ASEAN ENERGY MARKET INTEGRATION (AEMI):

DRAFT AEMI BRAINSTORMING PAPERS

AEMI BRAINSTORMING SESSION, BANGKOK, OCTOBER 14-16, 2014

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ASEAN ENERGY MARKET INTEGRATION (AEMI)

BRAINSTORMING SESSION

October 14-15-16, 2014, Montien Hotel Bangkok

Forum held under Chatham House Rule

__Tuesday, October 14, 2014__

18:00-18:30	*Welcome Remarks*
	Dean Chayodom Sabhasri, Faculty of Economics, Chulalongkorn University
18:30-21:00	*Welcome Dinner at the Montien Hotel*

__Wednesday, October 15, 2014__

Visit to Biomass Energy Plant (Saraburi) and Ayutthaya's Historical Park
Whole Day Trip (casual attire)

9:00	**Leave the Montien Hotel for the Biomass Energy Plant (Saraburi)**
10:30-12:30	**Visit of the Biomass Energy Plant** Guided by Prof. Dr. Tharapong Vitidsant, Vice President, Chulalongkorn University *The plant is a practice research center at Saraburi province. It is dedicated to developing new sustainable energy technology for the utilization of biomass and waste to produce energy.*
12:30-13:30	*Lunch at the Krua Baan Suan (Saraburi)*
13:30-14:00	**Trip to the ancient capital city of Ayutthaya**

14:00-18:00 **Visit of the Historical Park**
Guided by Prof. Monthon
The city of Ayutthaya was founded by King Ramathibodi I in 1350 and was the capital of the country until 1767. The Ayutthaya historical park covers the ruins of the old city. In 1991, a part of Ayutthaya Historical Park was declared a UNESCO World Heritage Site.

18:00-20:00 **Dinner Cruise on the Chao Phraya River**
A dinner cruise around Ayutthaya, indulging in a charming and nostalgic atmosphere of the old capital.

20:00-21:00 **Trip back to the Montien Hotel**

Thursday, October 16, 2014

9:00-9:30 **Opening Remarks – The Future of the AEMI Initiative: What's Next**
Nawal Kamel, Chulalongkorn University
Philip Andrews-Speed, National University of Singapore

9:30-9:45 Photo Group Session

9:45-10:15 **Energy pricing and subsidies**
Youngho Chang, Adoracion M. Navarro, Tri Widodo

10:15-10:45: **An Assessment of trade and investment – Barriers in energy services in ASEAN**
Ma. Joy V. Abrenica, Adoracion M. Navarro, Tri Widodo

10:45-11:15 Coffee Break

11:15-11:45 **Evaluation of ASEAN infrastructure connectivity needs**
Youngho Chang, Ir. Tuan Ab. Rashid bin Tuan Abdullah

11:45-12:30 **ASEAN energy technology strategy 2015-2030**
Bundit Fungtammasan, Lim Chee Ming, Aishah Mohd Isa, Maxensius Tri Sambodo, Suneerat Fukuda, Athikom Bangviwat, Christoph Menke, Atit Tippichai, Agya Utama, Jirapa Kamsamron

12:30-14:00 Lunch at the Montien Hotel

14:00-14:30	**Development of ASEAN energy security strategy** **Youngho Chang,** Maxensius Tri Sambodo, Philip Andrews-Speed **Developing energy security indicators** Sopitsuda Tongsopit, Weerin Wangjiraniran
14:30-15:00	**Address energy poverty through AEMI** **Maxensius Tri Sambodo,** Nguyen Thi mai Anh, Ir. G. Lalchand
15:00-15:30	**Benefits of AEMI: A survey of the literature** **Xunpeng Shi,** Tri Widodo, Anindya Bhattacharya
15:30-16:00	*Coffee Break*
16:00-16:30	**Understand national perspective in joining AEMI** **Ir. Tuan Ab Rashid Bin Tuan Abdullah,** Tran Van Binh, Aishah Mohd Isa, Endang Jati Binti Mat Sahid
16:30-17:00	**Develop a geo-political strategy of ASEAN energy security** **Philip Andrews-Speed,** Christopher Len, Seksan Anantasirikiat
17:00-17:30	**Conclusions and next Steps** Nawal Kamel, Chulalongkorn University Philip Andrews-Speed, National University of Singapore
17:30-17:45	**Closing Remarks** **Dr. M.R. Kalaya Tingsabadh, Vice President, Chulalongkorn University**
17:45-18:30	*Drinks*
18:30-21:00	*Farewell Dinner at the Montien Hotel*

AEMI BRAINSTORMING SESSION, BANGKOK, OCTOBER 14-16, 2014

AEMI PAPERS

ศูนย์อาเซียนศึกษา จุฬาลงกรณ์มหาวิทยาลัย
ASEAN STUDIES CENTER
CHULALONGKORN UNIVERSITY

AEMI BRAINSTORMING SESSION: CONCLUSIONS
AEMI PAPERS AND TIMELINE

ENERGY SUBSIDIES – ENERGY PRICING AND SUBSIDIES

Youngho Chang, Adoracion M. Navarro and Tri Widodo

I. Introduction

An invisible hand would allocate resources to those who value the resource highest followed by the next highest one and so on. The market allocation of energy resource would be efficient but cause unwanted outcomes. If the market price is applied to the low income household, then they would end up paying a large share of their income to get the amount of energy resources to sustain decent living or consuming far less amount of energy resources required for decent living. To correct these unwanted outcomes and ensure the low income household to get the required amount of energy for decent living, governments of most ASEAN countries opt to implement various energy pricing schemes and subsidies. The outcomes of such government-administered pricing schemes, however, prove that the schemes distort the allocation of precious resources and most of subsidies did not reach the target groups of subsidies.

Governments provide direct and indirect subsidies to either energy producers or consumers, as well as allow the provision of cross-subsidies from one economic agent to another through energy policies. Direct subsidies involve budget transfers from the government to the producer or consumer and in some literature, these are called explicit subsidies. Examples include pricing of petroleum products, electricity, and related energy consumption goods below cost-recovery level and financing the losses through government budget. Indirect subsidies are those which do not involve government budget transfers but can either result in opportunity losses for the government or create fiscal impacts later on. These are sometimes called implicit subsidies. Examples are free or soft interest rates on loans of public utilities and tax breaks or subsidies for oil and gas exploration. Cross-subsidies involve one group paying more than other groups and examples include price discounts for poor electricity consumers and feed-in tariffs for renewable energy through consumer charges regardless of income class.

This paper aims to examine how ASEAN countries implement energy and fuel subsidies and explore feasible options for energy pricing and taxation, with the view to identifying a cohesive approach across ASEAN for the energy market to function efficiently, while respecting national welfare objectives of protecting the poor and of addressing energy poverty. It also tries to formulates innovative options in the short and medium terms, including the use of different instruments (for example, tax breaks, social security mechanisms, rebates on energy bills or combinations of these instruments) to “decouple” energy pricing from welfare objectives to assist the poor in most vulnerable communities. Along with these, it explores ASEAN-wide equalization mechanisms, inspired from those in action in some federal systems.

This paper is structured as follows. Section 2 examines the typical forms of energy use in developing countries, presents the forms of subsidies and reviews existing energy pricing and subsidies in ASEAN in general and specifically Indonesia, Myanmar, the Philippines, Thailand and Singapore. Possible ways of de-coupling subsidies are explored in section 3 and some options for ASEAN countries are suggested in section4. Section 5 concludes this paper.

II. Review of Existing Energy Pricing and Subsidies in ASEAN

a. An Overview

Energy is a basic commodity and low-income households usually spend sizeable shares of their income on cooking fuels and energy. One of the key justifications for the various fuel subsidies is that they promote social equity by encouraging low-income households to use high-quality fuels. Table 1 shows the patterns of energy consumption by typical households of different income in developing countries. Kerosene is considered a 'key fuel' because low-income households in developing countries use it heavily for cooking. Kerosene subsidies are justified as they could redistribute income from the rich to the poor. Diesel is used heavily for public transport in developing countries and diesel subsidies are expected to make public transportation more affordable for the urban poor. Subsidized modern fuels that can replace traditional biomass are expected to help the world combat indoor air pollution, prevent forest degradation and reduce fuel collection time (Dick, 1980; Pitt, 1985; Kosmo, 1989). Making these fuels more affordable and accessible by energy and fuel subsidies can improve low-income households' living conditions and social welfare and such benefits justify some form of energy subsidy.

Table 1: Typical End Uses by Energy Source in Developing Countries

Uses	**Household Income Level**		
	Low	**Middle**	**High**
Cooking	Wood, residues, kerosene, dung	Wood, charcoal, residues, dung, kerosene, biogas	Charcoal, kerosene, LPG, coal
Lighting	Candles, kerosene, none	Candles, kerosene	Kerosene, electricity
Space heating	Wood, residues, dung, none	Wood, residues, dung	Wood, residues, coal
Space Cooling & Refrigeration	None	Electricity	Electricity, kerosene, LPG
Other appliances e.g. radio, television	None	Grid electricity, batteries	Grid electricity, batteries

Source: UNESCAP (2005).

In reality, however, fuel subsidies often prove to be regressive, benefiting mainly the higher-income households, while the entire population including the low-income households shares the costs. There are three main reasons for this. First, the poorest households may be unable to afford even subsidised energy or may have no physical access to it (UNEP and IEA, 2002). For example, in Ecuador, subsidised kerosene was diverted to the transport sector and much of it never reached the poor, especially in rural areas (ESMAP 2000). On the other hand, high-income households, which own automobiles that run on subsidised fuels, stand to benefit from the lower fuel prices.

Second, even if the poor are able to benefit from a fuel subsidy, the absolute financial value to them may be very small because low-income households generally have the lowest consumption of fuel and electricity. Higher-income households tend to benefit much more in nominal terms since they consume more of the subsidised fuels. For example in India, LPG subsidies have benefited almost exclusively better-off households, who generally prefer LPG for cooking and water heating (Dick, 1980; Kosmo, 1989; UNEP and IEA, 2001).

Third, subsidised fuel prices can lead to big price differences with neighboring countries, thus encouraging fuel smuggling. When fuels are smuggled out of the country, the government has to pay for the costs of the subsidies while the intended beneficiaries do not enjoy the subsidies. Fuel smuggling is estimated to cost the Indonesian government US$1.6 billion and the Malaysian government US$65 million in 2004 (Tan and Lian, 2005). As such, fuel subsidy programs can paradoxically widen the income gap between the rich and the poor. They are thus an inefficient way to achieve social equity (IEA, 1999; ESMAP, 2000).

b. The Status of Energy Subsidies in ASEAN

To date, there is no comprehensive survey yet of the presence of these subsidies per type of subsidy (i.e., direct, indirect or cross-subsidy) in ASEAN countries. The latest available data are for the amount of subsidies per product category regardless of the type of subsidy. To compare the energy subsidies across countries, we look at available data on subsidies as percentages of GDP and government revenues (Tables 2 and 3 below) from the International Monetary Fund or IMF (2013), which was also cited in Sambodo et al. (2013).

Table 2: Pre-tax Subsidies for Petroleum products, electricity, natural gas, and coal in 2011

Country	Petroleum products		Electricity		Natural gas		Coal	
	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue
Brunei Darussalam	2.34	3.77	0.98	1.57	0	0	0	0
Cambodia	0	0	n.a	n.a	n.a	n.a	n.a	n.a
Indonesia	2.58	14.51	0.66	3.69	0	0	0	0
Lao P.D.R	0	0	n.a	n.a	n.a	n.a	n.a	n.a
Malaysia	1.24	5.67	0.33	1.49	0.31	1.41	0	0
Myanmar	0.54	9.35	n.a	n.a	n.a	n.a	n.a	n.a
Philippines	0	0	0	0	0	0	0	0
Thailand	0.15	0.66	1.64	7.24	0.14	0.61	0.25	1.08
World	0.3	0.91	0.22	0.64	0.16	0.48	0.01	0.03

Source: IMF (2013) Energy Subsidy Reform: Lessons and Implications. (January 2013). International Monetary Fund (IMF): Washington, D.C.

Table 3: Post-tax Subsidies for Petroleum products, electricity, natural gas, and coal in 2011

Country	Petroleum products		Electricity		Natural gas		Coal	
	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue	% of GDP	% of Gov't Revenue
Brunei Darussalam	5.92	9.51	1.37	2.19	1.12	1.81	0	0
Cambodia	0	0	n.a	n.a	n.a	n.a	0	0.01
Indonesia	3.87	21.74	0.72	4.04	0.3	1.67	0.47	2.62
Lao P.D.R	0	0	n.a	n.a	n.a	n.a	n.a	n.a
Malaysia	5.12	23.39	0.56	2.54	0.79	3.36	0.74	3.38
Myanmar	0.97	16.93	n.a	n.a	n.a	n.a	n.a	n.a
Philippines	0.2	1.18	0	0	0.08	0.43	0.46	2.65
Thailand	1.4	6.16	1.76	7.77	0.72	3.19	0.84	3.73
World	1.26	3.77	0.26	0.77	0.43	1.28	0.77	2.31

Source: IMF (2013).

The latest available data on fossil fuel consumption subsidies per capita are also the IMF pre- and post-tax estimates as of 2011. There are available 2012 data from the International Energy Agency (IEA) but these are for four countries only, namely, Indonesia, Malaysia, Thailand and Vietnam. Table 4 below summarizes the fossil fuel consumption subsidies in ASEAN countries.

Table 4: Fossil Fuel Consumption Subsidies, Total, US$ per capita, 2011 and 2012

Country	IMF Pre-tax estimates (2011)	IMF Post-tax estimates (2011)	IEA Estimates (2012)
Brunei Darussalam	1279	3238.2	n.a.
Cambodia	0	0	n.a.
Indonesia	113.8	188.1	109.3
Lao PDR	0	0	n.a.
Malaysia	189.2	726.7	252.4
Myanmar	4.4	8	n.a.
Philippines	0	17.3	n.a.
Singapore	0	605	n.a.
Thailand	117.3	255	136.4
Vietnam	n.a.	n.a.	39.2

Sources: the IMF data - Global Subsidies Initiative Interactive Map (http://www.iisd.org/gsi/interactive-maps) and the IEA data - International Energy Association Database (http://www.iea.org/subsidy/index.html)

When subsidies are distortive or not well-targeted, these could have adverse effects on resource allocation across sectors and economic agents. For example, budget transfers to the energy sector may be competing with the budget needs of important social services such as health and education. Moreover, fossil fuel consumption subsidies may be benefiting the rich more than the poor as the former have larger consumption of fossil fuels through their use of private cars and air conditioning.

Resources being poured into subsidies may also be taking away funds for investment in addressing energy poverty. Energy poverty may be addressed by expanding access to electricity grids, providing electricity to off-grid areas through the use of renewable energy, and enabling modern cooking methods that do not burn wood products. It should be noted that energy poverty in ASEAN is still a crucial concern given that as of 2011, 22 percent of 134 million people in ASEAN still have no access to electricity and 47 percent or 279 million people still rely on the traditional use of biomass for cooking (Table 5 below).

Table 5: Population without Access to Electricity and with Biomass on Cooking

	Population without access to electricity		Population relying on traditional use of biomass for cooking*	
	Million	**Share (%)**	**Million**	**Share (%)**
Brunei Darussalam	0	0%	0	0%
Cambodia	9	66%	13	88%
Indonesia	66	27%	103	42%
Lao PDR	1	22%	4	65%
Malaysia	0	1%	1	3%
Myanmar	25	51%	44	92%
Philippines	28	30%	47	50%
Singapore	0	0%	0	0%
Thailand	1	1%	18	26%
Viet Nam	3	4%	49	56%
ASEAN	133	22%	279	47%

Note: * Preliminary estimates, as noted by IEA (2013).
Source: International Energy Agency (2013). Southeast Asia Energy Outlook: World Energy Outlook Special Report.

Energy subsidies are a potentially explosive political and social issue in Southeast Asia. Many countries in Southeast Asia have fuel subsidies in place. Oil subsidies are commonly perceived to be beneficial to society, serving good economic and social objectives. When global oil prices soared in 2005, however, many such countries experienced unsustainable financial burden on the government budgets and were forced to cut back on subsidies. It is important to examine the economics of these subsidies and assess if they are indeed serving sound objectives.

Subsidies in practice often do not achieve the objectives they are expected to serve. Significant fuel price differential with respect to neighbouring countries can contribute to financial losses through fuel smuggling. To the extent that oil consumption increases under the subsidised prices, oil subsidies can have significant adverse environmental effects. As a result of the distorted fuel pricing structure, Southeast Asian economies are less efficient in their use of oil than developed countries (ADB, 2005).

Subsidy for energy consumption is a common characteristic in both developing and developed countries. Energy subsidy might be defined as any government interventions that lower the cost of energy production, raise the revenue of energy producers or lower the price paid by energy consumers. Energy subsidies would be tolerable if the subsidies can improve social welfare, create jobs creation, encourage the new sources of energy supply and promote economic development to energy security. Large energy subsidies in many countries, however, also have to compete for limited resources that could otherwise be used to deliver other essential services, widen the scope for rent-seeking and commercial malpractice, discourage both supply- and demand-side efficiency improvement, promote noneconomic consumption of energy, and can make new forms of renewable energy uncompetitive (World Bank, 2010). There are many forms of energy subsidy, but almost all countries in the world are focused in electricity subsidy policy and fuel (i.e., kerosene, diesel and LPG) subsidy policy (IEA, 2010). Table 6 presents countries with low levels of modern energy access and their energy subsidy policies. In the case of the Philippines, 94 percent of total subsidy is allocated to the energy subsidy; while in the case of Indonesia, it is 58 percent.

Table 6: Subsidies on Electricity, LPG, and Kerosene in Countries with Low Levels of Modern Energy Access

Country	Presence of Subsidies			Electricity, LPG & kerosene subsidies as a share of total subsidies (%)
	Electricity	LPG	Kerosene	
South Africa	Yes	Yes	No	16
China	Yes	Yes	No	38
Indonesia	Yes	Yes	Yes	58
Philippines	No	Yes	No	94
Thailand	Yes	Yes	No	47
Vietnam	Yes	No	No	39
Bangladesh	Yes	No	Yes	29
India	Yes	Yes	Yes	50
Sri Lanka	Yes	Yes	No	23
Peru	No	Yes	Yes	30

Notes

1. Countries have been selected from the IEA subsidies dataset on the basis of their low levels of modern energy access (ie. electrification rate lower than 95% or modern fuels access lower than 85%)

2. Kerosene, LPG and electricity have been selected as they support the basic needs of the poor and can be more easily targeted than subsidies on other energy forms.

Sources: IEA (2010)

c. Country Studies: Indonesia

Indonesia has a long history about energy subsidy - electricity and fuels. The subsidy has played important roles in the societies, not only for consumption but also production and distribution. Many studies show, however, that the subsidy has been misallocated. The Coordinating Ministry for Economic Affairs of Indonesia (2008) noted that subsidy has been the rich’s crowd pleaser, that is, the distribution of fuel subsidy is skewed to wealthy households. The Ministry found that the top 40% of wealthy households enjoyed 70% of the subsidies while the bottom 40% of low income households benefited only 15% of the subsidies. World Bank (2009) found similar result from a survey conducted in 2005, the richest 40% of households enjoyed 60% of the subsidy. Recent result from World Bank (2011) suggests that 50% of wealthy households consumed 84% of subsidized fuel with the top 10% consuming 40% of total subsidy. In contrast, the bottom 10% only consumed less than 1% of total subsidy. Further analysis suggests that two-third of poor households do not consume fuel at all.

For the last decade, Indonesia has had relatively high energy subsidy compared to other countries. According to a price-gap methodology, whereby subsidies are measured as the difference between the regulated retail price and an agreed benchmark price that is an estimate of the “economic price”, Indonesia featured among the ten non-OECD countries providing the most generous energy subsidies in the world, in particular for oil (Mourougane, 2010). Because of these subsidies, retail gasoline price per liter and electricity tariff per kWh in Indonesia are relatively lower than other countries. Retail gasoline price per liter in Indonesia is lower than retail gasoline price in the average of Asia countries and OECD countries, and electricity tariff per kWh in Indonesia is also relatively lower than other countries (IEA, 2010). Beaton and Lontoh (2010) state that, in 1965, fuel subsidies represented approximately 20 percent of the country’s total spending. In the 2000s, after the New Order regime collapsed, percentage subsidy over country’s total spending has been gradually decreased. In 2005, fuel subsidies represented 29 percent of the country’s total spending. In 2010, fuel subsidies represented 12 percent of the country’s total spending and in 2012 represented “only” 9 percent of the country’s total spending. In terms of the amount of total subsidy, in the last ten years, energy subsidy represents more than 80 percent of the Indonesia’s total subsidies in which fuels subsidies represent more than 70 percent of the Indonesia’s energy subsidies. In last ten years, there have been at least nine changes in terms of fuel price represented by premium price in Indonesia (Table 7). In order to compensate the changes of fuel price, the Indonesia government implemented a cash transfer program for near-poor and poor households verified by the Indonesia Statistic Bureau (BPS).

