tariff degression reduces the risk of overcompensation and provides a clear incentive for developers to reduce costs and improve efficiencies. As highlighted above, these changes should occur gradually.

- Utility purchase obligation: Without a purchase obligation, investor confidence decreases; and the perceived risk of the policy to investors increases.

- Priority access and dispatch: Grid-access guarantees, which are important for small-scale and larger industrial developments, inspire investor confidence.

- Integration of costs into the rate base and shared equally across the country: A fair and transparent distribution of costs (including grid integration and balancing) mitigates the presence of "free-riders" and can help address transmission bottlenecks.

[67] World Economic Forum, Green Growth Platforms initiative; Mitchell, C. et al, 2011: Policy, Financing and Implementation. In IPCC *Special Report on Renewable Energy Sources and Climate Change Mitigation*, Cambridge University Press, Cambridge, United Kingdom; Detail sourced from NREL, *A Policymaker's Guide to Feed-in-Tariff Policy Design*, July 2010.

[68] In 2008, Spain's solar market experienced unprecedented growth, due to a combination of an aggressive tariff structure and a rush to install projects prior to policy revisions due in September 2008. This led to 2,575 MW of capacity additions in 2008.The Government of Spain responded by instituting annual caps on the total installed capacity of 500 MW for 2009 and 2010.

Actionable insight 1.3: Set clear interconnection protocols, coordinate generation-to-transmission planning and adopt supporting technologies for intermittent renewables integration

The smooth grid integration of a large share of intermittent renewable energy sources calls for: a sound policy and regulatory framework that provides interconnection standards and financial incentives to the grid companies; coordinated generation-transmission planning; and technology solutions such as smart grids, energy storage, pump storage and grid-friendly wind turbines with better power factor control and grid fault management capability to reduce disturbances to the grid.[69]

Experience from Europe indicates that transparency and uniformity in rules pertaining to interconnection are crucial factors for renewable energy developers.[70] Grid operators are required to publish uniform and non-discriminatory standards for grid interconnection. The greater the clarity of these standards, the lower the administrative costs for individual project applications will be. The application process should also be different for large, utility-scale projects, calling for grid and environmental impact studies, than for smaller systems. Interconnection procedures should therefore be streamlined for smaller systems, preventing unnecessary bottlenecks and administrative complexity.[71] Ensuring that these standards are in place is the responsibility of EGAT, which has implemented a grid code to assign criteria, duty and responsibility related to the operation of grid connection, and to define grid-related regulations and technical specifications.

Traditional planning methods for transmission expansion based on interconnection requests present challenges for renewable energy integration. In general, the planning, permission and construction of new transmission can take 5-10 years. In contrast, it can take nine months to a few years for large-scale renewable energy projects to be developed. A wind farm, for example, could be completed in 12-15 months.[72] This conflict poses considerable risks to developers and transmission system operators (TSO) and creates the familiar "chicken-and-egg" conundrum: transmission lines are unlikely to be built without the assurance that generation will be present to fill them and generating capacity is unlikely to be built without the assurance that transmission lines will be in place to deliver the product to market.

Coordinated generation-transmission planning is therefore critical to the success of renewable energy expansion. This requires detailed grid analysis that considers how a proactive approach can be taken to transmission expansion, based on resource availability, developer interest and project submissions. Grouping renewable energy developments into high-potential clusters has proven successful.[73] Supporting the implementation of the AEDP will require that EGAT contemplate adopting such an approach.

As penetration rates of variable renewable generation increase, ensuring the reliable and stable management of the grid becomes increasingly difficult. As little as 7% penetration of distributed wind turbines on the low-voltage network can create major problems on the distribution network.[74] Smart grids will support greater deployment of variable generation technologies by providing operators with real-time system information that enables them to manage generation, demand and power quality. This, in turn, serves to improve system flexibility and maintain stability and balance.[75] To mitigate the intermittent nature of renewable generation, the smarter grid can leverage embedded storage to smooth output levels. Energy and pump storage systems further assist in controlling the release of power onto the grid. The key advantage of storage is that electricity that is generated does not immediately have to be sent to a consumer. This "time shifting" of electricity provides another means to manage the balance between supply and demand over shorter time periods.

In March 2011, the PEA announced its smart grid development road map, which will be implemented between 2012 and 2026.[76] This process begins with a design and testing phase from 2012 to 2016, including a smart grid and an advance metering infrastructure pilot to be implemented in Pattaya City. From 2017 onwards, the roll-out of further large-scale projects will take place. While the MEA and EGAT have adopted a series of policies and projects related to the efficiency and strengthening of the grid, neither organization has a clear smart grid strategy. Thailand will thus require a more unified approach if it is to deliver a smart grid effectively.

[69] World Bank and NESDB, *Thailand: Clean Energy for Green Low-Carbon Growth*, 2011.
[70] M. Ragwitz et al. *Assessment and Optimization of Renewable Energy Support Schemes in the European Electricity Market: Final Report*. Karlsruhe, Germany: Optimization of Renewable Energy Support (OPTRES) project for the European Commission, DG TREN, and Intelligent Energy for Europe (IEE).
[71] M. Mendonça, D. Jacobs and B. Sovacool, *Powering the Green Economy: The feed-in tariff handbook*, London: Earthscan, 2009.
[72] NREL, *A Policymaker's Guide to Feed-in-Tariff Policy Design*, July 2010.
[73] ibid.
[74] World Economic Forum, *Accelerating smart grid investments*, 2009.
[75] IEA, *Technology Roadmap: Smart Grids*, 2011.
[76] Thailand-EC Cooperation Facility, *Smart/Intelligent Grid Development and Deployment in Thailand (Smart Thai)*, Brief report on existing policies affecting smart grid development and analysis of barriers in Thailand, January 2012.

Actionable insight 1.4: Promote the sustainable growth of the biofuels sector by creating a clear sustainability framework, increasing land productivity and supporting R&D for advanced biofuel technologies

Biofuels production interacts with society and the environment in complex ways. Its impact on health, poverty and biodiversity can be positive or negative, depending on the design and implementation of specific projects. There are, for example, a number of risks to food security from expanded biofuel production, such as increases in the prices of sugar and palm fruits, and potential competition for land for food production by expansion of palm oil plantations. Thailand currently dedicates 88% of its arable land to four major crops – palm, sugar cane, rice and cassava – three of which are used as biofuel feedstocks.[77]

To ensure that biofuels production based on current feedstocks is sustainable and does not impinge on food production, Thailand needs to focus on creating clear sustainability frameworks and standards, the likes of which have been established in several other countries. For example, in the United States, the Renewable Fuel Standard mandates minimum GHG reductions from renewable fuels, discourages the use of food and fodder crops as feedstocks and estimates indirect land use change (ILUC) effects to set thresholds of GHG emission reductions for categories of fuels.

An important element of increasing sustainability in biofuels production will be to increase land productivity and improve yields for current feedstocks. To meet the AEDP's ethanol target of 9 ml/day by 2021, the Thai government plans to improve feedstock yields to 94 tons/hectare for sugarcane and 31 tons/hectare for cassava. To meet the biodiesel target of 5.97 ml/day, the expansion of oil palm acreage will be encouraged, with yields increased to 20 tons/hectare.[78]

[77] Arunratt Wuttimongkolchai, Petroleum Products and Alternative Fuels Research Department, PTT Research and Technology Institute, *Biofuel R&D Program*, 27 March 2012.
[78] USDA Foreign Agricultural Service, Global Agricultural Information Network (GAIN) Report, *Thailand: Biofuels Annual*, 2012, 29 June 2011.

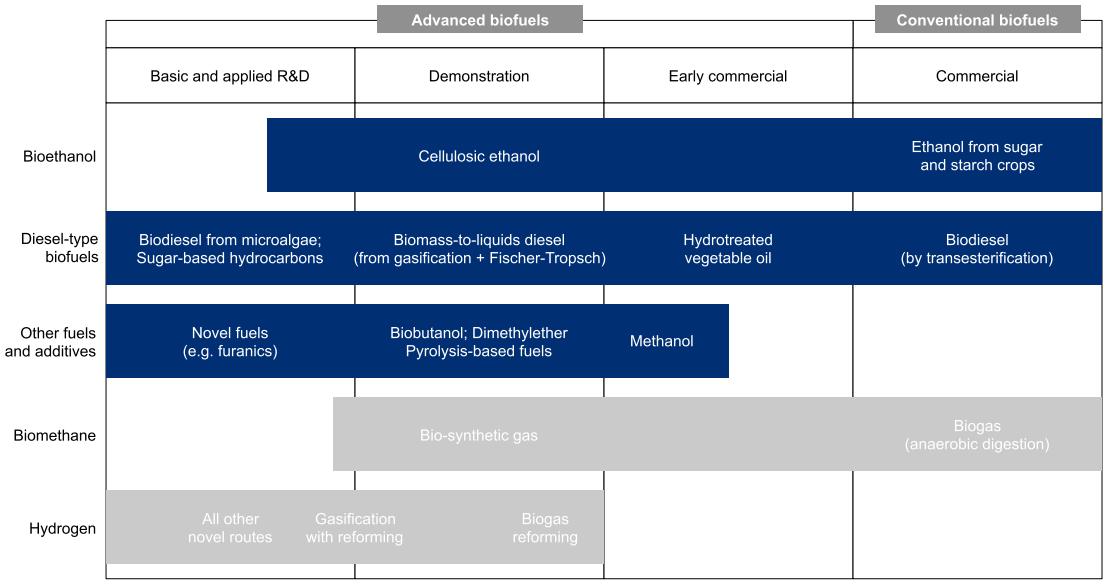
Many techniques available for increasing land productivity and feedstock yields have already been adopted in Thailand, including improved agricultural management techniques such as irrigation, fertilizer and pesticide use. Further improvements could be achieved across feedstocks through conventional plant breeding, focusing on traits relevant to energy production. The IPCC estimates that there is the potential to increase yields at the global level. Oil palm could be increased by 30% by 2030, relative to 2009 data, through the use of breeding techniques and increased mechanization. It estimates the yield increase potential for sugarcane to be between 20 and 40%, based on the creation of more productive strains, genetically modified organisms (GMOs) and improved irrigation.[79]

Meeting Thailand's long-term biofuels targets also calls for the promotion of advanced biofuel technologies,[80] focusing on alternative energy crops. These include lingocellulosic biomass sources, such as stover, switchgrass and other agricultural waste, that have higher yields and can be produced on non-arable land.

Globally today, the installed advanced biofuel capacity is roughly 175 million litres gasoline equivalent (Lge) per year, but most plants are currently operating below nameplate capacity. Production capacity of another 1.9 billion Lge/year is currently under construction. Project proposals for an additional 6 billion Lge/year capacity have been announced for implementation by 2015.[81] Many of these technologies are in early stages of development and not yet fully commercial (see Figure 13).

[79] Chum et al., "Bioenergy", in *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*, 2011.
[80] *Conventional biofuel technologies* include established processes that are produce biofuels on a commercial scale. These biofuels, commonly referred to as first-generation, include sugar- and starch-based ethanol, oil-crop based biodiesel and straight vegetable oil, as well as biogas derived through anaerobic digestion. Typical feedstocks used in these processes include sugarcane and sugar beet, starch-bearing grains like corn and wheat, oil crops like rape, soybean and oil palm, and in some cases animal fats and used cooking oils.
Advanced biofuel technologies which are still in the research and development, pilot or demonstration phase, and are commonly referred to as second-generation biofuels. Second-generation biofuels are those biofuels produced from the non-starch/sugar components (cellulose, hemicellulose or lignin) of both crops and waste agricultural products. These components are converted into ethanol and biodiesel using advanced chemical processes. Second-generation technologies convert a greater proportion of the feedstock biomass into biofuel, because it is not only the starch-based or oilseed portion of the crop that is processed. Second-generation biofuel can either be blended with petroleum-based fuels combusted in existing internal combustion engines, and distributed through existing infrastructure or is dedicated for the use in slightly adapted vehicles with internal combustion engines (e.g. vehicles for DME). Examples of second-generation biofuels are cellulosic ethanol and Fischer-Tropsch fuels.
[81] IEA, *Technology Roadmap: Biofuels for Transport*, 2011.

