

I. Rationale for AEMI

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Abstract

Primary energy demand in ASEAN is projected to almost double over the next 20 years. This implies further widening of the supply-demand gap, which may well lead to increasing reliance on energy imports and the doubling of ASEAN's contribution to global carbon emissions. To better understand the ASEAN energy challenges, this chapter first reviews the current national energy conditions (institutional framework and policies) and maps out energy resources and infrastructure across ASEAN. Four potential mitigation measures for the energy gap problem are identified: (a) efficient utilization of energy; (b) reduction of carbon content of energy; (c) diversification of sources of energy supply; and (d) regional interconnection of energy supply infrastructure and resources. The background review clearly demonstrates the uneven distribution of energy resources and demand centers in ASEAN and the fact that the existing infrastructure for both gas and power connectivity is not yet at sufficient levels to allow for the seamless flow of energy between countries. Trading of energy between countries, through the ASEAN Energy Market Integration (AEMI) mechanism, will be an even greater challenge, given the varied energy institutional setup across the ASEAN region. The second half of this chapter seeks to define AEMI and establish its core objectives. Five key building blocks for a successful AEMI are identified: (a) trade liberalization; (b) investment liberalization; (c) the development of regional energy infrastructure and institutions; (d) liberalization of domestic energy markets; and (e) energy pricing reform. Based on this comprehensive review of the ASEAN energy situation, it is clear that much work remains to be undertaken to move AEMI towards the next step to bringing the AEMI objectives to fruition.

A. Introduction

The ASEAN region has been experiencing buoyant economic growth for the past few decades and is expected to expand further into the future. GDP per capita for ASEAN is projected to more than double from 2010 to 2030, reaching US\$ 3,736/person (in 2000 US dollars), indicating a general improvement in lifestyle and income for the member countries as well as strong population and economic growth rates. To meet this strong growth, primary energy demand in the region will also double over the same period to reach 956 Mtoe (million tons of oil equivalent) in 2030 (Institute of Energy Economics, Japan, 2013, p.160).

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This thirst for energy will likely cause various energy security and environmental issues in the near future. It has been posited that integrating the ASEAN energy market may “lead to a less volatile, more flexible and resilient market through regional cooperation such as infrastructure connectivity, trade and investment arrangement, and the harmonization of regulatory and technological framework” (ERIA, 2011). To better understand the rationale behind creating an integrated ASEAN energy market, it is important to first understand the current energy situation in ASEAN countries, both as a whole and as individual nations.

This chapter will present the rationale that is behind creating an integrated ASEAN energy market by first reviewing the existing national energy conditions across ASEAN and then defining the concept of the ASEAN Energy Market Integration (AEMI). This will serve as a common platform for identifying gaps and opportunities in developing and integrating ASEAN energy markets.

1. Scope of work

The scope of this chapter can be broadly categorized under two objectives:

(a) *Mapping out the ASEAN Energy Challenge*

- Map out current national energy market conditions across ASEAN, indicating the extent and nature of “energy balances” (gas, oil, coal, electricity and renewable energy) and identify where energy resources lie across ASEAN and where energy gaps are expected to be by 2030.
- Map out current physical infrastructure, indicating potential energy flows from energy surplus to energy deficit countries within ASEAN, given the current state of connectivity; and
- Provide an overview of ASEAN national energy market structures and policies.

(b) *Defining AEMI*

- Review definitions of energy market integration in the context of the European Union and East Asia (EMI) and provide a definition for AEMI, using terminology consistent with that of the ASEAN Secretariat.
- Establish the core objectives pursued by AEMI, notably to achieve open and competitive national energy markets across ASEAN, which are physically and institutionally integrated; and
- Identify AEMI hardware components (e.g., infrastructure, physical energy trading) as well as software ones (e.g., policies, standards and regulations) needed for AEMI to deliver its promise.

2. Methodology

This study encompasses four main areas:

(a) *Reviewing the existing national energy conditions across ASEAN*

The idea is to provide an overview of ASEAN energy demand and supply trends, national energy market structure and relevant energy policies by reviewing the available studies, outlooks and databases listed in table 1.

Table 1. Available energy databases and outlooks

Publication	Publication details	Outlook details	Scenarios
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The 3rd ASEAN Energy Outlook	Published in February 2011 by ASEAN Centre for Energy and the Institute of Energy Economics, Japan	Base Year: 2007 Projection Years: 2008-2030 Data: Disaggregated energy data for all ASEAN countries	1. Business-as-usual 2. Alternative Policy Scenario: assumes energy savings targets are met for each country
The Asia/World Energy Outlook 2012	Published in January 2013 by the Institute of Energy Economics, Japan	Base Year: 2010 Projection Years: 2011-2035 Data: Aggregated energy data for all ASEAN countries, disaggregated data available for Indonesia, Malaysia, Philippines, Thailand, Viet Nam and Singapore (6/10 ASEAN countries)	1. Reference Scenario 2. Technologically Advanced Scenario
APEC Energy Demand and Supply Outlook, Fifth Edition 2013	Published in February 2013 by Asia Pacific Energy Research Centre	Base Year 2009 Projection Years: 2010-2035 Data: Disaggregated energy data available for Brunei Darussalam, Indonesia, Malaysia, Philippines, Thailand, Viet Nam and Singapore (7/10 ASEAN countries)	1. Business-as-usual Scenario 2. High Gas Scenario 3. Alternative Urban Planning Scenario 4. Virtual Clean Car Race
Asian Development Outlook 2013	Asian Development Bank	Only historical macroeconomic data	

A suitable database/projection has been chosen that can be used as a basic reference point for the whole AEMI study. So far, the best candidate is the Institute of Energy Economics, Japan Asia/World Energy Outlook, as this is the latest publication, covering all ASEAN countries and takes into account the latest energy developments and policies in their methodology (i.e., rapid economic growth in the region, Fukushima Nuclear Accident and latest renewable energy policies etc.).

(b) Reviewing the ASEAN resource availability and accessibility

As before, existing studies on potential energy resources (gas, coal, oil, electricity and renewable energy) and energy infrastructure (electricity grid and gas pipelines) are reviewed to provide an overview of ASEAN resource availability and accessibility. Some of the information sources that have been identified are compiled as detailed below:

- World Energy Resources 2010
- BP Statistical Review of World Energy 2012

- US Geological Survey
- Clean Energy Info Portal
- Energy Information Agency, International Energy Database 2013

Information on the existing and future energy interconnections for the ASEAN region will be based on the ASEAN Centre for Energy 2013 publication, Development of ASEAN Energy Sector.

(c) Mapping out the ASEAN energy challenge

With a clear idea of how the geographical distribution of energy resources and demand lies across the region as well as the current state of connectivity, it would be possible to map out the potential energy flows within ASEAN from areas with energy surplus to areas with energy deficit. At the same time, using energy demand projections up to 2030, those areas where energy gaps will tend to occur can be identified. It would also be possible to determine whether the overall ASEAN energy gap can be sufficiently addressed by improving energy efficiency and technology alone, or whether further cooperative measures are required.

(d) Defining the AEMI

The definition of AEMI will be based on reviews of existing definitions of energy market integration – for example, under the European Union and East Asia (EMI) context the terminology is consistent with that of the ASEAN Secretariat. The major components of AEMI will likely be investment, trade, infrastructure, national market openness and energy pricing. A quick review of the current status of these five areas under AEMI will be done to identify the AEMI hardware components (e.g., infrastructure, physical energy trading) as well as software components (e.g., policies, standards and regulations) needed for AEMI to deliver its promise.

B. Energy demand and supply in ASEAN

1. Historical trends and outlook in energy demand and supply

The latest aggregated information available for ASEAN is the Institute of Energy Economics, Japan Asia/World Energy Outlook 2012 (available at <http://eneken.ieej.or.jp/en/whatsnew/410.htm>).

(a) Energy and economic indicators

In the past, energy demand in ASEAN was driven by strong GDP and population growth. While GDP and population growth is projected to gradually slowdown in future, with improving GDP per capita, a shift from rural to urban lifestyle, increasing automobile ownership, more industrialized economic structure etc., primary energy consumption per capita is expected to more than double from 0.77 toe per capita in 2010 to 1.63 toe per capita in 2035 (table 2).

Table 2 Energy and economic indicators

Energy and Economic Indicators								AAGR (%)
	1980	1990	2000	2010	2020	2030	2035	2010-2035
GDP (\$2000 billion)	214	367	601	992	1643	2507	3043	4.6
Population (million)	348	430	504	571	628	671	689	0.8
CO ₂ emissions (Mt)	205	358	705	1086	1706	2427	2864	4.0
GDP per capita (\$2000)	615	855	1193	1738	2615	3736	4417	3.8
Primary energy consumption per capita (toe)	0.21	0.32	0.55	0.77	1.07	1.42	1.63	3.0
Primary energy consumption per GDP ^{*1}	338	380	465	443	408	381	369	-0.7
CO ₂ emissions per GDP ^{*2}	956	974	1172	1094	1038	968	941	-0.6
CO ₂ per primary energy consumption ^{*3}	2.83	2.57	2.52	2.47	2.55	2.54	2.55	0.1
Automobile ownership (million)	4.5	10	20	36	56	88	108	4.5
Automobile ownership ^{*4}	13	23	40	63	89	131	157	3.7

Source: Institute of Energy Economics, Japan, 2013.

Notes: *1 toe/\$2000 million, *2 t/\$2000 million, *3 t/toe and *4 vehicles per 1000 people.

(b) Primary energy consumption

Primary energy consumption mix will be dominated by oil at 34% share in 2035 (table 3), followed by coal and gas at a 28% share each. Renewable energy will experience the highest growth during the same period, driven by improving technology and strong policy support.

Table 3. Primary energy consumption

Primary energy consumption	Mtoe							Shares (%)			AAGR (%)
	1980	1990	2000	2010	2020	2030	2035	1990	2010	2035	2010-2035
Total ^{*5}	72	140	280	439	670	956	1124	100	100	100	3.8
Coal	3.6	12	32	84	161	257	319	8.9	19	28	5.5
Oil	58	88	153	197	265	339	379	63	45	34	2.6
Natural Gas	8.4	29	71	122	192	268	310	21	28	28	3.8
Nuclear	-	-	-	-	-	12	19	-	-	1.7	-
Hydro	0.8	2.3	4.1	6	12	18	20	1.7	1.4	1.8	4.9
Geothermal	1.8	6.6	18	25	33	51	60	4.8	5.6	5.3	3.6
Other Renewables	-	0.3	0.6	4.3	9.1	17	22	0.2	1.0	1.9	6.7

Source: Institute of Energy Economics, Japan, 2013.

Notes: *5 Trade of Electricity and heat are not shown.

(c) Final energy consumption

The industry sector will continue to be the largest energy consumer in the ASEAN region, as countries in the region continue to shift towards a more industrialized nation. Oil will continue to be the dominant fuel, although with a lower share (table 4).

Table 4. Final energy consumption

Final energy consumption	Mtoe							Shares (%)			AAGR (%)
	1980	1990	2000	2010	2020	2030	2035	1990	2010	2035	2010-2035
Total ⁵	51	91	182	297	439	610	710	100	100	100	3.5
By sector											
Industry	18	28	59	101	155	221	260	31	34	37	3.8
Transport	17	32	62	92	123	156	174	35	31	25	2.6
Buildings, etc.	13	19	41	56	94	145	177	21	19	25	4.7
Non-Energy Use	2.4	11	21	47	67	88	99	13	16	14	3.0
By energy											
Coal	2.1	6.1	14	36	65	95	113	6.7	12	16	4.7
Oil	41	67	125	179	230	296	333	79	60	47	2.5
Natural Gas	2.5	7.4	17	29	48	66	76	8.1	9.8	11	3.9
Electricity	4.7	11	28	52	93	147	181	12	17	26	5.1
Heat	-	-	-	-	-	-	-	-	-	-	-
Renewables	-	-	-	0.9	2.6	5.6	6.6	-	0.3	0.9	8.3

Source: Institute of Energy Economics, Japan, 2013.