Table 7: Premium Price in Indonesia, 2003-2013

Effective Date		Premium Price (Rupiah per Liter)
Year	Date	
2013	June 22nd	6,500.00
2009	January 15th	4,500.00
2008	December 15th	5,000.00
	December 1st	5,500.00
	May 24th	6,000.00
2005	October 1st	4,500.00
	March 1st	2,400.00
2003	January 21st	1,800.00

Source: Pertamina (2012)

The Indonesian government sets the electricity rates for all of consumer groups, namely industry, business, residential and public services. The amount of subsidy is determined annually by the government, based on the difference between the average cost of electricity production proposed by *Perusahaan Listrik Negara* (PLN), the state-owned electric company, and the average electricity rates set by the government. The average cost of electricity production is based on an estimate of the composition of the energy inputs for generating electricity and the power plants, transmission, distribution and supply costs, and a margin for PLN (International Institute for Sustainable Development, 2012). In other words, Indonesian government implements electricity subsidies by reduction the cost of electricity load per month and reduction of electricity usage cost (cost per kWh). Table 8 shows the consumer and electricity rate classification.

Table 8: Consumer and Electricity Rates Classification based on Decree of the Minister of Energy and Mineral Resources No. 07 Year 2010 Date of June 30, 2010

No.	Group	Limit Power	cost of electricity load per month (2010)
1	Social Rates	22O VA	-
		450 VA	Rp10,000
		900 VA	Rp15,000
		1300 VA	*
		2200 VA	*
		3500VA–200 kVA	*
		>200kVA	*
2	Households Rates	450 VA	Rp11,000
		900 VA	Rp20,000
		1300 VA	*
		2200 VA	*
		3500 VA – 5500 VA	*
		>6600kVA	*
3	Business Rates	450 VA	Rp23,500
		900 VA	Rp26,500
		1300 VA	*
		2200 VA-5500 VA	*
		6600 VA – 200 kVA	*
		>200 kVA	*
4	Industry Rates	900 VA	Rp26,000
		1300 VA	Rp31,500
		2200 VA	*
		2200 VA – 14kVA	*
		3500 VA – 14kVA	*
		>14 kVA-200 kVA	*

Note: * PLN has its own formula to calculate the rates and it is stated on the rule.

In the last ten years, the average amounts of electricity subsidies in Indonesia account for 28 percent of total subsidies. The electricity industry in Indonesia is heavily operated by fuels (Ministry of Energy and Mineral Resource, 2013). As a result, the changes of world oil price influenced the operating cost of the electricity industry in Indonesia and electricity rates paid by consumers. In the last ten years, electricity rates in Indonesia have changed six times, namely in 2003, 2004, 2009, 2010, and 2013. Table 8 shows consumer and electricity rates classification based on the decree of the minister of energy and mineral resources no. 07 year 2010 date of June 30, 2010. In 2012, electricity subsidies reached Rp64.97 trillion.

In the last ten years, electricity rates in Indonesia have changed six times in 2003, 2004, 2009, 2010, and 2013. In 2013, the Indonesian government through the Decree of the Minister of Energy and Mineral Resources No. 30/2012 has set the electricity rates adjustments. The decree states that the adjustment will be implemented in stages by three months. It means that there are four times of electricity rates adjustments during 2013 and it is started in January 2013. Based on the decree, not of all customers are experiencing an increase in electricity rates. There aren't increases in electricity rates for customer using 450 VA electricity power and 900 VA electricity power. The electricity rates quarterly raise an average of 4.3 percent and a maximum total of 15 percent in one year.

From the descriptions above, there are two main factors why energy sectors, especially fuels, become essential factor in macroeconomic policy and budget policy in Indonesia. First, oil consumption in Indonesia has surpassed Indonesian oil production. Second, the electricity industry in Indonesia is operated heavily by fuels. As a result, the changes in world price of oil affect fuels and electricity price policy in Indonesia.

d. Country Studies: Myanmar

As of 2013, Myanmar, with a population of 59.78 million, has an electrification ratio of only 29 percent, an annual generation capacity of 10,964.9 gigawatt-hours (GWh), and an annual power consumption of 8,450.3 GWh. It exports its surplus generation to neighboring countries. Its 3,734.9 megawatts (MW) installed capacity is dominated by hydropower plants, which account for 74.44 percent of the total installed capacity (Khaing Nyein Aye 2013).

Myanmar is rich in hydrological resources. Its Ministry of Electric Power considers its four major rivers, namely, Ayeyawady (2,063 kilometers (km)), Chindwin (1.151 km), Thanlwin (1,660 km) and Sittaung (310 km), as having huge hydropower potential. Most of the existing hydropower plants are in the northern part of country; however, the areas with large electricity consumers are in the south, in the Yangon region. Thus, the power system needs long transmission lines and managing voltage drops and keeping the system stable are always a huge challenge. The current transmission and distribution facilities are also old and need upgrading. As a result, load shedding is about 20 percent of demand and transmission and distribution losses are about 19.43 percent (Khaing Nyein Aye 2013).

The country's energy sector development is primarily led by the government and the electricity sector is based on a state-owned single buyer model. ADB (2012) explains that seven ministries in Myanmar are responsible for energy matters and the Ministry of Energy is the focal point for policy and coordination. The other ministries are: the Ministry of Electric Power for the electricity generation, transmission and distribution; the Ministry of Mines for coal-related developments; the Ministry of Agriculture and Irrigation for biofuels and micro-hydro; the Ministry of Science and Technology for renewable energy; the Ministry of Environmental Conservation and Forestry for fuelwood, climate change, and environmental safeguards; and the Ministry of Industry for energy efficiency. ADB, however, notes that overall energy planning by the Ministry of Energy is limited.

Under the single buyer model for electricity, the state-owned Myanmar Electric Power Enterprise (MEPE) buys electricity from public and private producers. The MEPE is also responsible for transmission network development, operation and maintenance. It also operates gas-fired power plants. The MEPE sells electricity to two public enterprises the Electricity Supply Enterprise (ESE) and the Yangon Electricity Supply Board (YESB) (Chrisman 2014). The YESB distributes electricity to consumers in Yangon City and the ESE to the rest of the country. The ESE, on the other hand, acts as a distributor to the rest of the country, comprising 13 states and regions, and also undertakes off-grid generation (ADB 2012).

Public information on pricing of various energy products are scarce. In the case of electricity, the OECD (2014) notes that there is no standardized price setting system and the purchase price of electricity is re-negotiated on annual basis. The government, however, is aware of the need to establish such system and has announced plans to come up with one that is consistent with international practices.

Chrisman (2014) reports that the electricity tariffs are one of the lowest tariffs in Asia and heavily subsidized. Some experts estimate that production costs can be as high as 125 MMK/kWh but the tariffs are below this. The government also sells below its purchase price. For example, in October 2012, the government bought electricity at 80 Myanmar kyats (MMK)[1] per kWh but sold it to households at MMK35 to MMK50 per kWh and to industrial consumers at MMK75 per kWh. The huge subsidy required to keep up with this practice is huge and the government puts it at MMK185 billion per year (Chrisman 2014).

It has been reported that providing heavily subsidized electricity has debilitated the Ministry of Electric Power's fiscal situation and rendered it unable to invest in necessary expansion and upgrading of the power system (Chrisman 2014). As a result, blackouts have been occurring, which are especially more constant in Yangon (Myanmar Times 2014).

[1] USD1.00 = MMK974.00 as of September 6, 2014 (http://www.currencyc.com/usd-mmk.html).

The demand for electricity in Myanmar is also increasing rapidly and such rapid increase is expected to continue as electrification and industrial growth are pursued. Peak demand is expected to increase from 1,806 MW in 2012 to 3,078 MW by 2016 (Ministry of Electric Power-Myanmar 2013). Investments in new generation capacity are therefore necessary and such new investments may be discouraged by a pricing regime that heavily utilizes subsidies.

Subsidies for petroleum products are also present. According to the IMF (2013), in 2011, post-tax subsidies for petroleum products represented 9.7 percent of GDP and 16.93 percent of government revenues, pre-tax subsidies for petroleum products amounted to 0.54 percent of GDP and 9.35 percent of government revenues.

Removing subsidies has also been difficult and in the past has caused a political upheaval, such as the incident that sparked the "Saffron Revolution" in 2007. On August 15, 2007, the then ruling military junta that was officially named State Peace and Development Council declared the removal of all fuel subsidies without any warning. Immediately, the prices of diesel and petroleum rose by 66 percent, and the price of natural gas rose by 500 percent. As a result, the prices and commodities spiked, leading to protests which were first led by students and democratic activities and then after a few days were joined by thousands of Buddhist monks in saffron robes. The non-violent protests were cracked down violently by the military junta, which raided monasteries around the country and took many monks captive (Burma Center Prague 2010). This unfortunate experience should be viewed, however, not as an argument against the removal of fossil fuel subsidies but as an argument for a well-planned and phased-in approach to such removal--one that considers the political realities of a country, estimates the possible impacts on inflation, and sets up safety nets for the marginalized sectors of the economy.

e. Country Studies: The Philippines

The Philippines is a country with a population of 92.3 million in 2010[2]. Primary energy supply in the country as of 2011 was 39.4 million tons of oil equivalent (MTOE), about 40 percent of which were imported since the country's energy self-sufficiency was only about 60 percent (DOEa 2013). The Philippines consumed a total of 72,922,011 MWh of electricity in 2012 (DOEb 2013). The generation capacity mix (in terms of installed capacity) as of 2012 was: 18 percent oil, about 21 percent hydro, 11 percent geothermal, 33 percent coal, about 1 percent new and renewable energy, and 17 percent natural gas.

The Philippines' electric power industry currently has four distinct sectors: generation, transmission, distribution, and retail electricity supply. This market structure emerged as a result of reforms that began in 2001 when Republic Act (RA) No. 9136 or the Electric Power Industry

[2] The 2010 census resulted in a count of 92.3 million people but given the birth rate, the Philippines' Commission on Population estimated that as of July 27, 2014, the country's population had hit the 100 million-mark.

Reform Act (EPIRA) was passed. Prior to EPIRA implementation, the generation, transmission and supply activities were vertically integrated and the state-owned National Power Corporation (NPC) acted as the transmission grid operator, dominant generator, and sole supplier of wholesale electricity to distribution utilities (i.e., private distribution utilities, local government-owned distribution utilities, and electric cooperatives). Other generators, called independent power producers (IPPs), used to sell their generated power to NPC. Through the years, the NPC’s liquidity problem grew. The NPC’s bankruptcy and its impact on the country's deteriorating fiscal position in the late 1990s and early 2000s ushered the industry restructuring through the EPIRA.

With the privatization of NPC generation assets, many players in the generation sector emerged and competition was introduced through the establishment of the wholesale electricity spot market (WESM) in Luzon in 2006 and in Visayas in 2010. At present, generated power is traded through two mechanisms—one, through bilateral contracting between generating firms and distribution utilities and big end-users, and two, through the WESM. Thus, given the competitive environment, the industries for oil, hydro, geothermal, coal, new and renewable energy, and natural gas resources development are also private.

Power grid operation is also currently private. As mandated by the EPIRA, the concession for grid operation was offered to the private sector through a competitive bidding. The distribution sector remains a regulated sector with local monopolies held by the distribution utilities in their respective franchise areas. The EPIRA also laid down the framework for the introduction of retail competition and open access on distribution wires. Under retail competition, consumers with at least one MW of electricity consumption can freely choose their suppliers. The transition to retail competition officially began on June 26, 2013 and 239 consumers in the contestable market are now being supplied by their chosen suppliers.

The Philippines used to stabilize the impacts of world oil prices on domestic prices through an Oil Price Stabilization Fund but the fund was scrapped when the downstream oil industry was deregulated in 1998. Since the deregulation, the government has faced pressures to protect consumers from rising fuel prices and during periods of high oil prices in 2011 and 2012, it implemented a targeted subsidy program for public transport operators. The Public Transport Assistance Program (also called "Pantawid Pasada") distributed free smart cards, which could be used to discount fuel bills at refilling stations, to jeepney[3] and tricyle drivers. This subsidy is no longer available at present.

Electricity pricing at the wholesale level is a result of market forces—bargaining between generating firm and distribution utility for bilateral contracts and competition at the WESM for electricity not covered by bilateral contracts. The transmission operation is a natural monopoly

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[3] A public utility vehicle in the Philippines which evolved from post-World War II practice of stripping down surplus military jeeps and altering these by configuring the back seat into two long parallel benches to accommodate many passengers.

business and thus the transmission charge is regulated. The distribution sector remains a regulated sector with local monopolies held by the distribution utilities in their respective franchise areas and thus the distribution charges are also regulated.

The EPIRA introduced a major reform in the distribution sector—the unbundling of the utilities' electricity rates. At present, distribution utilities show in the consumers' bills how their electric bills are divided into these components: generation charge, transmission wheeling rate, system loss, distribution charge, consumer subsidies, universal charges, and government taxes. The EPIRA also introduced the "lifeline rate" scheme or socialized pricing mechanism for consumers. Under this scheme, electricity consumption of 20 kWh or less per month is free of charge, 21-50 kWh per month enjoys a 50 percent discount in rates, 51-70 kWh enjoys 35 percent discount, and 71-100 kWh enjoys a 20 percent discount. Senior citizens are also entitled to a 20 percent discount.

A producer's price guarantee mechanism is set to be implemented in the renewable energy sector. A law enacted in 2008 instituted a feed-in tariff policy and created the National Renewable Energy Board (NREB) to administer this policy. The feed-in tariff (FIT) policy is a scheme wherein renewable energy developers are assured of a fixed FITs or price per kilowatt-hour for the energy that they will be able to produce. The payments for these FITs will then come from a FIT allowance (FIT-All) that will be collected from electricity consumers. The overall design aims to encourage the investment in and use of renewable energy resources. To date, installation targets and FIT rates per type of technology have already been approved by the regulator and renewable energy businesses are starting to invest but the actual implementation of the FIT rates and FIT-All has not yet started.

f. Country Studies: Thailand

Thailand, a country with an estimated 67.37 million people as of 2014, relies heavily on fossil fuels for its primary energy consumption. Fossil fuel consumption accounted for over 80 percent of total energy consumption in 2010. As the economy expands and industrializes, oil consumption for transportation and industrial uses grows. At present, Thailand is the second largest net oil importer in Southeast Asia, next to Singapore. Electricity generation is highly dependent on domestically abundant natural gas, accounting for over 60 percent of the 32.4 GW installed capacity in 2011. Generation in 2011 amounted to over 152 terawatt-hours (TWh) (EIA 2013).

The governance system is characterized by having a separate Ministry of Energy and an independent regulator, the Energy Regulatory Commission (ERC). The Ministry is in charge of overall government energy policy and the Commission regulates pricing, transmission expansion, and the power development fund (WEF 2012). The power development fund is being used to support the expansion of electrification in rural areas, subsidize services for underprivileged energy consumers, compensate power consumers who pay more expensive rates due to the failure of the system operator, fund the development and rehabilitation of communities surrounding power plants, promote the use of renewable energy and low impact generation technology, and support awareness-building among the public on power-related issues. The fund is sourced from collections from electricity business operators (Ruangrong 2012).

The electric power industry is vertically integrated, with the state-owned Electricity Generating Authority of Thailand (EGAT) acting as a generating company and the sole transmission provider. EGAT awards licenses to generate to companies. It accounts for nearly half of total generation, independent power producers over 35 percent, and small state power producers the rest. EGAT sells wholesale electricity to Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA), Thailand's two distribution authorities (EIA 2013). The MEA is responsible for the distribution of electricity within metropolitan Bangkok and the PEA for the provinces of Thailand (WEF 2012).

The oil and gas industry is dominated by PTT Public Company Limited (PTT), a state-owned and fully integrated oil and gas company which undertakes exploration and production. Together with EGAT, PTT is responsible for the majority of the electricity and oil and gas industry value chains in Thailand (WEF 2012).

The price of petroleum products is being stabilized through the Oil Fund, which was established in 1973. The Oil Fund has been used not only to smoothen the impacts of world market price swings of oil but also to periodically cross-subsidize fuels that are deemed "socially sensitive" such as gasoline, diesel and liquefied petroleum gas (LPG) and, in recent years, bioethanol and biodiesel. The Committee on Energy Policy Administration (CEPA) manages the oil fund and decides on the imposition of levies or grant of subsidies to a fuel. The CEPA takes account of the global oil prices and the level of monetary reserves in the fund when determining levies and subsidies (IISD 2013).

Pricing for electric power is regulated by the ERC and is guided by an automatic adjustment mechanism. The base tariff is adjusted every four months in line with changes in fuel cost, the power purchase cost, and the impact of policy expense. Such policy expense consists of a so-called "adder" for renewable energy development and the power development fund (Ruangrong 2012). The adder is a feed-in premium for renewable energy which guarantees higher tariffs for it, with the intention to make investments profitable.

Consumer energy subsidies in Thailand exist for five energy products: LPG, natural gas for vehicles, diesel, electricity and biofuel blends. Electricity subsidies take the form of half-price up to free electricity to low-consuming households. IISD (2013) estimates that the subsidies as of 2012, which is presented in table 9 as follows:

Table 9: Subsidies for Fuel and Electricity in Thailand in 2012

Energy type	Subsidy type	Borne by	Estimate (THB million)
LPG	Direct subsidy and under-recoveries	Oil fund and oil companies	57,317
NGV	Under-recoveries	PTT	12,820*
	Excise tax exemption	National budget	n/a
	Municipality tax exemption	Municipalities budgets	n/a
	Taxi conversion from LPG to NGV	PTT	n/a
	Low interest loans	PTT	n/a
	NGV credit card	PTT	n/a
	Investment in NGV infrastructure	PTT	n/a
Diesel	Excise tax exemption	National budget	108,231
	Green Fuel for fishing vessels	PTT	n/a
Electricity	Free and half price electricity to poor	Cross-subsidized by other electricity consumers	7,550
	Regulated base tariff and fuel charge	EGAT	9,000
Ethanol	Oil fund subsidy	Oil fund	n/a
blends >20%	Reduced taxes and levies	Oil fund and national government	n/a
Biodiesel	Mandatory consumption	Fuel blenders and consumers	n/a
	Excise tax exemption	National budget	0.87
Total			194,918

* Subsidy estimates relate to 2012 except PTT losses from NGV sales, which relate to 2011.

Source: International Institute for Sustainable Development (IISD). 2013. *A Citizen's Guide to Energy Subsidies in Thailand*.

IISD (2013) notes that the fuel subsidies are "universal" in Thailand since there has been no attempt to target the poor or vulnerable groups be the sole recipients of subsidies. This means that the benefits from subsidies flow disproportionately more to those who consume more energy or the upper income groups. Electricity subsidies, on the other hand, are more targeted than fuel subsidies since the poorest consumers receive the greatest price support. However, the macroeconomic costs of energy subsidies are apparent in the fiscal strain that they impose on the government and the financial strains on state-owned companies. Moreover, such subsidies tend to undermine investments in the energy sector, as is apparent in the natural gas sector wherein below-cost rates discourage private retailers to invest in NGV refueling stations.

g. Country Studies: Singapore

In ASEAN countries, Singapore is a unique country in terms of energy and fuel subsidies. Singapore does not have fuel subsidies but has a rebate scheme for electricity use for low-income households. The rebate scheme is called U-Save scheme, which is a permanent goods and service tax voucher scheme introduced in 2012. The intended target groups are lower- and middle-income households. There are three components – Cash, Medisave and U-Save. It pays differently by types of flats. The rebate is directly credited to the households' utility account. Table 10 shows the details of the U-Save Scheme in Singapore. There was a 'special payment' in July 2014 that is one-time payment to lower- and middle-income households and another one-time 'special payment' is due in January 2015.

Table 10: U-Save Scheme in Singapore:

	April 2014	July 2014			October 2014	January 2015			April 2014
Flat Type	Regular GST Voucher U-Save	Regular GST Voucher U-Save	Special Payment	Total	Regular GST Voucher U-Save	Regular GST Voucher U-Save	Special Payment	Total	Regular GST Voucher U-Save
1-room	$65	$65	$130	$195	$65	$65	$130	$195	$65
2-room	$65	$65	$130	$195	$65	$65	$130	$195	$65
3-room	$60	$60	$90	$150	$60	$60	$90	$150	$60
4-room	$55	$55	$55	$110	$55	$55	$55	$110	$55
5-room	$50	$50	$50	$100	$50	$50	$50	$100	$50
Executive	$45	$45	$45	$90	$45	$45	$45	$90	$45

Source: Energy market Authority, 2014

The U-Save scheme pays for as low as S$180 for the residents at executive flats and as high as S$325 for the residents at 1- or 2-room flat. For example, the average electricity consumption of 1-room households is about 1,520 kWh from July 2103 to June 2014 (SP Services, 2014). Assuming the average electricity tariff during that period S$0.26 per kWh, the electricity expenses are about S$394 and the 1-room households receive S$325 from the U-Save scheme. This covers slightly more than 80% of their electricity expenses. Other than the utility rebate scheme, Singapore does not have any energy and fuel subsidies.

III. Ways of de-coupling subsidies

Energy subsidies take the form of direct cash payments by governments to energy producers or consumers to promote the production or usage of energy. Other measures that do not target the prices of energy directly include legislation or direct interventions in the market in the provision of energy, which will in turn put downward pressure on the market price.

A subsidy is defined as “any measure that keeps prices for consumers below market levels, or for producers above market levels or that reduces costs for consumers and producers” (UNEP, 2008). Energy subsidies are defined as “any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers, or lowers the price paid by energy consumers” (UNEP, 2008). Table 11 presents various subsidy mechanisms that allow a government to correct (or distort) the market in one or combined ways.