Figure 13 – Status of advanced and conventional biofuel technologies



(Reproduced from IEA, Technology road map: Biofuels for transport, 2011)

Figure 14 – Development of advanced biofuel technologies in Thailand[82]

Focus area	Feedstock	Process	Advantages	Technical challenges	Current state of development (Global)	Current state of development (Thailand)	Economic status
Feedstocks							
Cellulosic ethanol	▪ A number of feedstocks are available – sweet sorghum	▪ Cellulose and hemicellulose feedstock components converted into fermentable sugars using hydrolysis ▪ Sugars fermented into bioethanol using conventional methods	▪ Non-edible ▪ Can be grown on non-arable land ▪ Reduced lifecycle GHG emissions	▪ Efficient sugar conversion ▪ Reducing enzyme and pre-treatment costs	▪ Several pilots in many countries, with first commercial plants coming into operation	▪ Thai Roong Ruang Group has established a pilot project using sugarcane bagasse, a by-product of an existing ethanol plant. Experimental stage with 10,000 l/day production. Full capacity of 120,000 l/day	▪ High up-front capital costs for commercially viable plants ▪ Costs for fuel production have been declining rapidly in recent years
Jatropha	▪ Jatropha shrub that yields oil-rich kernels	▪ Crushing, and pressing to produce natural oil ▪ Hydrolysis to produce biodiesel	▪ Non-edible ▪ Can be grown on non-arable land ▪ Low water requirement ▪ Rapid growth (oil extraction possible in 2-5 years) ▪ Perennial	▪ Not economic at current yields: Trials in India on non-arable land led to low seed yields due to lack of moisture and nutrition	▪ Numerous pilots in place for feedstock development in Latin America, Africa and Asia	▪ PTT RTI working with Kaset sart University on optimizing strains to increase seed yield; multiple field trials running	▪ In a 2007 study Goldman Sachs estimated that the breakeven point for Jatropha production was $43/bbl ▪ Recent experience in India has challenged this estimate
Algae	▪ Microalgae lipids	▪ Cultivation in open ponds or closed photobioreactors ▪ Lipid production, extraction and conversion of microalgae neutral lipids ▪ Remainder of algal mass digested or used in other process	▪ High productivity ▪ CO2 abatement tool ▪ Potential to recycle nutrietn waste streams ▪ Cultivation anywhere ▪ Can utilise a wide variety of water sources	▪ Cost of processing solely for fuel production are high ▪ Logistical challenges in scale-up ▪ Water consumption minimization	▪ Active R&D by companies small and large including pilots pursuing jet and diesel fuel substitutes	▪ PTT consortium "THINK ALGAE" between PTT, CU, MU, KMUTT, BIOTEC (NSTDA), & TISTR began in September 2010 with the aim of achieving commercialisation by 2017 ▪ PTTCH consortium including Solix, Microalgal Biotechnology Lab, NSTDA & MFU ▪ DEDE consortium including KU, BU, Pinthong Engineering, BCP, Queensland University, & James Cook University focused on freshwater and marine	▪ Cost estimates vary significantly, but commercial production is estimated to be a decade away
Processes							
Biomass-to-liquid (BTL)	▪ Lignocellulosic	▪ Biomass converted to syngas rich in hydrogen and carbon monoxide ▪ Syngas is cleaned and catalytically converted through Fischer-Tropsch (FT) synthesis	▪ Catalytic process is well understood	▪ Plant costs ▪ Gas clean-up costs ▪ Catalytic reactor designs ▪ Improvements in catalyst efficiency	▪ One first commercial plant underway (using wood). Many demonstration and pilot processes under way	▪ The Thai Air Force has been leading an initiative on BTL production in partnership with KMUTNB ▪ A number of small scale BTL plants are operational across Thailand	▪ A recent study estimated that FTS diesel can be produced for $4-5 per gallon in a 2,220 tons of biomass per day plant ▪ Up-front capital costs for plants are high and are likely to exceed GTL costs
Bio-hydrofined diesel (BHD)	▪ Plant oils, animal fat, waste	▪ Hydrogenation	▪ Well-known technology, standard in petrochemical operations	▪ Feedstock costs	▪ One large and a number of small commercial demos underway	▪ PTT RTI is working with PTT's refinery group as well as universities for process and catalyst development	▪ Feedstock costs far exceed those traditionally used

[82] Accenture, "Irrational Exuberance?" *An assessment of how burgeoning biofuels market can enable high performance, A supply perspective*, 2007; Axelsson, L., and Franzen, M., *Performance of Jatropha biodiesel production and its environmental and socio-economic impacts*, 2010; Promode Kant and Shuirong Wu, *The extraordinary collapse of jatropha as a global biofuel*, Environmental Science and Technology, 45, pp. 7,114-7, 115, 2011; Arunratt Wuttimongkolchai, Specialist, Petroleum Products and Alternative Fuels Research Department, PTT Research and Technology Institute, 27 March 2012; Chum et al., "Bioenergy", in *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*, 2011; Ratanvalee Inochanon, *Algal biofuel technology R&D activity in Thailand*, PTT Research and Technology Institute, 13-14 December -2010; National Petroleum Council, *Advancing Technology for America's Transportation Future: Fuel and Vehicle System Analyses, Biofuels Analysis*, Draft, 1 August 2012; Goldman Sachs, *Food, feed and fuels: An outlook on the agriculture, livestock and biofuel markets*, March 2007.

Thailand's long experience with biofuel production and its existing infrastructure form a favourable framework for the set-up of an advanced biofuels industry, though high-skilled labour shortages might cause a bottleneck in the start-up phase. The country has established several R&D projects on advanced biofuels, partly through collaboration among the National Innovation Agency, universities and research institutes.

As outlined in Figure 14, Thailand is in the early stages of developing the majority of these technologies. The technical challenges related to algal-based biofuel production make of it a longer-term option and call into question whether commercial operations will be up and running by the end of the AEDP, in 2021.

Factors such as the risks involved in investing in early-stage technologies, the time it takes to bring them to market, and the uncertain nature of renewable energy markets (currently relying heavily on policy support), indicate that the Thai government will need to play a central role in providing the funding required to bring these technologies to scale and commercialization through R&D.

Potential approaches to supporting R&D development include the following features:

- *Contingent grants* can serve to cover some of the costs during the highest-risk development stages and in some cases increase investor confidence, thereby leveraging sorely needed capital.
- *Technology incubators* can assist developers in covering their operating costs, provide advice on business development and raising capital, help to create and mentor management teams, and provide energy-related market research. An example is the UK Carbon Trust Incubator Programme, which acts as an important stepping stone to commercialization for new sustainable energy and low-carbon technologies.
- *Public research centres* can provide a means for "open innovation", a way for companies to acquire intellectual property by jointly contracting with one or more public R&D centres and to endorse the costs and benefits associated with innovation. Public research centres are being developed for silicon PV cells in Belgium; and the Indian government wishes to explore a similar approach.
- *Public-private partnerships* in research include cofunded research, which creates direct research-related networking among different stakeholder groups, disciplines and locations. It may enable partners to take bigger risks, change traditional behaviour, build a supply chain, and ultimately realize a product, process or business model. Research networks can draft joint action plans in order to meet short-, medium- and long-term goals for technology performance and cost reduction; and governments can then scrutinize and adopt these plans. In the United States and Europe, the popularity of public-private partnerships for demonstration is growing.
- *Prizes* are sometimes used to foster technology development. Although the R&D risks are borne by competitors, the competitors are free in their approach to innovation and the competition process is sometimes easier than applying for public grants.

Thailand currently issues tax credits to offset the cost of investments in R&D for private institutions, but provides limited direct support for renewable energy technology development. Where investments do occur, they tend to focus on supporting the expansion of technologies deemed commercially viable. To meet the targets encapsulated within the AEDP for biofuels, as well as other renewable energy technologies, the country should consider expanding its support for R&D by reviewing the above-mentioned options. Stakeholders emphasized that this support should focus on small and medium enterprises which tend to be the engines of innovation, as opposed to large incumbents, which are better suited to acting as implementers at scale.

Stakeholders emphasized the importance of adopting a targeted approach to R&D investment. Focusing on those technologies with which Thailand has a competitive advantage would benefit from acting as a "first mover", rather than a "fast follower". One example highlighted was that of cellulosic ethanol production from sugarcane bagasse. Since this is a by-product of ethanol production, it capitalizes on the country's existing bioethanol refinery capacity, access to feedstock and low-cost workforce. This has been demonstrated successfully by the Thai Roong Ruang Group (see Figure 14).

To conclude, it should be noted that biofuels are not a panacea. A wide range of options can enhance energy security, reduce transport energy intensity and lower emissions: including vehicle fuel economy standards, a fuel tax, public transport, electric vehicles and "walkable" cities. Heavy investment in second-generation biofuels today may hinder investment in alternative technologies in the mid-term, such as in electric vehicles which are arguably well suited to Bangkok, a city where the majority of destinations are within a short distance. Biofuels should therefore not be seen as a solution in and of itself, but part of a broader portfolio of sustainable transportation policies.

Actionable insight 1.5: Attract and support oil and gas independents to develop marginal and mature fields

The oil and gas sector in Thailand is focusing on maximizing production in the Gulf of Thailand, which is beginning to plateau. The objective is to extend the plateau to 2020, by expanding production in marginal and mature fields. The government will soon announce a new bidding round of 22 blocks, 11 of which will be in the north-east and five in the Gulf. The prospects for the blocks are thought to be positive: over the past five years, 500 wells have been drilled, with high success rates for independents and majors.[83] However, the fields are generally in more difficult, less productive locations (reserves per well have been in the region of 0.5 bcf), with relatively high well costs.

A range of technical measures can be deployed to support the development of marginal and mature oil and gas fields. From the perspective of production optimization, these include the use of subsea manifolds; long flow lines from well-head to production platforms; and, in the case of oil, improved and enhanced oil recovery (IOP and EOR). Promoting operational excellence will also be important if costs are to be controlled. Options include: improving the condition of offshore facilities; investing in the maintenance and renewal of assets to sustain their integrity and improve their reliability; reviewing artificial lifting methods; and industrializing project development, fast tracking their projects through to first oil or gas. Information flows will also need to improve. Increased levels of production logging will enhance the understanding of well performance and enable more targeted production. Similarly, 3D/4D/borehole seismic reviews will improve understanding about existing reservoirs and generate new opportunities.[84]

Many of these technologies have been adopted in the Gulf – the government's role should be to support continued investment through an appropriate policy framework. Operating in mature and marginal fields reduces capital efficiency for producers, as more funds are spent on recovering the same amount of oil and gas. Supporting investment in marginal fields will therefore call for a tailored fiscal regime to reduce costs.

Access to infrastructure will be critical when marginal fields which are not large enough to support their own infrastructure are being developed. Potential responses include infrastructure-led exploration and the targeting and configuring of fields for common access and export to existing shore/processing facilities. This, in turn, requires that fields be developed in adequate time to maximize their contribution to reserves recovery, before the infrastructure itself becomes uneconomical. As such, Thailand should seek to assess the current availability of and access to existing infrastructure that could support the development of marginal fields. It should also consider developing a voluntary code of infrastructure practice that guarantees new and smaller operators access to third-party infrastructure.

[83] Interview with the Department of Mineral Fuels, Ministry of Energy, Thailand.
[84] Accenture research, based on project experience.

In Focus: Supporting marginal and mature field production in the North Sea

Thailand could learn from the experiences of the United Kingdom and Norway. These countries are attempting to boost production in the North Sea, where the assets are similarly shallow water and a mix of oil and gas.

Norway has successfully worked in collaboration with the oil industry to support the development of marginal fields. The measures have included government-industry partnerships to pilot new enhanced oil recovery technologies and changing tax rules to make the value of increased production more attractive. Through this effort, existing fields could produce an additional 16 billion barrels by the end of their lifetimes, extending the output of some existing wells beyond 2050.[85]

In contrast, the United Kingdom has experienced recent challenges in promoting output, owing to an unexpected increase in the rate of the Supplementary Charge to Corporation Tax (SCT) in the March 2011 budget. Centrica cited this as a reason for shutting in its South Morecambe field, which contributed to 6% of domestic gas production in 2010. The UK government has since responded by expanding the Field Allowance – a field specific relief against SCT allocated to help overcome the commercial disadvantages of operating in a challenging environment – to older, mature fields ("brown-fields"). Additionally, it has expanded the Small Fields Allowance, applicable for fields of up to 45 million barrels of oil equivalent (boe). These fiscal incentives support production in mature and marginal fields, however the fiscal instability created by increases to the SCT have increased the risk premium associated with operating in UK Continental Shelf and may deter investors. This highlights the importance of maintaining a stable fiscal regime.[86]

[85] McKinsey Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.
[86] Oil & Gas UK, *Economic Report 2012*, July 2012.

Actionable insight 1.6: Build on bilateral relationships with neighbours to open up new sources of supply

With production of indigenous sources of gas now plateauing, Thailand will need to look increasingly towards international markets to secure its supplies. As with the rest of the energy sector, this will require a more diversified approach, in which hydrocarbons are sourced from multiple "hubs".

The ASEAN region will remain a core hub, but ensuring that supplies continue to flow will depend on the development of new fields, most notably the Natuna field in Indonesia and the overlapping area between Cambodia and Thailand.

The Natuna field exhibits great promise, but being both a deep-water and high-CO2 content asset, it bears considerable challenges. As development thus far has been hindered by disagreements between partner companies, an integrated plan incorporating the TAGP needs to be established.

The shared field with Cambodia is potentially prolific, being a mirror image of the field solely situated on the Thai side, where infrastructure is fully developed. It represents the next big reserve pool for both nations. The failure to develop the field has been a consequence of poor relations between the two governments. However, under the current Thai administration, the relationship has improved markedly, presenting the opportunity for development in the near future.

Even if development begins apace at both the Natuna and Cambodia fields, stakeholders we interviewed in Thailand believe it will be over 10 years before first gas. In the short- to medium-term, Thailand will need to focus its efforts on wider international markets. Currently 40% of its supplies are sourced through the Strait of Hormuz. In response, PTT has been expanding its operations in a number of geographic regions, adding hubs in Canada and Australia. While in both instances, operations are focusing on oil production, significant opportunities also exist in LNG.

Supporting this approach will require a clear understanding of potential price swings on international markets. The importance of this is evident in gas markets, which are pervaded by uncertainty. This is the consequence of the convergence of three events: the advent of the shale gas "revolution", the growth of LNG capacity, and the expansion of inter-continental pipeline infrastructure. These events, resulting in unprecedented growth in gas supply, and the subsequent decoupling of oil and gas prices, have provoked a range of opinion on how gas markets will transition in future.

Historically, gas markets have operated in three regional markets, the United States, Europe and Asia, as high transportation costs link gas prices closely to the geographical area of supply. The dramatic changes to both supply and demand witnessed by the industry have raised the question of whether the regional gas markets will converge, and if so, to what extent. A range of possibilities may emerge as governments and energy companies seek to balance energy security and economic opportunity. At one end of the spectrum, minor convergence may occur, with regional markets continuing to dominate; at the other, lies a fully globalized gas market. In either scenario, Thailand must be cognisant of emerging market dynamics.

Actionable insight 1.7: Focus on capacity-building to lay the foundations of the nuclear sector

In 2011, the Nuclear Power Infrastructure Establishment Coordination Committee and supporting sub-committees prepared an Integrated Nuclear Infrastructure Review Mission and Readiness Report for submission to the National Energy Policy Council (NEPC). This was intended to move the development of a Thai nuclear sector from a project planning phase to project implementation. However, in April 2011, NEPC postponed the project by three years, in order to bridge gaps in capacity and promote public understanding.

In response, EGAT has been participating in training programmes, run in conjunction with China Guangdong Nuclear Power Company and Tokyo Electric Power Company (TEPCO), as well as international agencies, including the IAEA and JAEA. Master's and PhD programmes in nuclear engineering have been established at Chulalongkorn and Kasetsart universities. In South Korea, at RCA-KAIST, Master's programmes are being funded too. EGAT has been driving a public information programme, including 40 exhibitions across Thailand which were attended by over 30,000 people and seminars attended by local community leaders.[87] These efforts to increase energy literacy will be pivotal for public acceptance of major energy infrastructure projects, as highlighted in the focused section on this topic.