Given that, by 2009, only five ASEAN countries had achieved access to electricity of above 95%,⁵ the other ASEAN countries will likely continue to strive to provide better electricity access to their population in line with their individual Millennium Development Goals (MDGs) targets. At the same time, even in countries with good electricity access, electricity use will also probably continue to grow.

This growing electricity use can be mainly contributed to the improving economies and lifestyle in ASEAN countries, which entails the purchase of more electrical appliances for daily use such as space cooling/heating, cooking, cleaning and even entertainment. ASEAN countries are currently plagued by traffic congestion, and a popular solution for this problem is to build electricity-based transit systems. These factors contribute to the projection that electricity consumption will almost double its share, from 17% in 2010 to 26% of the total final energy consumption mix in 2030.

(d) Electricity

To meet the growing electricity demand, total electricity generated is expected to more than triple from 2010 to 2035. Most of the electricity will be generated from thermal energy, however, with a slightly decreasing share from 86% in 2010 to 83% in 2035 (table 5). It is encouraging to see that non-fossil fuel has become increasingly important in the ASEAN electricity mix, as these non-fossil fuels sources emit less carbon compared with fossil fuel combustion.

⁵ The World Bank Database, "Access to Electricity", defines this as the percentage of population with access to electricity, with the ASEAN countries that have achieved above 95% being Brunei Darussalam, Malaysia, Singapore, Thailand and Viet Nam.

Table 5. Electricity generation

Electricity generated	TWh							Shares (%)			AAGR (%)
	1980	1990	2000	2010	2020	2030	2035	1990	2010	2035	2010-2035
Total ¹⁵	62	154	370	674	1256	2007	2449	100	100	100	5.3
Coal	3.0	28	79	185	404	716	926	18	27	38	6.7
Oil	47	66	72	59	84	97	100	43	8.8	4.1	2.1
Natural Gas	0.7	26	154	335	580	856	1012	17	50	41	4.5
Nuclear	-	-	-	-	-	45	74	-	-	3.0	-
Hydro	9.8	27	47	70	137	212	235	18	10	9.6	5.0
Geothermal	2.1	6.6	16	19	38	59	69	4.3	2.9	2.8	5.2
Other Renewables, etc.	-	0.6	1.0	6.1	13	23	33	0.4	0.9	1.4	7.0

Source: Institute of Energy Economics, Japan, 2013.

(e) ASEAN outlook as a whole and the APAEC Initiative

The ASEAN economic growth projected for the next 25 years is encouraging; however, this economic growth will spur demand growth for energy to more than double from 2010 to 2035. This development may become unsustainable, as it will likely require increasing energy imports and producing more carbon emissions.

ASEAN leaders and policymakers have been fully aware of these implications, and the political will to jointly address these energy challenges was clearly expressed in the 1997 Summit Declaration, entitled the ASEAN Vision 2020, in which the ASEAN Heads of Governments agreed to “establish interconnecting arrangements for electricity, natural gas and water within ASEAN through the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline, and promote cooperation in energy efficiency and conservation as well as development of new and renewable energy resources”.

A series of medium-term action plans have been prepared to act as a blueprint for ASEAN cooperation in attaining the ASEAN 2020 Vision; the current action plan, the third in the series, is the 2010 ASEAN Plan of Actions for Energy Cooperation (APAEC 2010-2015). The program areas relevant to the AEMI concept are included in the next two sections.

(f) APAEC 2010-2015 – Program Area No. 1

ASEAN power grid

Paragraph 31: ASEAN recognizes the critical role of an efficient, reliable and resilient electricity infrastructure for stimulating regional economic growth and development. The continuing efforts of the ASEAN Member States in strengthening and/or restructuring their respective power market industry are oriented towards this direction. Currently, electricity is accessed by roughly 66% of the ASEAN peoples made available through grid power supply, stand-alone and distributed power generation systems. Electricity is produced through a mix of oil, gas, coal, hydro, geothermal and other renewable energy sources. Regional electricity production grew at an average yearly rate of 8% from 1990 to 2005 and is projected to grow at 6.1% annually from 2005 to 2030. Enhancing electricity trade across borders, through integrating the national power grids of the ASEAN Member States, is expected to provide benefits of meeting the rising electricity demand and improving access to energy services.

Paragraph 32: The ASEAN Power Grid (APG) is a flagship program mandated in 1997 by the ASEAN Heads of States/Governments under the ASEAN Vision 2020 towards ensuring regional energy security while promoting the efficient utilization and sharing of resources. To pursue the program, ASEAN adopts a strategy that encourages interconnections of 15 identified projects, first on cross-border bilateral terms, then gradually expand to sub-regional basis and, finally to a totally integrated Southeast Asian power grid system. Currently, the APG is in progress with four on-going interconnection projects and additional 11 projects are planned for interconnection through 2015. The investment requirement of the APG is estimated at USD 5.9 billion. A potential savings of about US\$ 662 million in new investment and operating costs is estimated resulting from the proposed interconnection projects.

Paragraph 33: Objective – To facilitate and expedite the implementation of the ASEAN Interconnection Master Plan, and to further harmonize technical standards and operating procedures as well as regulatory and policy frameworks among the ASEAN Member States.

Strategic goals

- To achieve a long-term security, availability and reliability of energy supply, particularly in electric through regional energy cooperation in Trans-ASEAN Energy Network;
- To optimize the region's energy resources towards an integrated ASEAN Power Grid System; and
- To further harmonize all aspect of technical standard and operating procedure as well as regulatory frameworks among member country.

Highlights

- Implement 15 interconnection projects of which 4 are in operation, 3 under construction and 8 under preparation;
- Total investment including upgrading of existing interconnections is estimated to be US\$ 5.9 billion; and
- Projects are open for private and public sector investment, supported by the ASEAN Infrastructure Financing Mechanism (AIFM) which will be formulated by the ASEAN Finance Ministers.

(g) APAEC 2010-2015 – Program Area No.2

Trans-ASEAN Gas Pipeline (TAGP)

Paragraph 34: The ASEAN Vision 2020 emphasizes the establishment of the interconnecting arrangements towards achieving a long-term security, availability and reliability of energy supply, particularly in oil and gas, through regional energy cooperation in Trans-ASEAN Energy Network comprising of the Trans-ASEAN Gas Pipeline (TAGP) and the ASEAN Power Grid (APG). TAGP aims to interconnect the gas pipeline infrastructure of ASEAN Member States and to enable gas to be transported across the borders of the Member States. APG, on the other hand, ensures that gas for power is also being optimized with other potential sources of energy.

Paragraph 35: The original TAGP aimed to develop a regional gas grid by 2020, by linking the existing and planned gas pipeline networks of the ASEAN Member States. The updated ASCOPE-TAGP Master Plan 2000 involves the construction of 4,500 kilometers of pipelines, mainly undersea, worth US\$ 7 billion. Eight bilateral gas pipeline interconnection projects, with a total length of approximately 2,300 km, are currently operating. They are: (i) P. Malaysia to Singapore in 1991; (ii)

Yadana, Myanmar to Ratchaburi, Thailand in 1999; (iii) Yetagun, Myanmar to Ratchaburi, Thailand in 2000; (iv) West Natuna, Indonesia to Singapore in 2001; (v) West Natuna, Indonesia to Duyong, Malaysia in 2001; (vi) South Sumatra, Indonesia to Singapore in 2003; (vii) Malaysia-Thailand Joint Development Area to Malaysia via Songkhla in 2004; and (viii) Malaysia-Singapore in 2006. These interconnections form part of the backbone of energy security and sustainability of supply objectives of ASEAN to be accelerated by 2015 and serve as a key driver of growth to the various energy consuming sectors of the ASEAN economies.

Paragraph 36: Over the years, natural gas demand has increased tremendously while new gas finds are not imminent to meet this new regional demand growing yearly at about 7-8%. ASEAN consumes approximately 10 billion cubic feet per day (BCFD) of natural gas. ASCOPE has reflected in its updating of the TAGP 2000 Study and Roadmap the latest gas supply and demand situation in the region. Findings indicated that there is a widening supply gap from 2017 rising to more than 12,000 MMSCFD by 2025. ASCOPE E&P BDC has been tasked with studying how best to further increase the gas supply. Many options are considered for addressing the future shortfall of gas such as exploring new discoveries in the region, or by increasing imports of LNG gas. Coalbed methane (CBM) is also identified as possible additional supply source. However, the East Natuna gas field of Indonesia remains the main source of energy in ASEAN for the future and its commercialization is the key to addressing the supply gap. The said gas field has about 70% CO₂ and reserves of 45 trillion cubic feet (excluding CO₂), with a gas price that is affordable and competitive with alternative fuels such as coal or fuel oil. ASEAN Member States are also building LNG re-gasification terminals to supplement their energy needs. Moreover, ASCOPE and HAPUA are strategizing actions to strike a supply-demand balance for gas to be used in the TAGP and APG in view of the growing regional gas demand.

Paragraph 37: Objective – To facilitate the implementation and realization of the Trans-ASEAN Gas Pipeline Infrastructure Project, to ensure greater security of gas supply.

Strategic goals

- To achieve long-term security, availability and reliability of energy supply, particularly in oil and gas, through regional energy cooperation in the Trans-ASEAN Energy Network;
- To work on managing high CO₂ gas fields;
- To commercialize the East Natuna Gas Field to fulfill current demand and address a future supply gap;
- To further explore and secure additional gas supplies from non-conventional sources, i.e. Coalbed methane (CBM);
- To expedite the pipeline construction under the ATGP Updated Master Plan 2008, once the East Natuna supply is available;
- To leverage existing bilateral pipeline interconnections for future gas mobility within the region.

Highlights

- To promote and increase cleaner coal use and trade for regional energy security;
- To strongly encourage the use of clean coal technologies through regional cooperation.

(h) Barriers to APAEC 2010-2015

The ASEAN Centre for Energy (ACE) and the Korea Energy Economics Institute (KEEI) recently carried out a joint review of the main components of APAEC 2010-2015 in order to identify the major challenges that ASEAN energy sector is facing in ensuring energy security and sustainable development.⁶ The results of their research shed light on the major barriers to implementing the current cooperative approach. The review recognizes that realizing the objectives of ASEAN energy cooperation “do not merely require having infrastructure available, but also having all the institutional, regulatory, legal, technical, and economic aspects functional”. It stresses the need to go beyond the current “piecemeal approach” based on “bilateral trade under pre-arranged power purchase and limited exchange”, and towards the creation of “sub-regional integrated power grids and ultimately integrated APG.”

The APAEC review highlights the facts that actions under APAEC are undertaken essentially from a national perspective, and bilateral agreements are struck sporadically as piecemeal endeavours that do not add up to the cohesive, effective system needed to deliver secure, affordable and sustainable energy throughout the region. The overall conclusion is that the absence of policy and institutional dimensions constitute major barriers to the successful implementation of APAEC and greatly slow down its progress. Moreover, despite numerous resolutions and efforts for more than three decades, the APAEC review concedes that there is difficulty in effectively delivering more cohesive ASEAN energy markets, and a sense that the political will for doing so is lacking.

The forthcoming ASEAN Economic Community (AEC) provides for arrangements and agreements to transform ASEAN into a single market with a free flow of goods, services, investment and skilled labor, so that resources go into their most productive uses within ASEAN for the benefit of all. The objective of AEMI is to extend the scope of such provisions to the energy sector – that is, to allow the free flow of energy products, services and investment in the framework of AEC, in order to achieve access to secure, affordable and sustainable energy sources within AEC.⁷ AEMI would thus build on the series of the three APAECs, taking them a step further, from regional energy cooperation into regional energy integration.⁸

It is interesting to note that the APAEC 2010-2015 document, while advocating for the integration of energy networks (both pipelines and power grids), does not mention the introduction of a trade/energy market. The existing cross-border energy exchanges thus far are limited to zero exchange or pre-established purchase agreement (bilateral) (ACE, 2013).