Table 11: Various Forms of Energy Subsidies

Government Intervention	Example	How the subsidy usually works		
		Lowers cost of production	Raises price to producer	Lowers price to consumer
Direct financial transfer	Grants to producers	✓		
	Grants to consumers			✓
	Lower-interest or preferential loans	✓		
Preferential tax treatment	Rebates or exemptions on royalties, sales taxes, producer levies and tariffs	✓		
	Tax credit	✓		✓
	Accelerated depreciation allowances on energy-supply equipment	✓		
Trade restrictions	Quotas, technical restrictions and trade embargoes		✓	
Energy-related services provided directly by government at less than full cost	Direct investment in energy infrastructure	✓		
	Public research and development	✓		
	Liability insurance and facility decommissioning costs	✓		
Regulations of the energy sector	Demand guarantees and mandated deployment rates	✓	✓	
	Price controls		✓	✓
	Market-access restrictions		✓	

Source: UNEP, 2008

The amount of oil subsidies can be calculated by estimating differentials in the transmissions of world prices to domestic markets. However, it is not an easy task as governments tend to hide their fiscal expenses on them and different pricing mechanisms are employed by different governments. The degree of transmission can be estimated by calculating the pass-through of oil prices between two periods:

$$\frac{p^d_{t+1} - p^d_t}{p^w_{t+1}e_{t+1} - p^w_t e_t} \qquad (1)$$

where p^d and p^w are the domestic fuel price in local currency and world price in US dollars, and e is the exchange rate (Jha, Quising and Camingue, 2009). A lower pass-through indicates higher subsidies and vice-versa. Governments that do not pass through world oil prices fully to consumers will incur a fiscal burden.

The amount of consumption subsidies can be calculated by the price-gap approach. The price-gap is any difference between the end-user price and the reference price for a commodity and the difference implies the presence of a subsidy (IEA, 2012). By isolating the subsidies that affect end-user prices, the model allows the studying of factors that affect short-term demand and supply decisions, enabling the broader testing of how subsidies might affect energy markets and society welfare (Koplow, 2009).

During the period of high volatility in the global oil price, most governments in developing countries intervened in the domestic market with price-based policies. In particular, Indonesia, Malaysia and Thailand were identified as the top subsidizers in Asia (UOB, 2008). Indonesia's oil subsidy expenditures in 2008 reached $13 billion by October, Malaysia spent $11.1 billion on fuel price subsidies between 2005 and 2008, and Thailand's oil fund nearly depleted in July 2008, after running a deficit of $2 billion in 2005 (Kojima, 2009).

Fuel subsidies often result in market inefficiency and price distortions, and fail to meet the intended objectives – to alleviate energy poverty and to promote economic development. Economic inefficiencies are caused by various reasons. First, demand-side subsidies given in the form of grants to consumers or by lowering end-user prices will lead to an increase in energy consumption as well as wastage. Policies with poor efficacy will see middle- and high-income users benefit more from the subsidies and increase their energy usage as well. These increases in demand (wastage) will in turn worsen the country's terms of trade. Net energy exporting countries end up exporting less energy overseas in order to meet domestic energy demands, thus lowering their export earnings. Net energy importers need to import more energy and hence suffer more import leakages. Economic growth is thus hampered.

Second, energy subsidies aiming to alleviate energy poverty and to raise living standards among the poor that may not be as effective as intended by the government because only a small proportion of subsidies going to the poor (IEA, 2010). The World Bank estimated that the richest 20% of the population in Venezuela received six times more in fuel subsidy per person than the bottom third of the population in the early 1990s (Baig, Mati, Coady and Ntamatungiro, 2007). The fuel subsidy have distorted the allocation of resources and led to investment or consumption choices that do not reflect the scarcities of resources, thus moving the economy further away from Pareto-optimality. The less than optimal allocation of resources in turn results in a sub-optimal outcome for consumption and economic growth. The lack of infrastructure in the rural area where most of the lower-income households live and the administrative complexities involved also often result in the ineffectiveness of the subsidy policies in several developing countries (Barnes and Halpern, 2000).

Third, subsidies usually put a significant fiscal burden on governments. The average domestic fuel subsidy burden in major oil-exporting countries in 1999 was about 3.5% of the countries' GDP (Baig, Mati, Coady and Ntamatungiro, 2007). This is a direct fiscal cost on the governments when domestic subsidized oil prices do not adjust to match changing (rising) world prices. In 2005, average fuel prices doubled, and the low level of retail fuel prices in Indonesia meant that government subsidies doubled from 2003 to 2005, with the subsidies estimated to be 3.4% of GDP in 2005 (Baig, Mati, Coady and Ntamatungiro, 2007). To reduce a budget deficit, Malaysia cut fuel subsidies and allowed government-controlled fuel prices to rise between 2004 and 2008. The fuel price hike in February 2006 alone appeared to make the government to save RM4.4 billion (Narayanan, 2007). The saved government revenues could be recycled for better uses.

Fourth, poorly designed and/or enforced subsidy schemes can be abused and further increase the government's fiscal burden but without achieving the desired effect. For instacne, differences in fuel subsidy schemes have led to sharp price differences between neighboring Arab countries between Egypt and the Palestinian territories that resulted in large-scale fuel smuggling across borders (Fattouh and El-Katiri, 2012).

ASEAN countries have provided extensive price subsidies to consumers to raise the welfare of lower-income households and to promote social equity. A unit subsidy is the typical form of energy and fuel subsidies in ASEAN countries. If a lump sum amount that is equivalent to the subsidy amount based on the unit subsidy were paid to the target groups for the subsidies, then their utility would have been greater than that under the unit subsidy (Dahl, 2014). The cash payment is clearly better as it is enhancing the poor's welfare but in reality it does not work that way as stated earlier. The amount of cash paid the poor may not be used for purchasing energy or electricity but some other purposes. This clearly will not achieve the stated goal of giving subsidies – to help the lower- and middle- income households get the sufficient amount of energy to sustain decent life. Although economic theory clearly tells the cash payment scheme will enhance the consumer's welfare under subsidy but in reality the cash payment will not guarantee whether the stated goals for giving subsidies have been achieved as the cash payment scheme will come with many leakages. Without sealing the leakages, the cash payment scheme may perform poorer than the unit subsidy scheme.

The retails prices of various oil products in Indonesia, Malaysia and Thailand that are results of fuel subsidies and those prices in Singapore where no fuel subsidies are prevailing are presented in table 12. It clearly shows that most of the retail prices of various oil products in Singapore are more than twice expensive than those in Indonesia, Malaysia or Thailand. The prices in Singapore are linked to the global price.

Table 12: Retail Prices of Various Oil Products (Unit: US$/liter, US$/kg for LPG)

	Indonesia	Malaysia	Thailand	Singapore
Premium	0.537	0.516	0.687	1.120
Regular	0.594	0.508	0.667	1.050
Diesel	0.578	0.427	0.655	0.645
LPG	0.510	0.486	0.433	1.436
Kerosene	0.219	-	0.670	-

Source: Statistics from ADB (2005); EPPO (2006); NEAC (2006); Pertamina (2006); Singapore Power (2004); Tan and Lian (2005). Calculations author's own.

As Singapore proves in implementing its U-Save scheme, direct payment to the subsidy recipient's energy or electricity account would be the best available option as it can seal such leakages and minimize the possible dead weight loss from implementing energy and fuel subsidies. Even a voucher can be used wrongly if It can be discounted somewhere.

The forms of effective subsidies need to be identified if there is such s form. With this, we can estimate the potential in saving from phasing out ineffective subsidies.

IV. Suggested options

Removing energy and fuel subsidies, apparent and hidden alike, are virtually not possible. This will lead us to find a second best option – any subsidy scheme with the least leakage. One suggested option is what Singapore is implementing – U-Save scheme. Crediting subsidies directly to the customer's account would be the best option. More details need to be developed through various in-depth studies and refined via simulations and field tests.

V. Conclusions

Energy is a necessity and many governments in ASEAN have energy subsidies. Helping the poor is a novel goal but in reality it ends up helping those who do not need such subsidies. With the intrinsic deadweight loss of energy subsidies, missing the target of the energy subsidies have made removing energy subsidies or improving the system of energy subsidy programs a top priority of policy-makers in ASEAN countries. The gap between the domestic energy price and the global one needs to be reduced and eventually eliminated.

In terms of social welfare, however, energy subsidies are an essential channel of securing a certain level of standard of living for the poor or needy people. As many cases in ASEAN countries have shown, a unit subsidy or cash payment will not achieve the intended goal of helping the poor. The U-Save scheme in Singapore that directly deposits the amount of the subsidy into the recipient's account could be an example that can be implemented for energy subsidies at the least cost but maximized benefits for the target group.

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TARIFF BARRIERS – AN ASSESSMENT OF TRADE AND INVESTMENT BARRIERS IN ENERGY SERVICES IN ASEAN

Joy Abrenica, Adora Navarro and Tri Widodo

I. Motivation

The goal of the ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015 is to ensure that the region would have secure and reliable energy supply through regional infrastructure projects such as the ASEAN Power Grid and Trans-ASEAN Gas Pipeline. While APAEC makes no explicit reference to liberalization of trade and investment in energy services, it is sensible to suppose that such measure is in the menu of strategies being considered by the ASEAN leaders to meet the plan's objective.

Bringing energy services into the fold of multilateral disciplines, however, has not had much success, except in a few preferential trading arrangements. Many countries are still protective of their domestic energy suppliers and natural resources, and thus maintain high barriers to foreign trade and investment in energy services.

Yet there are notable changes. A growing number of economies are becoming more disposed towards open and nondiscriminatory market for energy. In these economies, new regulations encouraging competition and private sector ownership are replacing heavy market controls and government ownership – propelled in many cases by the poor performance of state-owned utilities. The fiscal burden of subsidies and investment deficiencies in certain activities because of distorted incentives structure are also providing additional impetus to market reforms.

Many economies are likewise refraining from using price controls and import restrictions, particularly in globally traded fuels such as oil and coal. Where there are active spot and futures trading markets and financial instruments that can help reduce price volatility, it is more logical and practical to provide free rein to market forces in determining energy prices and managing supply. Moreover, even in markets where state utility monopolies are still in control, opportunities for domestic and foreign firms to sell to such monopolies have been introduced as a way of ensuring that capacity additions and innovations are not held up by limitations in public funds.

Despite the changing landscape, significant barriers to energy trade and investment persist. This paper takes stock of these barriers and proposes measures to eliminate them through the multilateral disciplines of ASEAN. The focus is on energy services**,** or activities related to the "exploration, development, extraction, production, generation, transportation, transmission, distribution, marketing, consumption, management, and efficiency of energy, energy products, and fuels."[4] The policies of the individual ASEAN Member States (AMS) that impede foreign trade and investments in energy services are identified and assessed. The main source of these policies is the individual Member's schedule of commitments in the ASEAN Free Trade Agreement in Services (AFAS). Their energy programs and plans are also reviewed to evaluate their inclination to forego these barriers to attain energy market integration. Other issues that may impact negotiations to reduce or eliminate trade and investment barriers are also discussed such as the application of emergency safeguards and inclusion of regulatory disciplines in the energy services agreement.

The next section defines the scope of energy services. The WTO Secretariat Note on Energy Services serves as the main reference, albeit Indonesia's parallel classification is also discussed. Section III takes an inventory of energy sector commitments in AFAS. Few AMS made specific commitments to energy services, but all underwrite several energy-related sectors. Section IV discusses the nature of trade and investment restrictions maintained by AMS in energy and related sectors. Whether or not the AMS are inclined to lift these barriers may be deduced from their policies, programs and plans that are analyzed in Section V. The shape of an energy services agreement to remove the identified barriers is explored in Section VI. Apart from modalities and timeline of liberalization, the agreement may also contain provisions on emergency safeguards and disciplines on government procurement. It may also include a Reference Paper (akin to the telecommunications reference paper) that would impose obligations on AMS to institute competition safeguards and regulatory reforms. Finally, Section VII summarizes key issues and outlines the tasks ahead towards attaining energy market integration.

II. What are Energy Services?

In spite of the sector's size and importance, energy services have not been well represented in global trade agreements. A possible explanation for this omission is the ambiguity on the scope of energy services. Unlike construction or telecommunications, energy services are not identified as a separate division in the United Nation's provisional central product classification (UNCPC), nor in the WTO services sector classification (W/120). Rather, what are considered energy services appear in the W/120 with other generic services, such as business services, construction, distribution and transportation. In ASEAN, as it is in THE WTO, Members use the W/120 as a guide for scheduling their commitments. Negotiators tend to focus on sectors whose scope is readily identifiable, trade is significant and there is strong business and consumer interest in trade liberalization. That energy services are not easily distinguishable from other

[4] Definition of "energy services" in the "Communication from the United States: Energy Services," S/CSS/W/24, Council for Trade in Services, World Trade Organization, 18 December 2000.

services categories in W/120 make the sector less of a candidate for commitments and negotiations. Unless the definitional issues are settled, no meaningful negotiations on the sector can proceed.

Recently, the Secretariat Note on Energy Services, issued by the Council for Trade in Services of the World Trade Organization (S/C/W/311, 12 January 2010) identified three main energy services activities, namely:

- Services incidental to mining, which includes:
  - services rendered on a fee or contract basis at oil and gas fields, e.g., drilling services, derrick building, repair and dismantling services, oil and gas well casings cementing services (CPC 883), but excluding mineral prospecting services, oil and gas field exploration and geophysical (e.g., seismic) and geological surveying services which are covered by engineering-related scientific and technical consulting services (CPC 8675); and
  - site preparation work for mining, including tunneling, overburden removal and other development and preparation work of mineral properties and sites (CPC 5115), but excluding construction services incidental to oil and gas mining which are classified under CPC 88300[5];
- Services incidental to energy distribution (CPC 887), referring to:
  - transmission and distribution services on a fee or contract basis of electricity, gaseous fuels and steam and hot water to household, industrial, commercial and other users, but excluding transport services via pipeline on a fee or contract of petroleum and natural gas; and
- Transportation of fuels, specifically:
  - transportation via pipeline of crude or refined petroleum and petroleum products and of natural gas (CPC 7131); and
  - transportation of coal slurry (covered under "Transportation of other goods", CPC 7139).

It is important to underscore that the activities enumerated above refer to "services incidental to" production activities such as mining and manufacturing. The main production activity *per se*, whose end-product is a good, is not a service, and therefore outside the scope of AFAS. But if the production is for a fee or on contract basis, *i.e.,* on account of a third party, such activity is nonetheless classified a service. Thus the same activity carried out by a contractor and manufacturer may be treated differently – the former as a service, the latter not. The decisive factor of whether to consider an activity a service or production is the ownership of the raw material that is processed, treated or transformed. The activity undertaken by a manufacturer

[5] The explicit exclusion of services incidental to mining oil and gas is meant to delineate similar activities that are undertaken for coal mining. Thus CPC 883 is understood to cover the former, while CPC 5113, the latter.

that owns the raw materials is a production, whereas that by a contractor on account of another producer is a service.

If the activity is not production for a fee or contract, how does one distinguish mining from services incidental to it? The WTO Members grappled with this difficult question and offered the following specific activities as examples of services incidental to mining: "on land site preparation, on land rig installation, drilling, drilling bits services, casing and tubular services, mud engineering and supply, solids control, fishing and downhole special operations, well site geology and drilling control, core taking, well testing, wireline services, supply and operation of completion fluids (brines), supply and installation of completion devices, cementing (pressure pumping), stimulation services (fracturing, acidising and pressure pumping), work over and well repair services, plugging and abandoning of wells."[6] Similarly, apart from transmission and distribution for a fee or contract, CPC 887 covers incidental activities such as central network control services and power management and monitoring services. It is not clear however if transmission and distribution *per se* are covered by CPC 887, but the general view is they are.

In addition to the above subsectors, the following activities, to the extent they are critical to the energy supply chain, are considered energy-related services:

- construction work for long distance pipelines and power lines;
- wholesale trade services of solid, liquid and gaseous fuels and related products;
- retail sale of fuel oil, bottled gas, coal and wood;
- bulk storage services of liquids or gases;
- engineering design services for oil and gas recovery procedures;
- construction, installation and/or maintenance of drilling equipment, pumping stations, treating and storage facilities and other oil field facilities.
- geological, geophysical and other scientific prospecting services;
- testing and analysis services of the chemical and biological properties of soil and minerals;
- management consulting services; and
- services related to management consulting

The broad list of activities considered as energy services reflects the thinking that all activities in the supply chain should be considered, although only those that are usually outsourced are services. Such comprehensiveness however poses a conceptual problem that many of the activities regarded as energy-related are lumped with other services that are non-energy. For example, construction work for dams, long distance pipelines and power lines is classified under the broad heading of "construction work for civil engineering (CPC 513). Similarly, wholesale trade services of solid, liquid and gaseous fuels are indistinguishable from other wholesaling

[6] WTO Secretariat Note, pp. 11-12.

activities under the subclass CPC 622, broadly labeled as “wholesale trade services”. In this sense, therefore, it is impossible to delineate the boundaries of the energy services sector using the CPC. Nonetheless, the UN classification system provides a useful starting list of activities that may be covered by energy services.

Nor has the CPC helped resolve several definitional issues. A lingering debate is whether electricity is a good or service. One view maintains that generated power is a commodity produced through a process of transforming fuels into electrons. A contrary view underscores, however, the services-like characteristics of electricity – non-storable and must be consumed as it is produced. This debate has far-reaching implications since it determines which agreement (hence discipline) applies to the activity. If treated as a good, ATIGA or GATT applies; if services, then it is subject to AFAS or GATS discipline.

Which between ATIGA and AFAS applies to electric power generation matters significantly to the growing community of independent power producers (IPPs). The rules of ATIGA apply to goods manufactured, not to producers, whereas the disciplines of AFAS are enforced on the producers. If electricity were considered a good, then the IPPs cannot demand market access and national treatment that are only granted under AFAS.

There is no final word on the issue but most WTO Members seem to share the view that electricity is a commodity, hence generation of electricity falls outside the GATS discipline, but transmission and distribution of electricity are services. The recent dispute on Canada’s feed-in-tariff (FIT) program that was viewed as violation of Canada’s obligations under GATT 1994 suggests a leaning towards the commodity interpretation of electricity.[7]

Still, the foregoing conceptual conundrum is not confined to electricity; it applies also to oil refining, gas liquefaction and re-gasification.[8] Again, it matters whether these activities are viewed as production or services in determining the rights and obligations of suppliers.

The issue is confounded further by the liberality afforded to Members in scheduling their commitments in AFAS. In general, AMS follow the CPC, but may choose not to. Indonesia, for

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[7] See WT/DS412/10 and WT/DS426/9.

[8] Although there are contending views on the classification of these activities, three versions of the CPC, including the latest, categorized regasification and liquefaction as services. Concretely, these activities are labeled “liquefaction and re-gasification of natural gas for transportation” under Division 67 of “supporting transportation services”.

example, adopted the classification that they proposed to the WTO in 2001, which included activities bordering on production and services. Indonesia's insistence on adopting its proposed classification reflects its view that a broader classification would give more opportunities to developing countries to participate in trade.

Under the Indonesian classification system (which was in hue with the proposal of Venezuela at that time), the sector is divided into five subclasses: upstream activity, downstream activity, energy commercialization, professional services and other energy services. Upstream services consist of activities related to exploration and development of renewable and nonrenewable energy sources. Downstream services pertain to energy transformation, transportation and distribution. Energy commercialization services consist of wholesale and retail supply of energy and commission's agent services. Professional services cover specialized supply services, human resources training and development services. Finally, "other energy services" is a gamut of activities not included in the four other subclasses.

The Indonesian system includes detailed activities that fall under the same CPC classes in the WTO energy services classification. For example, among the upstream activities is the "exploration, drilling and sampling services" which is classified as "services incidental to mining" (CPC 88300). But the Indonesian system is more expansive since it includes activities not covered in the WTO energy services checklist. Specifically, "other energy services" include research and development (R&D) activities in resource exploration, petroleum, material and conservation technologies, as well as environment protection services. Annex I juxtaposes the WTO and Indonesian energy services classification systems.

III. Specific Commitments on Energy Services in AFAS[9]

A. Main Energy Services

If the commitments in AFAS are any indication, the path towards energy market integration seems long and arduous. At this stage, only a handful of AMS are willing to liberalize their main energy services sector as Table 1 suggests. The list includes energy services identified by the WTO from the CPC as well as those that have no specific CPC codes but are distinctly energy-related.

[9] See Annex II for an inventory of sector-specific commitments of the 10 Member States.

Table 1. Commitments Undertaken by AMS on Main Energy Services

	CPC No.	No. of AMS
Services incidental to mining:		
Services rendered on a fee or contract basis at oil and gas fields	883	0
Site preparation work for mining	5115	0
Services incidental to energy distribution	887	3
Services incidental to energy manufacturing (including electricity)	-	1
Services related to energy supply	-	1
Services related to power generation	-	1
Transportation via pipeline of crude or refined petroleum and petroleum products and of natural gas	7131	2
Transportation of other goods (which includes coal slurry)	7139	1

The foregoing attests to the scarcity of commitments in main energy services. None of the AMS made commitment to liberalize services incidental to mining; only four (Cambodia, Indonesia, Myanmar and Philippines) have undertaken commitments in services incidental to energy distribution; only two (Cambodia and Philippines) committed to liberalizing transportation of crude or refined petroleum via pipeline; and only one (Cambodia) scheduled transportation of coal slurry. On the other hand, Myanmar and the Philippines scheduled commitments in sectors not identified in the CPC, specifically services related to energy manufacturing and services related to energy supply and power generation, respectively.