Further capacity-building efforts should focus on developing the sizeable support industries required for a robust nuclear sector. A wide range of specialist sub-contractors and suppliers is involved in providing and installing the systems and components of a plant. As the *New Energy Architecture: Japan* study demonstrates, countries making use of nuclear power need to establish strong capabilities across the nuclear value chain, including managing cooling shutdown, storing spent fuel, disposing of contaminated water, and decommissioning.[88]

The safe running of nuclear plants involves technical and managerial competence. Almost all nuclear accidents in the past were partially a result of human error. The Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) concluded that the disaster was "man-made", with its root causes in "the organizational and regulatory systems that supported faulty rationales for decisions and actions".[89] This underlines the importance for Thailand of implementing appropriate organizational systems and oversight, and instilling a culture of safety, from project planning through to operation.

Any country intending to launch a nuclear programme needs to have in place an appropriate legal framework for nuclear-related matters. This includes establishing a system for regulating, licensing and monitoring nuclear activities and facilities, overseen by an independent and adequately resourced agency. Thailand has set up the Office of Atoms for Peace (OAP), a nuclear regulatory body located in the Ministry of Science and Technology. To strengthen this organization, Thailand should consider the recommendations of the Fukushima NAIIC, with regard to the criteria for the creation of a new regulatory body, outlined in "In Focus: Regulation of the nuclear sector".

[87] Kalayanamitr Cherid, EGAT, *Status of Nuclear Energy in Thailand*, 21 March 2012; Jittapan Ineead, *Thailand: Country report on nuclear power programme*, IAEA School on Nuclear Energy Management, Japan, 2012.
[88] World Economic Forum, *New Energy Architecture: Japan*, 2012.
[89] The National Diet of Japan, *The official report of The Fukushima Nuclear Accident Independent Investigation Commission*, Executive Summary, 2012.

In Focus: Regulation of the nuclear sector – Excerpt from the official report of the Fukushima Nuclear Accident Independent Investigation Commission

Recommendation 5:

Criteria for the new regulatory body

The new regulatory organization must adhere to the following conditions. It must be:

1. Independent: The chain of command, responsible authority and work processes must be: (i) Independent from organizations promoted by the government (ii) Independent from the operators (iii) Independent from politics.

2. Transparent: (i) The decision-making process should exclude the involvement of electric power operator stakeholders. (ii) Disclosure of decision-making process to the National Diet is a must. (iii) The committee must keep minutes of all other negotiations and meetings with promotional organizations, operators and other political organizations and disclose them to the public. (iv) The National Diet shall make the final selection of the commissioners after receiving third-party advice.

3. Professional: (i) The personnel must meet global standards. Exchange programmes with overseas regulatory bodies must be promoted, and interaction and exchange of human resources must be increased. (ii) An advisory organization including knowledgeable personnel must be established. (iii) The no-return rule should be applied without exception.

4. Consolidated: The functions of the organizations, especially emergency communications, decision-making and control, should be consolidated.

5. Proactive: The organizations should keep up with the latest knowledge and technology, and undergo continuous reform activities under the supervision of the Diet.

2. Efficiency

Actionable insight 2.1: Develop more efficient production processes and increase product quality in the manufacturing sector

Over the past decade, energy-intensive industrial sectors have been an important component of Thailand's economy. Manufacturing has, in particular, been an expanding area of economic activity. For example, as Thailand is perceived as a ready point of entry to the rest of Asia and beyond, it attracts automotive manufacturers and has become a hub for the production of one-tonne pickup trucks. Now the world's largest producer of trucks, the country exports to 130 markets worldwide.[90] The ongoing expansion of the manufacturing sector has contributed to continued high levels of energy intensity.

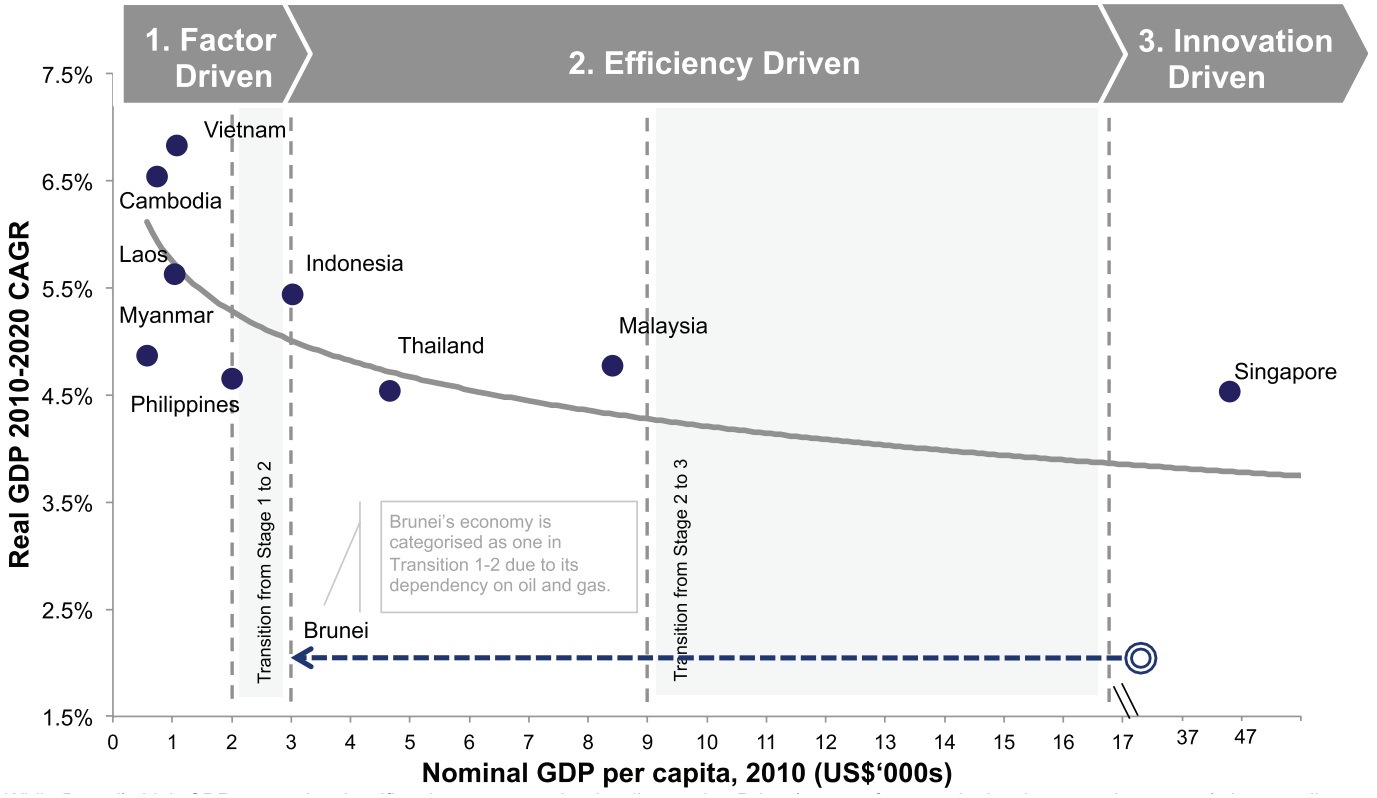
[90] Accenture, *Capturing the ASEAN Wave*, Outlook, 2012, Issue 1.

Based on its current level of economic development, Thailand will need to focus on developing more efficient production processes, increasing product quality in the manufacturing sector and expanding into higher value-added activities (see Figure 15, depicting the economic development paths of countries within the ASEAN region). This will form an important component of achieving the objectives of the 11th National Economic and Social Development Plan, which aims to rebalance Thailand's economic structure to lower energy-intensive, higher value-added activities.

Figure 15 – Thailand's economic development path

Source: Accenture Analysis of data from IHS Global Insights, 2011.

Note: While Brunei's high GDP per capita classifies the country under the 'Innovation-Driven' stage of economic development, the country's heavy reliance on oil and gas as factor inputs classifies it as 'Factor Driven' economy.
State of economic development is used based on World Economic Forum's Global Competitiveness Report 2009-2010



Actionable insight 2.2: Focus on creating efficiency standards, adopting innovative financing mechanisms and government-led procurement initiatives, to increase the uptake of energy efficiency measures in residential and commercial buildings

A wide array of options exist for improving the efficiency of residential and commercial buildings. The range includes upgrading lighting to light-emitting diodes (LEDs) and installing dimmable lighting ballasts with photo sensors (which optimize light according to available daylight and the number of occupants in a room), applying passive solar principles, using sunlight to aid in natural heating, and much more.

Since Thailand enjoys significantly more efficient technologies than were available to other countries which went through the same stage of development, more efficient consumption can be embedded in its new middle-class consumers than in past consumers with the same income levels. For example, a refrigerator built in 2000 consumed 70% less energy than one built in 1970 and a new car could travel the same distance on 40% less fuel.[91]

Major challenges to execution remain, however. As while more efficient technologies are available, there are numerous hurdles to driving up adoption rates. For example, in both residential and commercial buildings, agency issues arise when the landlord bears the cost of investing in energy-efficient insulation, but the tenant benefits through lower energy bills. Additionally, while energy-efficiency measures often have attractive returns, it can be difficult for households and commercial enterprises to attract the capital required to fund them, because the borrower may be deemed not creditworthy. Additionally, the underlying assets are difficult to reclaim, in the case of default (e.g. removing insulation from housing).

Government efficiency standards can be an effective, low-cost way of overcoming principal-agent barriers and coordinating a transition to more efficient products, particularly white goods, consumer electronics products, air-conditioning, lighting and vehicles. With the implementation of such standards, economies of scale emerge and the prices of energy-efficient products typically decline to the level of the former, less efficient products. Instead of regulating the use of specific technologies, standards are more effective if they set targets for overall efficiency, leaving the details of how to achieve these targets to innovations at the company level.

Rebates and incentives for the installation of efficiency measures, such as fitting new windows and better insulation, have proven to increase efficiency. However, findings from interviews conducted in Thailand indicate that such incentives have seldom been sufficiently commercially attractive to drive take-up, since the time for return on investment can be substantial. More innovative financing mechanisms are needed to help overcome capital constraints and rapid payback requirements. Examples include tying loan payments to the property or to the utility meter, instead of to the homeowner, and ensuring that investments always have a positive cash flow to the homeowner (i.e. the monthly savings are greater than the loan payment). A model of this approach is the United Kingdom's Green Deal, which enables private firms to offer consumers energy-efficiency improvements to their homes, community spaces and businesses, at no upfront cost. Payments are recouped through a charge in instalments on the energy bill.[92]

To help address inherent technology and market risks, the Thai government can also act as a lead customer of emerging technologies through public-sector procurement. This was highlighted as an area that warrants improving.

[91] McKinsey Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.

[92] Accenture, *Achieving high performance in the home energy services market: A review of opportunities for energy service providers in the United Kingdom*, 2011.

Actionable insight 2.3: Create a "smart" city road map for Bangkok

Accommodating 7 million residents,[93] Bangkok is Thailand's largest city and greatest source of energy demand. Rapid growth has caused the city to sprawl – a consequence of poorly integrated land use plans – resulting in a population density lower than many peer cities. That same growth has put pressure on the city's resources: land, energy and water. Daily, the city grinds to a halt under the weight of its congestion. Although air quality has improved, Bangkok's carbon emissions are much higher than those of its peers in the developed world. If it is to be a leading global city, it must manage these challenges more effectively and efficiently. Otherwise, the city runs the risk of locking itself into a resource-intensive approach.

A new set of options are available. Social media, the Internet, "cloud" computing, embedded sensors and mobile phones are creating a smart or digital infrastructure that grows more powerful every year, facilitating communication, collective problem-solving, making electricity grids more efficient and providing new options for services (such as video conferencing instead of driving to the office).[94] Governments, businesses and individuals are increasingly sharing their data, which is spurring digital entrepreneurial activity and the creation of more integrated, citizen-centric services. This trend will continue as cities create "information marketplaces" to enable data exchange and commercialization.[95] Just as city governments provided physical infrastructure in the 20th century (roads, rail, bridges and canals), in the 21st century, the city will play a role in providing digital infrastructure (such as open data platforms and broadband connectivity), to cope with urbanization and stimulate economic growth.

Bangkok can draw upon these technological developments to become a smart city and meet its challenges through the strategic application of ICTs, providing new services to citizens and managing its existing infrastructure. When citizens and businesses are empowered to make better decisions about travel and transporting goods and understand better the real cost of using electrical appliances, they make better use of resources. These resources will, in turn, be allocated more efficiently, in parallel with saving costs and the transitioning to a more efficient economy.

Bangkok has a climate change plan in place. However, in order to take full advantage of the opportunities provided by ICTs, a clear smart city road map needs to be defined. This road map should include the development of innovative governance and business models that enable collaboration amongst city departments and public-private sectors.

[93] *CIA Factbook*, Population figures for 2009.
[94] Accenture, Cisco and the GMSA, *Smart Mobile Cities: Opportunities for Mobile Operators to Deliver Intelligent Cities,* 2011; Accenture, The Climate Group and ARUP, *Information Marketplaces: The New Economics of Cities*, 2011.
[95] ibid.

In Focus: Smart city development in Japan[96]

Retrofitting: Yokohama Smart City Project

Yokohama is an established city of 3.68 million, with a number of distinct areas, including a highly developed urban centre, a suburban commuter zone and an industrial development zone built on reclaimed land. The Yokohama Smart City Project is a five-year pilot programme with a consortium of companies that aims to create a new urban model for the rest of the world to emulate.