The establishment of a regional market will require political willingness and compromise among the Governments. A truly competitive market needs suitable market structures, an adequate guarantee of supply, common transmission networks with adequate access and pricing rules, and a minimum level of harmonization among member markets involved (Pérez-Arriaga, 2010). For ASEAN, this will likely require further negotiations and legislation at the top-level that goes beyond bilateral agreements and network integration.

⁶ *Development of ASEAN Energy Sector*, ASEAN Centre for Energy, Korea Energy Economics Institute, 2013.

⁷ Consistent with a similar definition for EMI, covering the EAS countries, in *Energy Market Integration in the East Asia Summit Region: Review of Initiatives and Estimation of Benefits*, ERIA, 2010.

⁸ For a full review of current ASEAN initiatives in the energy sector, refer to *Development of ASEAN Energy Sector*, ASEAN Centre for Energy and Korea Energy Economics Institute, 2013.

The next section on institutional framework, energy industry structure and relevant energy policies looks at some of the criteria based on existing national conditions for each of the ASEAN member economies.

2. Institutional framework, energy market structure and relevant energy policies

Table 6 contains an overall view of the energy institutional profile for each ASEAN country. Three categories are covered, the institutional framework (i.e. who regulates the energy sector?), the energy industry structure (i.e. who provides the energy services) and relevant energy policies (i.e. which laws and policies governs the energy sector?). This table focuses more on information related to gas and electricity as these are the commodities covered under the AEMI project (TAGP and AGP).

The information is collected from various sources; Clean Energy Info Portal (<http://www.reegle.info/index.php>); APEC Energy Demand and Supply Outlook 5th Edition (<http://aperc.iecej.or.jp>); and documentation/websites of the individual countries.

Table 6. Regulatory conditions in each ASEAN economy

Country	Institutional framework	Energy industry structure	Relevant energy policies
Brunei Darussalam	The energy sector is overseen by the Energy Department under the Prime Minister Office (EDPMO). Regulated energy prices.	Fully overseen by the Government. Electricity is provided by the Department of Electrical Services (DES) and Berakas Power Management Company (BPMC). O&G sector major players: Brunei Shell Petroleum, Total E&P Offshore	- Oil Conservation Policy (1981) - Brunei Natural Gas Policy (Production and Utilization) (2000) - Five-year National Development Plans

Country	Institutional framework	Energy industry structure	Relevant energy policies
Cambodia	<p>Overseen by the Ministry of Industry, Mines and Energy (MIME) and its three departments:</p> <ol style="list-style-type: none"> 1. Department of Energy Development 2. Department of Technique 3. Hydropower Department <p>Electricity is regulated by Electricity Authority of Cambodia (EAC).</p> <p>Cambodia National Petroleum Authority (CNPA) regulates the petroleum sector.</p>	<p>Electricity provided by Electricity du Cambodge (EdC) (government-owned power utility) and IPPs.</p> <p>Private sector participation through IPP power purchase agreements.</p>	<ul style="list-style-type: none"> - Power Sector Strategy 1999-2016 - Rural Electrification by Renewable Energy Policy (2006) - Renewable Electricity Action Plan (REAP) 2002-2012 - National Strategic Development Plan (NSDP) of Cambodia (2009)

Country	Institutional framework	Energy industry structure	Relevant energy policies
Indonesia	<p>Overseen by the National Energy Council (DEN).</p> <p>Ministry for Energy and Mineral Resources (MEMR) regulates the energy sector, along with its sub-agencies:</p> <ul style="list-style-type: none"> - Directorate General of Oil and Gas - Directorate General of Mineral and Coal - Directorate General of Electricity - Directorate General of New Energy, Renewable and Energy Conservation <p>Regulated energy prices.</p>	<p>O&G industry currently undergoing regulatory changes. E&P based on production sharing contracts with Pertamina (government-owned). Major IOCs operating in Indonesia are Chevron, Total, Conoco Phillips, Exxon and BP.</p> <p>Downstream gas pipelines are operated by the state-owned gas distribution utility Perusahaan Gas Negara (PGN).</p> <p>Initial restructuring of the electricity took place in 1994. The Perusahaan Elektrik Negara (PLN) is the government-owned electricity utility that is the sole buyer and seller of electricity in the power market. The utility shares its generation business with IPPs and cooperatives. At the transmission and distribution level, certain assets have been decentralized (i.e. the Java-Bali Electricity Transmission Unit).</p>	<ul style="list-style-type: none"> - National Energy Policy (2006) - Oil and Gas Law (Law No 21/2001) - Electricity Law (Law No 30/2009)
Lao People's Democratic Republic	<p>Overseen by Ministry of Energy and Mines (MEM). Relevant departments under MEM are:</p> <ul style="list-style-type: none"> - Department of Energy Promotion and Development (DEPD) - Department of Electricity (DOE) - Department of Geology and Mines 	<p>Electricity provided by state-owned, vertically-integrated utility Electricité du Laos (EdL).</p>	<ul style="list-style-type: none"> - Electricity Law (1997) - National Policy on the Environmental and Social Sustainability of the Hydropower Sector (2005)

Country	Institutional framework	Energy industry structure	Relevant energy policies
Malaysia	<p>The key ministries and agencies for Malaysia's energy sector are:</p> <ul style="list-style-type: none"> - Energy Unit of the Economic Planning Unit (EPU) of the Prime Minister's Department - Ministry of Energy, Green Technology and Water (KeTTHA) - Energy Commission (ST) <p>Regulated energy prices.</p>	<p>Petronas holds exclusive ownership rights for O&G exploration and production. Other companies must operate through production sharing contracts (PSC).</p> <p>The electricity industry has been partially deregulated with participation by IPPs. The main government-linked electricity utilities are Tenaga Nasional Berhad (TNB), Sabah Electricity Berhad (SESB) and Sarawak Energy Berhad (SEB).</p>	<ul style="list-style-type: none"> - National Energy Policy (1979) - National Depletion Policy (1980) - Economic Transformation Program (2010)
Myanmar ⁹	<p>The Ministry of Energy (MOE) is the focal point for overall energy policy and coordination and O&G regulation. Other ministries involved in energy sector are:</p> <ul style="list-style-type: none"> - Ministry of Electric Power - Ministry of Mines (MOM) for coal - Ministry of Agriculture and Irrigation (MOAI) for biofuels and micro-hydro (for irrigation purposes) - Ministry of Science and Technology (MOST) for renewable energy - Ministry of Environmental 	<p>State-owned enterprises related to O&G sector:</p> <ul style="list-style-type: none"> - Myanma Oil and Gas Enterprise (MOGE): E&P and transportation of O&G. - Myanma Petroleum Products Enterprise (MPPE): Operates refineries, fertilizer plants, LPG plants and methanol plant. - Myanma Petrochemical Enterprise (MPE): Operates the Marketing and Distribution of petroleum products. 	<ul style="list-style-type: none"> - Myanmar Electricity Law (1984) - Electricity Rules (1985) - The Petroleum Act (1934) - Petroleum Rules of 1937 (as amended in 1946) - National Environment Policy (1994) - Myanmar Energy Policy

⁹ ADB, Myanmar Energy Sector Initial Assessment, available at www.adb.org/sites/default/files/myanmar-energy-sector-assessment.pdf.

Country	Institutional framework	Energy industry structure	Relevant energy policies
	<p>Conservation and Forestry (MOECAF)</p> <ul style="list-style-type: none"> - Ministry of Industry (MOI) for energy efficiency 		
Philippines	<p>The energy sector is overseen by the Department of Energy (DOE). The department has oversight of five government-owned and controlled corporations:</p> <ul style="list-style-type: none"> - National Power Corporation (NPC) - National Electrification Administration (NEA) - Philippine National Oil Company (PNOC) - Philippine Electricity Marketing Corporation (PEMC) - Power Sector Assets and Liabilities Management Corporation (PSALM) <p>Oil pricing is deregulated, and electricity pricing is set by the Energy Regulatory Commission (ERC). The ERC also regulates the electricity sector.</p>	<p>O&G E&P activities are undertaken by private entities through service contracts with DOE, which is contracted through the annual Philippine Energy Contracting Round (PECR) Mechanism.</p> <p>The Wholesale Electricity Spot Market (WESM) was established in Luzon and Visayas. Other parts of the power market are serviced by the state-owned National Power Corporation (NPC) that generates its own electricity and buys from IPPs. Electricity distribution is serviced by a mixture of private utilities and electricity cooperatives.</p>	<ul style="list-style-type: none"> - Philippine Energy Plan (2004-2013) - Electricity power Industry Reform Act (2001)
Singapore	<p>The electricity and gas industries are regulated Energy Market Authority (EMA).</p>	<p>Open electricity and gas markets.</p> <p>Domestic gas pipeline network is owned and operated by PowerGas Ltd.</p>	<ul style="list-style-type: none"> - Energy for Growth: National Energy Policy Report (2007)

Country	Institutional framework	Energy industry structure	Relevant energy policies
		<p>Generations companies compete in the National Electricity Markets of Singapore (NEMS) to sell electricity to the grid network operated by EMA.</p>	<ul style="list-style-type: none"> - Gas Network Code (2008)
Thailand	<p>The energy sector is overseen by the Ministry of Energy.</p> <p>Government agencies responsible for energy include the:</p> <ul style="list-style-type: none"> - Office of the Minister - Office of the Permanent Secretary - Department of Alternative Energy Development and Efficiency (DEDE) - Department of Energy Business - Department of Mineral Fuels - Energy Policy and Planning Office (EPPO) - Electricity Generating Authority of Thailand (EGAT) - Energy Regulatory Commission - Nuclear Power Program Development Office 	<p>The three major state enterprises in the O&G sector are:</p> <ul style="list-style-type: none"> - Petroleum Authority of Thailand (PTT) - PTT Exploration and Production Co. Ltd (PTTEP) - Bangchak Petroleum Public Co. Ltd (Bangchak). <p>Electricity is generated by the Electricity Generating Authority of Thailand (EGAT) and IPPs, Small Power Producers (SPP) and Very Small Power Producers (VSPP). EGAT also owns the whole transmission system but electricity distribution and retailing is conducted by the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA).</p>	<ul style="list-style-type: none"> - Power Development Plan (2012 Update) - Energy Business Act (2007)

Country	Institutional framework	Energy industry structure	Relevant energy policies
Viet Nam	<p>The Ministry of Industry and Trade (MOIT) is responsible for the state management of all energy industries.</p> <p>Inside MOIT, the General Directorate of Energy administers the Viet Nam Electric Power Group (EVN), the Viet Nam National Coal and Mineral Industries Group (Vinacomin) and the Viet Nam Oil and Gas Group (PetroVietnam, or PVN).</p> <p>The power market is regulated by the Electricity Regulatory Authority of Viet Nam (ERAV)</p> <p>Regulated energy prices.</p>	<p>Upstream O&G production is carried out by PVN and private companies that have Product Sharing Contracts (PSC) with PVN. Downstream functions are carried out by PVN.</p> <p>Electricity is supplied by state-owned Electricité du Vietnam (EVN) and other companies that operate based on Build-Operate-Transfer and IPP schemes. The state maintains a monopoly on the transmission operations.</p>	<ul style="list-style-type: none"> - National Energy Development Strategy (2007) - Electricity Law (2005)

National Regulations and ASEAN Energy Market Integration

Table 6 clearly demonstrates the varied regulatory conditions throughout the ASEAN region. For electricity, the only country with a competitive market is Singapore. Some countries, such as Malaysia and Thailand, have a deregulated supply side, but with no power purchase pool. The Philippines has power pools in certain parts of the electricity network while other countries such as Brunei Darussalam and the Lao People's Democratic Republic (Lao PDR) are served by state-owned utilities. For natural gas markets, the majority of the ASEAN countries operate based on the Product Sharing Contract mechanism while access to the gas transmission pipeline is usually owned and regulated by state-owned companies. Furthermore, the prevalence of national electricity utilities and price control mechanisms (i.e., subsidies) in several ASEAN countries will most likely become a challenge to AEMI development in the near future, as certain ASEAN countries may choose to protect their national interests rather than pursuing regional objectives.