Two of the three AMS that scheduled services incidental to energy distribution have much narrower commitments than the full coverage of CPC 887. Cambodia, in particular, specified that it is committing only to "consultancy services related to the transmission and distribution on a fee or contract basis of electricity, gaseous fuels and steam and hot water to household, industrial, commercial and other users." Similarly, Indonesia stipulated that its commitment covers only "consultancy services related to operation of power plant and network. In contrast, without limiting its commitment, the Philippines clarified its understanding of CPC 887 coverage as "energy distribution networks such as pipelines for transmission, distribution and supply of natural gas, and power transmission and distribution system."

Following two major market reforms in 1998 and 2001 – oil deregulation and electricity market restructuring, respectively –the Philippines emerges to have the deepest commitments in energy services among the AMS. Thus, the Philippines committed to liberalizing the operations of oil terminals, depot and refinery, as well as the exploration and development of oil and gas, geothermal and coal. The Philippine AFAS schedule also indicates that it permits the construction and operation of power plants under a build-operate-transfer (BOT) scheme. But in practice, the Philippine policies are even more liberal than its schedule of commitments bears out. Under the law that restructured the Philippine electricity market, foreign entities are not limited to constructing and operating power plants under a BOT scheme; instead they could do on their own account.[10]

It may seem that Myanmar's commitments are broader and deeper than the Philippines because it committed to energy manufacturing, not just supply and power generation. Yet this is doubtful because of the ambiguity in Myanmar's schedule. Other than stipulating that energy manufacturing includes electricity, Myanmar provided no further information on which activities it meant to cover. Is generation of electricity, or production of any energy, covered by such commitment? The former seems to be suggested by the inclusion of electricity. Since the sector is not found in the CPC, the lack of information on its coverage somewhat undermines the usefulness of the commitment in attracting foreign suppliers and investors. Worse, it renders Myanmar vulnerable to future disputes on potential breaches of its commitment.

B. Energy-Related Services

In contrast to the limited commitments in main energy services, Member States appear more inclined to undertake commitments in services that may be considered energy-related. However, it is difficult to ascribe such liberality to their pursuit for energy market integration since the sectors involved are too broad in scope, so that energy-related activities are just among many that they cover. Thus the commitment on engineering services, for example, may have been propelled by other considerations such as promoting labor mobility, without regard to its possible contribution to energy market integration. Nonetheless, since engineering services are important to the energy supply chain, the commitment is still considered to contribute to the goals of AEMI.

An inventory of AMS commitments in energy-related services sectors is presented in Table 2. Most of these sectors – management consulting for instance – can hardly be identified as energy

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[10] In fact, since the Philippine government is no longer allowed to build its own power plants, the BOT scheme referred to in the schedule no longer applies.

services because of their very wide scope. A commitment to such sector is nonetheless counted as commitment on energy-related services unless the scope of commitment is delimited. If the schedule is written plainly for wholesale trade services (CPC 622), for example, it is presumed to apply to wholesale trade services of solid, liquid and gaseous fuel, unless otherwise stipulated. Where the commitment is however identified for a non-energy activity, e.g., wholesale trade services of food, beverages and tobacco, it is considered to apply only to the activity identified and to nothing else, hence it is not counted as an energy services commitment.

Table 2. Commitments Undertaken by AMS on Energy-Related Services

	CPC No.	No. of AMS
Engineering services	8672	10
Integrated engineering services	8673	8
Management consulting services	865	9
Services related to management consulting	866	8
Technical testing and analysis services	8676	8
Related scientific and technical consulting services	8675	4
Maintenance and repair of equipment	8861-8866	3
Construction work for civil engineering	513	9
Renting services related to equipment for construction or demolition of building or civil engineering works with operator	518	8
Commission agents' services	621	6
Wholesale trade services	622	4
Retailing services	632	4
Retail sales of motor fuel	613	2
Maritime transport - freight transportation	7212	10
Rail transport services - freight transportation	7112	4
Internal waterways transport - freight transportation	7222	3
Road transport services - freight transportation	7123	8
Services auxiliary to all modes of transport - storage and warehouse	7422	8
Liquefaction and gasification only for coal	884	1
Business services on subsurface surveying services	86752	2
Surface surveying services	86753	1
Skill training services (not classified under education services and educational institution) related to alternative energy production, on a fee or contract basis	97090	1

There appears to be convergence of commitments in 10 out of 23 of energy-related services. Indeed, all AMS undertook commitments in engineering services and maritime transport for freight transportation. Except for one or two AMS, most committed to the liberalization of integrated engineering services, management consulting services, services related management consulting, technical testing and analysis services, construction work for civil engineering, renting services related to equipment for construction or demolition of buildings or civil engineering works, road transport for freight transportation and services auxiliary to all modes of transport – storage and warehouse.

All of the foregoing services contribute ultimately and significantly to the production and distribution of energy. The liberalization of maritime transport for freight, as a case in point, is relevant in transporting bulk liquids or gases in special tankers. Likewise, the liberalization of services auxiliary to all modes of transport is seen to facilitate bulk storage and warehousing of liquids and gases. To this end, enforcing the market access and national treatment obligations of those who undertook commitments in these sectors is a significant step towards the attainment of an integrated energy market.

C. Comparison of Commitments in Energy and Non-energy Services

The scheduling of a number of energy and energy-related services in AFAS is indeed a positive sign, even if such commitments were motivated by other goals unrelated to energy market integration. It bears asking however whether the commitments in energy services are more or less liberal than those taken in non-energy sectors.

To facilitate comparison of commitments in the two sectors, reference is made to the horizontal commitments or limitations on market access and national treatment that apply to all sectors included in the schedule unless stipulated otherwise. An exemption from the horizontal commitments makes the commitment to the sector more liberal. On the other hand, the inclusion of additional limitations renders the commitment to the sector more restrictive than those applied to other scheduled sectors. Where the horizontal commitment is "unbound", a definite limitation makes the commitment more liberal. If the horizontal limitation is defined, an "unbound" entry makes the commitment to the sector more restrictive.

Tables 3 and 4 show on which energy services are commitments more liberal than those taken on non-energy services based on limitations on market access under modes 3 and 4, respectively. Under mode 3, commitments of Brunei and Cambodia are generally less restrictive in energy than in non-energy services. The opposite is true for Malaysia and the Philippines. Overall, the market access commitments in energy services under mode 3 are more restrictive than in non-energy services. Under mode 4, the number of more restrictive commitments in energy is just about the same as those equally restrictive compared to non-energy services.

Table 3. Comparison of Commitments in Energy and Non-energy Services : Limitations on Market Access, Mode 3

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
Engineering services	8672										
Integrated engineering services	8673										
Management consulting services	865										
Services related to management consulting	866										
Technical testing and analysis services	8676										
Services incidental to mining	883										
Services incidental to energy distribution	887										
Related scientific and technical consulting services	8675										
Maintenance and repair of equipment	8861-8866										
Construction work for civil engineering	513										
Renting services related to equipment for construction or demolition of building or civil engineering works with operator	518										

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
Commission agents' services	621										
Wholesale trade services	622										
Wholesale trade services of electricity, town gas, steam and hot water											
Retailing services	632										
Retail sales of motor fuel	613										
Retailing services of electricity, town gas, steam and hot water											
Maritime transport - freight transportation	7212										
Rail transport services - freight transportation	7112										
Internal waterways transport - freight transportation	7222										
Road transport services - freight transportation	7123										
Pipeline transport - transportation of fuel	7131										
Transportation of other goods	7139										
Services auxiliary to all modes of	7422										

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
transport - storage and warehouse											
Liquefaction and gasification only for coal	884										
Business services on subsurface surveying services	86752										
Surface surveying services	86753										
Services related to supply of energy											
Services related to power generation											
Skill training services (not classified under education services and educational institution) related to alternative energy production, on a fee or contract basis	97090										

Color legend: yellow = less restrictive; green = equally restrictive; red = more restrictive.

Table 4. Comparison of Commitments in Energy and Non-energy Services : Limitations on Market Access, Mode 4

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
Engineering services	8672										
Integrated engineering services	8673										
Management consulting services	865										
Services related to management consulting	866										
Technical testing and analysis services	8676										
Services incidental to mining	883										
Services incidental to energy distribution	887										
Related scientific and technical consulting services	8675										
Maintenance and repair of equipment	8861-8866										
Construction work for civil engineering	513										
Renting services related to equipment for construction or demolition of building or civil engineering works with operator	518										

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
Commission agents' services	621										
Wholesale trade services	622										
Wholesale trade services of electricity, town gas, steam and hot water											
Retailing services	632										
Retail sales of motor fuel	613										
Retailing services of electricity, town gas, steam and hot water											
Maritime transport - freight transportation	7212										
Rail transport services - freight transportation	7112										
Internal waterways transport - freight transportation	7222										
Road transport services - freight transportation	7123										
Pipeline transport - transportation of fuel	7131										
Transportation of other goods	7139										
Services auxiliary to all modes of	7422										

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
transport - storage and warehouse											
Liquefaction and gasification only for coal	884										
Business services on subsurface surveying services	86752										
Surface surveying services	86753										
Services related to supply of energy											
Services related to power generation											
Skill training services (not classified under education services and educational institution) related to alternative energy production, on a fee or contract basis	97090										

Color legend: yellow = less restrictive; green = equally restrictive; red = more restrictive.

IV. Barriers to Trade and Investment in Energy Services

As in other services markets, foreign suppliers face various forms of restrictions on trade and investment that essentially fall under two categories: limitations on market access and national treatment, and distortive and discriminatory regulations. Concretely, among these barriers are the following:

- direct restriction on foreign service suppliers to provide services across borders;
- cross-border restrictions on entry of equipment and tools needed for production or maintenance service;
- establishment restrictions, i.e., caps on foreign ownership, requirements to enter into joint venture with local suppliers;
- restrictions on mergers and acquisitions;
- restrictions on deployment of foreign executives, technicians and other specialists;
- restrictions on temporary entry of skilled people and manager, often in terms of unclear or discriminatory rules for multiple-entry visas and for the period that temporary workers may stay in the country;
- cumbersome and opaque licensing procedures applied to energy service providers;
- regulatory uncertainty and lack of transparency in decision making;
- application of mandatory renewable portfolio standards to the extent that they favor local products from specific regions and state, and de facto exclude imports from eligibility; and
- discriminatory access to essential facilities such as transmission and distribution systems.

The individual schedules of commitments in AFAS identify the limitations on market access and national treatment that Member States maintain on the sectors they have committed to liberalize. In energy services, these limitations are mostly found in mode 3 (commercial presence) and 4 (presence of natural persons). Table 5 summarizes these restrictions.

Table 5. Types of Barriers to Trade and Investment in Energy Services

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
Engineering services	8672	1,3,4,5	4, 5	3, 4, 5	3, 4, 5	3, 4, 5, 6	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	4, 5
Integrated engineering services	8673	1,3,4,5	4, 5	3, 4, 5	3, 4, 5	3, 4, 5, 6	3, 4, 5		3, 4, 5		4, 5
Management consulting services	865	3,4,5	4, 5	3, 4, 5	3, 4, 5	3, 4, 5, 6		3, 4, 5	4, 5	4, 5	4, 5
Services related to management consulting	866	3,4,5	4, 5	4, 5		3, 4, 5, 6		3, 4, 5	4, 5	4, 5	4, 5
Technical testing and analysis services	8676	3,4,5	4, 5	3, 4, 5		3, 4, 5, 6		3, 4, 5	4, 5	4, 5	3, 4, 5
Services incidental to mining	883										
Services incidental to energy distribution	887		4, 5	3, 4, 5			3, 4, 5	3, 4, 5			
Related scientific and technical consulting services	8675	3,4,5	4, 5							4, 5	4, 5
Maintenance and repair of equipment	8861-8866	3,4,5		3, 4, 5				3, 4, 5			
Construction work for civil engineering	513	3,4,5	4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5		4, 5	4, 5
Renting services related to	518	3,4,5	4, 5	3, 4,	3, 4, 5		3, 4, 5	3, 4, 5		4, 5	4, 5

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
equipment for construction or demolition of building or civil engineering works with operator				5							
Commission agents' services	621		4, 5				3, 4, 5	3, 4, 5	4, 5	4, 5	3, 4, 5
Wholesale trade services	622					3, 4, 5, 6	3, 4, 5		4, 5		3, 4, 5
Wholesale trade services of electricity, town gas, steam and hot water											
Retailing services	632					3, 4, 5, 6	3, 4, 5				3, 4, 5
Retail sales of motor fuel	613		4, 5					3, 4, 5		4, 5	
Retailing services of electricity, town gas, steam and hot water											
Maritime transport - freight transportation	7212	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5
Rail transport services - freight transportation	7112	3, 4, 5		3, 4, 5				3, 4, 5			3, 4, 5
Internal waterways transport - freight transportation	7222			3, 4, 5	3, 4, 5						3, 4, 5
Road transport services - freight	7123		4, 5	3, 4,	3,	3, 4,		3,	4, 5	3,	3, 4,

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
transportation				5	4, 5	5, 6		4, 5		4, 5	5
Pipeline transport - transportation of fuel	7131		1, 3, 4, 5					3, 4, 5			
Transportation of other goods	7139		1 ,3, 4, 5								
Services auxiliary to all modes of transport - storage and warehouse	7422	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5	3, 4, 5, 6	3, 4, 5	3, 4, 5		4, 5	3, 4, 5
Liquefaction and gasification only for coal	884			3, 4, 5							
Business services on subsurface surveying services	86752			3, 4, 5		3, 4, 5, 6					
Surface surveying services	86753					3, 4, 5, 6					
Services related to supply of energy								3, 4, 5			
Services related to power generation								3, 4, 5			
Skill training services (not classified under education services and educational institution) related to alternative energy	97090					3, 4, 5					

	CPC	BRU	CAM	INA	LAO	MAL	MYA	PHL	SGP	THA	VNM
production, on a fee or contract basis											

Legend: 1 = cross-border restrictions on foreign service suppliers; 2 = cross-border restrictions on entry of equipment and tools needed for production or maintenance services; 3 = establishment restrictions, e.g., caps on foreign ownership, registrations requirements, terms of joint venture agreements with local suppliers; 4 = restrictions on deployment of foreign executives; 5 = restrictions on temporary entry of skilled personnel; 6 = restrictions on mergers and acquisition.

V. Energy Policies in ASEAN Member States

Given the commitments of Member States to liberalize energy services that are critical to the attainment of market integration, a key question is how inclined are the economies in implementing policy reforms, and even market restructuring, to see through the elimination of trade and investment barriers. This section reviews the present energy policies and programs of individual AMS to discern their potential stance to an agreement that would seek to eliminate these barriers.

A. Myanmar

Foreign investment in Myanmar was previously governed under the Foreign Investment Law of 1988. A new Myanmar Foreign Investment Law (MFIL) was enacted on November 2, 2012 which declared open to foreign investment many types of economic activities, but exempted those economic activities which are already reserved for the state by the State-owned Economic Enterprises Law (SEE Law). Myanmar laws and implementing rules are in the local language, but there are available interpretations. PwC Myanmar (2014) explains that the SEE Law specifies 12 economic activities which are closed to private investment and can only be carried out by the government. Among these activities, the ones which directly relate to the energy sector are: exploration, extraction and sale of petroleum and natural gas and production of products of the same (item 3 in the list); and electricity generating services, other than those permitted by law to private and cooperative electricity generating services (item 11 in the list).

PwC Myanmar also notes that the government, on a case-by-case basis, may permit the 12 activities to be carried out by any person or economic organisation, with or without a joint venture with the government and subject to unspecified conditions. The newly transformed Myanmar Investment Commission or MIC (a commission formed in 1994 as a government-appointed body and transformed in 2012 into an independent board) deliberates on the investment proposals submitted to the government on a case-by-case basis. PwC Myanmar reports that as of January 31, 2013, the MIC notification includes the following:

- 21 types of economic activities which are not allowed to be carried out by foreign investors
- 42 types of economic activities to be allowed only by joint venture with Myanmar citizens
- types of economic activities to be allowed in accordance with the particular conditions specifically prescribed such as:

  (a) types of economic activities to be allowed only with the recommendations of the relevant ministry

  (b) types of economic activities to be allowed only with the approval of others (i.e. meeting some standards and requirements such as meeting Good Animal Husbandry Practice)

  (c) types of economic activities requiring environment impact assessment reports.

The PwC report, however, does not list the specific types of activities.

Lui (2013) explains that pursuant to the MFIL, the government published as implementing rules the Foreign Investment Rules and the Classification of Types of Economic Activities Notification (collectively, the Rules). Under the rules, foreign equity in joint ventures is limited to a maximum of 80 percent for a range of restricted sectors, such as infrastructure development and construction. Foreign investment in such restricted sectors may be subject to specific conditions and approvals, including clearances from the relevant government ministries and regulatory offices. Local equity in an enterprise established under the MFIL can be transferred to foreigners (or other Myanmar citizens) but such transfer is subjet to approval by the MIC, which can withhold the approval on a "broad range of grounds."

Foreigners and foreign companies are also prohibited from owning land, as expressed in the 1987 Transfer of Immovable Property Restriction Law. Transfer to a foreigner or foreign company by way of sale, purchase, gift, acceptance of a gift, mortgage, acceptance of a mortgage, exchange or any other means are expressly prohibited. However, under the new MFIL, investors are eligible to lease land from the government or private citizens or business for a lease term of up to 50 years, with the option for two continuous extensions of 10 years if approved by the MIC. Investors must register their land lease agreement with the Registrar of Deeds. Such registration may be waived by the MIC, but the lease agreement must still be properly stamped as required by the Burma Stamp Act.

The mobility of capital is highly restricted and this is due to lack of regulations, which in turn leads to transactions (such as conversion and cross-border transfer of currencies) that are riddled with permits and not so straightforward processes. Although the financial sector is covered by the 1990 Law on Financial Institutions, it appears that this had not been enough as Myanmar's banking sector is currently severely underdeveloped.

With respect to the employment of foreigners, there is no restriction on the number of expatriate employees to be hired by foreign companies registered under the Myanmar Companies Act (CA). But generally, foreigners cannot be appointed as directors in local companies formed under the CA and owned by Myanmar citizens.

Under the new MFIL, preference shall be given to Myanmar citizens when organizations formed under the permit issued by the MIC hires personnel. Where the foreign investment needs skilled personnel, the foreign investor is required to employ local citizens through the following gradual introduction of local citizens: at least 25% of the workforce shall be local citizens in the first two years, 50% within the second two years and at least 75% within the third two-year period. Lui reports, however, that the Rules are silent on the jobs that will be classified as skilled. For jobs which do not require special skills, the foreign investor shall employ local employees only. MIC permits for forming economic organizations also require the foreign investor to make arrangements for local and foreign training so as to ensure local personnel proficiency in their work and promotion to higher ranks of service.

The insufficiency of specifics in the laws and rules, coupled by the case-by-case basis approach, is a double-edged sword. It may allow the government greater flexibility and room for growth in the learning process toward foreign direct investment liberalization. However, it may also pave the way for undue arbitrariness and spawn corruption. The potential arbitrariness in the way foreign investments may be handled is particularly concerning given that Myanmar's institutions are not yet sufficiently equipped to implement the rule of law. According to one report (Castellani 2013), it still struggles with corruption bred by "tea money", widespread bribery, arms trafficking, tax evasion and money laundering. Moreover, the locals themselves have little confidence in the ability of the judiciary to resolve disputes as the country lacks well-trained lawyers.

Nevertheless, it is still too early to judge how Myanmar will perform with respect to foreign direct investment liberalization, and how this will impact the cross-border exchange of energy-related services and mobility of energy services professionals. What is positively striking in Myanmar's approach is that it implicitly recognizes that not all restrictions are bad and the necessity of some restrictions is actually justified by the level of development of the country. We refer to the restrictions on hiring foreign skilled workers. One of the urgent and alarming concerns in Myanmar when the military junta gave way to a more democratic government is the small pool of skilled workers. The restrictions on employment of foreign skilled workers and the requirement to hire local citizens for skilled positions will provide employment opportunities that can improve social mobility and alleviate poverty. These will also enable Myanmar to eventually have a larger pool of skilled citizens which can set up their own industries and elevate the capacity of governance institutions.

B. Philippines

The Philippine Constitution and Republic Act (RA) 7042 or the Foreign Investments Act of 1991 provide the legal basis for foreign investments in certain economic activities. As a general rule, RA 7042 permits foreigners to invest as much as 100 percent equity in local enterprises except in areas reserved for Filipinos under the Constitution and existing laws. To clarify this, the government issues and updates every two years what is called a "Negative List" or a list of economic activities where foreign equity is either prohibited or limited. The latest is the 9th Foreign Investment Negative List issued through Executive Order (EO) 98 in 2012. The 9th Negative List contains the following restrictions on economic activities that may be considered relevant to the energy sector:

Restriction	Economic activity
No foreign equity	Practice of professions Engineering Architecture Chemistry Environmental planning Geology Accountancy Law
Up to 40 percent foreign equity	Exploration, development and utilization of natural resources Ownership of private lands Operation and management of public utilities Project proponent and facility operator of build-operate-transfer project requiring a public utilities franchise

The listing of activities described above as having 40 percent equity limitation emanate from the Constitution's expressed restrictions on foreign investments in the country's natural resources, land, and public utilities. Thus, the current thinking is that these activities can only be clarified but cannot be removed through the Negative List amendment every two years, unless the Constitution itself is amended.