Core components of the initiative include:

- Expansion of renewable energy deployment: Homeowners will be encouraged to purchase solar systems, with the objective of deploying 27 MW of PV by 2014.
- Introduction of a Community Energy Management System: Energy management systems are being installed in general households (Home Energy Management Systems (HEMS)) and at business facilities (Building Energy Management Systems (BEMS)). HEMS are being installed in 4,000 homes, with network energy-consuming equipment, including domestic electrical appliances and hot-water systems, in order to enable automatic and centralized control. BEMS are being installed in three areas; they will automate and centralize energy conservation monitoring and controls for all energy-related equipment in a commercial office, plant or in a district heating and cooling system. Renewable energy output fluctuations will be controlled by combining stationary storage batteries, HEMS and BEMS.
- Mass introduction of EVs: A roll-out of electric vehicles will be incentivized and supported by the development of a network of charging stations. The network will facilitate charging and discharging. It will turn the fleet into power-storage facilities that assist in the introduction of large-scale PV systems into the grid, while reducing the well-to-wheel emissions of EVs.

These initiatives are expected to lead to a reduction in carbon emissions of 64,000 t-CO_2 by 2014.

New build: Fujisawa Sustainable Smart Town

Panasonic, Fujisawa City and a consortium of companies are working to build a new smart town on the vacant lot of Panasonic's former factory site, due to open in March 2014. The partners will collaborate on building an innovative smart town of 1,000 households, demonstrating the efficient use of energy by promoting widespread use of energy-saving devices and proposing new solutions that integrate measures for energy creation, storage and management.

Core components of the initiative include:

- Master planning for providing an eco-conscious, comfortable lifestyle and concomitant services: The project will adopt city block designs that take into consideration how to achieve a natural environment in harmony with lifestyles. This will include: a "green axis", establishing parks and planting vegetation along main roads; designing parking that facilitate car-sharing to reduce the carbon footprint of the transportation sector; and developing real estate assessment indexes that facilitate a market acceptance of environmentally-conscious urban development as real estate value.
- "Town that is connected from the start" through the optimal design and introduction of infrastructures and equipment in all city blocks. Comprehensive information and energy systems will be installed for homes, commercial premises and public facilities. Systems will be packaged together, to include energy-generating devices (solar photovoltaics and fuel cells), storage devices (batteries and water pumps), energy-saving devices (LED lighting), and smart energy gateways with interactive displays. These systems will have built-in compatibility with future networks.
- Service model that enables a next-generation lifestyle unique to a smart town: New models will be deployed for a variety of services, including energy, mobility, security and healthcare.

[96] Accenture research and project insights; Panasonic, "Nine leading companies and Fujisawa City to collaborate on sustainable smart town project", 26 May 2011.

Actionable insight 2.4: Create a more targeted programme of subsidies for the transportation sector

Fossil fuel subsidies for consumers have been used by developing country governments as a means to alleviate energy poverty, redistribute national resource wealth and control inflation. While such subsidies may bring some social and economic benefits, they also come at a considerable cost, burdening public finances and increasing GHG emissions and wasteful consumption. Indeed, in 2010, the world spent almost twice as much subsidizing fossil fuels as it did investing in renewable energy (US$ 409 billion versus US$ 211 billion).[97] Furthermore, the World Economic Forum's study on India demonstrated that often these subsidies are implemented ineffectually and fail to help the poorest sectors of society.[98]

Thailand has made progress in subsidy removal; petrol and diesel subsidies were removed in the 1990s and 2000s. While subsidies for liquefied petroleum gas (LPG) and compressed natural gas (CNG) are still in place, they are being phased out. But progress has been slowed by public opposition[99]. This has hindered the government's ability to change fuel consumption patterns. Current price differentials between gasohol and gasoline have not encouraged consumers to switch to gasohol. Instead, the public is turning to the highly-subsidized LPG and CNG. Consequently, ethanol consumption is expected to be 1.13 ml/day in 2012, well short of the government's target of 2 ml/day in 2012.[100]

In response, the government should seek a more targeted approach to the application of subsidies to the transportation sector. For petroleum products, this will require continuing with the current programme of gradual phase-out, while mitigating the negative social and economic impacts by providing welfare support offsets (see "In Focus: Learning lessons from Nigeria").

For the biofuels sector, the Thai government has announced a programme to promote gasohol. The sales of Octane 91 regular gasoline will be terminated by 1 October 2012; the government will subsidize E20 gasohol (a blend of 20% ethanol and 80% gasoline) from the State Oil Fund, at 3.0 baht/litre (US$ 0.36/gallon), cheaper than Octane 95 gasohol. The plan will provide an incentive for gasoline stations to expand the E20 gasohol sales by giving 0.5 baht/litre (US$ 0.06 /gallon) marketing margin above the Octane 91 regular gasoline sales. The government will continue to support the manufacturing of the Eco-car (E20 vehicles) and flex-fuel vehicles (FFV) which are compatible with E85 gasohol (a blend of 85% ethanol and 15% gasoline) by reducing excise tax for automobile manufacturers by 50,000 baht/vehicle (US$ 1,587/vehicle) for FFV and 30,000 baht/vehicle (US$ 952/vehicle) for the Eco-car.

In both instances, it is crucial that these efforts be coordinated with industry. This requires, firstly, that industry be better prepared for the proposed changes. Currently, only one of Thailand's refineries is ready to shift from Octane 91 regular gasoline production to gasohol production by October 2012. Secondly, it requires that those industries that are disproportionately damaged by the changes be protected, to prevent their competitive advantages from becoming eroded. Denmark, for example, offset increases in energy taxes, ensuring that the total tax burden stayed the same. These reforms helped to drive an 80% improvement in energy efficiency in Denmark between 1979 and 2010 and generated significant growth in employment.[101] Where industry non-compliance persists, the government should consider adopting a strict programme of enforcement.

[97] IEA, *World Energy Outlook 2011*; REN21, *Renewables 2011 Global Status Report*.
[98] World Economic Forum, *New Energy Architecture: India*, 2012.
[99] *The Nation*, Energy policy "fuelling price rises", 19 March 2012.
[100] USDA Foreign Agricultural Service, Global Agricultural Information Network (GAIN) Report, *Thailand: Biofuels Annual*, 2012, 29 June 2011.
[101] Organisation for Economic Co-operation and Development, *Environmentally related taxes in OECD countries: Issues and strategies*, November 2001.

In Focus: Learning lessons from Nigeria, for effective subsidy removal

In recent years, there has been a wave of subsidy-removal efforts. Many countries have phased out fossil-fuel subsidies or are planning to do so. For example, in November 2009, APEC leaders (including Thailand) committed to "rationalize and phase out over the medium-term inefficient fossil fuel subsidies that encourage wasteful consumption" to producers and consumers, following a declaration from the G20.[102]

On 1 January 2012, the Petroleum Products Pricing Regulatory Agency in Nigeria removed the country's gasoline subsidy with immediate effect, leading to a doubling of prices. The government estimated that removing the subsidy would save US$ 8 billion annually.[103] Trade and labour unions reacted with a week-long strike that brought the country to a near standstill. The government was forced to revise its decision, then reducing gasoline prices by 30%.

Nigeria is not alone in having provoked a fierce reaction to subsidy removal. A year earlier, the Bolivian government attempted to remove gasoline subsidies, but was forced to renege on its decision, when violent protests erupted across the country.[104] These cases demonstrate how subsidies create deeply-rooted interests among those who are accustomed to receiving their support, and, accordingly, how difficult it is to remove them.

The lesson to learn from Nigeria's experience is that subsidy removal should take place as part of a well communicated, phased approach. The impact of removing resource subsidies on the poor should be mitigated by offsetting it with welfare support; and industries that would be disproportionately affected should be compensated.

Social "safety nets" – policies providing direct assistance to the poor who are adversely affected by subsidy removal – can take a number of forms. Direct transfers may include targeted cash payments, or near-cash payments (such as vouchers and food stamps), while indirect transfers may include fee waivers for essential services, such as health, education and transport.[105]

Singapore, for example, compensated low-income households for increases in water tariffs with "quasi-cash" rebates that households could use to pay utility bills, including water.[106] Mexico paved the way for a phased reform of electricity tariffs with its PRONASE energy-efficiency programme, focusing on low-income households and replacing inefficient fridges and incandescent light bulbs in a quarter of a million households. The Mexican government is also considering options for eliminating subsidized electricity tariffs in rural areas and compensating farmers with a lump-sum cash transfer to help them fund investment in more efficient irrigation technologies.[107] The advantage of these policies is their suitableness for the poor, resulting in a lower cost to the government to deliver the same net benefits.

[102] OECD, *OECD-IEA Fossil Fuel Subsidies and Other Support*, accessed on 6 August 2012 at http://www.oecd.org/site/tadffss/oecd-ieafossilfuelsubsidiesandothersupport.htm.
[103] Morgan Bazilian and Ijeoma Onyeji, *Fossil fuel subsidy removal and inadequate public power supply: Implications for business*, Energy Policy, 2012.
[104] CNN, "Morales reinstates Bolivian gas subsidies", 31 December 2010.
[105] World Bank, *Subsidies in the Energy Sector: An Overview, Background paper for the World Bank Group Energy Sector Strategy*, July 2010.
[106] Tan Yong Soon, Lee Tung Jean and Karen Tan, *Clean, green and blue: Singapore's journey towards environmental and water sustainability*, 2009.
[107] Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.

3. Integration

Actionable insight 3.1: Take an inclusive view of connectivity, incorporating physical, institutional, financial and human components

Stakeholders in the region have varying perspectives on the progress made related to regionally integrated energy architecture. While a number of connections between countries exist, these have been completed on a bilateral basis and success at the multilateral level has been limited.

During discussions held in Thailand, stakeholders emphasized that the region needed to adopt a broader sense of connectivity.

As defined in the *Master Plan on ASEAN Connectivity,* this definition consists of three core components:[108]

- Institutional: Develop institutional mechanisms to facilitate trade in goods and services, and the appropriate types of investment policies and legal frameworks to attract private investors
- Human: Develop initiatives that support human resource development, encourage innovation and entrepreneurship and build stronger socio-economic bonds
- Physical: Develop an integrated and well-functioning energy network

Across these components, the region faces a number of challenges. Considerable differences exist in current capabilities. (See Figure 16 for an overview of some of the key indicators from the World Economic Forum's Global Competitiveness Index and EAPI.)

For greater progress to be achieved, stronger institutional and human connections must first be established ahead of the formation of the AEC in 2015.. Steps that can be taken to improve connectivity are outlined below.

[108] ASEAN Secretariat, *Master Plan on ASEAN Connectivity*, Jakarta: ASEAN Secretariat, January 2011.

Figure 16 – ASEAN performance on the Global Competitiveness Index[109]

Competitiveness index ranking ↑

	Institutional			Human		Physical		
	Political structure	Competitiveness Index Rank (/144)	GDP per capita (US$)	Population (million)	Secondary education enrollment (%)	Energy Architecture Performance Index Rank (/105)	Quality of infrastructure (CI Rank/144)	Quality of electricity supply (CI Rank/ 144)
Singapore	Parliamentary republic	2	49,271	5.3	107.0	48	2	6
Malaysia	Federal constitutional elective monarchy	25	9,700	29.0	68.3	65	29	35
Brunei	Constitutional sultanate	28	36,584	0.4	109.7	60	43	45
Thailand	Constitutional monarchy	38	5,394	70.7	79.2	46	49	44
Indonesia	Presidential system	50	3,509	244.2	77.2	64	92	93
Philippines	Presidential system	65	2,223	95.3	84.8	62	98	98
Vietnam	Single part state	75	1,374	90.0	77.2	83	119	113
Cambodia	Constitutional monarchy	85	852	14.4	46.2	101	72	105

[109] World Economic Forum, *Global Competitiveness Index 2012-13*; Laos and Myanmar are not covered by the GCI or the EAPI.

Institutional Connectivity

Making the single market a reality calls for reduced institutional barriers, particularly in relation to the movement of goods, services and resources within the region. Enhanced institutional connectivity would raise the effectiveness of physical connectivity by easing the flow of goods and services (with improved transport and trade facilitation services) and ensuring greater economic and social returns from greater physical connectivity and deeper economic linkages (through higher investments).

From a tariff perspective, significant progress has been made. On 1 January 2010, the ASEAN-6 countries applied zero tariffs on 99% of goods. Not far behind, the remaining countries traded 98.6% of goods at 0-5% of tariff rate.

A number of non-tariff barriers remain, which lower the potential benefits of the ASEAN Free Trade Area. Indeed, in some countries non-tariff barriers have been rising, as industries look for additional protection, including subsidies, tax incentives and soft loans, to help them manage new competition. These links between government and business distort the single market objective. Energy sector liberalization will therefore be an important component of bringing about change. The establishment of independent and authoritative national regulators will help to support this process. In the longer term, regional regulators could be set up.

National and regional regulators would play an important role in coordinating institutional alignment. Key tasks will include harmonizing technical and safety standards and legal and regulatory frameworks. Relevant issues include jurisdiction, third-party access, the issuing of permits and licenses, and the standardization of contractual arrangements.

Human Connectivity

Significant differences in capacity exist among countries within the ASEAN region. Overcoming these challenges requires that the stronger countries in ASEAN support others in human capacity-building. This will need to take place across a range of capabilities, beyond the technical skills required to create an integrated energy architecture. For example, given the linguistic differences between countries, English language skills may play an important role in enabling cross-border trade and contract negotiation, with strong inter-governmental communication required for dispute resolution.

The promotion of deeper intra-ASEAN social and cultural interaction and understanding will be an important step in driving connectivity. This integration will be supported by greater mobility between member countries. In Thailand, the Alien Employment Act prohibits foreigners from employment in certain professions (such as civil engineering and legal services) and other professions are regulated by professional associations. A progressive relaxation of visa requirements and the development of mutual recognition arrangements are needed. Encouraging greater mobility may act as a blessing and a curse, subjecting countries to the risk of a “brain drain”. But competition for talent will force countries to develop strategies to effectively retain it.

Physical Connectivity

To date, the existing power interconnections in ASEAN have been developed through direct government-to-government negotiation, with subsequent bilateral agreements with (and ownership by) the power utilities concerned. The interconnections established by the bilateral agreements deliver electricity from one main producer to one main buyer, on long-term contracts. Although the planned multi-country interconnection projects have been deemed technically feasible by the Forum of Heads of ASEAN Power Utilities/ Authorities (HAPUA), their economic viability is yet to be established and accepted by participating economies.