Obviously, there is still much to be done in terms of harmonizing energy institutions across ASEAN before AEMI can become a realistic option. Some of the key actions include:

- Harmonization of technical, legal, regulatory and commercial frameworks;
- Adopting more trade-compatible industry structures (liberalization of energy markets);
- Developing integrated transmission networks with transparent access for market players (both for gas pipelines and for power grids, and includes technical access and common access tariffs);
- Creating new regional level institutions (made up of national operators) that oversee the co-operation framework, administer disputes, organize regional planning framework etc.;
- Removing trade and investment barriers (rationalization of inefficient energy subsidies and creating a secure investment environment).

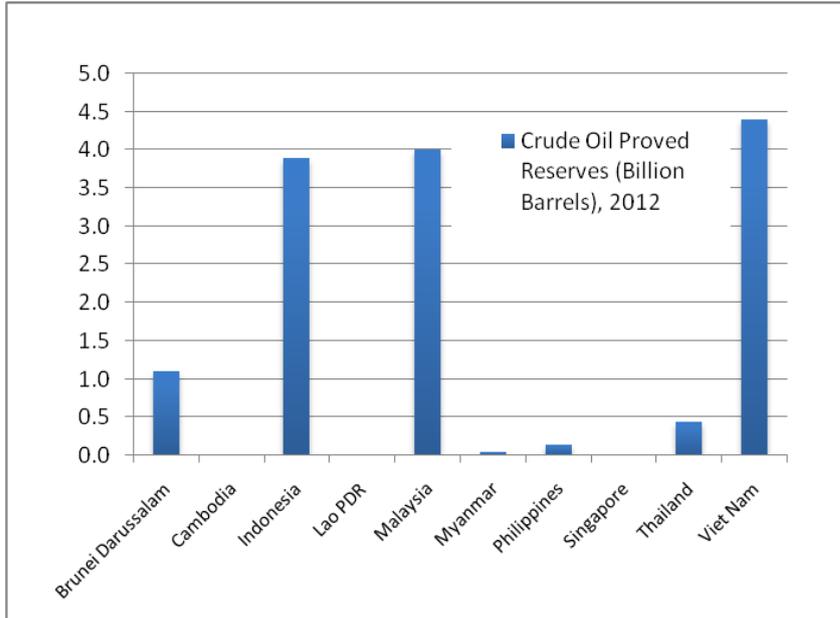
C. Mapping the ASEAN energy challenge

1. Energy resources in ASEAN countries

(a) Current availability

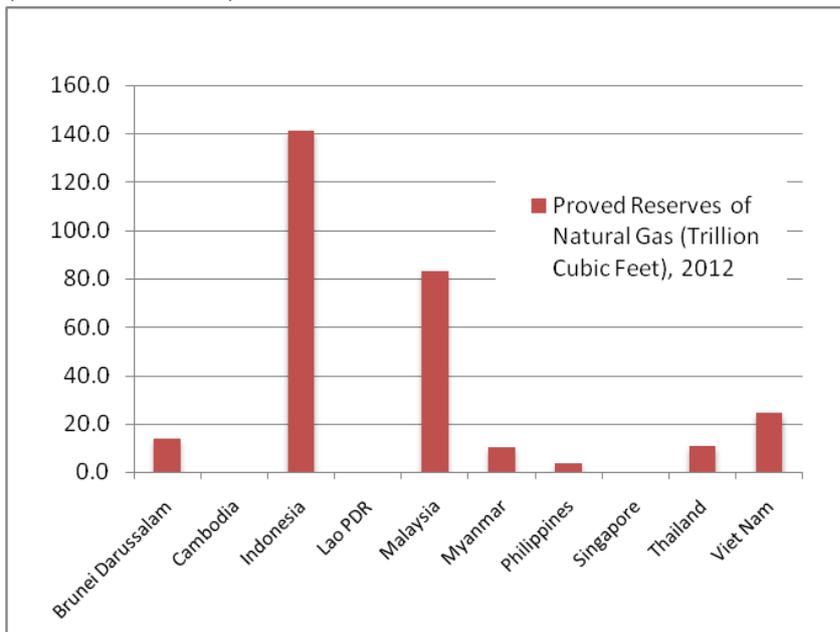
The ASEAN region as a whole is blessed with an abundance of fossil fuel resources, i.e., oil, natural gas and coal. Oil and natural gas are largely concentrated in four countries – Indonesia, Malaysia, Viet Nam and Brunei Darussalam. As for coal, Indonesia has the biggest recoverable coal in the ASEAN region at 6,718 Million Tons followed by Thailand (1,505 Million Tons). It is estimated that the 10 member countries of ASEAN have 14 billion barrels of oil reserves, 286.6 trillion cubic feet of natural gas reserves and 9,408.4 billion tons of coal reserves. Figures 1, 2 and 3 show the available reserves in ASEAN by countries, in 2012.

Figure 1. Crude oil proved reserves by country, 2012 (billion barrels)



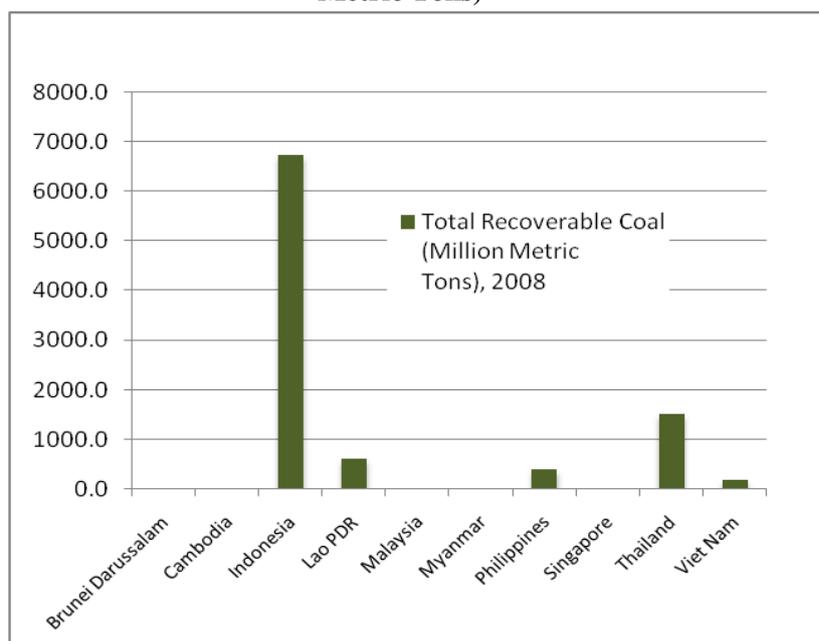
Source: EIA, 2013.

Figure 2. Proved reserves of natural gas by country, 2012 (trillion cubic feet)



Source: EIA, 2013.

Figure 3. Total recoverable coal by country, 2008 (Million Metric Tons)



Source: EIA, 2013.

The ASEAN countries are also capable of harnessing their own indigenous renewable energy resources to produce electricity; however, the type and amount of renewable energy available varies from country to country. Table 7 shows the renewable energy potential for hydropower and geothermal, which illustrates the varied distribution of energy resources in ASEAN. Unfortunately, a common source for solar energy potential is not available; however, based on a brief literature survey, it is clear that the region is highly suitable for solar photovoltaics but not solar thermal, and therefore there is much potential for solar PV installations in ASEAN countries, even for resource-poor Singapore.

Table 7. Renewable energy potential

	Technical hydropower potential (TWh/year)	Geothermal potential
Brunei Darussalam	N/A	-
Cambodia	34	-
Indonesia	402	27.67 GW _e
Lao PDR	63	-
Malaysia	123	-
Myanmar	139	-
Philippines	20	4340 MW _e
Singapore	-	-
Thailand	16	N/A
Viet Nam	123	340 MW _e

Source: WEC, 2010.

(b) ASEAN energy dependence outlook

The Asia Pacific Energy Research Centre (APERC, 2013) has projected coal, oil, gas and electricity production for seven of the 10 ASEAN member countries. The expected total primary energy production and electricity production for these seven countries are shown in table 8. For detailed data on production by types of fuel, refer to the tables provided by APERC at their website, <http://aperc.iecej.or.jp>.

Table 8. Total primary energy production and electricity production

	Primary energy production (Mtoe)			Electricity production (TWh)		
	2009	2020	2030	2009	2020	2030
Brunei Darussalam	18.8	17.1	13.8	3.6	3.7	3.9
Indonesia	355.7	409.7	505.7	159.8	285.9	478.5
Malaysia	90.0	96.3	93.4	108.1	145.6	190.9
Philippines	24.3	29.1	28.9	67.1	103.8	154.7
Singapore	0	0.1	0.1	44.3	50.8	52.9
Thailand	61.7	70.3	80.9	152.8	196.7	269.7
Viet Nam	78.9	100.1	116.1	92.2	173.8	313.9

Source: APERC, 2013.

Note: Statistics for Cambodia, the Lao PDR and Myanmar are not readily available.

APERC has also projected the final consumption for the seven countries; however, for the sake of completeness, table 9 includes the total final energy demand and total primary energy consumption for Cambodia, the Lao PDR and Myanmar produced by the ASEAN Center for Energy in 2011. Note that the base year for these countries is 2007, not 2009.

Table 9. Total final energy demand and total primary energy consumption

	Total final energy demand (Mtoe)			Total primary energy consumption (Mtoe)		
	2007/2009	2020	2030	2007/2009	2020	2030
Brunei Darussalam	0.9	1.6	1.6	3.1	3.1	3.1
Cambodia*	4.6	7.7	10.9	5.2	9.3	13.2
Indonesia	145.9	192.2	260.7	202.0	259.2	428.9
Lao PDR*	2.0	3.7	6.0	2.2	6.2	8.7
Malaysia	39.8	51.4	68.9	66.8	83.0	101.9
Myanmar*	14.0	21.6	32.6	15.7	23.8	35.2
Philippines	23.1	29.8	41.1	38.8	52.1	70.1
Singapore	14.1	18.2	21.0	18.5	27.2	29.8
Thailand	75.8	102.4	133.0	103.3	141.2	201.9
Viet Nam	55.6	80.8	116.5	64.0	99.8	153.9

Sources: ACE, 2011; APERC, 2013.

Note: *Statistics for Cambodia, Lao PDR and Myanmar are from ACE (2011) and the base year is 2007.

Based on available data, the energy self-sufficiency for seven out of the 10 ASEAN countries can be calculated and tabulated as shown in table 10. It can be seen that only two of the seven countries analyzed will remain energy independent by 2030, but even for these two countries, the self-sufficiency ratio is steadily declining.

Table 10. Energy self-sufficiency for ASEAN countries

	Energy self-sufficiency		
	2010	2020	2030
Brunei Darussalam	6.1	5.5	4.5
Indonesia	1.8	1.6	1.2
Malaysia	1.3	1.2	0.9
Philippines	0.6	0.6	0.4
Singapore	0.0	0.0	0.0
Thailand	0.6	0.5	0.4
Viet Nam	1.2	1.0	0.8

Source: Authors' calculation based on tables 8 and 9.