The Constitution, however, empowers the Philippine president to enter into financial or technical assistance agreements (FTAA), which are essentially service contracts, with fully-foreign owned corporations for large-scale exploration, development, and utilization of minerals, petroleum, and other mineral oils. Thus, there are no equity restrictions on service contracts for petroleum exploration and extraction. Currently, the government is holding the Fifth Philippine Energy Contracting Round (PECR).

In the FTAA setup, one crucial requirement set by the Constitution is that the participation of foreign contractors must have real contributions to the economic growth and the general welfare of the country. The setup is largely seen in the country as satisfying the nationalist sentiments (since the contractors are viewed as contractors of the state) and at the same time aiding the development of sectors wherein local capital and expertise are lacking. The application of the FTAA setup, however, has been recently tested, particularly for geothermal energy. The Renewable Energy Act of 2008 or RA 9513 does not impose foreign equity restrictions on entities which may be awarded renewable energy service contracts, including those for geothermal energy. But the drafters of the implementing rules and regulations of the law took the position that the 40 percent foreign equity restriction set by the Constitution applies; the rules state that only Filipinos or corporations with at least 60 percent Filipino capitalization may develop renewable energy sources.

Then a 2009 circular by the Department of Energy (DOE Circular No. DC2009-07-0011) exempted large-scale exploration, development or utilization of geothermal energy resources from the nationality restriction. (Note that the Philippines has large untapped geothermal resources and is the second largest producer of geothermal energy worldwide, next to the United States.) This is an arrangement that is patterned after the FTAA setup and recognizes the definition in RA 9513 of geothermal energy as a mineral resource. However, this flexibility in foreign ownership seems to have been set aside as the recently launched Fifth PECR does not include geothermal energy, unlike the predecessor Fourth PECR in 2011 which included it. No official reason has been published but it appears that in this case, the government is weighing the flexibility made possible by executive rules against possible legal challenges that may put foreign investments in peril. Still, the experience shows strong willingness to remove restrictions to foreign investments in the energy sector.

With respect to ownership of land, it is as a general rule restricted to Filipinos only, but there are exceptions. The Constitution makes exceptions in the case of hereditary succession by foreigners and when the acquisition was made by a former natural-born citizen. The Constitution also exempts those corporations at least 60 percent of which are owned by Filipinos. The Supreme Court of the Philippines has also clarified that if land is invalidly transferred to a foreigner who subsequently becomes a Filipino citizen, the flaw in the original transaction is cured and the title of the transferee is rendered valid (Borromeo vs. Descallar, G.R. No. 159310, 24 February 2009). RA 4726 also permits foreign nationals to own real estate property, such as condominium units or shares in condominium corporations, as long as not more than 40 percent of units in a real estate project are acquired by foreigners. Moreover, the 1994 Investors' Lease Act (RA 7652) allows foreign investors to lease land for 50 years with one 25 year renewal.

The Philippines does not restrict repatriation of capital and remittance of income. However, if the initial investment was not registered with the Central Bank, they will not be able to access foreign exchange to fund the remittance or repatriation from a regulated banking entity.

With respect to employment of foreigners, restrictions come in the form of working visa requirements and application for an Alien Employment Permit (AEP). However, the requirements are not too burdensome as foreign workers generally arrive on a tourist visa and then apply later for the AEP and have the tourist visa converted to working visa.

Overall, the Philippines seem to be less restrictive than its ASEAN neighbors when it comes to capital mobility, owing to its well-developed financial institutions and rules, and labor mobility, owing to its flexible tourism and foreign employment rules. However, it is more restrictive when it comes to foreign equity participation, owing to limits set by the highest law of the land, its Constitution. Nevertheless, as the geothermal-related experience shows, the commitment to remove barriers to energy sector investments is there.

C. Thailand

The Constitution of Thailand (amended 17 times since the Siamese Revolution of 1932) assures that "a person shall enjoy the liberties to engage in an enterprise or an occupation and to undertake a fair and free competition." It also provides that "the restriction on such liberties shall not be imposed except by virtue of the law" enacted for specific objectives, including preserving natural resources and protecting the public in regard to public utilities. Thus, relative to the Philippines, Thailand has a more flexible way of eliminating barriers to foreign direct investment through legislation.

Restrictions on foreign direct investments in Thailand are set out in the Foreign Business Act of 1999 and its 2013 amendments. In the energy sector, foreigners are not permitted to participate as majority shareholders (i.e., they can own only up to 49%) in the following economic activities: oil and gas extraction and development; power distribution and transmission; power generation using biomass, coal, hydro, solar and wind. Foreign equity limitation of 49 percent on commercial presence is also applied to a range of professional services, some of which are used in the energy sector such as accounting, legal, architecture, engineering, and construction. For construction services, exceptions are made for those which are rendering basic services to the public in public utilities or transport requiring special tools, machinery, technology or construction expertise having the foreigner's minimum capital of 500 million baht or more, and other categories of construction as prescribed by ministerial regulations.

Foreigners are not permitted to own land in Thailand but they can lease land and own buildings. The 1979 Thailand Condominium Act sets a quota of 49 percent of a building's units for foreign ownership, and therefore a foreigner can own condominiums 100 percent outright as long as this quota has not yet been exceeded.

For projects requiring government procurement, there are legal preferential treatments. (Note that Thailand is not a signatory to the WTO Agreement on Government Procurement.) Thai and US companies are given a 7 percent automatic price advantage. Tenders that are not more than 5 percent higher in cost but have local certification are also given preferential treatment (servicestradeforum.org).

Repatriation of capital, profits, interests and dividends in foreign currency from Thailand is not restricted as long as there are proper documentary evidences.

The repatriation in foreign currency of capital, profits, interests and dividends is not restricted as long as there are proper documentary evidences. However, there are a few restrictions on the transfer of foreign currency into the country. Unlimited amounts of foreign currency may be brought in under the condition that it must be sold or converted into Thai baht or deposited into a foreign currency account located in Thailand within 360 days (Tilleke & Gibbins International Ltd. 2013).

The employment of foreigners is governed by the 1978 Working of Aliens Act. In general, the Department of Employment considers first whether the opening for a foreign worker can be filled by a Thai, whether the foreign worker is qualified, and whether the job is responsive to the needs of Thailand. All companies are also required to observe a Thai to foreign employee ratio of 4:1, except when the Board of Investment waives this restriction. Nikomborirak (2011) reports that downstream gas transmission and downstream petrochemical businesses are among the Board-promoted businesses for which the bringing in of skilled workers and professionals is allowed. Gas exploration and production businesses, however, are not in the list.

Barriers to foreign direct investment can also take the form of industry structure and there are indications that in the natural gas industry, wherein the state-owned PTT Public Company Limited monopolizes the supply business, there will be liberalization. Reports abound that the regulator has drafted rules allowing third-party access to PTT's gas pipelines, leveling the playing field among domestic and foreign companies by setting just one fee for natural gas transmission, and allowing domestic power plants and other industrial customers the freedom to choose their own gas supplier. It was also reported that global firms Chevron and Shell will participate in gas distribution as soon as the industry is opened (Energy Tribune 2013). The commitment of the Thai government to this reform is strong since it has to find alternatives to Thailand's dwindling gas reserves, which are expected to last for only ten more years. Securing as many natural gas suppliers as possible is a crucial first step.

VI. Towards an Energy Services Agreement

Notwithstanding the limited commitments by Member States to liberalize trade in energy services and the presence of various barriers on energy trade and investments as noted in Section III and IV, the preceding section suggests the common need for secure and reliable supply of energy even among those with indigenous supply. Such imperative could draw these economies together to agree on a plan that will see through the free flow of energy trade and investments in the region.

Such a plan for liberalization of energy services may take the form of an agreement to: (i) develop and implement strategies to remove substantially all impediments to free flow of energy services in the region; (ii) adopt common regulatory principles that would govern domestic energy services; and (iii) conclude mutual recognition agreements (MRAs) specifically for professionals engaged in energy and energy-related services.

The envisaged ASEAN Energy Services Agreement (AEAS) may evolve in the same way as the ASEAN Free Trade Agreement in Services (AFAS). That is, Member States may agree to a progressive liberalization of energy and energy-related sectors, based on clear and agreed upon targets, while respecting national policy objectives and differences in levels of economic development, hence readiness to liberalize markets and institute regulatory reforms.

Critical in rallying support for a separate trade liberalization agreement on energy services is an assurance to Member States that the flexibilities afforded to them in AFAS will be extended as well in AEAS. Specifically, two principles should be highlighted in such an agreement, namely the ASEAN Minus X formula and allowance for flexibility.

Liberalization through the ASEAN Minus X formula means that Member States that are ready to liberalize can proceed ahead while others may follow at a later time. Under this principle, two or more Member States may proceed with the agreed services sector liberalization without having to extend the concessions to non-participating Member States. The latter may choose to participate when ready. This negotiating formula has helped advance the liberalization agenda while sustaining harmony in the region.

Given the differences in economic development and readiness for market liberalization of Member States, it is also critical to afford them the same flexibilities as in AFAS. Member States which are unable to meet the agreed upon schedule and parameters of liberalization at a particular round of negotiations are given opportunity to catch up in succeeding rounds, or to substitute sub-sectors that have been agreed upon to be liberalized in a round with another sub-sector outside of the agreed list. Thus, while the targets for liberalization are specific and firm, some degree of deviation is allowed to Member States who may not be ready to comply as yet.

In setting the schedule of liberalization, it would do well if Member States follow the same approach they have taken in AFAS. Specifically, liberalization could begin in common services subsectors or those in which four or more Members have made commitments under GATS or previous AFAS packages. Section IV noted that majority of Member States have made commitments in 10 of 23 energy-related services, to wit:

integrated engineering services, management consulting services, services related management consulting, technical testing and analysis services, construction work for civil engineering, renting services related to equipment for construction or demolition of buildings or civil engineering works, road transport for freight transportation and services auxiliary to all modes of transport – storage and warehouse. Members could then agree on the time line to liberalize the other sub-sectors.

Considering the importance of efficient regulation – the absence of which can frustrate all efforts to liberalize – it seems appropriate to consider the inclusion of an energy services reference paper, akin to those included in GATS for telecommunications and accountancy. The provisions in the telecoms reference provide a basis for consideration although they would have to be adopted to the context of energy services. Four core areas are nonetheless important to securing a precompetitive regulatory environment for energy services: third party access to essential facilities, market transparency, competitive safeguards and independent regulation.

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AEMI BENEFITS – BENEFITS OF ASEAN ENERGY MARKET INTEGRATION: A SURVEY OF THE LITERATURE

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Abstract

This study reviews the benefits of energy market integration (EMI) in ASEAN that have been recorded in the literature. Due to the scarcity of ASEAN focused studies, we examined the studies that either indirectly addressing ASEAN or ASEAN member countries. A summary of the general benefits is presented at the second section. Furthermore, it elaborates the benefits from five perspectives: trade liberalization, investment liberalization, regional energy infrastructure development, energy pricing reform, and liberalization of domestic energy markets. The study finds significant benefits for those initiatives, although the benefits may be different among the ASEAN member countries. Based on this survey and estimation, policy implications are offered.

1. Introduction

ASEAN is working towards a single market by 2015, under the guideline of AEC (Bali Concord II, 2003). Considerable progress in the Energy Market Integration (EMI) was made as a result of cooperation achieved through the ASEAN plus Three (APT) process and, later through the East Asian Summit (EAS) process (Shi and Kimura, 2010).

This chapter will examine the potential benefits of EMI in ASEAN at both national and regional levels. The benefits could be economic, social and/or environmental. It will provide quantitative information to the policy makers, who may use this information to judge their policy options.

The benefits are primarily drawn from the literature. Due to the scarcity of ASEAN focused studies, we examined the studies that either indirectly addressing ASEAN or ASEAN member countries. Whenever possible, the review results try to exclude other countries, in particular, China and India, which heavy weight in the ASEAN Plus Three (China, Japan and South Korea) or East Asian Summit. However, such exclusion is not possible in many cases. However, many empirical studies are applicable to ASEAN without geographical prejudice. We also try to interpret the results in the ASEAN context, if the results are not directly relevant to ASEAN.

Following the conceptual framework for analyzing EMI issue in the literature (Shi and Kimura, 2010, 2014), we group the findings into 5 section plus an overall section.

2. Overall benefits of EMI

A few papers (Chang et al., 2013; Widodo and Rafiazka, 2014) simulates the welfare impacts of energy prices decrease due to ASEAN EMI (AEMI). The welfare impacts of AEMI impacts are divided into two (Widodo and Rafiazka, 2014): (i) direct impact (solely due to price equalization in a specific energy price), and (ii) indirect impact (due to price changes of other goods as responses of price equalization in a specific energy price). The direct impact has been estimated in a previous study (Chang et al., 2013), while indirect impact was estimated as estimated in a recent study (Widodo and Rafiazka, 2014). The study find that indirect impact is in often a few hundreds to a few thousands time of direct impact. Table 1 reports the aggregated results of benefits from a 10% reduction of product price due to AEMI. Benefits are measured as both Compensating Variation (CV) and Equivalent Variation (EV) from different sub-group of products as classified in the Standard International Trade Classification (SITC) classification 3 digit level.

Table 1 Welfare Impact of 10% Decrease in Price of Energy product (million US$)

Product	Measure	Indonesia	Malaysia	Philippines	Thailand	Singapore	Vietnam	Cambodia
Coal, lignite and peat (322)	CV	19,175.8	19,741.0	38,002.4	24,847.9	40,839.5	10,474.0	614.4
	EV	21,307.4	21,948.3	42,229.6	27,621.7	45,377.3	11,638.8	682.7
Briquettes et al (323)	CV	388.7	1,180.5	-55,297.1	-12,235.9	-45,015.7	3,352.3	-56.5
	EV	389.5	1,187.6	-48,268.2	-11,659.6	-40,546.4	3,463.8	-56.0
bituminous minerals (332)	CV	2,970.2	860.1	19,560.8	-6,393.0	199,509.9	31,323.3	-92.2
	EV	3,015.4	863.8	20,438.8	-6,228.0	390,917.4	44,769.8	-91.4
Petroleum products, refine (333)	CV	4,302.7	1,171.9	36,582.6	-6,764.1	-28,056.9	38,401.5	-4,143.3
	EV	4,403.4	1,178.9	40,612.9	-6,583.7	-26,287.1	60,776.6	-2,472.0
Residual petroleum products etc. (334)	CV	4,527.7	1,809.9	26,468.0	94,077.9	-15,206.5	17,881.0	-1,559.2
	EV	4,637.2	1,826.8	28,451.6	151,745.4	-14,660.8	29,707.4	-1,243.8
Gas, natural and manufactured (341)	CV	-726.0	42.3	20,551.2	57,613.0	-11,278.3	-8,373.7	128.3
	EV	-723.3	42.3	21,727.6	75,104.0	-10,975.3	-7,753.7	131.0
Electric current (351)	CV	-592.4	26.7	-273,439.2	-488.0	210,783.9	-6,679.3	117.3
	EV	-590.6	26.7	-158,966.9	-487.1	435,620.8	-6,279.0	119.6
Energy Total	CV	30,046.8	24,832.4	-187,571.4	150,657.7	351,575.9	86,379.1	-4,991.2
	EV	32,439.1	27,074.4	-53,774.5	229,512.7	779,445.8	136,323.7	-2,930.0

Source: (Widodo and Rafiazka, 2014)

The study find that two countries, the Philippines and Cambodia, both of which have high energy price due to relative liberalized market, will suffer from such an energy price decrease. However, the sources of loss are different. In the Philippines, the loss mainly originate from electricity while in Cambodia, the loss is sourced from petroleum group. These loss suggests that those sectors in the two countries have had excess profits currently. One example is that the Philippines' electricity prices (averaged at 24 US cents per kWh) was the fifth highest in the world in 2013 (Tiglao, 2014).

Sheng and Shi (Sheng and Shi, 2011, 2013) construct two indexes, the energy trade index and the energy market competition index, to measure EMI at the country level by applying the PCA approach and use these measurements to examine the impact of EMI on growth convergence by estimating both the σ-convergence and β-convergence. Data used in this study come from four major sources including the World Development Indicator (WDI) Database, the cross-country historical adoption of technology (CHAT) dataset, the UN Comtrade Database and Subramanian and Wei (2007) and covers 49 countries in 1960, 118 countries in 2008. Both Pooled ordinary least square (OLS) and country-fixed effects (FE) econometrics techniques were applied. They find that an integrated energy market may significantly help poor countries to catch up with rich countries in economic growth, thus reduce income disparity across countries, and accelerate the step of the catch-up. When EMI has been implemented and the investment and technology progress are well controlled, the poor countries can save at least 10 years when catching up with rich countries that have double income per capita.

Moreover, a comparison among three regions, i.e., EU, NAFTA and EAS, shows that energy market in the EAS region has integrated more quickly than that in the EU or the NAFTA regions in recent years and EAS countries are more likely to achieve economic convergence than the rest of the world. Yet, the impact of the EMI process on economic convergence in the EAS region is relatively smaller than that in EU. The study also finds that investment and capacity building may help to facilitate the catch-up and promote economic convergence across countries. Since ASEAN is at the core of the EAS regional integration and EMI, the impact of AEMI should not be less than that of EAS EMI found in these studies.

With a similar measurement of EMI, Sheng and Shi (Sheng and Shi, 2012a, b; Sheng et al., 2013) show that rapid economic growth due to industrialization and urbanization tends to increase the energy consumption per capita, which in turn may generate a surge in the overall demand for energy. They used the General Method of Moment (GMM) regression technique to estimate a cross-country energy demand function with a data set covering 71 countries over the period of 1965-2010. The econometric results show that an increase in economic growth may increase 0.6 per cent of energy consumption per capita. Moreover, economic growth also leads to lower price and income elasticity (in absolute terms). However, energy market integration can help to reduce the energy demand pressure and to smooth the demand shock through decreasing the income elasticity and increasing the price elasticity in particular in the long run. This finding is important for ASEAN, the energy demand of which, according to IEA's recent projection, will increase by over 80% between 2011 and 2035 under the IEA's "new policies scenario," a rise equivalent to current demand in Japan (IEA, 2013). Without AEMI, energy demand, at least in some country, may experience some shocks and thus create stress to energy security.

The benefits of EMI on energy markets prices was examined in the case of China, have implications on ASEAN as well. Using the panel data of 27 provinces between 1978 and 2008, Sheng at. al (Sheng et al., 2014) employed an instrumental regression technique to examine the relationship between economic growth, energy demand/production and the related policies in China. The empirical results show that forming a cross-province EMI will in general reduce the response of equilibrium user costs of energy products to their local demand and production. The findings implies that AMEI can also help to reduce price variability in ASEAN where energy demand will grow dramatically.

Since many ASEAN countries are agricultural exporters, they may be vulnerable to an increase in energy price particularly to crude oil price hike because energy costs may play an important part in the food industry. Hamid, Zakariah, and Zarina (Hamid et al., 2011) apply the input-output (I-O) table methodology, to selected East Asian countries to evaluate whether there exist any potential benefits of the food industry from EMI. They find that resilient economies, especially developed EA countries, have consistent performance in terms of value added creation and imported inputs during the period of energy price surge. In addition, the price spread model implies that a doubling of crude oil price will cause CPI for food to rise by approximately 22%.

The case study of Malaysia and Singapore demonstrated that although Malaysia is an oil-exporting country and Singapore mostly imports its energy need, similarly both were vulnerable to the increase in crude oil price (Table 2). This suggest that ASEAN will benefit from AMEI if AMEI can help mitigate price hike.

Table 2 Total effects of increase in oil price for Malaysia and Singapore, 2005

Malaysia				Singapore			
Total effects	**VA'* (I-A)**	**M'* (I-A)**	**M/VA**	**Total effects**	**VA'* (I-A)-1**	**M'* (I-A)-1**	**M/VA**
Food Crops	0.829	0.162	0.195	Food preparations	0.402	0.595	1.478
Vegetables	0.715	0.274	0.383	Bread, biscuits & confectionery	0.559	0.439	0.784
Fruits	0.828	0.161	0.195	Sugar, chocolate & related products	0.300	0.699	2.332
Poultry Farming	0.754	0.232	0.307	Oils & fats	0.240	0.759	3.155
Other Livestock	0.804	0.186	0.231	Dairy products	0.447	0.552	1.234
Fishing	0.747	0.224	0.300	Coffee & tea	0.408	0.590	1.444
Meat and Meat Production	0.721	0.257	0.356	Other food products	0.423	0.575	1.359
Preservation of Seafood	0.674	0.292	0.434	Soft drinks	0.484	0.513	1.061
Preservation of Fruits and	0.652	0.324	0.497	Alcoholic drinks & tobacco products	0.568	0.426	0.751
Dairy Production	0.518	0.455	0.878	Food & beverage services	0.718	0.279	0.388
Oils and Fats	0.730	0.236	0.323				
Grain Mills	0.530	0.442	0.834				
Bakery Products	0.606	0.358	0.591				
Confectionery	0.453	0.528	1.165				
Other Food Processing	0.566	0.394	0.695				
Wine and Spirit	0.495	0.340	0.688				
Soft Drink	0.496	0.468	0.944				

Note; Highlighted cells have value more than 1.
Source: (Hamid et al., 2011)

3. Trade liberalization

The impact on trade liberalization in ASEAN (Lee and Plummer, 2010; Park, 2000) and East Asia (Lee et al., 2009) is sometime addressed in the literature but little attention has been focused on the case of energy. Bhattacharya and Kojim (2010) is the only relevant study on regional wide energy trade liberalization in ASEAN and East Asia. In their study, they simulated the impact by removing tariff and export subsidy/tax using the REPA model, which is a multi-regional computable general equilibrium (CGE) model developed for conducting integrated policy impact assessment encompassing environmental, economic and poverty impacts in East Asia (Kojima, 2008).