Similarly, the existing nine gas pipelines are based on bilateral arrangements between two member countries, with no pipelines passing through a transit country. Furthermore, the proposed set of pipelines would originate from the Indonesian gas field, Natuna D-Alpha, which is yet to be developed, having been delayed by technical and commercial challenges. The pipelines would be developed approximately seven years after a final investment decision (FID) on Natuna is taken.[110]

In sum, neither the existing electricity nor gas model matches up to the requirements for multi-country interconnection and third-party access that characterize the APG and TAGP. The models are not part of a common system shared by the member countries, featuring both term contract sales and spot-trading supply between network suppliers and countries. As indicated previously, strengthening institutional and human-to-human connectivity will lay the foundations for making progress regarding physical connectivity. An important feature of this will be clarifying the project economics of the APG and TAGP, in order to make FIDs.

[110] IEA, *WEO 2009*.

Actionable insight 3.2: Clarify Thailand's hub strategy, identifying its best prospects and infrastructure requirements

The formation of the AEC will change Thailand's energy sector considerably. Given its location in the region, the country can become a central hub for energy trade in many different sectors – including gas, electricity and biofuels – and has identified this explicitly as an objective.

During discussions, stakeholders emphasized that while Thailand has many of the ingredients needed to become a hub for energy trade, a robust strategy and strong leadership are required to ensure that the opportunity is reaped.

Formulating this strategy calls for a clear understanding of:

- Attributes required to become a trading hub
- Specific energy-related opportunities available and the viability of these options, based on how the country's strengths complement those of its neighbours

What does it mean to be a trading hub?

The World Economic Forum has developed an Enabling Trade Index (ETI) to assess the extent to which individual economies have developed institutions, policies and services that facilitate the free flow of goods over borders and to destinations.[111] The ETI is structured around the main enablers of trade, broken down into four core components:

- Market access: The extent to which the policy framework of a country welcomes foreign goods into a country and enables access to foreign markets for its exporters
- Border administration: The extent to which the administration at the border facilitates the entry and exit of goods
- Transport and communications infrastructure: Whether the transport and communications infrastructure necessary to facilitate the movement of goods across the border are present
- Business environment: The quality of governance and the overarching regulatory and security environment affecting the business of importers and exporters

Countries that are able to establish themselves as trading hubs perform well across each of these core components, as they have established open and easy access to reliable markets for a wide number and variety of participants. In contrast "transition" hubs – those that are yet to meet a certain level of maturity across the four components – attract greater volumes per year, but there is reasonable doubt as to whether they will develop sufficiently to become more than mere national markets.

Thailand ranks 57th on the ETI. As seen in Figure 17, its key enabling trade factors are its efficient import-export procedures, including customs administration. Import and exporting goods in Thailand requires little in the way of time and administrative procedures. Additionally, the country benefits from a well developed transport infrastructure and accessible, high-quality transport services.[112] On a less positive note, room for improvement remains with respect to the transparency of its border procedures, physical security, and access to domestic markets, on which Thailand ranks a low 110th, despite numerous rounds of liberalization attempted under ASEAN.

An overview of Thailand's performance on the ETI, as compared to its peers, shows that it has some ground to catch up. While Thailand scores higher than many peers, Malaysia and Singapore outperform it, the latter doing so by a significant margin (see Figure 17). As the top performer on the ETI, Singapore has shown outstanding performance across the board. The country is recognized for its open trade policy, the simplicity of its tariff structure, the quality of its transport infrastructure, and its regulatory environment – the best in the ETI sample – boasting well-defined property rights, little corruption and undue influence, and a high level of openness to FDI.

Thailand's ability to position itself to become a trading hub – in energy or otherwise – will be contingent on improving its maturity across the above-mentioned components. It is a priority for the country to improve in each of these areas, ahead of the formation of the AEC in 2015.

[111] IWorld Economic Forum, *Global Enabling Trade Report 2012*.
[112] It should be noted that the assessment of transport infrastructure does not incorporate some of the elements required for the transportation of energy – including storage facilities, pipelines and electricity grids.

Figure 17 – An overview of ASEAN performance on the Enabling Trade Index

KEY: (1) Score 1-7; Larger bubble, higher score (1) Green shading indicates score ranks in top 30 on ETI (1) Red shading indicates score ranks in bottom 30 on ETI

	2012 Index	Subindex A: Market Access	Subindex B: Border administration			Subindex C: Transport & communications infrastructure			Subindex D: Business environment		Most problematic factors for exporting	Most problematic factors for importing
	Overall ETI Score	*Domestic & foreign market access*	*Efficiency of customs administration*	*Efficiency of import-export procedures*	*Transparency of border administration*	*Availability & quality of transport infrastructure*	*Availability & quality of transport services*	*Availability & use of ICTs*	*Regulatory environment*	*Physical security*		
Cambodia	3.5	4	3.7	4.2	2.4	3.1	2.9	2.3	3.7	4.1	▪ Diff. meeting buyer quality requirements ▪ Market identification ▪ Inappropriate production tech/skills	▪ Tariffs and NTBs ▪ Border corruption ▪ Burdensome import procedures
Indonesia	4.2	4.9	4.1	5.1	2.9	4.1	3.9	3.2	4.0	4.3	▪ Market identification ▪ High cost/delays due to domestic transport ▪ Access to trade finance	▪ Tariffs and NTBs ▪ Border corruption ▪ Burdensome import procedures
Malaysia	4.9	4.6	4.5	5.5	4.1	5.8	5.2	4.7	4.8	5.2	▪ Market identification ▪ Tech requirements & standards abroad ▪ Rules of origin requirements abroad	▪ Tariffs and NTBs ▪ Burdensome import procedures ▪ High cost/delays due to int. transport
Philippines	4.0	4.9	4.3	5.0	2.5	3.2	3.8	3.3	3.5	3.8	▪ Access to imported inputs at comp. prices ▪ Market identification ▪ Diff. meeting buyer quality requirements	▪ Burdensome import procedures ▪ Border corruption ▪ Tariffs and NTBs
Singapore	6.1	6.2	6.6	6.4	6.5	6.2	6.1	6.0	5.7	5.8	▪ Access to imported inputs at comp. prices ▪ Tech requirements & standards abroad	▪ High cost/delays due to int. transport ▪ Burdensome import procedures
Thailand	4.2	4.0	4.7	5.5	3.0	5.0	4.3	3.6	3.9	4.3	▪ Access to imported inputs at comp. prices ▪ Market identification ▪ Tech requirements & standards abroad	▪ Burdensome import procedures ▪ Tariffs and NTBs ▪ High cost/delays due to int. transport
Vietnam	4.0	4.4	2.8	4.9	2.6	3.7	4.4	4.0	3.6	4.9	▪ Market identification ▪ Access to imported inputs at comp. prices ▪ Access to trade finance	▪ Tariffs and NTBs ▪ Burdensome import procedures ▪ High cost/delays due to domestic transport

What opportunities are available for Thailand to become an energy trading hub for the ASEAN region and which of them are viable?

Countries throughout ASEAN are preparing for economic integration, many of which share Thailand's ambition to become an energy trading hub. In some cases, this will lead to healthy competition, but poor decisions may result in negative financial consequences. Thailand should therefore evaluate carefully where the most promising opportunities lie.

Below, we provide an overview of the opportunities highlighted during our discussions in Thailand and their associated challenges. This report does not seek to recommend specific technologies and infrastructure investments that Thailand should pursue. Instead, we urge the government to build on our analysis when identifying priority areas for investment. It is already a stated objective of the Thai government to become a hub for ethanol trade and, accordingly, an example is supplied of the kind of detailed assessment that should be conducted, exploring Thailand's positioning within the ASEAN ethanol market.

Power

Thailand has the strongest system in the Greater Mekong Subregion and is well located to develop into the backbone of a regional grid. However, the lack of regional harmonization raises the challenge of connecting a strong grid with a weak one. As the transmission operator, EGAT's perspective is that multi-directional connections will not be pursued until neighbouring transmission is upgraded. While EGAT will seek to support neighbours in this process, interviewees commented that it may take Laos and Cambodia over 10 years to upgrade and for Myanmar possibly longer. The creation of a regional trading exchange therefore remains a distant prospect.

Oil

Thailand has long harboured ambitions of becoming an oil trading hub. The first step towards this was building the Sriracha Oil Centre, which includes facilities for oil trading, refining, petrochemical storage and transportation. The centre is located in an oil free trade zone, with a special taxation policy. A pipeline was also built to transport oil products from the centre to the north and north-east of Thailand and the south-west of China. In order to progress on this front, Thailand needs to reduce transportation times around the Gulf of Thailand.

Recently, the idea of creating a land bridge – the plan dating back more than 20 years to build a 180 km (112 mile) trans-peninsula rail, road and pipeline, linking the Gulf of Thailand to the Andaman Sea – has been resurrected, since it would speed up the transport of crude oil from the Middle East for refining. It is unclear whether the government would pursue this idea, however.[113] A principal challenge, beside the cost of the infrastructure required, is that Singapore is already established as a global player in oil trade and accounts for 15% of its trade worldwide.[114]

LNG

For some participants we addressed in Thailand, the trans-ASEAN gas pipeline is progressing too slowly. Present planning for the TAGP does not fully recognize LNG as a potentially integral part of a regional gas transport system. While the supply source for TAGP – Natuna – appears far from development, several LNG-receiving terminal projects in the ASEAN region (and many more in the wider East Asia region) could be operated when commissioned to materially enhance gas market integration. In response, Thailand could consider pursuing an LNG model, setting up regasification terminals that allow it to import gas, for use in indigenous power generation, and to re-export to other parts of ASEAN and China, via its pipeline network. Key hurdles to this are Thailand's dwindling domestic reserves of gas and the need to build a network of supplies and long-term contracts via which to secure supplies.

Competition in the region may also be considerable. From a supply perspective, a number of neighbours – including Brunei, Malaysia and Indonesia – are leading LNG exporters. And while Thailand's build-out of regasification infrastructure progresses, Singapore, which has considerable experience in the trade of hydrocarbons, also has terminals under construction. Finally, regardless of the barriers and the potential for competition, certain participants in our study felt that LNG, as a trading opportunity, represented the "least value generation" option.

Ethanol

Thailand's strong agricultural base and its longstanding experience in the biofuels sector potentially position it to become the "Brazil of ASEAN". Current levels of ethanol production would allow for exports to the region once infrastructure is established, as would the proposed levels of second-generation production. Thailand is considered a "pioneer among Asian countries" in creating policies to promote biofuels – this is further reinforced by the analysis appearing at the end of this section.[115] However, questions linger over the long-term demand for biofuels in the region and over whether this demand would be jeopardized by the roll-out of electric vehicles. Other interviewees cautioned that becoming a biofuels trading hub would require that policies be aligned across the biofuels value chain, from production to export, and infrastructure be established to facilitate export, including an extended pipeline network and a storage centre.

Renewables Components

Thailand currently imports the majority of its energy components, with most investment in the sector coming from foreign multinationals. Participants argued that the country should look to develop a manufacturing sector to support renewables development, as part of a fundamental industrial shift to the production of higher value-added technologies. For example, with Thailand's silica mining industry in Kanchanaburi and Ratchaburi, the opportunity exists to draw on the country's upstream feed of raw material for local solar wafer and, ultimately, solar cell production. The creation of a dedicated supply chain for solar cells, combining specialized firms in geographical clusters around the mining sites, could attract potential business partners and enhance conditions for local innovation and technology and infrastructure development and, similarly, encourage international cooperation.[116] Other participants, however, argued that Thailand should focus on assembly and installation – playing the role of a regional systems integrator – rather than manufacturing, thereby becoming a gateway for multinationals wanting to invest in renewables in the Greater Mekong Subregion.

To conclude, countries in ASEAN should remember that integration is a reciprocal process. It should not represent an opportunity to exploit the resources of others for unilateral economic advantage. Rather, countries should work together, drawing upon one another's strengths for the collective good of the region.

[113] Khettiya and Apornrath Phoophongphiphat, "Thailand aims to be regional energy hub, to up oil reserves", Reuters, 6 October 2011.
[114] Jeremy Grant and Javier Blas, "Singapore vies to become commodities hub", *Financial Times*, 22 May 2012.

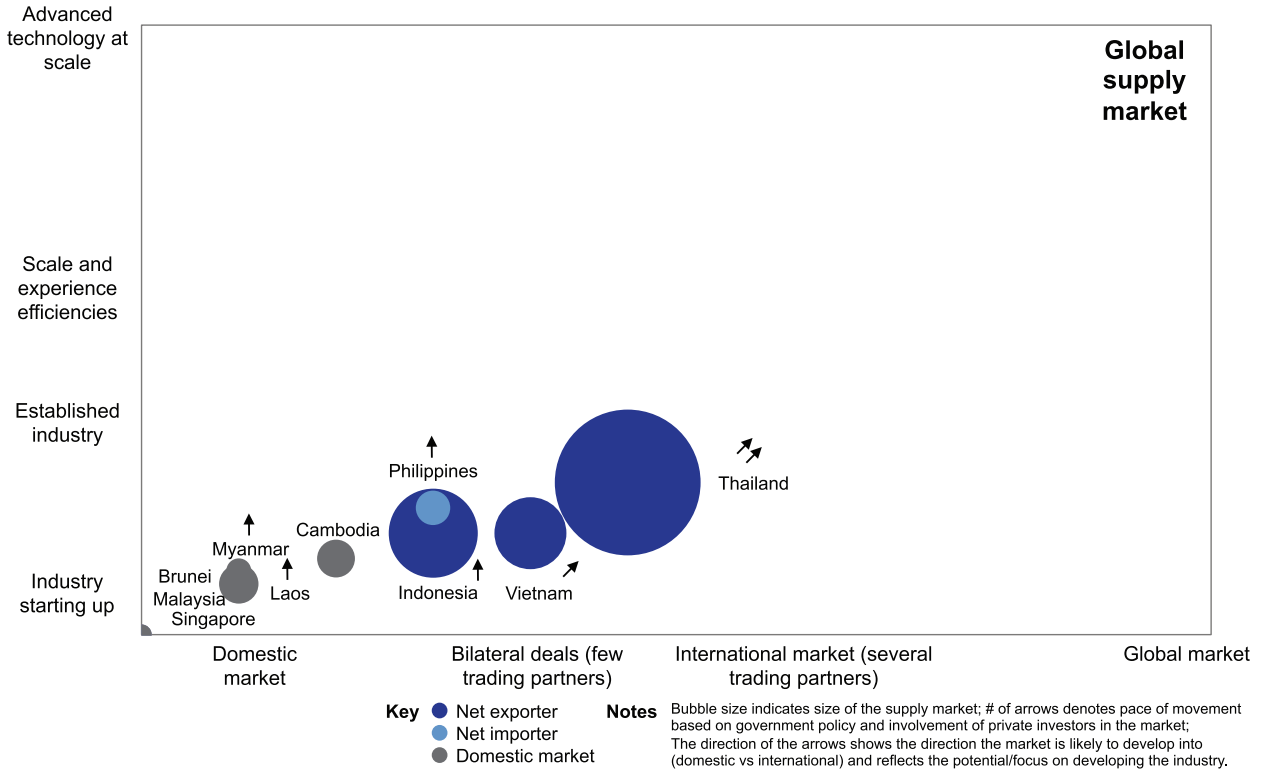
[115] USDA, GAIN Report, *Thailand, Biofuels Annual, 2011*.
[116] APEC Peer Review on Low-Carbon Energies (PRLCE), *Background Information*.