Note: Statistics for Cambodia, the Lao PDR and Myanmar are not readily available.

(c) The looming ASEAN energy gap

Energy resources in ASEAN are unevenly distributed, as can be seen from figures 1, 2 and 3 as well as table 7, with some countries rich in fossil fuel resources, others with vast hydropower potential while others are resources-poor and have limited indigenous energy potential.

However, analysing the consumption and self-sufficiency projections for the ASEAN economies reveals a worrying trend. Energy demand for each ASEAN country (even Brunei Darussalam) is projected to continue to increase up to, and likely beyond 2030. For some countries, e.g., Indonesia and the Lao PDR, the projected increase is more than double the demand at the base year. What this may mean is that energy production may be not enough to meet the rapidly increasing demand, i.e., the supply-demand gap will keep increasing over the outlook horizon in 20 years. In fact, based on table 10, by 2030 it appears likely that only Brunei Darussalam and Indonesia will remain self-sufficient.

The looming energy gap for ASEAN countries can be attributed to three main reasons: (a) the rapidly increasing energy demand; (b) over-dependency on fossil fuels to meet demand; and (c) depleting energy reserves. There are also other factors that may further exaggerate the situation; for example, technically available hydropower potential may not be exploitable if the cost of harnessing this potential is too expensive; or using nuclear energy for electricity generation may not be pursued if perceived as a risk to national stability.

2. Energy trade in ASEAN countries

(a) Current energy trade in ASEAN countries

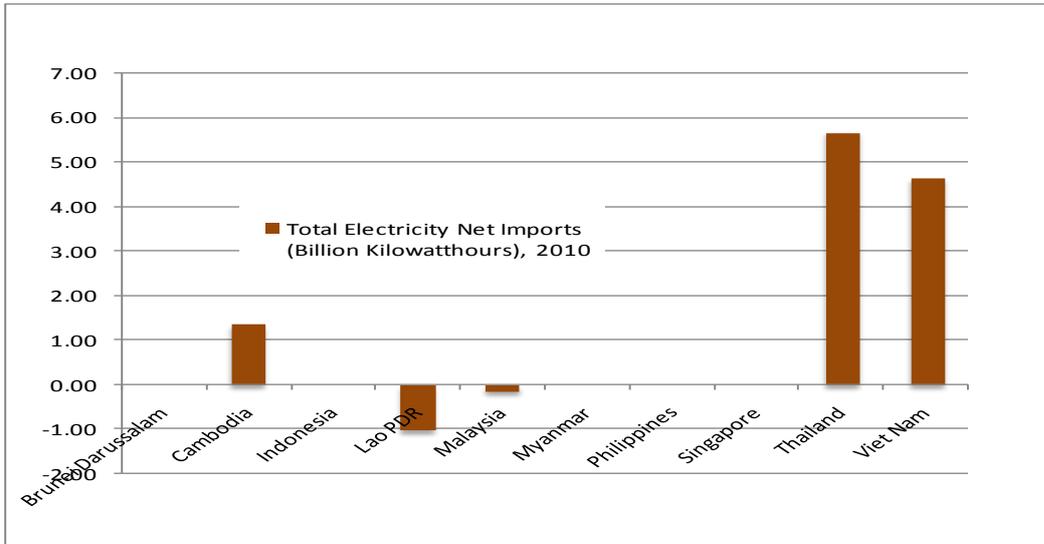
Trade is the import or export of commodities to or from a country. To maintain consistency, in this report the net import for each commodity is shown for each country where net import is the difference between energy import and export quantity for a particular country. A country with a negative net import is a country in a positive net export position (i.e., an exporting country). This indicator is important in determining the possibility of securing energy supply within the region through existing and future energy infrastructure interconnection.

Four commodities are covered in this report – electricity, natural gas, coal and oil. It should be noted that electricity and natural gas can be traded between ASEAN member economies via either the ASEAN Power Grid (electricity) or the Trans-ASEAN Gas Pipeline (natural gas) while coal and oil are transported via more conventional means (road, rail or shipping).

(b) Electricity trade

The electricity net import position for all the ASEAN member countries are shown in figure 4. The Lao PDR and Malaysia were net exporters of electricity at 1.02 billion KWh and 0.151 billion KWh, respectively, in 2010. On the other hand, Thailand and Viet Nam both had high electricity net import values at 5.672 billion KWh and 4.635 billion KWh, respectively, in 2010. Cambodia was also a net importer of electricity at 1.357 billion KWh in 2010.

Figure 4. Net electricity imports by ASEAN countries, 2010 (billion kilowatt hours)

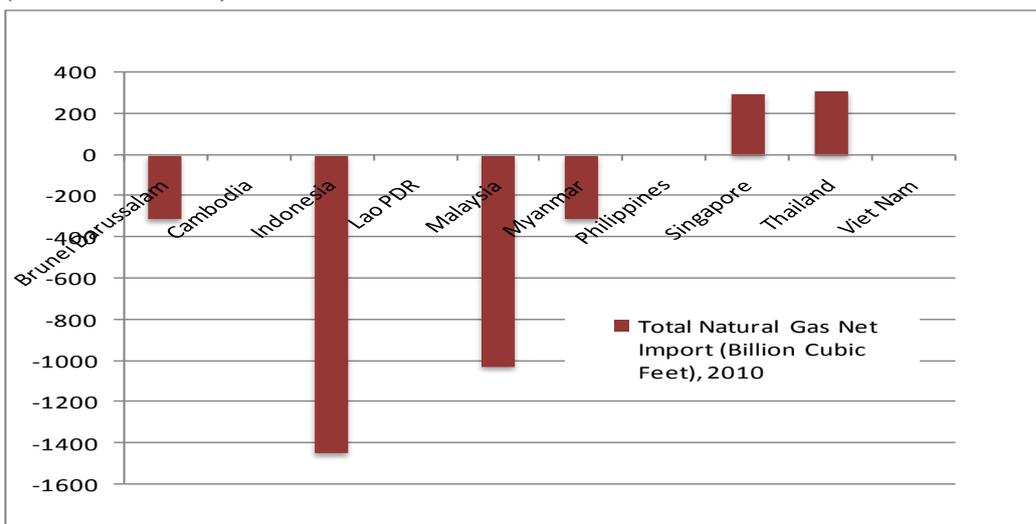


Source: EIA, 2013.

(c) Natural gas trade

In 2010, four of the 10 ASEAN member countries (Brunei Darussalam Indonesia, Malaysia and Myanmar) were natural gas net exporters. Indonesia had the biggest net exporter value at 1,444.38 billion cubic feet, followed by Malaysia (1,025.90 billion cubic feet), Brunei Darussalam (311.83 billion cubic feet) and Myanmar (311.13 billion cubic feet). Singapore and Thailand were net importers of natural gas in 2010, at 311.13 billion cubic feet and 296.65 billion cubic feet, respectively.

Figure 5. Natural gas net Imports in ASEAN countries, 2010 (billion cubic feet)

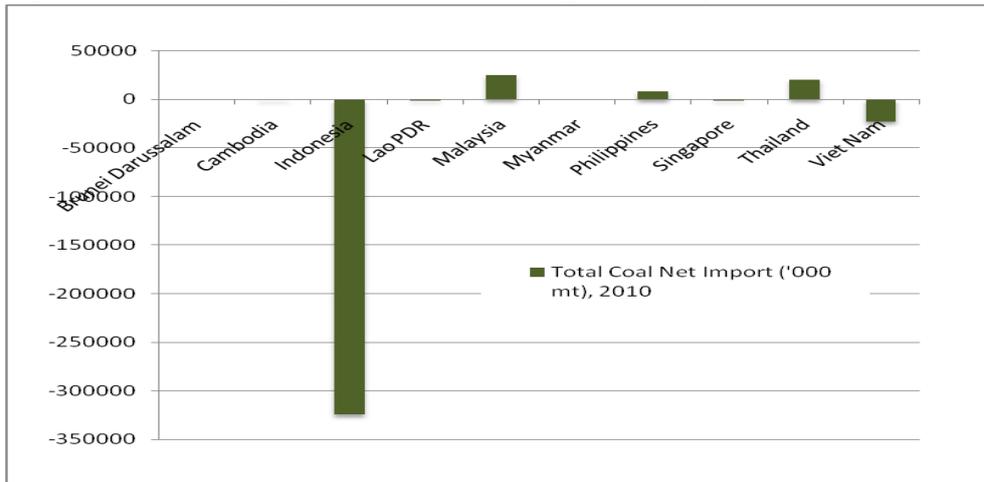


Source: EIA, 2013.

(d) Coal trade

Indonesia is the largest net exporter of coal in the ASEAN region, amounting to about 324,606 Thousand Metric Tons in 2010. Viet Nam and the Lao PDR were also net exporters of coal in 2010, albeit at much lower values of about 22,689 Thousand Metric Tons and 460 Thousand Metric Tons, respectively. On the other hand, five of the 10 ASEAN member countries were net importers of coal in 2010 (Cambodia, Malaysia, the Philippines, Singapore and Thailand), mainly to fuel their power generation sector and for application in the industry sector. Figure 6 depicts the net coal imports in the ASEAN region.

Figure 6. Coal, net imports in the ASEAN region, 2010 ('000 Metric Tons)

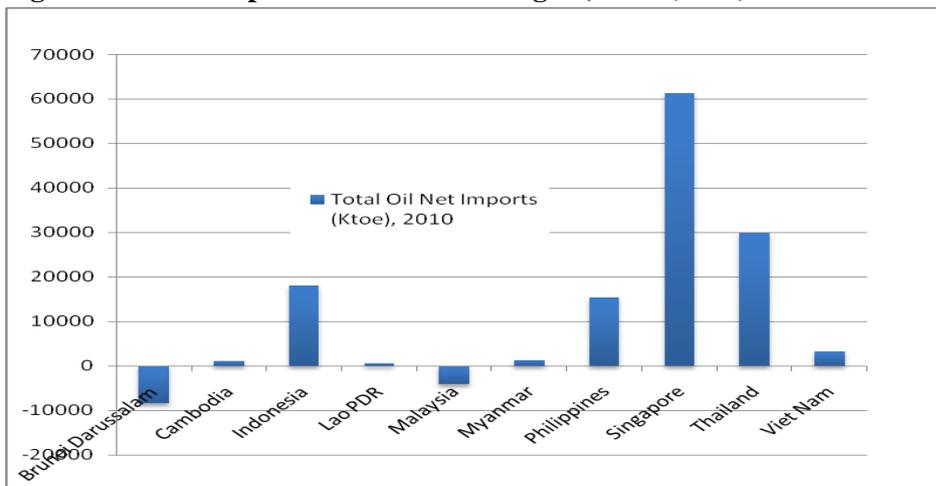


Source: EIA, 2013.

(e) Oil trade

Figure 7 shows that most of the ASEAN countries were net oil importers in 2010; only Malaysia and Brunei Darussalam were net oil exporters. Oil is essential for the transportation sector.

Figure 7. Net oil imports in the ASEAN region, 2010 (Ktoe)



Sources: EIA, 2013; and Pornkeratiwat, 2013.

(f) *Energy sources: Import/export outlook*

APERC (2013) has projected the imports/exports of coal, oil, gas and electricity for seven of the 10 ASEAN member countries. Tables 11 and 12 show the projected net import values for coal, oil, gas and electricity up to 2030. It is projected that Indonesia will remain a major coal net exporter in 2030 while Malaysia, the Philippines, Singapore, Thailand and Viet Nam will remain net importers of coal. As for oil resources, all ASEAN member countries are expected to become oil net importers by 2030, with the exception of Brunei Darussalam, which will remain an oil net exporter throughout the projection period (2010 to 2030).