The results show that although the distribution of economic benefits is not balanced, the magnitude of impact in most countries is close to zero. Cambodia and Vietnam will benefit the most from trade liberalization. Other ASEAN countries like Indonesia, Malaysia and Singapore will lose in that context. However, such loss is comparatively very small. The reasons for the negative impacts are complicated in the CGE model, which models the impact through complex inter-sectoral and international linkages. For example, the real GDP loss of Singapore is mainly due to a reduction in trade balance, as trade liberalization will undermine the comparative advantage of the current free trade policy of Singapore. With the increase of GDP, CO2 emission will also increase. Due to border tax reduction to zero, more or less all the countries experience reduced levels of domestic energy prices except Indonesia and Malaysia (Table 3).

Table 3 Impact of energy trade liberalization on GDP, CO_2 emissions and consumer prices of energy commodities

Region	Real GDP	CO_2 emissions	Coal price	crude oil price	Gas price	petroleum products price	Electricity price	gas distribution price
Cambodia	0.128	1.25	1.79	1.7	-0.23	-4.28	-0.26	0.02
Indonesia	-0.065	-0.37	3.37	1.15	0.17	0.18	0.28	0.02
Lao PDR	-0.130	0.96	-2.96	-0.03	-0.07	-1.89	-0.25	0.02
Myanmar	-0.044	-0.37	2.62	-0.03	1.42	-0.84	0.43	0.24
Malaysia	-0.078	-0.47	2.54	-0.21	0.49	0.57	0.34	-0.01
Philippines	0.011	0.38	-2.36	0.56	-0.04	-0.34	-0.22	0.02
Singapore	-0.070	0.12	1.85	1.19	-0.14	0.11	0.02	-0.05
Thailand	0.011	-0.13	0.95	0.28	-0.09	0.22	0.01	-0.02
Vietnam	0.263	3.21	5.16	-0.59	-6.14	-8.44	0	0.34
Brunei Darussalam	-0.147	-0.02	1.19	1.79	-0.22	0.41	0.07	0.16

Source: Bhattacharya and Kojima (2010).

At sub-regional level, there are more studies. Watcharejyothin and Shrestha (2009b) evaluates effects of energy resource development within the Greater Mekong Sub-region (GMS) during 2000–2035 with a MARKAL-based integrated energy system model of the five GMS countries. The study found that an unrestricted energy resource development and trade within the GMS region would reduce the total-regional energy systems cost by 18% and would abate the total CO_2 emission by 5% as compared to the base case.

4. Investment liberalization

Kojima and Bhattacharya (2011) developed a dedicated multi-regional CGE model for conducting a quantitative assessment of electricity sector investment scenario in which the investment demands in the EAS member countries projected by the International Energy Agency are met. The assessment results show that for meeting energy sector investment demands, FDI will play an important role not only to benefit investing and hosting countries but also to increase the regional GDP as the whole. The most interesting finding shows that introduction of FDI increases not only the national GDP of the investing countries but also the regional GDP as the whole EAS region by 0.04%. However, the study also shows that many ASEAN countries will loss due to investment liberalization. The unfordable results, however, are explained as the limitation of CGE technique by the Authors. Therefore, better methods for estimating investment liberalization are needed.

5. Regional Infrastructure development

There are quite a few studies on the impact of ASEAN regional infrastructure development. Bhattacharya and Kojima (2008) has shown in a study on impact of cross border energy infrastructure development project in ASEAN region that increasing physical linkages between two countries will bring more economic benefits and will reduce more CO2 emissions than business as usual situation. Due to cooperative infrastructure development activities, economic burden on individual country get reduced significantly and increases the efficiency of resource use to produce energy in the system.

In the case of power grid connection, Chang and Li (2012) build a dynamic linear programming model and simulate optimal development paths of power generation capacities in ASEAN countries. They consider three scenarios (no trade, 20% trade and 50% trade in electricity) of developing optimal power generation capacity and their impacts on market integration in ASEAN. Their findings show that a more open power trade regime encourages the development of renewable sources of power generation, and accrues more savings in the total cost of meeting the growing future power demand from 2010 to 2030. Specifically under the scenarios of partial trade (20% and 50% capacity) the present value of cost savings would be USD 20.9 billion (3.0%) and USD 29.0 billion (3.9%), respectively. Thus even with partial integration (cross-border power trading) substantial cost reduction could be realized.

At bilateral case, Watcharejyothin and Shrestha (2009a) analyzed the effects of hydropower resource development in Laos and power trade between Laos and Thailand using a MARKAL-based model for an integrated energy system between the two countries. They find that 80% exploitation of hydropower resource in Laos would induce power trade between the countries. In such case, although the energy system cost save is marginally, the trade would mitigate the

CO_2 emission by 2% when compared with the base case. Thailand will benefits from the trade in terms of lower energy system cost, better environmental quality and, greater energy diversification, while Laos earns significant export revenue.

In the case of ASEAN natural gas pipeline connection, Chang and Li (Chang and Li, 2011) use a competitive equilibrium model to analyze the implications of an integrated and competitive natural gas market in the region. They find that by adopting an integrated and competitive natural gas market in the region, overall welfare of countries involved in natural gas trade in the region improves by 5.5%. In general, their study shows that the supply of natural gas from the region, which has cheaper transportation costs, increases its portion in the total supply of natural gas. By introducing new natural gas infrastructure in the region, Chang and Li observe that welfare of countries involved in natural gas trade in the region further increases by 0.3%.

6. Energy Subsidy removal

Energy subsidies in ASEAN are frequently studied. Oktaviani, *et al*. (2005) analyze the impact of fuel subsidy reduction on macroeconomic variables, agricultural sector, and income distribution using a recursive CGE model and finds an increased fuel price at consumer level reduces the Indonesian real GDP. Their results show that the *reduction in fuel price subsidy tends to increase prices of industrial outputs* highly dependent on fuel, such as the transportation and fishery sectors. They found that wage of skilled labor, land rent, and capital rent declined steadily in response to changes in fuel price. They also found households would incur income losses following the reduction in fuel subsidy, decreasing the overall welfare of households. They suggest to compensate the poor either through direct transfer, or through the development of infrastructure.

Widodo and his three colleagues (Widodo et al., 2012) consider several scenarios of the removal of fuel subsidies in Indonesia and found that the removal of fuel subsidies without redistributing the money back to the economic system would reduce production output, GDP, and labor income. At the sector level, it is found that the removal of fuel subsidy would have the greatest impact on energy intensive sector, with the Chemical and cement industry, the Electricity, gas, and drinking water, and Food, beverage, and tobacco industry, to be the most affected sectors. Their simulation results also show that the impact on labor income is higher than that on capital returns and the lowest income group will be affected most. In contrast, high-income earners as well as workers in agriculture sector would be the least affected by the removal of the fuel subsidy. If this amount of subsidy is reallocated to four targeted sectors- i.e. 1) Agriculture; 2) Trade; 3) Food, Beverage, and 4) Tobacco Industry; and Education and Health, the gains would be smaller than the negative effect of fuel subsidy removal. This suggests that the sectoral compensation approach cannot compensate the overall loss of the economy. This discouraging findings, however, could be due to the limitation of the methodology (*Social Accounting Matrix*, SAM). For example, their multiplier exercise is based on a fixed economic structure and does not take into account of the dynamics over time and cannot capture productivity gains; and it does not allow for substitution effect either as prices are fixed.

In the case of Malaysia, Hamid and Rashid (2012) investigate the effects of subsidy removal using the Malaysian input-output table supplemented by a static CGE model and find significant economic benefits. The I-O table analysis illustrates that the removal of subsidy of one ringgit will increase the output by six cents and GDP by eight cents at the final demand. Their findings imply that phasing out oil subsidy would initially increase the general prices that will especially affect the heavily oil-dependent sectors such as the petroleum refinery, wholesale and retail trade, and motor vehicles. The authors also argue that there are significant variations across industries since different proportions of energy inputs are employed in the production process. In general, the less energy intensive industries and domestic resources-based industries are less affected by the removal of subsidies. The most effect is on workers' income that experiences an increase of 34 cents due to the removal of subsidies. The authors further argue that delaying the removal of subsidies will primarily increase costs for the government and leave little room for policy space in case market prices are higher than expected.

In the Vietnamese case, Khanh (2012) explores the impacts of an increase in the electricity tariff from 6.0 US cents/kWh (domestic price) to 9.5 US cents/kWh (international rate) (a rise of 58.3% in the electricity tariff) in Vietnam (Khanh, 2012). He shows that prices in the five most affected sectors would in turn increase by 11.15% (water), 7.36% (gas), 4.82% (paper & paper products), 4.73% (chemicals and chemical products) and 4.30% (sports and entertainment). The price increase in all other sectors would be less than 4%. These increases in prices would lead to an increase in the CPI (Consumer Price Index) of 4.2%. Lower income earners suffer more from an electricity tariff increase because their payment for electricity represents a bigger share in their annual expenditure than the rich's. Nguyen argues that though the impacts of subsidy removal on the economy are not very large, a one-shot increase in electricity tariffs would be socially unacceptable. He thus proposes a gradual approach towards subsidy removal and separate implementation in each sector. Nguyen further argues that an improvement in efficiency in the power sector would help reduce the repercussions of subsidy removal.

Subsidy removal, which is naturally a transfer payment, will not generate value-added, but rather than tends to reduce GDP through reducing consumers' disposable income, which will discourage aggregate consumption, and increasing costs of production, which will likely decrease aggregate investment (I) (Hamid and Rashid, 2012). The benefits of subsidy removal will be increased if the efficiency gains can be captured. With the subsidy removal, energy price will direct energy to be used in the most efficient sectors and thus increase the allocation efficiency of the economy and increase the productivity of the energy. Such benefits are likely to be significant but cannot be fully captured by the current models.

By capturing some of those efficiency and productivity gains using a multi-regional Computer General Equilibrium (CGE) approach, Kojima and Bhattacharya (Kojima and Bhattacharya, 2011) find that even if a partial removal of energy subsidies can ripe the benefits of market efficiency improvement. It is estimated that around 500 Million USD of subsidy reduction per annum in the EAS region can improve the regional economic condition in terms of real GDP by around 0.05% and its welfare by around 0.14% compared to the base line scenario of 2020. Energy subsidy reduction also helps to push down the demand for subsidized commodities in the market and also subsequently cuts the sales of subsidized energy commodities in the domestic market. Such energy will generate economic and security benefits.

7. Domestic liberalization

Bhattacharya and Kojima (2010) is also the only study that tries to quantify the impact of liberalization of domestic energy markets in ASEAN. To estimate the impact of domestic market liberalization using the REPA model, the simulation assumes that due to such liberalization there is an overall improvement in the total factor productivity of the energy distribution services (assumed 20% in the estimation), that is electricity transmission and gas distribution, due to increased competitiveness through open access to transmission systems. The simulation shows double benefits of market liberalization: i.e. overall economic development and reduction of CO_2 emissions (Table 4). These significant benefits, however, have an unbalanced distribution. The estimation results show that no single policy can create the miracle of an integrated market where all the member countries are winners. Some members may lose from certain initiatives. Such loss often is caused in sectors other than the energy sector, which indicates that trade-offs may occur between the energy sector and other sectors.

Table 4 Impact on GDP and CO_2 emissions due to market liberalization, % change to baseline 2020

	Real GDP	CO2 emissions
China	1.551	-0.84
Japan	0.737	-2.23
Korea	0.834	-1.53
Cambodia	0.725	1.78
Indonesia	0.852	1.87
Lao PDR	0.943	8.47
Myanmar	1.926	10.54
Malaysia	1.278	2.48
Philippines	0.934	-2.11
Singapore	0.760	-2.85
Thailand	1.464	1.05
Vietnam	2.479	4.52
Brunei Darussalam	1.139	1.70
India	1.825	-2.49
Australia	0.620	-1.29
New Zealand	0.829	2.59
Brazil	-0.010	0.27
EU	0.003	0.55
USA	0.003	0.43
Russia	-0.079	0.38
MENA and Venezuela	-0.029	0.11
Rest of the World	-0.004	0.49
World Total	0.259	0.01
EAS Total	1.090	-0.80

Source: Bhattacharya and Kojima (2010).

8. Policy implications and conclusion.

Although much of the current findings in the literature are applicable to ASEAN, some studies that are dedicated to ASEAN are highly recommended. The review of studies on AEMI finds that while trade liberalization and fossil fuel subsidy removal have been well studied, there are many room left for future studies. Even in the case of fossil fuel subsidies, the current macro models, such as GTAP, has limit capability due to highly aggregation of data in the model. Yet, the impact of subsidy removal is more or less understandable and thus future studies are not that urgent. More studies to deepen understanding on the other three aspects of AMEI are needed.

However, there are not many models that can easily be modified to the regional context. More fundamental works are needed to create ASEAN's own energy market integration assessment models. For example, from the bottom up approach, an ASEAN TIMES model would be very useful to study the economic impact and investment requirement for AEMI. From the top down approach, some global model with energy and environmental sectors, such as GTEM, are highly valuable. To construct that bottom up models, however, we need data of energy technologies, their penetration levels, and associated costs in all ASEAN member countries. While for building up of top down model, macro data which are required are more convenient to be compiled.

Based on the review, the following policy implications can be drawn. Trade and investment liberalization and development of infrastructure will generate net benefits for ASEAN. However, the distribution of the benefits, could be different across the member countries. In the case of trade liberalization, the countries that have freer trade regime will lose more since their comparative advantages will be undermined. Furthermore, the economic benefits of EMI often come with increasing CO2 emissions, which thus needs to be addressed through technical innovation and policy intervention.

Domestic liberalization may achieve both economic growth and CO2 emission reduction. But process of domestic liberalization is often challenge because there are subject to behind the board barriers, removal of which requires changes in national institutional frameworks and thus are sensitive (SHI, 2014).

Phasing out subsidies is politically and economically challenging and needs to be carefully planned in consideration of each individual country's circumstances. Despite the process requiring an extended time-frame, immediate actions in terms of planning could facilitate the process and reduce difficulty. The fiscal revenue saving of the government from subsidy removal can be either used to develop much needed infrastructure for economic benefits, or to assist the poorest for social benefits.

Different impacts among different policies demand a comprehensive development AEMI policy portfolio. In that case, some of the negative impact can be offered within a country boundary and thus will reduce resistance for such an integration. The regional integration shall also pay particular attention to the less developed countries, who may not be able to reap their potential benefits due to a lack of national and regional competitiveness resulted from institutional weakness and capacity limit.

Although the models have various limitations, the estimated results can be explained more optimistically. The estimated economic impacts are indicative in nature and could be less than real benefits, mainly because many economic benefits, and most environmental and social benefits, cannot be modeled. However, this study shows the direction of economic and environmental impacts of EMI in the region, which can be the building block for future policies in this context.

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ENERGY INFRASTRUCTURE – EVALUATION OF ASEAN INFRASTRUCTURE CONNECTIVITY NEEDS

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I. Introduction

An economy needs to extract available energy resources, process them and deliver the refined products to the end user for consumption. The endowments of energy resources in ASEAN countries are not even. Countries like Myanmar and Indonesia have huge endowments of various energy resources while countries like Singapore and Thailand do not have much or no endowment of energy resources. The energy-abundant country faces two major obstacles in developing the potential energy resources. First, it lacks in funds to develop the potential energy resources. Second, it does not have sufficient demand to ensure the full utilization of the potential energy resources. These obstacles led to a serious imbalance between the demand for energy and the supply of energy among ASEAN countries.

If there is transportation or transmission network between energy-abundant and energy-deficient countries, then the available energy resources can find the source of secured demand and the funds for full development of the available energy resources. This would bring a win-win situation for both countries – the former can increase its GDP and promote economic growth while the latter can accelerate its economic growth by ensuring the supply of energy. ASEAN have initiated to connect member countries by power grid and gas pipelines such as APG and TAGP and completed their master plans. However, the full connectivity seems to be still a long way to go.

This study aims to evaluate the needs of ASEAN infrastructure connectivity such as power grids, gas pipelines, LNG terminals and answer to the following research and policy questions.

- It evaluates ASEAN infrastructure connectivity needs to balance the long term energy demand and supply for the economic centres in every corner of ASEAN for the well-being and comfortable social wellbeing.
- The evaluation is to be based on the mapping of demand-supply need for various economic sectors within each of the long term national development.
- This can be a pre-study in sending the right signal to investors in each economic centres, in particular, to study the progressive infrastructure development to enable the energy flow from those resource rich area and deficient areas.

This paper is structured as follows. Section 2 reviews gaps in the infrastructure, either in term of physical connectivity, standard for interoperability, cross-border energy trading framework or barrier. It also documents the infrastructure need for energy market connectivity to support efficient use of energy resource appropriately and convert resources throughout the ASEAN grid without increasing the risk of the energy security to the participating nations. Section 3 briefly outlines the policy on common standards for smart metering usage and smart grids development to ensure interoperability across the network and empower end-user to get their energy need from options from any energy supplier within the ASEAN energy market – be it gas, electricity or other form of energy carrier. Section 4 presents a few policy recommendations and section 5 concludes this paper.

II. Assessment of the investment needs for physical connectivity

a. Long-term evolution of the regional power and natural gas market in ASEAN

In the Asia/World Energy Outlook 2013, IEEJ forecasts the final electricity consumption will be 2,220 TWh in 2040 from 614 TWh in 2011 (IEEJ, 2013).[11] This is more than a three-fold increase for the period of a little less than 30 years. Table 1 presents how fast the power demand in ASEAN countries will grow from 2010 to 2030 (IEEJ et al, 2011).[12]

Table 1: the Growth Rate of Power Demand in ASEAN Countries (Unit: %)

	Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Growth Rate	1.2	9.9	3.9	7.7	4.5	9.0	4.5	4.2	4.9	6.7

Sources: The Third ASEAN Energy Outlook, 2011

Together with IEEJ, ERIA explores effective investment options for power grid connection in East Asia. Table 2 presents the expected growth of electricity demand from 2010 to 2035 in ASEAN countries and two neighboring regions (Yunnan Province, China and Northeast India). This echoes the earlier forecast of strong growth in electricity demand in ASEAN.

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11 The forecast is based on the reference scenario in which the business as usual is assumed.

12 If legitimate forecasts on the growth of power demand are available, a kind of sensitivity analysis such as lower growth or higher growth cases could be done. As the focus of this research, however, is to examine the impact of regional power trade policy regime and corresponding power development planning, it does not consider alternative growth rates of power demand.

Table 2: The Expected Growth Rate of Electricity Demand

	TWh						AAGR		
	2010	2015	2020	2025	2030	2035	2010-2020	2020-2035	2010-2035
BRN	3.87	4.47	5.22	5.96	6.77	7.67	3.0%	2.6%	2.8%
IDN	169.79	252.38	341.64	448.07	576.05	733.09	7.2%	5.2%	6.0%
KHM	0.99	6.15	12.33	17.67	19.58	22.15	28.6%	4.0%	13.2%
LAO	8.45	22.54	51.35	65.44	67.13	68.82	19.8%	2.0%	8.8%
MYA	7.54	11.42	16.44	23.15	32.24	44.59	8.1%	6.9%	7.4%
MYS	124.10	161.20	205.10	254.00	309.10	371.80	5.2%	4.0%	4.5%
NEI	11.44	15.68	22.18	29.52	38.34	49.28	6.8%	5.5%	6.0%
PHL	67.74	84.63	106.79	130.51	156.00	185.93	4.7%	3.8%	4.1%
SGP	45.38	51.19	55.60	59.40	61.85	65.76	2.1%	1.1%	1.5%
THA	147.01	180.37	210.86	257.53	309.56	355.03	3.7%	3.5%	3.6%
VNM	92.17	148.35	219.59	295.41	398.83	538.70	9.1%	6.2%	7.3%
YNN	136.50	188.88	223.71	260.19	296.66	324.67	5.1%	2.5%	3.5%

Source: ERIA (2014)

Albeit the strong demand growth, the existing capacity of power generation is far smaller than what is needed. Table 3 shows the existing electricity generation capacity in MW as of 2012 in ASEAN region.