In Focus: Thailand's positioning within the ASEAN ethanol market

In order to understand better Thailand's potential to become an ethanol trading hub, we have conducted a detailed analysis of the ASEAN bioethanol market and the relative capabilities of the countries involved. Figures 18 and 19 provide an overview of the results, indicating how Thailand's ethanol market compares to that of its neighbours and three global players:

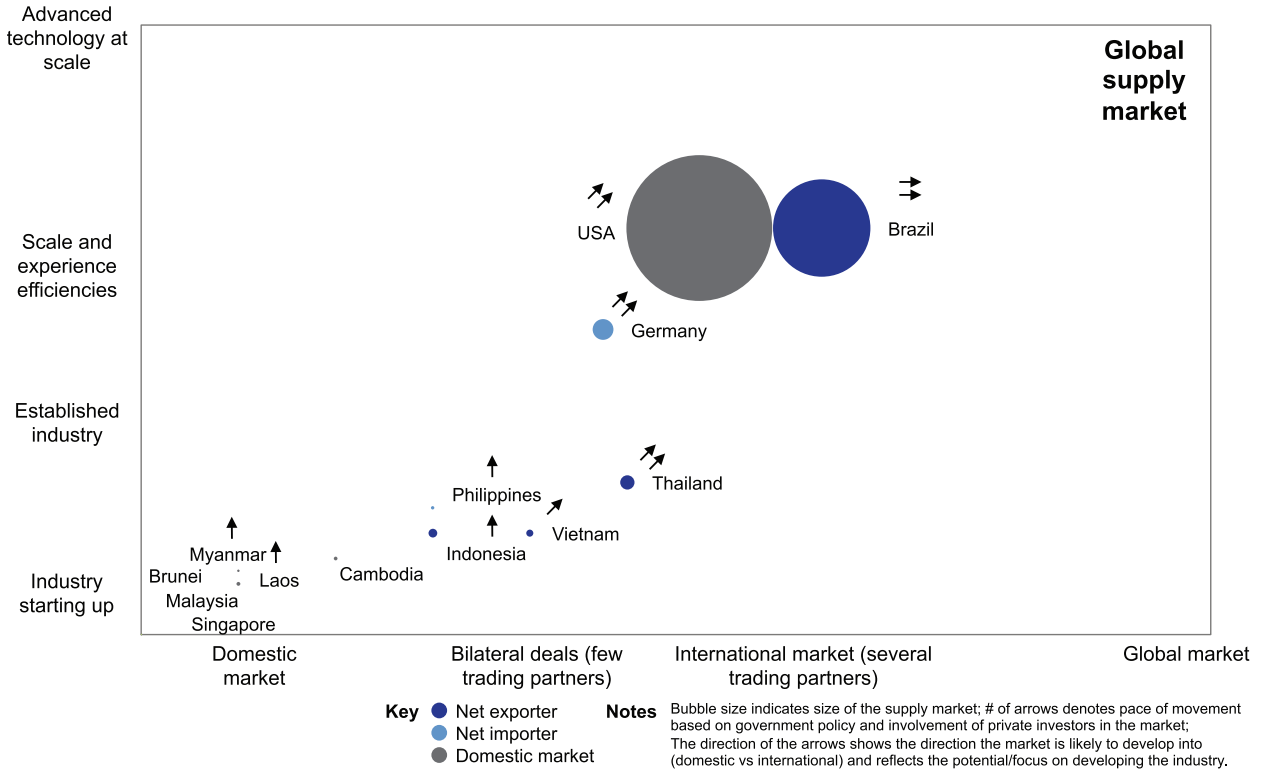
- The x-axis shows the span of markets in which the countries operate (or are planning to operate). Countries were scored between 0 and 10. Scoring was dependent on the share of volume that was traded, the amount of trading partners, and observed developments or stated intentions towards trading/export orientation. Markets with very limited ethanol trading (or none at all) received a score of 0. Limited activity, such as some capacity build-out with the aim of exporting, or an export history, received a score of 1. Higher scores were allocated to countries that produce either for export to a limited number of partners, are forced to export due to low domestic demand, or are forced to import in order to achieve their mandate. Markets with stated export strategies, an exporting track record and a large number of trading partners, received the highest scores in this category. A genuinely global ethanol market would receive a score of 10, but none was identified in this analysis.
- The y-axis shows the degree to which the countries' ethanol industries are developed. Metrics considered include: ethanol volumes, industry maturity/age, availability of advanced biofuels, R&D activity, and the track record of rolling out biofuels and developing the industry. Markets with very limited ethanol activity (or none at all) received a score of 0. Limited activity, such as some capacity build-out or some existing capacity with recent activity, received a score of 1. A large-scale, advanced technology market that has significant impact on the country's economy would receive a score of 10. No market achieved a score of 10, due to the limited scale of advanced technology, even in the otherwise most advanced markets. These markets received a score of 8, due to a considerable impact on the agriculture market, some impact on the energy market, considerable market penetration, and R&D activity.
- The arrows indicate the direction and speed of the market transition. They are based on the aggressiveness of regulation and involvement of private investors in the market, in line with observed activities and stated intentions.
- The size of the circle indicates the size of the countries' supply markets, based on production figures or, where unavailable, capacity figures.
- Colour coding indicates whether each country is a net importer, exporter or whether supply is solely focused on and produced from the domestic market. This assessment was based on trading volumes.

Figure 18 – ASEAN ethanol market – Geographic presence, maturity, production and movement[117]



[110] Publicly and commercially available sources were used to determine ethanol production, consumption, capacity and trade volumes in the assessed markets. The list of sources includes: US Department of Agriculture (USDA) Global Agricultural Information Network (GAIN); US EIA (Energy Information Administration); United Nations Statistics Division (UNstat); Eurostat; International Energy Agency (IEA); European Biodiesel Board (EBB); Brazilian Sugarcane Industry Association (UNICA); Renewables 21 (REN21); Bloomberg New Energy Finance (BNEF); and others, such as different national and industry sources.
Volumes were converted into millions of litres using US-metric, energy-volume and weight-volume conversion factors. Production figures or, when unavailable, capacity figures, were used to determine the size of each supply market. Trading volumes (import/export) were used to analyse international focus of the ethanol market and to indicate whether each market is a net exporter, a net importer or a largely domestic market. A combination of quantitative and qualitative analysis was conducted to assess each market's positioning in terms of maturity/technology advancement on one axis and international focus/potential on the other axis. Observed developments and stated intentions were taken into account to determine each market's trajectory (towards maturing the market and advancing the technology, towards greater international focus/potential, or both).

Figure 19 – ASEAN ethanol market compared with established markets



Our analysis clearly outlines the competitive advantage that Thailand holds over other ASEAN nations, in terms of its market maturity, technological advancement, the level of its export volumes and number of trade partners. While its exports are still small-scale, in comparison to the United States and Brazil, if the capacity of biorefineries is expanded as planned, Thailand could become a major player in global ethanol trade. Achieving this will, however, require significant investment in export infrastructure.

A brief overview of each country assessed follows.

An Overview of ASEAN ethanol markets

Certain ASEAN markets have insignificant ethanol activity, in terms of production and consumption: Brunei, Malaysia and Singapore. Brunei has no significant activity on record, while Singapore does not produce or consume considerable volumes of ethanol.[118] However, Singapore is a trading hub with large port capacity via which some ethanol trade takes place. For instance, some volume imported by the Philippines is shipped from Singapore.[119] Malaysia focuses on biodiesel; its ethanol production is limited. Ethanol demand is very low, due to gasoline subsidies.[120]

Three further ASEAN markets show limited signs of ethanol activity: Cambodia, Laos and Myanmar. IEA (2009)[121] recorded no production for Cambodia, although other sources[122] indicate that almost 40 million litres were produced by a single asset.

[118] International Energy Agency (IEA), Statistics, Renewables, http://www.iea.org/stats/prodresult.asp?PRODUCT=renewables, latest publicly available data, 2009, accessed on 9 August 2012.
[119] USDA FAS GAIN Report, Philippines, 2012.
[120] USDA FAS GAIN Report, Malaysia, 2011.
[121] IEA, op. cit.
[122] Phnom Penh Post, Cambodia's first biofuel plant set to reopen, http://www.phnompenhpost.com/index.php?option=com_jcs&view=jcs&layout=form&Itemid=555, 2010, accessed on 9/08/2012; Biofuels Digest, MH Bio-Energy delays cassava ethanol opening in Cambodia, http://www.biofuelsdigest.com/bdigest/2010/10/08/mh-bio-energy-delays-cassave-ethanol-opening-in-cambodia/, 2010, accessed on 9 August 2012.

This production capacity has since been idle, due to sustained high feedstock (cassava) prices which have affected production economics. Laos has not shown any significant recorded ethanol activity or capacity.[123] However it has the stated target of 10% of renewable fuels in the mix by 2020[124] and is attracting investment: an ethanol plant with 38 million litres per year capacity is currently under construction.[125] Similarly, Myanmar does not show any recorded volumes,[126] however certain sources[127] claim there could be up to 15 million litres per year capacity. There does not appear to be a blending mandate, but Myanmar has stated the aim of achieving 8% biofuels in transport (no year indicated).[128]

Indonesia, the Philippines, Thailand and Vietnam demonstrate ethanol activity at much higher levels. Indonesia's fuel ethanol production capacity has been modified to produce industrial ethanol for other applications. This was due to a dispute between government and industry over a price index mechanism.[129] Production reached almost 200 million litres in 2011, almost a quarter of which was exported.[130] Fuel ethanol is subsidized with approximately US$ 0.30/l at the pump, but production would not be economical under the index mechanism.[131] A target of 3% of biofuels in the energy mix by 2015 is in place and E3 blends are permitted.[132]

[123] Bloomberg New Energy Finance (BNEF), Intelligence, Renewable Projects, 2012, accessed on 7 August 2012.
[124] Institute of Energy Economics Japan (IEEJ), The 3rd ASEAN Energy Outlook, 2011.
[125] HAGL Group, http://www.hagl.com.vn/Group_Posts/DetailPost/201111261224302430, 2011, accessed on 8 August 2012.
[126] IEA, op. cit.
[127] Greater Mekong Subregion Economic Cooperation Program, Myanmar: Country Assessment on Biofuels and Renewable Energy, 2009; Myanmar Chemical Engineers Group 1, Experience of Biofuel Production in Myanmar, 2007.
[128] IEEJ, op. cit.
[129] USDA FAS GAIN Report, Indonesia, 2011.
[130] REN21, op. cit.; USDA, Indonesia, op. cit.
[131] USDA, Indonesia, op.cit.
[132] IEEJ, op. cit.

In the Philippines, the ethanol market is determined by mandated 10% ethanol blending with gasoline, which creates significant demand pressure.[133] Consequently, domestic supply has not been able to catch up, leading to a material need to import. Domestic capacity of approximately 35 million litres per year (2011)[134] is well utilized, but could only meet about 12% of domestic consumption, with the remainder being met by imports, mainly from South Korea, Thailand and the United States.[135] Capacity build-out is underway and expected to achieve about 200 million litres total capacity by 2013.[136]

Vietnam's ethanol production capacity, which was 130 million litres in 2011, is expected to grow to 330 million litres by the end of 2012.[137] Supply is dominated by PetroVietnam, which supplied 20 million litres to domestic consumers in 2011.[138] Domestic demand uptake has been limited, as the implementation of an E5 mandate has not yet taken place. The result has been an exporting focus for Vietnam's ethanol production. However, once the domestic mandate is fully implemented, it is expected that domestic demand will increase significantly.

Ethanol production in Thailand has grown steadily over the past five years, reaching 520 million litres in 2011. Domestic consumption has grown at a slower pace to 380 million litres (2011), allowing for significant export volumes. Demand from abroad is expected to increase and drive capacity build-out as well as utilization of existing capacity, while domestic consumption continues to grow slowly due to the lack of a binding mandate. This appears to be in line with the government's stated intentions to develop an ethanol-exporting industry.

An Overview of established ethanol markets

In addition to the 10 ASEAN countries, three established ethanol markets were included in this assessment: Brazil, Germany and the United States. These countries are characterized as some of the largest ethanol markets by volume and are among the most mature ones. However, there are stark differences between these three markets.