Table 11. Coal and oil net imports

	Net coal imports (Mtoe)			Net oil imports (Mtoe)		
	2010	2020	2030	2010	2020	2030
Brunei Darussalam	0.00	0.00	0.00	-7.54	-6.66	-5.09
Indonesia	-141.56	-195.86	-278.68	19.28	53.63	98.74
Malaysia	9.37	14.05	11.99	-7.70	11.45	25.16
Philippines	2.87	7.74	18.59	13.72	17.10	25.14
Singapore	0.12	0.63	0.49	56.80	72.15	85.13
Thailand	10.02	14.95	17.56	34.50	49.32	69.74
Viet Nam	-7.70	-4.03	7.45	-2.96	6.48	23.09

Source: APERC, 2013.

Note: Projections for Cambodia, the Lao PDR and Myanmar are not readily available.

Through 2030, Brunei Darussalam and Malaysia are expected to remain net exporters of natural gas. On the other hand, Indonesia and Viet Nam are expected to become net importers of gas by 2030, changing their status from net exporters of gas in 2020. Singapore and Thailand will likely remain natural gas importers throughout the projection period. Thailand and Viet Nam are projected to maintain their status as net importers of electricity through the projection period. Malaysia, on the other hand, will become a net exporter of electricity, albeit at a very low value.

Table 12. Gas and electricity net imports

	Net gas imports (Mtoe)			Net electricity imports (Mtoe)		
	2010	2020	2030	2010	2020	2030
Brunei Darussalam	-7.99	-7.14	-5.58	0.00	0.00	0.00
Indonesia	-27.06	-6.54	36.15	0.00	0.00	0.00
Malaysia	-21.81	-35.94	-32.16	-0.01	-0.02	-0.02
Philippines	0.00	0.00	0.00	0.00	0.00	0.00
Singapore	7.82	8.91	9.50	0.00	0.00	0.00
Thailand	4.16	11.17	19.34	0.49	2.63	3.85
Viet Nam	0.22	-1.71	9.34	0.48	0.69	0.69

Source: APERC, 2013.

Note: Statistics for Cambodia, the Lao PDR and Myanmar are not readily available.

3. Meeting the energy gap challenge

This analysis of the historical trends and outlook of energy demand and supply shows that energy supply security concerns are threefold: (a) rapidly increasing energy demand; (b) over-dependency on fossil fuel resources to meet demand; and (c) increasing dependence on energy imports due to depleting domestic resources.

These three factors will lead to an increasing energy gap between demand and supply of energy for the 10 countries in the ASEAN region. It is possible for ASEAN member economies to take advantage of the physical proximities of demand and supply centers in order to secure the energy supply, particularly gas (via pipelines) and electricity (via power grids).

(a) Potential mitigation measures for the energy gaps

The strategic options for achieving sustainable energy development could also act as potential mitigation measures for the energy gaps. These measures can be segregated into the following four main segments:

(i) Efficient utilization of energy

By enhancing energy efficiency (EE) in the residential and commercial sector; reducing demand for personalized modes of transport and a planned public transport scheme for the transportation sector; and promoting co-generation in industrial facilities and tackling technology inefficiency in the industry sector.

(ii) Reducing carbon content of energy

By developing renewable energy; development of low-carbon electricity such as nuclear power plants; the application of carbon capture and storage systems at coal-based power plants; and increasing the use of alternate fuels and cleaner sources of energy for the transport sector.

(iii) Diversifying sources of energy supply

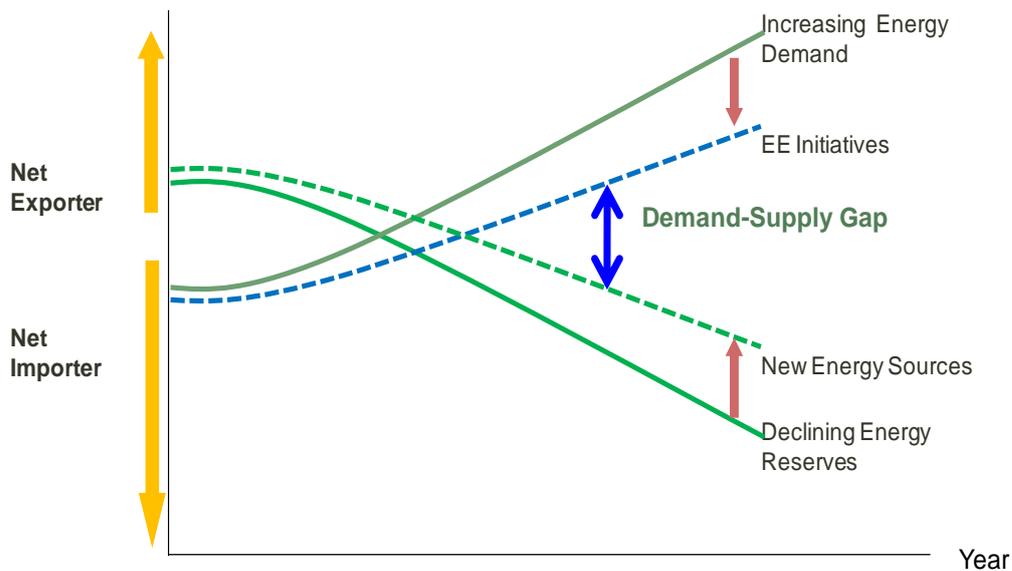
By intensifying hydro resources development; securing more gas from foreign sources; strengthening and expanding supply infrastructures to facilitate regional interconnection; and exploring and building capacity for the nuclear options (Endang Jati and others, 2013).

(iv) Regional interconnection of energy supply infrastructure and resources

The three measures to mitigate the energy gaps could be combined as depicted in figure 8. Energy efficiency measures will reduce the growth of energy demand, while declining energy reserves could be tackled by introducing new types of energy sources and by diversifying the location of the sources of energy supply.

Expanding the energy supply infrastructure and resources to facilitate regional interconnection is one of the key measures for diversifying the energy supply. In order to reduce the greenhouse emissions from the energy sector, measures to reduce carbon content of energy could be introduced concurrently with other measures.

Figure 8. Measures to mitigate energy gaps

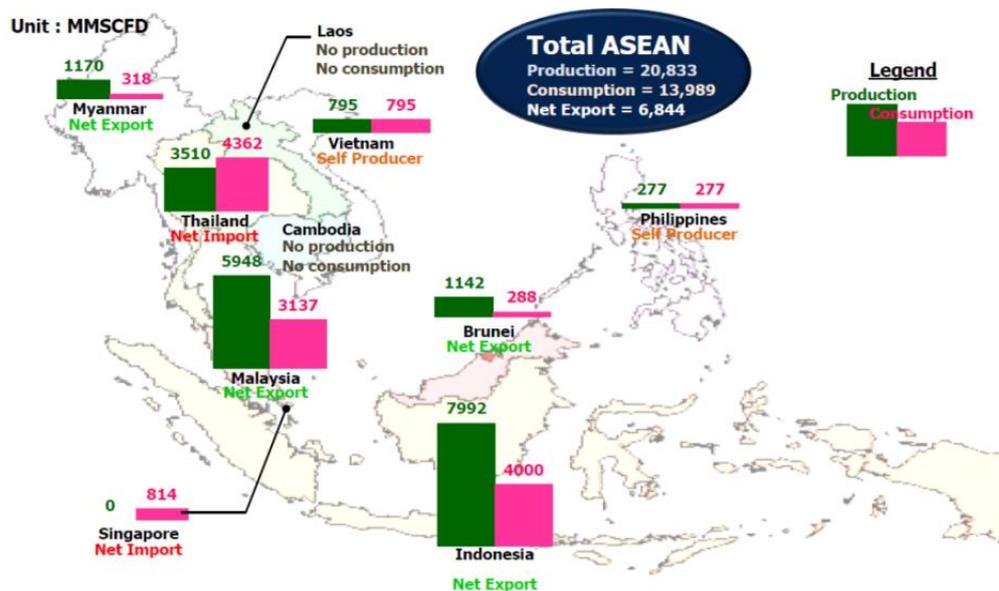


Note: Adapted from Malaysia Energy Planning Unit, 2012.

4. Mapping potential energy flows from energy surplus to energy deficit countries

As of 2013, two energy interconnection infrastructures exist in the ASEAN region, i.e., the Trans-ASEAN Gas Pipeline to transport natural gas, and the ASEAN Power Grid to transport electricity. Currently, there is enough supply of natural gas within the region to meet regional demand; as a group, the ASEAN region is a net exporter of natural gas at 6,844 MMSCFD.

Figure 9. Natural gas production and consumption in the ASEAN region



Note: Adapted from Pornkeratiwat, 2013.

(a) Current state of ASEAN connectivity

(i) ASEAN Power Grid¹⁰

The Heads of State/Government of the ASEAN member countries called for the establishment of electricity interconnecting arrangements within the region through the ASEAN Power Grid under the ASEAN Vision 2020 adopted by the Second ASEAN Informal Summit in Kuala Lumpur on 15 December 1997.

The ASEAN Power Grid is an effective way for ASEAN member economies to essentially pool electricity by interconnecting the various independent power systems through transmission networks between neighboring countries. Technically, this will improve the overall network reliability and stability of the interconnected power grids. From an economic point of view, expansion of power grids will allow investment economies-of-scale in power supply instead of individual power systems building independent facilities, and these interconnections would enable ASEAN member countries that export electricity to earn revenue from the sales. At the same time, large interconnected system would offer more opportunities for environmentally favourable energy resources for power generation to be developed than the isolated and smaller ones (APERC, 2000).

The underlying concepts for the development of the ASEAN Power Grid are to:

- (a) Maximize use of resources in the region to achieve best benefits for ASEAN;
- (b) Encourage development of large-scale power production in commercial scale;
- (a) Promote cooperation in the generation and use of power in ASEAN.

At the same time, the main objectives of establishing the ASEAN Power Grid are to:

¹⁰ This section was adapted from ACE (2013).

- (a) Promote a more efficient, economical and secure operation as well as to foster harmonious development of the national electricity network in the ASEAN countries by establishing or achieving a region-wide interconnection linking the member countries' national networks;
- (b) Optimize or maximize the use of energy resources in the region by sharing the benefits;
- (c) Reduce the financial burden from generation capacity expansion;
- (d) Share experiences amongst member countries;
- (e) Establish close power cooperation within the region.

The existing linkages of the ASEAN Power Grid, as of 2013, are listed in table 13 while figure 10 shows the same interconnections on the ASEAN map. Table 14 is a status report of current and future ASEAN Power Grid interconnection projects.