Table 3: The Existing Capacity of Power Generation

(MW)

	Coal	Gas	Oil	Nuclear	Hydro
BRN	0	885	32	0	0
IDN	15,603	9,680	7,705	0	4,343
KHM	10	0	286	0	207
LAO	0	0	8	0	2,125
MYA	0	347	29	0	1,678
MYS	5,685	7,875	3,136	0	2,897
NEI	60	824	143	0	1,200
PHL	4,598	2,656	4,653	0	3,441
SGP	0	4,077	2,850	0	0
THA	4,568	19,366	1,133	0	3,517
VNM	3,964	4,884	1,328	0	10,051
YNN	13,047	0	0	0	22,495

Source: ERIA (2014)

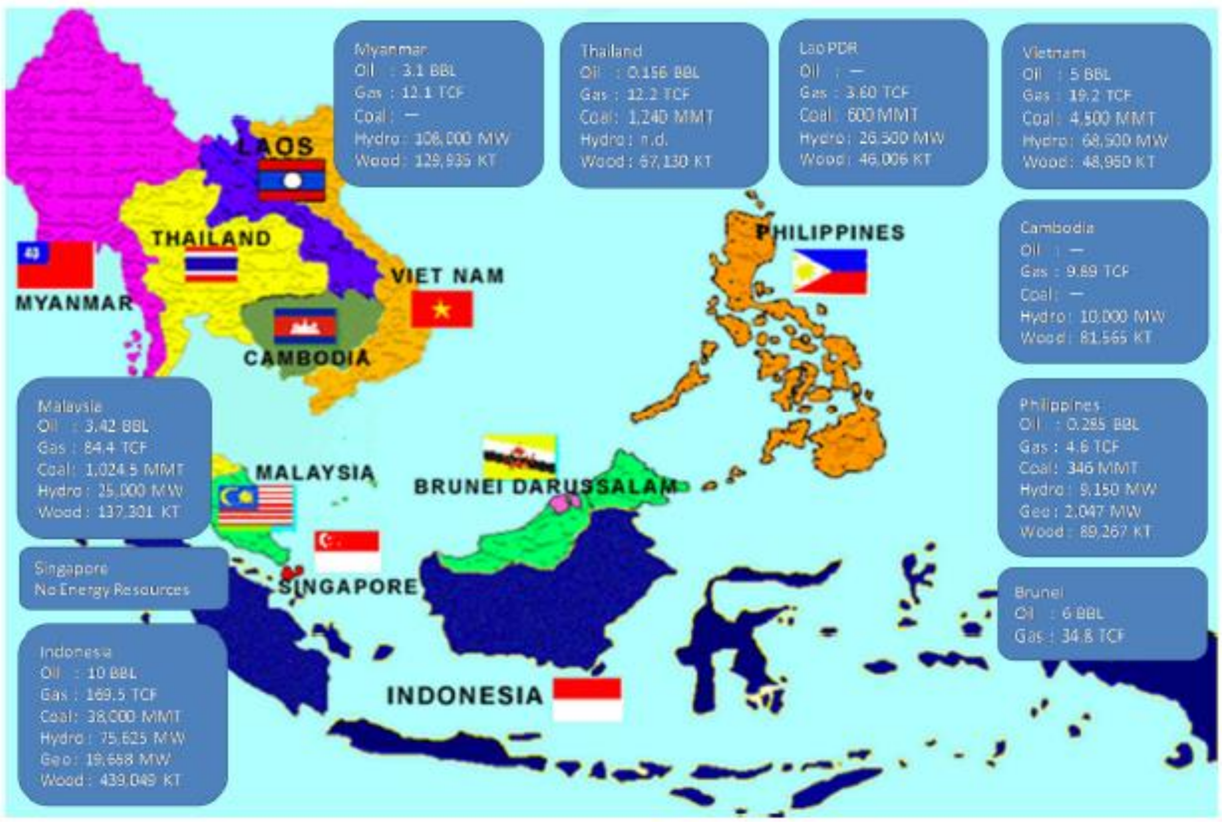
A simple calculation of the projected power generation out of the existing capacity shows that there is a huge deficiency in the capacity.[13] For example, assuming 80%

13 This evaluation does not take account the planned capacity additions.

availability (but this is pretty optimistic), Brunei may face a shortage in electricity supply sometime between 2020 and 2025 and Indonesia sometime between 2015 and 2020. The current level of existing installed capacity implies that there must be huge increases and investments in electricity generation capacity.

There are huge potentials in hydropower generation in ASEAN, however. Figure 1 shows the potentials of various energy resources and figure 2 presents the potential of hydropower generation in ASEAN countries.[14]

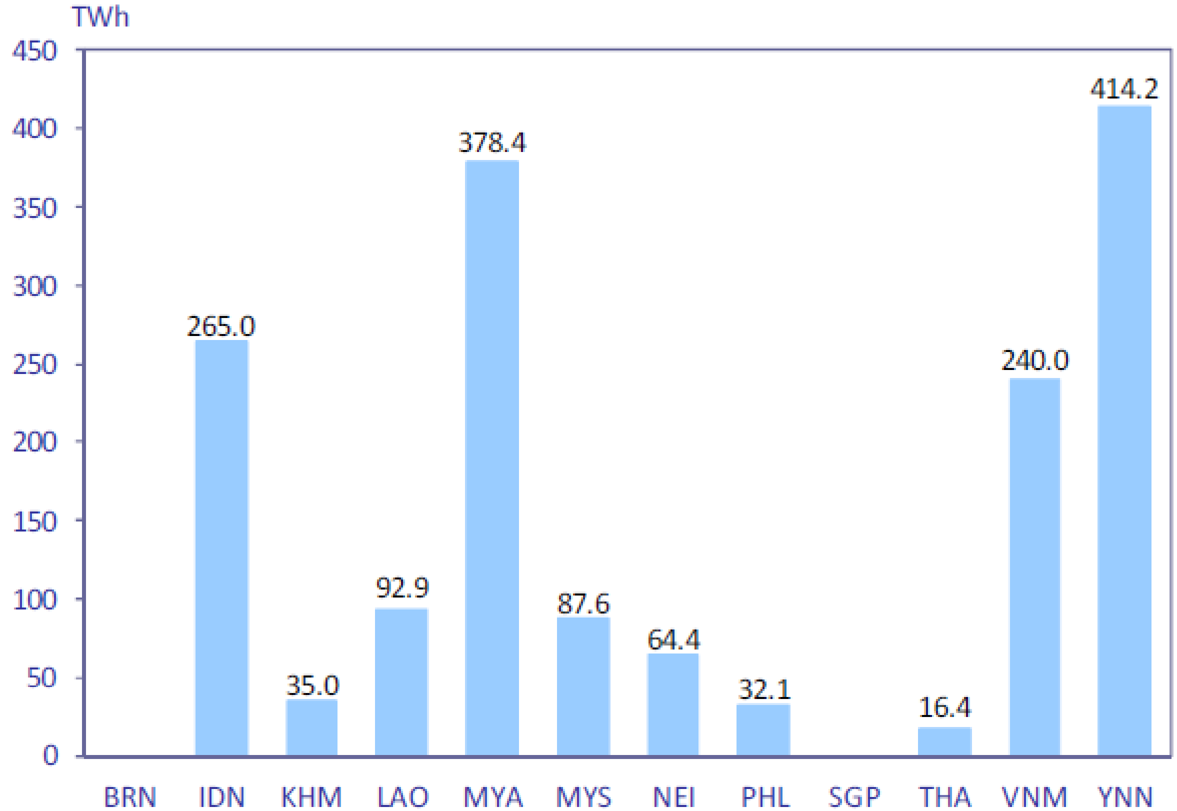
Figure 1: Potential of Various Energy Resources in ASEAN Countries



Source: ERIA (2014)

14 The resolution of original source is very vague.

Figure 2: Projected Hydropower Generation in ASEAN Countries.



Source: ERIA (2014)

The strong growth in electricity demand, the lack of installed power generation capacity to meet the surging electricity demand and huge potentials in hydropower in the region make integrating power grids and natural gas transportation a feasible solution.

Table 4 shows the natural gas reserves and the level of consumption for selected countries in ASEAN. The reserve-production (R/P) ratio is about 37. Figure 3 presents there are a large and strong upward trend in natural gas consumption in Indonesia, Malaysia and Thailand. For countries like the Philippines, Singapore and Vietnam, the level of natural gas is relatively lower than Indonesia, Malaysia and Thailand but there is also a strong upward trend in natural gas consumption.

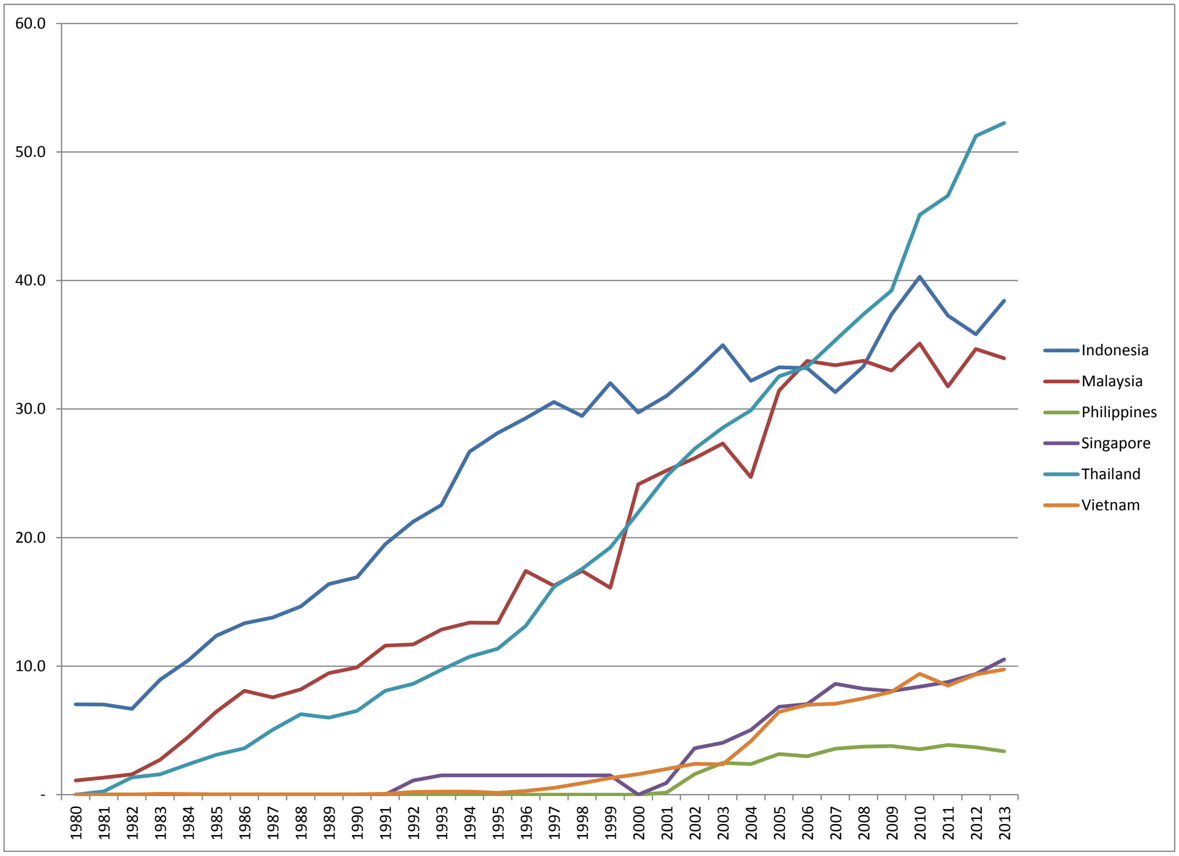
Table 4: Natural Gas Reserves and Consumption in 2013 (unit: billion cubic meters)

Country	Reserves (Billion cubic meters)	Consumption (Billion cubic meters)
Brunei	288.0	-*
Indonesia	2,926.5	38.4
Malaysia	1,091.4	34.0
Myanmar	283.2	-*
Philippines	-*	3.4
Singapore	0	10.5
Thailand	284.9	52.2
Vietnam	617.1	9.8
Total	5,491.1	148.3

Note: * denotes data is not available

Source: BP Statistical Review of World Energy 2014

Figure 3: Natural Gas Consumption in Selected Countries in ASEAN: 1980 – 2013



Source: Calculated from BP Statistical Review of World Energy 2014

The descriptive statistics of electricity and natural gas consumption shows that there is a strong demand growth in ASEAN. This also hints that there will be markets for power and natural gas if the power grids and gas transportation networks across the region are connected and relevant financial and regulatory infrastructure are provided. The following sections review the investment needs for physical infrastructure and explore what financial and regulatory infrastructure and how they can be provided to support ASEAN energy market integration.

b. Reviewing and updating of the APG and TAGP investment

ASEAN has envisioned connecting its power grids and natural gas pipelines to meet surging electricity demand growth by developing a huge potential in hydropower. The channels of realizing this vision are APG and TAGP. Table 5 shows the cross-border power transmission lines in ASEAN countries. The existing capacity is too small to cover the volume of power trade in the future among ASEAN countries. To cater the volume of power exchange in the future, ASEAN plans to interconnect various power grids across ASEAN countries.[15]

Table 5: Existing Cross-border Power Transmission Lines

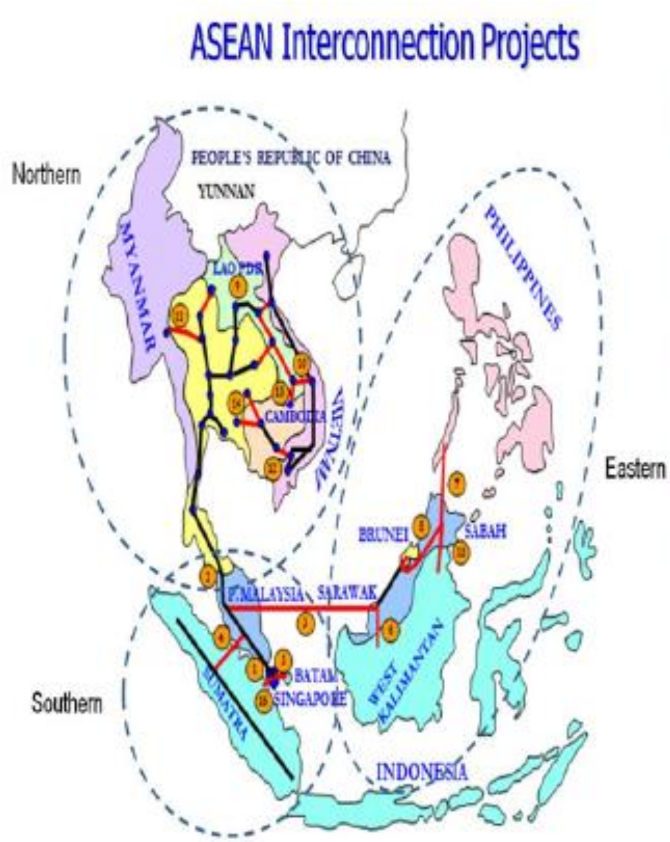
Country A	Country B	Project Name	Capacity (MW)
Malaysia	Singapore	Plentong-Woodlands	450
Thailand	Malaysia	Sadao-Chuping	80
Thailand	Malaysia	Khlong Ngae - Gurun	300
Laos	Thailand	Theun Hinboun- Thakhek - Nakhon Phanom	220
Laos	Thailand	Houay Ho -Ubon Ratchathani 2	150
Laos	Thailand	Nam Theun 2 -Roi Et 2	1000
Laos	Thailand	Nam Ngum 2- Na Bong -Udon Thani 3	615
Laos	Thailand	Theun Hinboun (Expansion) - Thakhek -Nakhon Phanom 2	220
Laos	Vietnam	Xehaman 3 - Thanhmy	248
Vietnam	Cambodia	Chau Doc - Takeo - Phnom Penh	200
Vietnam	Cambodia	Tai Ninh - Kampong Cham	200
Thailand	Cambodia	Aranyaprathet - Banteay Meanchey – Siem Reap - Battambang	120
China	Vietnam	Xinqiao - Lai Cai	250-300
China	Vietnam	Maguan - Ha Giang	200
Myanmar	China	Shweli 1 - Dehong	600

Source: Chimklai (2013); Zhai Yongping (2010); ADB (2013); APERC (2004); Bunthoeun (2012)

Figure 4 shows ASEAN interconnection projects and their details. There are three focus areas – Northern, Southern and Eastern. The Northern area mainly covers the Greater Mekong Sub-region, the Southern areas covers Malaysia, Singapore and Indonesia, and the Eastern area covers the Philippines, Brunei, East Malaysia and West Kalimantan. Table 6 presents the status of ASEAN interconnection projects as of August 2013. The existing interconnected capacity is 3,489 MW and on-going and future capacities are 7,162 MW and 22,474 MW, respectively. The total capacity will be 33, 125 MW. It is almost 10 folds increase.

15 The chronological sequence of how the decision of interconnecting the grids has been made and vis-à-vis actions is not reflected in table 5.

Figure 4: ASEAN Interconnection Projects



		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	2015
•	Khlong Ngae – Gurun (2nd Phase, 300MW)	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
9)	Thailand - Lao PDR	
•	Roi Et 2 - Nam Theun 2	Existing
•	Sakon Nakhon 2 – Thakhek – Then Hinboun (Exp.)	Existing
•	Mae Moh 3 - Nan - Hong Sa	2015
•	Udon Thani 3- Nabong (converted to 500KV)	2018
•	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)	2017
13)	Lao PDR - Cambodia	2016
14)	Thailand - Cambodia (New)	2015-2020
15)	East Sabah - East Kalimantan	2020
16)	Singapore – Sumatra	2020

Source: ERIA (2014)

Table 6: the Status of ASEAN Interconnection Projects (as of August 2013)

STATUS OF ASEAN INTERCONNECTION PROJECT AUGUST 2013 DATA				
				(MW)
SYSTEM REGION	EXISTING	ON-GOING	FUTURE	TOTAL
NORTHERN REGION	2,659	6,062	16,374	25,095
9. Thailand - Lao PDR	2,111	3,352	2,465	7,928
10. Lao PDR-Vietnam	248	2,410		2,658
11.Thailand- Myanmar			11,709	11,709
12.Vietnam-Cambodia	200			200
13.Lao PDR - Cambodia		300		300
14.Thailand - Cambodia	100		2,200	2,300
SOUTHERN SYSTEM	450	600	1,800	2,850
1. P. Malaysia - Singapore	450		600	1,050
4. P Malaysia - Sumatra		600		600
5. Batam - Singapore			600	600
16. Singapore - Sumatra			600	600
EASTERN SYSTEM		400	800	1,200
6. Sarawak - W. Kalimantan		200		200
7. Phillines - Sabah			500	500
8. Sarawak - Sabah - Brunei		200	100	300
15. E.Sabah - E. Kalimantan			200	200
NORTHERN - SOUTHERN SYSTEM	380	100	300	780
2. Thailand - P.Malaysia	380	100	300	780
SOUTHERN - EASTERN SYSTEM			3,200	3,200
3. Sarawak - P. Malaysia			3,200	3,200
GRAND TOTAL	3,489	7,162	22,474	33,125

Source: ERIA (2014)

Table 7 presents the details of on-going and planned cross-border transmission line projects, which is also called APG+. The physical connectivity is well planned but how to implement the planned interconnection needs more attention and collective efforts among member countries. Apart from a smooth implementation of physical interconnection, what has not been discussed is how to finance the physical infrastructure connectivity.

Table 7: Ongoing and Planned Cross-border Power Transmission Line Projects (APG+)

Country A	Country B	Project Name	Capacity (MW)
Thailand	P. Malaysia	Su - ngai Kolok - Rantau Panjang	100
Thailand	P. Malaysia	Khlong Ngae - Gurun (Addition)	300
Malaysia	Sumatra (Indonesia)	Melaka - Pekan Baru (AIM II Priority Project)	600
Sarawak (Malaysia)	W. Kalimantan (Indonesia)	Mambong - Kalimanyan	230
Sabah (Malaysia)	E. Kalimantan (Indonesia)	Newly Proposed	200
Sarawak-Sabah (Malaysia)	Brunei	Sarawak - Brunei	200
Laos	Thailand	Hong Sa - Nan 2 - Mae Moh 3	1473
Laos	Thailand	Nam Ngiep 1 - Na Bong - Udon Thani 3 -	269
Laos	Thailand	Xe Pien Xe Namnoi - Pakse -Ubon Ratchathani 3	390
Laos	Thailand	Xayaburi- Loei 2 - Khon Kaen 4	1220
Laos	Thailand	Nam Theun 1- Na Bong -Udon Thani 3	510
Laos	Thailand	Nam Kong 1 & Don Sahong - Pakse - Ubon Ratchathani 3	315
Laos	Thailand	Xekong 4-5- Pakse -Ubon Ratchathani 3	630
Laos	Thailand	Nam Ou - Tha Wang Pha -Nan 2	1040
Laos	Vietnam	Ban Hat San - Pleiku	1000
Laos	Vietnam	Nam Mo - Ban Ve - (Vinh)	100
Laos	Vietnam	Sekamas 3 - Vuong - Da Nang	250
Laos	Vietnam	Xehaman 1 - Thanhmy	488
Laos	Vietnam	Luang Prabang - Nho Quan	1410
Laos	Vietnam	Ban Sok - Steung Treng (Cambodia) - Tay Ninh	Unknown
Laos	Vietnam	Ban Sok - Pleiku	1151
Laos	Cambodia	Ban Hat - Stung Treng	300
P.Malaysia	Singapore		600
Batam (Indonesia)	Singapore	Batam - Singapore	600
Sumatra (Indonesia)	Singapore	Sumatra - Singapore	600
Philippines	Sabah (Malaysia)		500
Sarawak - Sabah (Malaysia)	Brunei	Sarawak - Sabah - Brunei	100
Thailand	Laos	Nong Khai - Khoksa - at; Nakhon Phanom - Thakhek; Thoeng - Bo Keo;	600
Thailand	Cambodia	Prachin Buri 2-Battambang	300

Thailand	Cambodia	Trat 2 - Stung Meteuk (Mnum)	100
Thailand	Cambodia	Pluak Daeng - Chantaburi 2 -Koh Kong	1800
Myanmar	Thailand	Mai Khot - Mae Chan - Chiang Rai	369
Myanmar	Thailand	Hutgyi - Phitsanulok 3	1190
Myanmar	Thailand	Ta Sang - Mae Moh 3	7000
Myanmar	Thailand	Mong Ton - Sai Noi 2	3150
China	Vietnam	Malutang - Soc Son	460
China	Thailand	Jinghong - Laos - Bangkok	1500
Myanmar	India	Tamanthi - ?	960
Cambodia	Vietnam	Sambor CPEC - Tan Dinh	465

Source: Chimklai (2013); Zhai Yongping (2010); ADB (2013); APERC (2004); Bunthoeun (2012)

III. Assessment of investment needs for renewable energy, smart grids and smart meters

a. Investment Needs for Renewable Energy

Provided that the physical and the financial interconnectivity is fully placed in ASEAN, Chang and Li (2013a) analyzed how cross-border power trading encourages renewable energy development in ASEAN and estimated possible economic and environmental benefits accrued from the power trading in ASEAN.[16] When cross-border power trade is allowed up to 20% of each country's peak demand, hydro capacity appears to increase by about 60%, wind energy by about 35% and geothermal energy by more than 20% compared to no-trade case. When cross-border trade is allowed up to 50% of each country's peak demand, the rate of renewable energy utilized appears to be close to 100% increases compared to the 20% case.