Brazil, the longest established commercial ethanol market, has sustained production levels of approximately 25 billion litres per year for the last four years.[139] It has a strong domestic demand due to the wide availability of high ethanol blends in gasoline for road vehicles. Over the last few years, due to lower harvests and mills switching to producing sugar due to the high sugar price, Brazilian production and exports have remained flat. Additionally, investment in new capacity has been lagging partly because of the difficulty in obtaining credit as a result of the 2008 financial crisis.[140] The flexibility of Brazilian production to switch from ethanol to sugar (and vice versa) makes forecasting difficult, but the recent removal of US import tariffs and the cost advantage of sugarcane ethanol over other pathways make it likely that Brazilian output (and exports) will grow in the near future.[141]

The ethanol market in the United States is the largest by volume. In 2011, production reached 54 billion litres, more than twice the amount of Brazil.[142] Ethanol is mainly produced from corn and used to be subsidized.[143] Some 4 billion litres were exported to Brazil in 2011,[144] but this is likely to reverse into imports from Brazil in the near future, as Brazilian output grows. The US market is characterized by strong domestic demand, mandated by the Renewable Fuels Standard (RFS) 2, which requires 15.2 billion gallons (58 billion litres) of renewable fuel in the mix by 2012.[145] This mandate will be met largely by ethanol, which is widely available in gasoline blends of up to E15. By 2022, the overall target for renewable fuels is 36 billion gallons (136 million litres), which shall be met largely by ethanol from conventional and cellulosic feedstocks.[146]

Germany's ethanol market is determined by European Union and national policy. The EU Renewable Energy Directive (RED) mandates that, by 2020, at least 10% of energy in transport petrol and diesel consumption come from renewable sources.[147] National legislation requires fuel suppliers to reach biofuel quotas of 6.25% in transport fuels by energy content. After 2015, these targets will be changed to a GHG reduction basis, which will require blending greater quantities of biofuels and/or blending biofuels with lower GHG values.

By 2017, the requirement is for the blend (biocomponent and gasoline/diesel) to achieve a 4.5% reduction in GHG, compared to the same amount of gasoline/diesel.[148] This will increase to 7% by 2020.[149] The German biofuels industry focuses on biodiesel which is produced and consumed in greater quantities than ethanol in Germany.[150] Domestic ethanol production cannot satisfy demand – approximately 30-40% of consumption is met through ethanol imports mainly from Brazil, the United States and Eastern Europe.

[133] ibid; USDA, Philippines, op. cit.
[134] BNEF, op. cit.
[135] USDA, Philippines, op. cit.
[136] BNEF, op. cit.; USDA, Philippines, op. cit.
[137] BNEF, op. cit.
[138] Agra-Net, PetroVietnam to continue ethanol exports on lack of domestic demand, http://www.agra-net.com/portal2/home.jsp?template=newsarticle&artid=20017963027&pubid=ag072, 2012, accessed on 9 August 2012.
[139] REN21, Renewables 2012 Global Status Report, 2012; USDA FAS GAIN Report, Brazil Biofuels Annual, 2011.
[140] Bloomberg, Brazil's Lower Ethanol Blend Won't Cut Gas Prices, Analyst Says, http://www.bloomberg.com/news/2011-08-31/brazil-s-lower-ethanol-blend-won-t-cut-gas-prices-analyst-says.html, 2011, accessed on 10 August 2012.
[141] Brazilian Sugarcane Industry Association (UNICA), Brazilian Ethanol Projections, Memorandum, 2011.
[142] REN21, op. cit.
[143] Bloomberg, http://www.bloomberg.com/news/2012-01-08/u-s-gasoline-rises-to-3-36-a-gallon-lundberg-survey-shows-1-.html, 2012, accessed on 9 August 2012.
[144] REN21, op. cit.
[145] US Environmental Protection Agency (EPA), Regulatory Announcement, EPA Finalizes 2012 Renewable Fuel Standards, 2011.
[146] EPA, Renewable Fuel Standard (RFS) 2, 2010.
[147] European Parliament, Directive 2009/28/EC, 2009.
[148] German National Legislation, BImSchG, Clause 37a (3a), version last changed on 26 November 2010.
[149] ibid.
[150] REN 21, op. cit.; USDA FAS GAIN Report, EU-27 Biofuels Annual, 2011.

4. Energy Literacy: A Cross-objective Enabler

Thailand's Energy Literacy Challenge

> **We may have to wait for blackouts for people to realize that we need new power plants.**

Interview participant

In recent years, energy has become more present in the global public consciousness. Events such as the Deepwater Horizon oil spill and the Fukushima incident, alongside continuing climate change, have caused growing concern about the impact of the energy sector on the environment. Consumers, often emboldened by NGOs and environmental activists, are voicing their concerns more and more.

In Thailand, this protest is evident in growing public opposition to the construction of new power plants, such as anti-coal protests in Prachuap Khiri Khan and anti-nuclear protests in Surat Thani and Kalasin Provinces.[151] Subsequent delays and project cancellations threaten to hinder the country's plans for greater diversification in its power sector. Moreover, efforts to build greater energy integration in ASEAN could face setbacks if Thailand proves unable to build the infrastructure required to complete physical interconnections.

Environmental concerns continue to affect the supply side, but have not had had a similar effect on the demand side, with energy consumption patterns remaining much the same. Rising incomes and higher individual purchasing power have resulted in higher per capita energy consumption. During the discussions in Thailand, stakeholders from across the value chain believed consumers continue to lack sufficient awareness about energy-saving opportunities.

This contradiction is not surprising. In a global survey of consumer attitudes towards the energy sector, *The New Energy World: The Consumer Perspective*, Accenture found that while consumers would like to see their country reduce the environmental impact of its energy sector, they would prefer that this be carried out on the supply side. Consumers would rather see low-carbon sources developed than be required, themselves, to adopt less energy-intensive behaviours and lifestyles. If consumers are to choose between easier availability of lower-carbon energy sources and making demand-side reductions themselves, 63% choose the former. This preference is despite the fact that supply-side, low-carbon solutions cause higher price points for consumers than demand-side options do.[152]

Such contradictions highlight the need for increased energy literacy. Consumers need to understand the trade-offs and competing objectives in energy policy and the implications of policy choices. For example, consumer opinions are often poorly informed about:

1. The cost of security of supply: Consumers tend to get very upset when the electricity supply fails and will commonly blame the utility for underinvestment. In few places is there an informed debate with consumers about the cost of improving the quality of services.
2. The cost of convenient energy supplies: Many consumers are used to total flexibility regarding their use of energy. The true costs of this convenience are generally not communicated to them and the potential financial benefits of demand-side action, such as load shifting, do not reach consumers.
3. The challenges involved in creating security of supply: Energy security can be developed via reliance on indigenous energy sources and through development of a diversified source of energy imports. The public tend to prefer nationally sourced energy security, but this is very rarely possible given current technology and in some instances, can be expensive to deliver. Developing an appropriate balance is important; and the public should be aware of their options.
4. Understanding the benefits: Consumers tend to take for granted their access to energy supplies. As one stakeholder commented, "We may have to wait for blackouts for people to realize that we need new power plants." This can create particular challenges in building large-scale infrastructure, as people focus on the inconvenience that construction brings, rather than the potential benefits.

Building awareness about the challenges associated with each of these issues will allow policy-makers in Thailand to initiate more informed debate on the future of energy policy and will play an important role in promoting a resource-efficient consumer lifestyle. The following sections provide three actionable insights with which to improve energy literacy and change consumer behaviour.

[151] *The Bangkok Post*, "Local focus for power plants could curb protests", 31 August 2011; *The Bangkok Post*, "Thai civil groups fight against nuclear plants", 16 March 2011.

[152] Accenture, *The New Energy World: The Consumer Perspective*, 2010.

Actionable insight 4.1: Foster understanding about energy issues

> **Targets have to be translated into a language that consumers understand.**[153]

Interview participant

Energy literacy can be boosted with traditional information programmes, such as:

- Energy labelling: Few consumers realize the extent of energy savings available through more efficient products. Clear and accurate labelling raises awareness and encourages companies to offer more efficient products. A labelling scheme is currently in place for consumer products in Thailand, but improved labelling could be deployed in the transport sector too, for instance, informing consumers about baht savings for the average user instead of solely about the fuel economy of vehicles.
- Energy academies: Thailand has recently created an energy academy to provide a training platform on energy issues for opinion leaders. Each year, two classes will cater for 70-80 people. The Minister of Energy, Arak Cholathanont, has enrolled in the pilot class. Such academies could be expanded to additional age groups and schools or social spheres, through partnerships with the Ministry of Education.
- Energy think tanks: Think tanks are currently in place to provide commentary on energy issues in Thailand. However, according to interviewees, these institutions are either politicized, or receive funding from vested interests. During discussions, stakeholders suggested that an independent think tank would promote behavioural change more effectively, by creating national dialogue about energy architecture change.

Changes in technology and the continued move of consumers online are shifting traditional preferences as to how public discussions take place. The government and utility providers can draw upon a variety of new tools to take advantage of this shift:

- Apps: Data visualization and analysis tools are a critical component of solutions seeking to engage consumers on energy use and management. As consumers gain greater access to and control over their energy use, electricity and gas will become much more personal products. Apps represent a powerful tool with which to relay information to consumers.
- Social media: Despite social media not being new, its reach and variety of uses is still growing. In a recent survey of 1,000 energy consumers in the United States, 67% said they had changed their behaviour between one and five times in the past year, based on content read on a social media site.[154] This phenomenon is not reserved for mature economics: 50% of consumers in emerging economies planned to use social media to discuss energy-related issues with other consumers or groups in the following 12 months, with 21% having done so already.[155] Social media can take many forms and be used in many ways. Potential options include creating online communities to discuss and learn about energy-related products, services and tips, and providing access to exclusive offers. BC Hydro, a Canadian utility, has developed an energy efficiency initiative called Power Smart, which has its own Facebook and Twitter communities, through which members share energy-saving tips.[156] Social media is particularly attractive to younger consumers, between 18 and 24, and should be targeted accordingly.
- Gamification: Over the past 30 years, video games have become increasingly interactive and engaging. With the advent of social media, smartphones and interactive web technologies, games have become mainstream. Every day, users spend more than 3 million hours playing the mobile game, Angry Birds.[157] Games are no longer only for children. They represent a significant new tool for addressing many of the most pressing challenges facing energy providers today. Combined with smart technology, "gamification" – using game thinking and mechanics to engage users and solve problems – can create unique consumer experience and encourage conservation behaviour. Gaming can be used to solve problems, as an educational tool and to change behaviour. For example, the Gaming for Good initiative, a partnership between Al Gore's Climate Reality Project and PSFK, has asked people to design innovative gaming applications to address sustainability and climate change challenges.[158] British Gas's EnCon CITY demonstrates the benefits of conservation by teaching players how energy is consumed and where it might be wasted.[159] Simple Energy, a US-based company, has designed an online platform that enables users to score their energy use against friends' and to receive rewards for conservation behaviour. Over the three-month pilot, the average savings of participants who used the social gaming application integrated with an automated control device was 20%; compared with 9% for those who used only the automated control device.[160]

[153] Comments received during interviews in Bangkok, April 2012.

[154] Accenture, *Actionable insights for the new energy consumer: Accenture end-consumer observatory 2012*.
[155] ibid.
[156] Power Smart, BC Hydro, www.bchydro.com.
[157] "New round for Zynga; As first-time players boom, IPO may be in the works," *The San Francisco Chronicle*, 27 June 2011, http://global.factiva.com.
[158] Gaming for Good, PSFK, www.psfk.com.
[159] EnCon CITY, British Gas, © Centrica plc, 2007, www.enconcity.com.
[160] "SDG&E Celebrates San Diego's Biggest Energy Savers," San Diego Gas & Electric press release, 5 January 2012, http://sempra.mediaroom.com.

Actionable insight 4.2: Create incentives and formal mechanisms to encourage change

Behavioural economists have found that diverse psychological or neurological biases motivate people to make choices. This idea has been developed, arguing that it is possible to nudge people towards better decision-making, by presenting their choices in different ways.[161]

Governments are now testing this theory. The United Kingdom, for example, has established a Behavioural Insights Team, nicknamed the "Nudge Unit".[162] Recent trials run by this unit are promising. In one case, a letter sent to individuals who had not paid their vehicle tax was rewritten in plain English: "Pay your tax or lose your car". The letter was occasionally personalized too, including a photo of the owner's car. With the rewritten letter, the number of people who paid tax doubled. With the combination of the rewrite and the photo, it tripled.[163]

The Nudge Team has also applied its approach successfully to energy efficiency. Research was showing that people were not taking up a financial incentive to insulate their homes to reduce energy consumption, because they did not want to clear their attic. The Team therefore designed a nudge: insulation firms offered to clear out the attic and to return the goods, if so desired, on completion of the work. The take-up of the grant increased threefold. It serves as an example of "goal substitution": replacing lower energy use with cleaning the attic.

Thailand should seek to learn from the approach of the Behavioural Insights Team in the United Kingdom and to apply the "nudge" approach, to incentivize change in energy consumption patterns. In doing so, it should be mindful of cultural differences. In particular, different cultures respond differently to "social norms" (social pressure to change behaviour in line with common practices). In the United States, social cues have proven effective in changing energy consumption patterns. In one case, OPOWER mailed home energy reports to customers, comparing their energy use to that of their neighbours and offered energy conservation tips. OPOWER ran the programme for 23 utilities, including six of the largest 10 utilities in the country, and letters were sent to 600,000 households. This intervention reduced average energy demand by 1.11% to 2.78%, from the baseline use.[164] While similar tactics are being trialled in the United Kingdom, they are unlikely to succeed in France, where citizens are not so easily swayed by social norms.

A more direct use of "nudges" occurs through financial incentives. Preliminary results suggest that when utilities give consumers monetary savings through dynamic pricing, which varies according to the time of day based on when peak demand occurs, consumers change how and when they use electricity.[165] These results hold true for reduction of peak use, especially when the reduction is enabled by consumer technologies and tools, such as smart thermostats and online energy management portals. To that end, EGAT, PEA and MEA should work to establish rates and tariffs that promote behavioural shifts.

EGAT, MEA and PEA can also look to draw upon partnerships to implement loyalty programmes, offering rebates or other rewards to consumers who purchase certain products or take specific actions. A potential partner could be Central Retail's "Spot the 1 Card", the first loyalty programme in Thailand, which now has 7.2 million members.[166]

An alternative for lower-income groups is prepaid energy, which is present in many countries and targets disadvantaged consumers. In South Africa, Eskom, has deployed 4.2 million prepay meters and maintains a network of vendors who sell prepaid electricity.[167] Through prepaid energy, consumers become more conscious of their own consumption and utilities gain valuable insights into a broader scope of energy consumption.