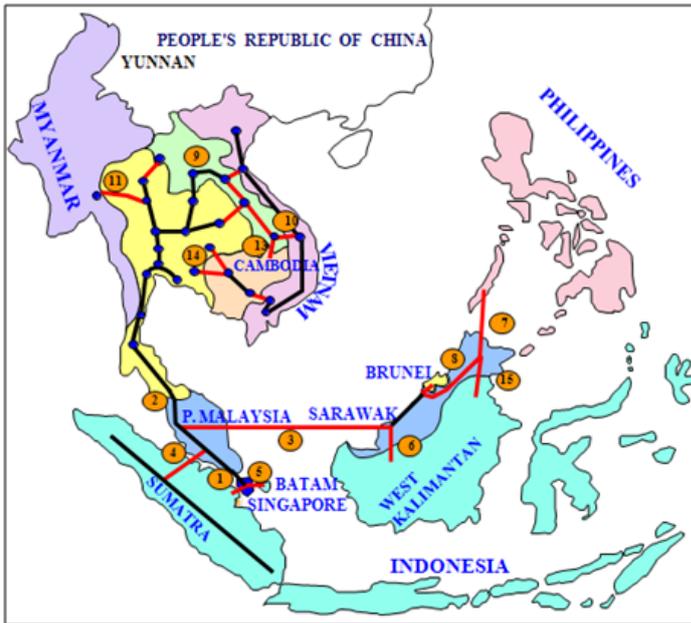
Table 13. Existing linkages of the ASEAN Power Grid

No	Interconnected Projects	System	Capacity (MW)	Type	SCOD
1	Thailand-Peninsular Malaysia				
	· Sadao-Chuping	HVAC	80	EE	1980
	· Khlong Ngae-Gurun	HVDC	300	EE	2002
2	Thailand-Lao PDR				
	· Nakhon Phanom-Thakhek-Theun Hinboun	HVAC	214	PP: La→Th	1998
	· Ubon Ratchathani 2-Houay Ho	HVAC	126	PP: La→Th	1999
	· Roi Et 2-Nam Theun 2	HVAC	946	PP: La→Th	2010
	· Udon Thani 3-Na Bong-Nam Ngun 2	HVAC	597	PP: La→Th	2011
	· Sakhon Nakhon 2-Thakek-Theun Hinboun (Expansion)	HVAC	220	PP: La→Th	2012
3	Peninsular Malaysia-Singapore				
	· Pentong-Woodlands	HVAC	450	EE	1985
4	Viet Nam-Cambodia				
	· Chau Doc-Takeo-Phnom Penh	HVAC	200	PP: Vn→KH	2009
5	Thailand-Cambodia				
	· Aranyaprathet-Banteay Meanchey	HVAC	100	PP: Th→Kh	2007
Total			3,483		

SCOD stands for Scheduled Commercial Operating Date

Source: ACE, 2013, table 2.5.

Figure 10. Map of the ASEAN Power Grid



Source: ACE, 2013, figure 2.2.

Table 14. Status of the ASEAN Power Grid projects

No.	Interconnection Projects	Revised Earliest COD
1	Peninsular Malaysia-Singapore (New)	2018
2	Thailand-P.Malaysia:	
	· Sadao-Bukit Keteri	Existing
	· Khlong Ngae-Gurun	Existing
	· Su Ngai Kolok-Rantau Panjang	2015
	· Khlong Ngae-Gurun (2nd phase, 300 MW)	2016
3	Sarawak-Peninsular Malaysia	2015-2021
4	Peninsular 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	2016-2017
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-Viet Nam	2011-2016
11	Thailand-Myanmar	2016-2025
12	Viet Nam-Cambodia (New)	2016
13	Lao PDR-Cambodia	2015
14	Thailand-Cambodia (New)	2015-2017
15	East Sabah-East Kalimantan	Feasibility Study
16	Singapore-Sumatra	2020

Source: ACE, 2013, table 2.4.

(ii) Trans-ASEAN Gas Pipeline

The Trans-ASEAN Gas Pipeline (TAGP) project was endorsed by the seventeenth ASEAN Ministers on Energy Meeting (AMEM) in July 1999. The responsibility for implementing the project was entrusted to the ASEAN Council on Petroleum (ASCOPE), in collaboration with national focal points and relevant institutions. During the twentieth AMEM on 5 July 2002 in Bali, Indonesia, the Ministers signed the ASEAN Memorandum of Understanding on the TAGP project, which sets out the cooperative framework for greater public-private partnership and collaboration in the Trans-ASEAN Gas Pipeline implementation (ACE, 2013).

The objectives of TAGP are to:

- (a) Provide energy supply security, which is essential for industrial development;
- (b) Strengthen cross-border economic and political ties;
- (c) Enable the members to share least-cost gas resources, which have an environmental impact advantage compared to other energy resources.

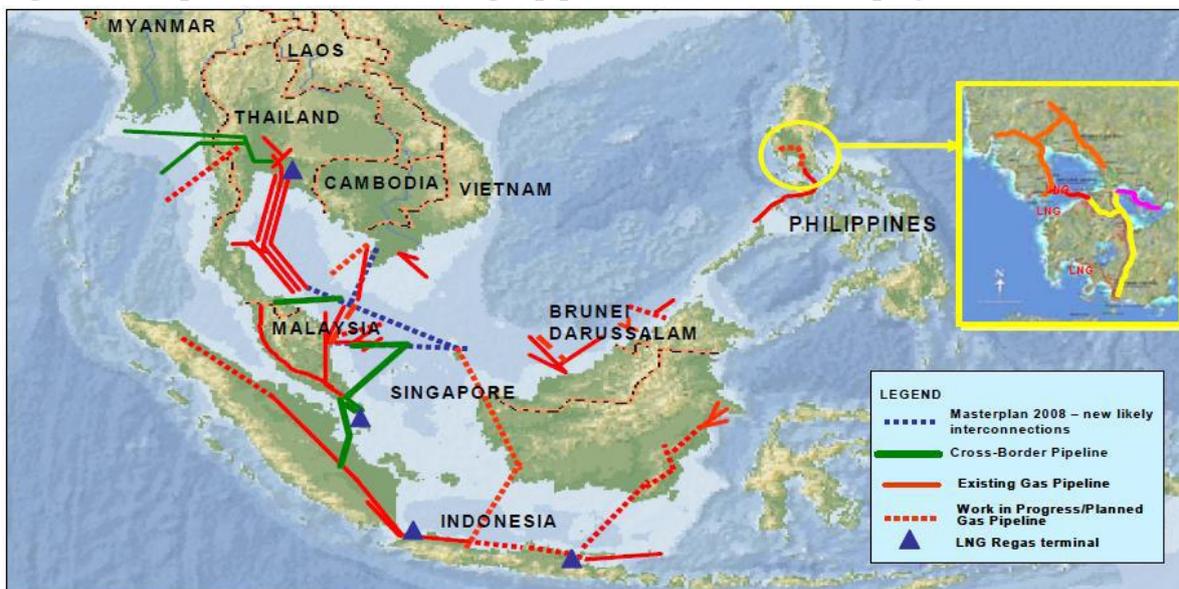
Currently there are 11 cross-border gas pipeline interconnection projects in operation; the total length of the gas pipeline is approximately 3,019 km. The twelfth cross-border gas pipeline, a 150-km new pipeline connection from Myanmar to Thailand, will come into operation in 2013 (figure 11). The gas infrastructure serves as a key driver of growth to the various energy-consuming sectors in the ASEAN economies. The list of existing pipelines is listed in table 15.

Table 15. Existing gas pipeline interconnections

No	Interconnection	Completion year	Length (km)
1	P. Malaysia-Singapore	1991	5
2	Yadana, Myanmar to Ratchaburi, Thailand	2000	470
3	Yetagun, Myanmar to Ratchaburi, Thailand	2000	340
4	West Natuna, Indonesia to Singapore	2001	660
5	West Natuna, Indonesia to Duyong, Malaysia	2001	100
6	CAA-Malaysia	2002	270
7	South Sumatra, Indonesia to Singapore	2003	470
8	CAA-Viet Nam	2007	330
9	Malaysia - Joint Development Area (JDA)	2009	100
10	Singapore to Malaysia	2006	4
11	Thailand - Joint Development Area (JDA)	2009	100
12	<i>M9-Thailand</i>	<i>2013</i>	<i>250</i>

Sources: ACE, 2013; and ACE, 2010.

Figure 11. Map of the interconnection gas pipelines under the TAGP project



Source: ACE, 2013, figure 3.2.

(b) *Expanded state of connectivity*

(i) *ASEAN Power Grid*

The updated status of the ASEAN Power Grid projects is listed in table 16. These are ongoing projects with tariffs or Memorandums of Understanding already signed.

Table 16. Updates on ASEAN Power Grid status

No.	Interconnection Projects	System	Capacity (MW)	Type	SCOD
1	Thailand-Peninsular Malaysia				
	· Su Ngai Kolok-Rantau Panjang	HVAC	100	EE	2015
2	Peninsular Malaysia-Sumatra				
	· Malaka-Pekan Baru (Selected by AIMS-II, Priority Project)	HVDC	600	EE	2018
3	Sarawak-West Kalimantan				
	· PPA signed in September 2012, Priority Project	HVAC	230	PP: Sw→WK (5 years) then convert to EE	2014
4	Sarawak-Sabah-Brunei				
	· Sarawak-Brunei (Committed in AIMS II)	HVAC	2x100	EE	2012 2016
5	Thailand-Lao PDR				
	· Mae Moh 3-Nan 2-Hong Sa	HVAC	1473	PP: La→Th	2015
	· Udon Thani 3-Na Bong-Nam Ngiep 1	HVAC	269	PP: La→Th	2018
	· Ubon Ratchathani 3-Pakse-Xe Pian Xe Namnoy	HVAC	390	PP: La→Th	2018
6	Lao PDR-Viet Nam				
	· Ban Hat San-Pleiku	HVAC	1,000	PP: La→Vn	2015
	· Nam Mo-Ban Ve	HVAC	TBC	PP: La→Vn	TBC
	· Xekaman 1-Thankhmy	HVAC	488	PP: La→Vn	2013
	· Stung Treng-Chau Doc	HVAC	207	PP: La→Vn	2014
	· Luang Prabang-Nho Quan	HVAC	1,410	PP: La→Vn	2015
7	Lao PDR-Cambodia				
	· Ban Hat-Stung Treng (G2G Agreement)	HVAC	300	PP: La→Kh	2016

Total 6,467

SCOD stands for Scheduled Commercial Operating Date

Source: ACE, 2013, table 2.6.

(ii) *Trans-ASEAN Gas Pipeline*

The East Natuna gas resource in Indonesia is expected to be the main source of gas for the ASEAN region in the future. The ability to exploit this gas resource is a key to addressing the supply gap (ACE, 2013). A proposed cross-border natural gas pipeline from East Natuna is listed in table 17.

Table 17. Proposed cross-border natural gas pipelines from East Natuna

No.	Cross-Border Pipeline	Length (km)	Note	Status
1	East Natuna, Indonesia-JDA-Erawan, Thailand	1500	Commencement date will be approximately 7 years from East Natuna gas supply sanction. Approximate volume to make each pipeline viable is 1 BSCF/day (i.e. 36"- 42" diameter of pipeline)	Subject to Supply Commercial viability
2	East Natuna, Indonesia-Kerteh, Malaysia	600		
3	East Natuna, Indonesia-Java, Indonesia	1400		
4	East Natuna, Indonesia-Viet Nam	900		
5	East Natuna, Indonesia-Brunei Darussalam-Sabah, Malaysia-Palawan, Philippines	Regional assumptions on East Natuna Gas field have changed since the 2000 Original TAGP Master Plan. High demand and limited gas supply with high CO ₂ content has increased cost of development of this pipeline.		

Source: ACE, 2013, table 3.2.

(c) *AEMI and the ASEAN connectivity*

The existing ASEAN connectivity for both gas pipelines and power networks are not yet at sufficient levels to allow for the seamless adoption of AEMI. However, this may not be a negative point. As discussed above, the current cross-border interchanges for power in ASEAN are based on bilateral agreements, since market integration was not a priority when APEAC was first formulated. Therefore, if ASEAN countries decide to make AEMI a priority in the future, upcoming interconnections can be designed with the view of market integration.

D. Integrated ASEAN energy market

Energy market integration (EMI) has been pursued in ASEAN and East Asia (EAS) for decades. However, no explicit definition of EMI has been established. What the vision and goals of EMI would be, and how it should proceed in East Asia has not been clear at all (Shi and Kimura, 2010; Kimura and Shi, 2011). To define the possible scenarios of EMI, it is worthwhile reviewing the development of EMI globally.

The European Union is one example often cited as a model for economic integration, including EMI. However, the European Union still needs to do further work in order to realize all the competitive benefits to which it aspires (Bannister and others, 2008). The European Union has been working on EMI between its member countries for many years, both for electricity and pipeline gas.

Although the longer-term goal of buyers and sellers operating competitively across national borders and without constraints has not been achieved, there has been some success, such as cross-broader energy flow (Bannister and others, 2008). The unachieved goal of competition may be partly due to doubt in Germany and France that an ownership unbundling, i.e., forcing large electricity-generating firms (monopolies and incumbent groups) to cede control over their distribution networks, is necessary for a better functioning energy market with better prices, greater supply security and environmental sustainability (Euractiv, 2007); and partly due to overlooking or politically debating of important technical and regulatory challenges that lead to confusion about the best way to proceed with the liberalization drive (Bannister and others, 2008). In summary, ownership unbundling, technical and regulatory challenges are still present while energy trade flows have occurred.

At the East Asia regional level, attempts to define EMI have started in 2010, with the launch of the ERIA study for the EAS Summit and its energy ministers. A conceptual framework was gradually developed for the study on EMI in East Asia, which effectively identified the major components of EMI in the whole EAS as: (a) trade liberalization; (b) investment liberalization; (c) the development of regional energy infrastructure and institutions; (d) liberalization of domestic energy markets; and (e) energy pricing reform, in particular, removal of fossil fuel subsidies (Shi and Kimura, 2010; and Kimura and Shi, 2011). The first four elements were agreed on and pricing, although sensitive, was noted explicitly by the fifth EAS Energy Ministers Meetings (ASEAN, 2011).

Kimura and Shi (2011) argued that these five issues were important elements of EMI and were interrelated. Well-functioning and transparent national energy markets are essential to developing an open, competitive, and more integrated EAS regional energy market. In order to increase energy market efficiency, it is necessary to remove impediments and distortions that prevent the efficient functioning of the market. This should include, but not be limited to, trade and investment liberalization and the reduction or removal of barriers, such as price restrictions, subsidies and monopolies. A region-wide movement of energy products requires both physical infrastructure and institutions to be in place. This framework was also followed by the later ERIA studies on EMI, including Shi and Kimura (2011), and Wu and others (2012).

The brief overview of the European Union and the EAS efforts on EMI finds that there is no single or authoritative definition of EMI. The definition of EMI depends completely on each regional bloc's background, including political willingness and regulatory framework. In ASEAN, the EAS EMI framework proposed by ERIA should also be applicable due to the close relationship between ASEAN and EAS. Trade and investment liberalization has been achieved, or at least attempted, in t AFTA and AEC. ASEAN regional infrastructure has long been attempted with the ASEAN Power Grid and Trans-ASEAN Gas Pipeline as the two flagship programs. Institutional apart from the infrastructure, such as Gas Swap Principle, has also been formulated recently (Shi and Malik, 2012).

The other two elements, domestic market liberalization and energy pricing reform, however, have rarely been mentioned in ASEAN. Fuel subsidies have a great presence in many ASEAN countries, such as Brunei Darussalam, Indonesia and Malaysia. Energy subsidies have become deep-rooted in ASEAN social and political structures, starting from the time of colonization, because Western forces used cheaper energy as an instrument to reduce protests from the local people over extraction of natural resources (Kojima and Bhattacharya, 2011).

Plans or actions for liberalizing energy prices and removing subsidies for fossil energy have been implemented in many countries, such as Indonesia and Malaysia. However, little advancement has been demonstrated in these two countries towards reducing the subsidy. Fuel subsidies are still

heavy in Brunei Darussalam, Indonesia and Malaysia. With such subsidy policies in place, countries have to close their boundaries. In order to prevent leakage of subsidies to others, limitations on purchasing fuels and preventive smuggling measures are often enforced at the borders of Singapore-Malaysia, Thailand-Malaysia and Cambodia-Viet Nam. In an integrated energy market, the national Government would have difficulties, if not finding it impossible, to control or manipulate fuel prices. The open market will bring fuels from cheaper to more expensive markets.

Similarly, for AEMI to be successful, it needs an open competitive national energy market as part of an integrated market. However, many ASEAN energy countries still have dominant national players, with electricity market as a distinguished example (Kimura and Shi, 2011).

However, EMI in ASEAN is more promising than the EAS, and it is possible to have a clear vision of ASEAN EMI in the near-future. The situation in ASEAN is slightly better than that in East Asia, as ASEAN has an institutional goal of establishing the ASEAN Economic Community (AEC), which provides for an overall architecture for EMI. The ASEAN energy section has a close relationship with all the four pillars under the AEC. As a commodity group and production input, energy is a necessary part of the single market and production base. Pursuing a competitive regional market requires an open and competitive energy sector, in line with the national economy in general. Energy is also important to equitable economic development by providing an electricity service to more than 100 million people who have no access to electricity in ASEAN, in line with the aims of United Nations Conference on Sustainable Development (Rio+20). However, the ASEAN Free Trade Zone, and AEC by 2015, is not a custom union as that in the European Union. Each Member State still has its own national tariff scheme, which, however, has to be limited to zero-5 per cent in the majority of cases. The segmental arrangements and the need for a clear vision make AEMI more challenging in moving towards an ASEAN energy market.

Given the above understanding, a proposed vision for AEMI is:

- By the end of 2015 when the AEC is expected to be established, ASEAN energy markets are likely to be a group of institutionally and physically connected, but not fully opened competitive national markets.
- After 2015, given the condition that the AEC is seriously moving forward and ASEAN is overcoming its challenges to become an integrated glomeration, ASEAN energy market will emerge at first as a more harmonized, more open and competitive regional market with some national restrictions on investments and import of electricity. However, electricity may be traded among member countries. The trading of electricity, if it happens, will likely be stimulated by the development of hydroelectricity in the Greater Mekong Subregion.
- Another challenging step is to achieve fully liberalized and competitive national energy markets by 2030. Beyond 2030, we may see a regional energy market, which although does not have identical national energy markets, can allow free flow of energy goods, investment and services. Economically feasible electricity trading can be realized without any institutional constraints. The success of AEMI requires higher levels of political trust and commitment among ASEAN member countries. The ASEAN member countries can change from a national energy security paradigm to an ASEAN regional energy paradigm.

E. Conclusion

This chapter has touched upon two important issues related to the rationale for ASEAN Energy Market Integration, i.e., mapping out the ASEAN energy challenges and defining ASEAN energy market integration. The ASEAN region has been experiencing rapid economic growth for the past few decades and is expected to expand further in the future; the regional economic growth projected for the next 25 years is encouraging and the GDP per capita for ASEAN is projected to more than double from 2010 to 2030, reaching US\$ 3,736 per capita (in 2000 US dollars). However, this economic growth will spur demand growth for energy, which is expected to more than double from 2010 to 2035. Energy demand for each ASEAN country (even Brunei Darussalam) is projected to continue to increase beyond 2030. For some countries, like Indonesia and the Lao PDR, the increase is more than double the demand at the base year. The implications are energy production that is unable to meet the rapidly increasing demand, further widening the supply-demand gap over the outlook horizon in 20 years.

The increasing energy gap for ASEAN countries can be attributed to two main factors, i.e., rapidly increasing energy demand and depleting energy reserves. There are also other factors that may further exaggerate the situation; for example, technically available renewable energy and hydropower potential may not be exploitable if the cost of harnessing this potential is too expensive, or using nuclear energy for electricity generation may not be pursued if perceived as high risk to national safety and stability in the region.

This chapter has identified four potential mitigation measures for the energy gap: (a) efficient utilization of energy – enhancing energy efficiency (EE); reducing demand for personalized modes of transport and a planned public transport scheme for the transportation sector; and promoting cogeneration in industrial facilities and tackling technology inefficiencies in the industry sector; (b) reducing carbon content of energy – developing renewable energy, development of low carbon electricity such as nuclear power plants, application of carbon capture and storage systems at coal-based power plants; and increasing the use of alternate fuels and cleaner sources of energy for the transport sector; (c) diversifying sources of energy supply – intensifying hydro resources development; securing more gas from foreign sources; strengthening and expanding supply infrastructures to facilitate regional interconnection; and exploring and building capacity for the nuclear options; and (d) regional interconnection of energy supply infrastructure and resources.

Energy resources in ASEAN are unevenly distributed; some countries are rich in fossil fuel resources, others have vast hydropower potential while some are resources-poor and have limited indigenous energy potential. Expanding the energy supply infrastructure and resources to facilitate regional interconnection are some of the key measures for tackling the issue of the energy gap and security. However, at this point, the existing ASEAN connectivity for both gas pipelines and power networks is not yet at sufficient levels to allow for the seamless flow of energy between countries. Trading of energy between countries, through the ASEAN Energy Market Integration (AEMI) mechanism, will be an even greater challenge given the varied energy institutional setup across the ASEAN region. This will require cooperation at the highest level of government as well as with leaders of the energy supply industries.

Recognizing the importance of a regional interconnection of energy supply infrastructure and resources, efficient utilization of energy and reduction carbon content of energy, ASEAN leaders and policymakers jointly expressed in the 1997 Summit Declaration the “ASEAN Vision 2020”, in which the ASEAN Heads of Governments agreed to “establish interconnecting arrangements for electricity, natural gas and water within ASEAN through the ASEAN Power Grid and the Trans-

ASEAN Gas Pipeline, and promote cooperation in energy efficiency and conservation as well as development of new and renewable energy resources”. A series of medium-term action plans have been prepared as a blueprint for ASEAN cooperation in attaining the ASEAN 2020 Vision. The current action plan, the third in the series, is the 2010 ASEAN Plan of Actions for Energy Cooperation (APAEC 2010-2015).

It is interesting to note that the APAEC 2010-2015 document, while advocating the integration of energy networks (both pipelines and power grids), makes no mention of the introduction of trade/energy markets. The existing cross-border energy exchange thus far is limited to zero exchange or pre-established purchase agreements (bilateral) (ACE, 2013).

Therefore, in moving towards achieving AEMI, a proposed vision for AEMI is:

- (a) By the end of 2015, when the AEC is expected to be established, ASEAN energy markets are likely to be a group of institutionally and physically connected, but not fully opened competitive national markets;
- (b) After 2015, given the condition that the AEC is seriously moving forward and ASEAN is overcoming its challenges to becoming an integrated glomeration, an ASEAN energy market will emerge at first as a more harmonized, more open and competitive regional market with some national restrictions on investments and imports of electricity. However, electricity may be traded among member countries. The trading of electricity, if it happens, will likely be stimulated by the development of hydroelectricity in the Greater Mekong Subregion;
- (c) Another challenging step is to achieve fully liberalized and competitive national energy markets by 2030. Beyond 2030, we may see a regional energy market, which, although does not have identical national energy markets, can allow free flow of energy goods, investment and services. Economically feasible electricity trade can be realized without any institutional constraints. The success of AEMI requires higher levels of political trust and commitment among ASEAN member countries. The ASEAN member countries can change from a national energy security paradigm to an ASEAN regional energy paradigm.

From the outset, the purpose of this chapter is to provide a background review of the current energy challenge and how best to link it to AEMI core objectives. Although this chapter provides a comprehensive review of the energy challenges as well as some ongoing initiatives that foster collaborative work at the ASEAN level through the nascent physical and institutional integration, much work needs to be undertaken to move AEMI towards the next step to bringing AEMI objectives to fruition. The context of a successful AEMI would be a necessary condition for the success of the AEC, which would enhance energy security and environmental viability across the region and undoubtedly yield significant economic benefits to all involved, from the economic, societal and environmental perspectives. The core areas for further research are: (a) to enhance the knowledge base in the individual ASEAN countries with regard to their challenges in tackling the energy gap; (b) to understand the national perspectives and action plans for moving towards an integrated energy market in terms of new interventions required in relation to policy and infrastructure developmental needs; (c) the level of acceptance and preparedness in liberalizing the energy market, both at the national and the ASEAN level; (d) how best to institutionalize the interconnections and energy trading from a bilateral to an open market system; and (e) the need to further enhance the understanding and development of AEMI definitions, objectives, and the

hardware and software needed for the integration to materialize the vision towards building a blueprint for ASEAN energy market integration.

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