[161] See Richard H. Thaler and Cass R. Sunstein, *Nudge: Improving decisions about health, happiness and wealth*, 2009.
[162] *The Economist*, "Nudge nudge, think think: The use of behavioural economics in public policy shows promise", 24 March 2012.
[163] Behavioural Insights Team, UK Cabinet Office, "Applying behavioural insights to reduce fraud, error and debt".
[164] Michael G. Pollitt and Irina Shaorshadze, "The role of behavioural economic in energy and climate policy", ESRC Electricity Policy Research Group, University of Cambridge, WP 1130.
[165] Accenture, *The New Energy Consumer: Balancing Strategic and Operational Imperatives, Reference guide 2.0*, 2012.
[166] Tops, "Central Retail launches SPOT The 1 Card making Thailand's largest loyalty program with 7.2 million members", accessed 20 July 2012, http://www.tops.co.th/activity/activity_20100827.html.
[167] Prepayment Overview, Eskom, www.prepayment.eskom.co.za.

Actionable insight 4.3: Demonstrate and role model change through pilot programmes that bring local benefits

The government should seek to boost understanding by highlighting relevant projects. One such example in Thailand was the PEA's move to upgrade street lights to more efficient models; relying on lighting that is more expensive, but will save energy and reduce costs in the long run.

A more powerful learning mechanism could stem from the creation of energy cooperatives that teach communities about energy generation, while generating revenue for them. This results in a clear association of value between the two. The model has been adopted successfully in Thailand: the government is supporting the organization of villagers into community enterprises which allow them to buy and manage small-scale biofuel extraction facilities. This has enabled farmers to collect and extract fuel from their crop and sell the finished product blended with diesel as biodiesel. However, the development of such projects was resource-intensive, as management skills were needed to run the cooperatives and the plant and a regular supply of feedstock was required to achieve a base level of efficiency. The private sector needs to be encouraged to play a role in filling gaps in competency.

Potential Trade-Offs and Risks in Achieving Thailand's New Energy Architecture Objectives

Managing the transition to a New Energy Architecture will not be easy. The imperatives of the energy triangle may reinforce or conflict with one another, forcing difficult trade-offs to be made and, in some cases, resulting in unintended consequences. There are a number of potential trade-offs that Thailand could make in contributing to a diversified, efficient and integrated New Energy Architecture, based on current policy proposals.

Efforts to bolster energy security through diversification may have negative implications for environmental sustainability. This is apparent in EGAT's Power Development Plan for 2010-30, which would result in the coal-fired generation in the nation's electricity supply doubling. Policies that support diversification may also carry considerable costs. The expansion of solar and wind, which has not yet reached grid parity, requires ongoing support from the FIT adder, other financial mechanisms and biofuels. Second-generation biofuels in particular, not yet commercially viable, will come at a considerable cost which is likely to increase energy prices in the short-term. Additionally, the policy framework runs the inherent risk that decision-makers will "pick" technologies, due to the short-term economic benefits they bring, rather than allowing natural winners to emerge. This, for example, is evident in Thailand's aggressive expansion of its biofuels sector, which in the short- to medium-term requires that supporting infrastructure be established. This infrastructure may then become redundant in the longer term, if the electric vehicle market expands.

As argued in the global report, *New Energy Architecture: Enabling an effective transition*, policies in support of energy efficiency result in positive net benefits for the three imperatives of the energy triangle, assisting in sustaining economic growth without placing unsustainable burdens on the world's energy supplies or the environment. Indeed, as outlined above, while energy efficiency initiatives carry an upfront cost, the cost is borne over time and will set Thailand on the path to sustainable growth.

Similarly, integration may result in positive net benefits across the triangle, but does carry certain potential economic risks. While an open market presents many opportunities, increased competition from regional energy companies may negatively affect Thailand's firms if they are not adequately prepared.

There is no "quick fix" solution to managing these trade-offs. What is required is an awareness that such trade-offs are being made. In response, decision-makers must ensure that they weigh up their choices carefully and create a portfolio of policies containing an energy mix that best balances the challenges inherent to the energy triangle.

Step 4: Defining Areas of Leadership – Creating Multistakeholder Partnerships

The creation of an enabling environment, one that is resilient to risk and responsive to the imperatives of the energy triangle, is beyond scope of an individual corporation or government. Our research on New Energy Architecture indicates that three key groups of stakeholders have a role to play:

Government – Creating a stable policy platform

- Clear and sustained government policy support is a prerequisite for effective transition
- Once a clear policy platform has been created, policy-makers should seek to support capacity-building, including centralized support for R&D programmes, and skills development for new and emerging industries

Industry – Driving implementation through innovation and investment

- Industry should build on government's lead, promoting implementation through innovation
- Increased levels of inter-industry collaboration will be vital to ensuring continued innovation as energy firms strive to draw upon each other's knowledge and experiences, access new markets and gain funding for highly capital-intensive projects

Civil society – Building greater transparency into the system

- Making changes to energy architecture will depend on building the support of all stakeholders in civil society
- Improving public involvement in shaping the future of the sector will be essential to building trust and ensuring broad support

Orchestrating a broad-based, systemic transformation can be extremely challenging. By nature, ambitious transformation requires that stakeholders extend beyond their traditional roles and structures and collaborate in new ways, to create coalitions to meet the New Energy Architecture challenge.

The importance of building a multistakeholder environment is underlined by the strong links that exist among resources: energy accounts for 8% of global water withdrawal, biofuels represent around 2% of cropland and mineral sources, such as rare earth metals and iron ore, are critical for energy technologies (from solar photovoltaics to offshore oil and for agricultural fertilizers).[168] This requires that different bodies work together to create integrated resource plans. When this does not take place, resulting conflicts among policy-makers, unclear ministerial responsibilities and insufficient coordination among the institutions involved will delay the transition to a New Energy Architecture.

[168] Global Institute, *Resource Revolution: Meeting the world's energy, materials, food and water needs*, November 2011.

The Current Stakeholder Environment in Thailand

During the discussions held in Thailand, stakeholders depicted the state's "machinery" as decentralized and, at times, unnecessarily bureaucratic. A number of authorities and coordinating committees are involved in energy policy formation, but do not act across the value chain. Instead, regulatory responsibilities are spread across institutions, with sometimes mismatching incentives. For example, even though departments within the Ministry of Energy, such as the Department of Mineral Fuels and the DEDE, are responsible for increasing gas production in the Gulf of Thailand and the penetration of wind power respectively, these efforts are hampered by the Energy Regulatory Commission and other agencies that have installed lengthy licensing processes requiring that operators participate in redundant transactions.

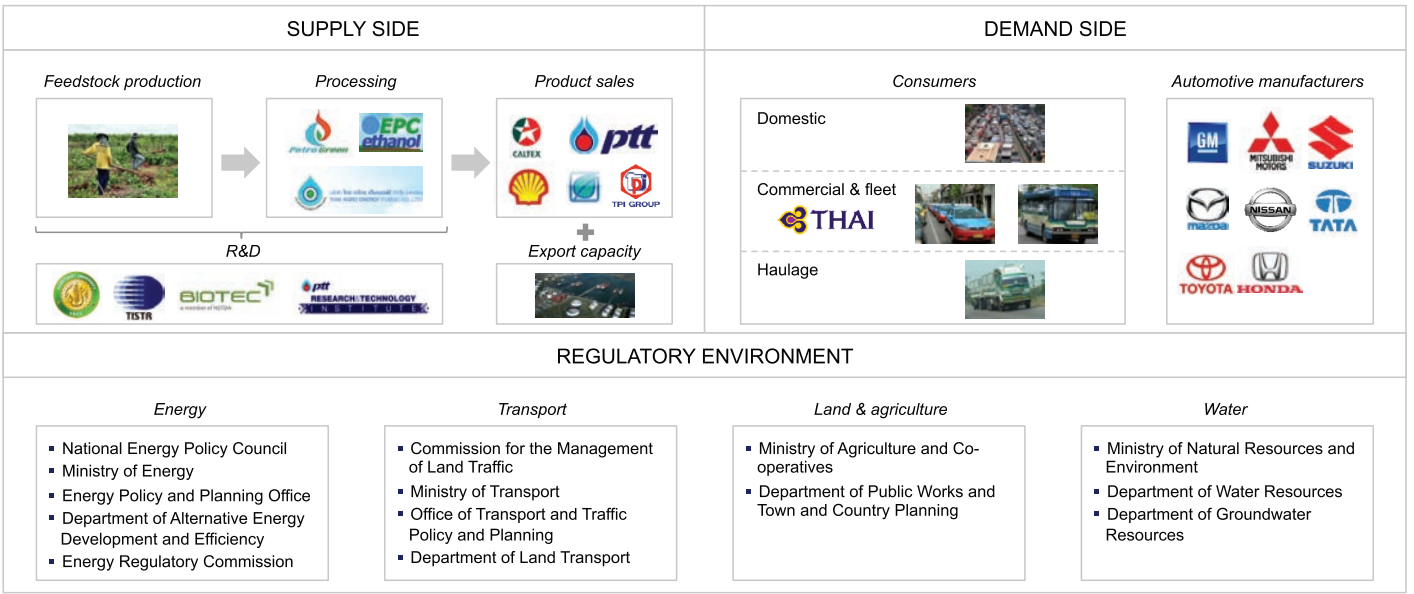
Alongside inter-ministerial cooperation, there is room for improvement in business-to-government dialogue. Interviewees in Thailand agreed that business-to-government interactions need to be more transparent.

Representatives from industry and government expressed their wariness of NGOs, with whom they have few formal lines of communication. Overall, decision-making processes, which are often top-down, need to evolve.

In Focus: Stakeholder networks in the biofuels sector in Thailand

The complex network of stakeholders in the energy sector in Thailand and the need for a more coordinated system are evident in the biofuels sector. The stakeholder ecosystem for the sector is illustrated by Figure 20. Through the DEDE, the Ministry of Energy has stated clearly the goal of expanding the biofuels sector considerably, with the objective of displacing the demand for petroleum products. However, due to the limited number of FFVs on the road, demand for E85 and E20 has not risen significantly. Consequently, PTT and others have not invested in increasing the quantity of E85 and E20 pumps available at gas stations. This lack has deterred consumers from purchasing FFVs. The resulting lack of demand has led car-makers in the country to focus on hybrid production, which can only run on E10. Enhanced coordination among government, industry and civil society would assist in tackling this vicious cycle.

Figure 20 – An overview of stakeholders involved in Thailand's biofuels sector



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

Based on the discussions, it is proposed that stakeholders in Thailand drive the transition to a New Energy Architecture taking the following steps:

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

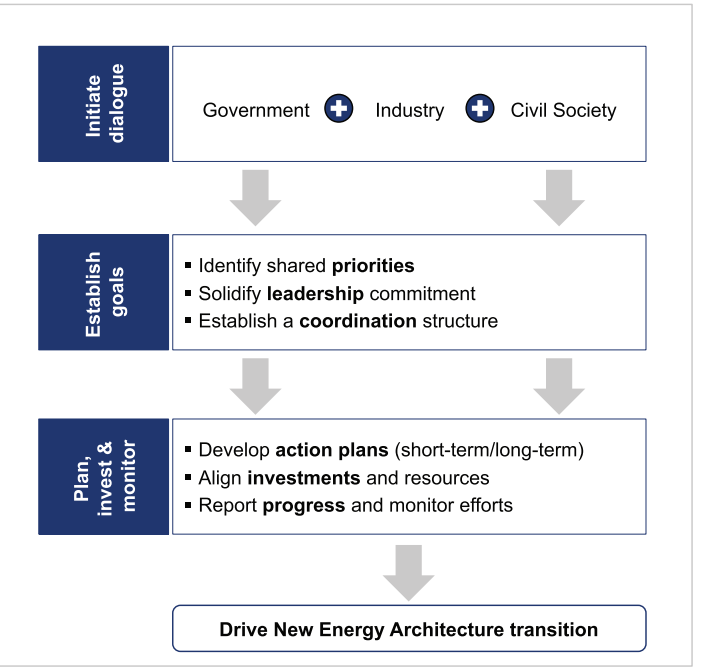
2. …by creating a "single window" of oversight…:
   For government to tackle conflicting policies, the formation of an individual institution or agency – a "single window" – is called for, one that drives the alignment process, setting common targets and incentives that are then monitored over time. For example, as part of its sustainable development strategy, the German government established a cross-ministry forum on resource efficiency. This ensures that departments do not optimize the productivity of a given resource without considering the trade-offs or shared benefits with other resources. Mexico and South Korea have also established presidential steering groups to drive more integrated resource management for "green growth".

3. …and multistakeholder partnership platforms…:
   Driving stronger alignment across stakeholder groups, and not just within government, calls for the formation of partnership platforms. As highlighted in Figure 21, 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 on these priorities. This form of collaboration will accelerate progress towards shared goals by aligning and focusing stakeholder investments, programming and collaboration.

4. …in order to build clear and consistent policies…:
   A collaborative approach will facilitate consistent and predictable policies, potentially to eliminate the sometimes mixed messages which are currently conveyed to businesses and the public – as seen, for instance, through the promotion of cheap energy for economic development, alongside energy efficiency measures.

5. …that are more effectively communicated to the public:
   Once collaborative, clear and consistent policies are created, they need to be communicated effectively to the public and industry. Targets should be translated into accessible language, enabling the public to understand how everyday life will be affected.

Figure 21 – New Energy Architecture Partnership Platforms[169]



Principles

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

[169] This model is adapted from World Economic Forum, *Putting the New Vision for Agriculture into Action: A Transformation is Happening*, 2012.

A Closing Note on Next Steps

We recommend that stakeholders in Thailand review and prioritize the actionable insights highlighted in this study, in order to lay out a road map for the creation of a New Energy Architecture for the country. To act upon this road map, stakeholders should form working groups and deliver on specific recommendations. The World Economic Forum will continue to provide its assistance in this process.

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