Market instruments for promoting renewable energy utilization such as Feed-in-Tariffs (FIT) and Renewable Portfolio Standards (RPS) are expected to harness more energy from renewable sources.[17] Taking account of the cost of carbon emissions, Chang and Li (2013b) also examined how the introduction of renewable energy-related polices such as FIT and RPS into the cross-border power trading in ASEAN facilitates renewable energy development and power trade. FIT appears to be better performing than RPS and implementing RPS of 30% by 2030 appears to a reasonable option as it achieves the moderate performance in reducing carbon emissions and developing renewable energy at a negligible increase in total cost of electricity generation.

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16 Large hydro power plants are included.

17 FIT schemes are expected to be phased out soon due to mainly the achievement of grid-parity in the near future. They are considered in the study for comparing the results with those of RPS and a sensitivity analysis.

Noticing the cost of realizing physical interconnectivity could offset the reduction in the cost of electricity generation, Li and Chang (2014) explored how the practical consideration of the cost of interconnecting cross-border power grid will influence the accrued economic benefits of cross-border power trade. Table 8 shows that the existing planning of power transmission infrastructure in the region, so-called APG+, appears to stand as commercially and financially viable.[18]

Table 8: Expected Cost Savings from Power Transmission Infrastructure

Scenarios	Cost Savings (%)	Net Savings ($billion)
20% Trade Allowed	0.15	2.2
50% Trade Allowed	0.67	8.0
80% Trade Allowed	1.0	12.1

Source: Li and Chang (2014)

The simulation model assesses only theoretical financial viability and the projects are assumed to be delivered on time. There is no consideration on any barriers in cross-border regulation, legislation or standards harmonization. To realize the theoretical financial viability, policies should be designed and implemented to relieve non-financial barriers so as to keep investment risks low and enable the financial viability.

b. Net metering

It can be foreseen that the energy resources, in particular those converted into electricity will require an electrical network infrastructure complete with appropriate metering. Net metering is the one potentially universal metering system that accounts for in and out flow (i.e., import and export) of the energy from one source point to load point. The estimated excess kW from source points to the grid in order to meet the daily demand for the respective load point can be identified and the tariff rate structure for commercial offers could be viable through net metering.[19] Studies show, however, that the rate required for sound investment can be high. A study shows that factors including

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[18] This assertion is based on the author's simulation study. The asserted viability must be scrutinized and tested further as ASEAN seems to lack in capital, ability or willingness to pay for such interconnection on behalf of consumers.

[19] Whether excess kW exists in utility networks, especially in the ASEAN region, is debatable as such excess capacity comes from very high PV or wind generation in countries with exorbitant levels of such intermittent generation capacities.

the net metering legislation, the size of the connected energy sources, capital equipment, direct and indirect manufacturing, and operation and maintenance costs can be the major contributor in determining the profitability based on net metering (Payne, Duke and Williams, 2014).

The net metering allows people to trade photovoltaic solar energy but the rate can be expensive. A study in Tunisia shows that net metering for PV Program is practically a good investment but the rates used in the trading are high and not attractive for investment unless the government can introduce a special tariff rate (Bouazzi and Karti, 2003).[20] Another study on USA homeowner using PV system in net metering shows that issues such as solar irradiant level, tax incentive and proper installation can be the key driver to get the money among different sponsor of the demonstration project. The study shows there were significant roles from the installation cost of the PV system with the tax incentive within the use of the net metering system in order to get the monetary benefit of using the PV system with the net metering system with different tax incentive scenario (Sedghisigarchi, 2009).

In order to allow the flow of energy resources across the different ASEAN nations, a policy framework is needed mainly to ensure long term investment is secured and sustainable. In particular to incentivize the infrastructure connectivity, investment over a period of time before the economic return ensues over the life time of network. The policy shall cover areas like regulatory framework to address mechanism for clearing house and rate structure; awareness program to address capacity development and awareness on the ASEAN level opportunity for import/export of electricity via the interconnected grid.; national/ASEAN agenda to support R&D in particular to optimize national resources in order to increase national economic value and contribution to domestic/national production) Thus increase the wellbeing of each nation state in ASEAN.

IV. Policy recommendations

This paper presents three recommendations. First, it suggests establishing an Independent System Operator (ISO) for physical infrastructure connectivity. The ISO will coordinate all grids and distributed generations and dispatch the least cost generation capacity and followed by next expensive generation capacity. Second, it suggest

[20] The requirement of high rate for attracting investment needs a reality check and is debatable as governments cannot guarantee high FIT rates for PV or other renewable energy generation capacity.

benchmarking the Nord Pool for implementing financial infrastructure connectivity. Third, it needs to establish a clearing house for power and natural gas.

In the case of the USA, legislations and policies were implemented at different levels both at the federal and the states in particular to pursue the high usage of energy metering system and various incentives, which benefits USA citizens economically, strengthen the national security and improve health (Singarao and Singh, 2009). A project in Europe tested a project to promote PV through net metering optimization mainly for use of retail customer connections (Christoforidis, Chrysochos and Hatzipanayi, 2013). Whether net metering could help accelerate the interconnectivity in the ASEAN region needs to be examined.

V. Conclusions

Facing a rapid growth in energy demand following a fast growth in its economy, ASEAN needs to increase its power generation capacity. ASEAN does not have much reserve of fossil fuels but has huge potentials in renewable energy, especially hydropower, wind and geothermal energy. However, the supply sources are scattered and the demand sources are far from the supply sources, so linking the supply sources to the demand sources is the key to facilitate the development of renewable energy in the region. Such interconnectivity needs have been well taken care of by ASEAN countries.

ASEAN has well-developed plans for interconnecting power grids (e.g., APG and APG+) and gas pipelines (e.g., TAGP). The interconnected power grids and pipelines encourage the trading of power generated from renewable sources and natural gases in the region, and the interconnected gas pipelines not only facilitate to develop indigenous natural gas but help transport imported natural gas throughout the region. To fully utilize the renewable energy potential, especially from hydropower, geothermal, solar or wind energy, appropriate metering is critical for the successful development of renewable energy.

Apart from connecting the physical infrastructure, the financial infrastructure for power trade also needs to be developed to complete the interconnectivity. For the physical and the financial infrastructure, an independent system operator along with a clearing house for all transactions can be established. The European experiences and Nord Pool could be a good benchmark for this purpose.

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ENERGY TECHNOLOGY - ASEAN Energy Technology Strategy 2015-2030

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Abstract

Over the next two decades, ASEAN's energy demand is predicted to grow by over 80% and electricity demand more than double due to population growth and rapid economic expansion. However there is a wide disparity among the ten member states on energy access and quality of energy services. And while the region's reserve of fossil fuels is fast depleting, its energy consumption continues to be dominated by these carbon-intensive fuels. Thus providing affordable, lower carbon and modern energy services while ensuring equitable access will be a formidable challenge in the next decades for each member state and the region as a whole. One of the key issues in meeting this challenge is ASEAN's capability to adapt and apply best available energy technologies and to innovate energy technology solutions appropriate to the local context. It is revealed in this review paper that, in general, there existed a significant gap between the technologies in stock in ASEAN and the best available technologies (BAT's) globally, be they conventional power generation technologies, renewable energy technologies, or end-use technologies in the industry, transport, commercial and residential sectors. There is also huge knowledge and capacity divide between current, predominant practices and the best practices in energy efficiency within each country and in the design and implementation of supportive policy measures for the development and deployment of cleaner technologies among member states. Taken together, there is significant scope for efficiency upgrading of existing power generation facilities and for efficiency gain through the installation of more efficient, state-of-the-art fossil-based facilities. There are abundant renewable energy sources, particularly bio-based resources for heat, electricity, and transport fuel production, hydro, geothermal and solar energy. Potential exists for the applications of carbon capture and storage (CCS) technology for enhanced oil recovery (EOL) and for power generation and industry sectors, though its feasibility has yet to be determined. Also, opportunities abound for energy saving and, hence CO_2 emission reduction, in all end-use and final service sectors.

However developing countries in ASEAN generally have difficulties to follow, adopt, and implement policies and strategies for the development and deployment of appropriate energy technology options to ensure energy security and access on the one hand, and to limit GHG emissions on the other. This is due to a number of economic and non-economic barriers, ranging from the lack of technical information and capability, financial schemes and investment resources, human capital capacity, to cultural, institutional, and legal barriers and the absence of forward-looking science, technology and innovation policy. For example, even though nearly all member states have implemented pertinent policies and programs with varying degree of success, 15-non

economic barriers, at the ASEAN level, in promoting renewable energy have been identified. Most of the top 5 barriers are related to government failures in providing infrastructure, leadership, reliable information, and incentives.

To move the energy technology agenda in ASEAN forward, it is proposed, first and foremost, that governments set clear and achievable long-term goals/targets, with appropriate implementation strategies. Agencies responsible for establishing strategies and implementing programs (e.g. tendering and evaluation) must be in place, along with program monitoring and evaluation mechanisms. Energy technology development and innovation policies should be sector and end-use specific and their definition and formulation based on clear and achievable objectives and on in-depth consultation with relevant stakeholders: concerned industrial sector representatives, research institution, universities and technology consultants and/or providers. A well-defined technology development plan for 3-5 years could then be developed together with the respective ministries, such as the ministries of economics, industry, finance and energy.

As regards to R&D, research programs should be well defined with a perspective for eventual commercialization, and therefore should cover research, development, demonstration and deployment (RDD&D) aspects. R&D grants should also be awarded on a transparent, competitive basis to collaborative project proposals involving academic institutions and industry partners.

In addition governments should provide easy finance access for innovation and investment in innovative projects through various schemes. Presently, a number of international financing mechanisms/schemes could be accessed by ASEAN countries, particularly in the context of climate or green financing, such as the Private Financing Network (PFAN) implemented by USAID, ADB's Clean Energy Financing Partnership Facility (CEFPF), and the Clean Technology Fund (CTF) – a multi-donor fund channeled through several development banks, etc. While these funds are useful and should continue to be accessed, it is felt that an ASEAN focused trust fund that would support ASEAN specific clean energy technology development and deployment agenda is desirable. It is against this background that the ASEAN Clean Energy Technology Trust Fund (CETTF) is proposed. Its objective is to serve as a key instrument to remove finanacial and other related barriers to the development and deployment of clean energy technologies at the ASEAN level. It is designed to provide financial support on projects, to divert private investors' risks by leveraging with its own funds, and to offer technical assistance to investors, through project loans, grants, and technical knowledge provision and exchange. A preliminary proposal on the fund structure, possible sources of fund, governance and procedures, and examples on the types of projects to be funded are outlined. However, a more detailed definition of the Fund based on broader stakeholder consultation needs to be conducted and in-depth investigation should be carried out to test and validate its feasibility and practicality.

1. Introduction

ASEAN, a vibrant region with a population close to 600 million, is experiencing very rapid economic growth while gearing up for regional economic integration in the name of ASEAN Economic Community (AEC) by 2015. With the region's population predicted to expand by almost one-quarter and the GDP to nearly triple within the next two decades, its energy demand will grow by over 80% and the demand for electricity will more than double. However despite this projected phenomenal growth, the reality at present is that over 20% of the population still have no access to electricity and nearly half of the population rely on the use of traditional biomass. At the same time the region's fossil fuel reserve is fast depleting, turning some of the net energy exporting member states into net importers. The fact that ASEAN's energy consumption is still, and likely to continue to be over the next several decades, dominated by fossil fuels is also a source of concern in the face of increasing threat of climate change, and Southeast Asia being one of the most vulnerable regions on earth. Thus the provision of secure and affordable energy while ensuring equitable access and environmental sustainability will be a formidable task for each member state and the region as a whole.

Because of the relatively long lifetime nature of most energy technologies, one of the critical challenges in meeting the above demands is the choice of technology, since the technology stock in place and in planning now will dictate how efficient and environmentally benign energy will be generated, transmitted or transported, and used over the next decades. This would then have significant ramifications on the security and sustainability of energy supply and use in the region. Other technology-related, critical issues include: the ability to apply and adapt the best available technologies to suit the local physical, social and environmental conditions, the capacity to innovate to lower the cost of energy technologies, and the ability to improve the efficiency of existing or installed facilities.

This paper therefore aims to identify barriers to and opportunities for the deployment of more energy-efficient and less carbon-intensive energy technologies in the electricity supply, transportation, industry and building sectors in ASEAN. It also attempts to analyze and suggest strategies and policy instruments, particularly financing mechanisms that are needed at the ASEAN level to support the realization of those opportunities.

The paper begins with a macroscopic view of global energy flows, energy resources of ASEAN nations and their future demand. A perspective on new energy technologies that will likely shape the global energy landscape in meeting the dual demands of energy security and sustainability is given in section 3. Sections 4 and 5 reviews and takes stock of the predominant type and status of energy technologies currently in use in the major economic sectors in ASEAN, followed by a review of the main types of cleaner energy technologies that should be promoted, over the 2015-2030 period. Section 6 identifies the challenges and barriers to the development and deployment of these technologies, including: technical, financial, investment, cultural, institutional, legal and human capital capacity aspects. Finally section 8 provides recommendations on strategies and mechanisms to remove major barriers to and support for, at the ASEAN level, the development and deployment of more energy-efficient and less carbon-intensive energy technologies.

2. Global Energy Flows and Energy Supply and Demand in ASEAN

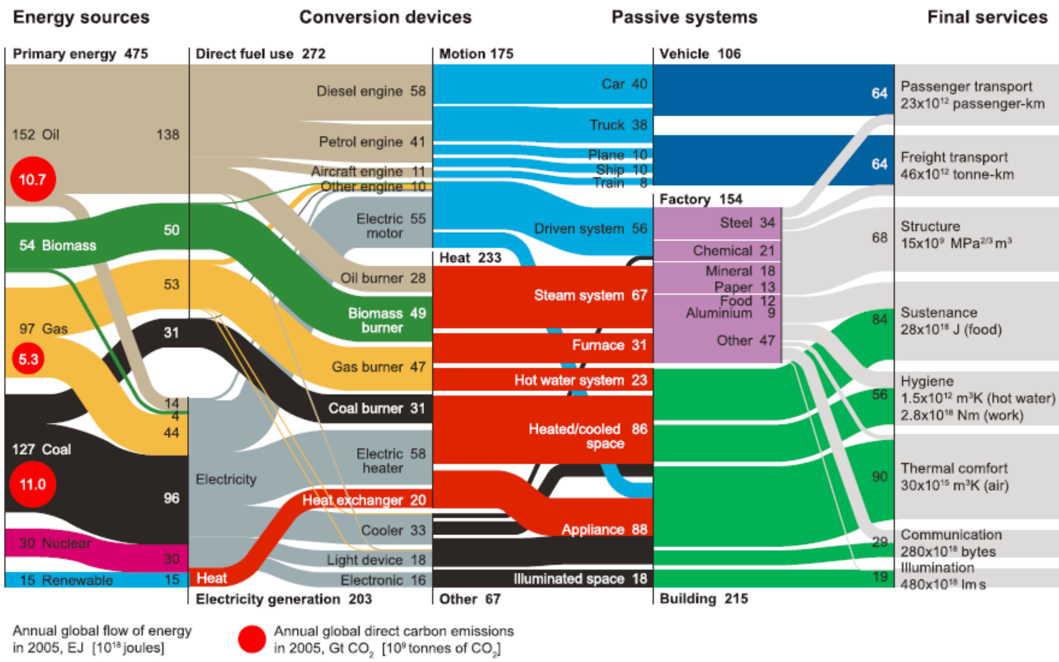
2.1 Global energy flows

Figure 2-1 shows the map of global energy flow through society, from primary energy sources, through different conversion devices to various end-uses or services, as at 2005 (Cullen and Allwood, 2010). Even though the data may be somewhat dated, it serves to demonstrate the nature of the flows, the critical role of energy technology in various stages, and the order of magnitude of the share of each component. For example, the global primary energy mix, shown on the left column, is as follows: 32% oil, 27% coal, 20% gas, 12% biomass, 6% nuclear and 3% renewables (hydro included). It is clear that fossil fuels still dominate, while low-carbon sources (nuclear, biomass, and renewables) make up only 20% of energy supply. Thus de-carbonizing the energy supply remains a formidable challenge when compared with gains from energy efficiency.

The majority, about 70%, of electricity is generated by burning coal and natural gas.

Figure 2-1 From fuel to service:tracing the global flow of energy through society

(Cullen and Allwood, 2010)



On final services side, 45% of total energy is used in buildings, 32% in factories, and the remaining in transportation, which is primarily powered by oil.

Thus efforts should be focused on improving energy efficiency throughout the conversion chain to end-uses. For example, combustion processes should be improved (as over 90% of energy sources are fuels which are combusted), and technical options for converting the chemical energy of fuels directly to electricity, heat, or motion, be explored.

The challenge for *passive systems* is to design technologies that make better use of energy, by preserving and recovering the heat in buildings, the materials in products, and the momentum in vehicles. Improvements can also be made by reducing the demand for final services, through behavioral and lifestyle changes. Furthermore, thermal comfort also ranks high on the list and can be targeted by reversing the practice of using high quality fossil fuels to supply low temperature heat. Significant savings are available from the wider use of heat pump technology and improving the insulation of buildings (Cullen and Allwood, 2010).

2.2 Energy profile of ASEAN nations

Despite having more than 28,000 billion barrels of oil reserves, the member countries of ASEAN (Association of South East Asian Nations, perhaps except Brunei Darussalam) are predicted to become a net importer of oil in the next 5-10 years. Apart from oil reserves, the region has some other natural resources potential such as natural gas and coal, but these resources are fastly depleting due to the rapid global economy growth particularly in developing world. Anticipating to downward movement of these fossil energy resources, most countries have begun developing renewable energy and even consider developing nuclear power plants to reduce their dependence on fossil energy and in some respects to help mitigate the impact of climate change.

The reserves on natural gas, for instance in Indonesia and Malaysia alone, are proven to be more than 5.5 TCM (Terra Cubic Meter) or almost 37% of the reserve available (over 15 TCM) in the whole Asian region. The total reserves of more than 4,300 MMT (Million Metric tonnes) coal in Indonesia (bituminous and lignite), Vietnam and Thailand (lignite) represent the biggest fossil fuel reserves in the region (ACE, 2005; IEA and ERIA, 2013). However, these reserves are relatively low compared to the worldwide reserves.

At of the end of 2011, Indonesia had 13.5 billion tonnes of hard coal reserves and 9.0 billion tonnes of brown coal reserves, ranking tenth- and sixth-largest globally, and by far the largest in Southeast Asia (BGR, 2012). Its reserves have risen significantly since end of 2010 – hard coal by 45% and brown coal by 15% (IEA and ERIA, 2013). Moreover, the country's coal production reached 296 Mtce in 2011, increasing by 15% per year on average since 2000, the largest in the region, followed by Vietnam (IEA and ERIA, 2013). The region's total final coal consumption increased from 248.7 Mtoe in 1997 to 1,620 Mtoe in 2006, to meet the electricity need which gradually increased from 369 TWh in 2000 to 3,600 TWh in 2010 (ACE 2005 and IEA 2008).

The oil price boom in 2007-2008 was the crucial moment for policy makers in ASEAN member countries to consider reducing its dependence on fossil fuels by shifting to other renewable energy resources. According to the prediction by Asian Center of Energy (ACE) (ACE, 2005), the share of generation mix in the region will move towards non-oil fuels. But by 2020, almost 45% of the fuel mix for power generation in ASEAN will still be coal, followed by 40% natural gas and only less than 2.0% oil. The rest of the electricity will be generated either by renewable energy or nuclear power.

Table 2-1 shows the comparison for ASEAN member countries to the world in terms of population, GDP, and energy consumption growth over the past 20 years. It shows that ASEAN's GDP growth has been far ahead of the global average. In contrast to GDP growth, energy consumption per capita growth in most ASEAN member states has been lower than the global average, except for Malaysia and Thailand, where the growth being much higher than the global average.

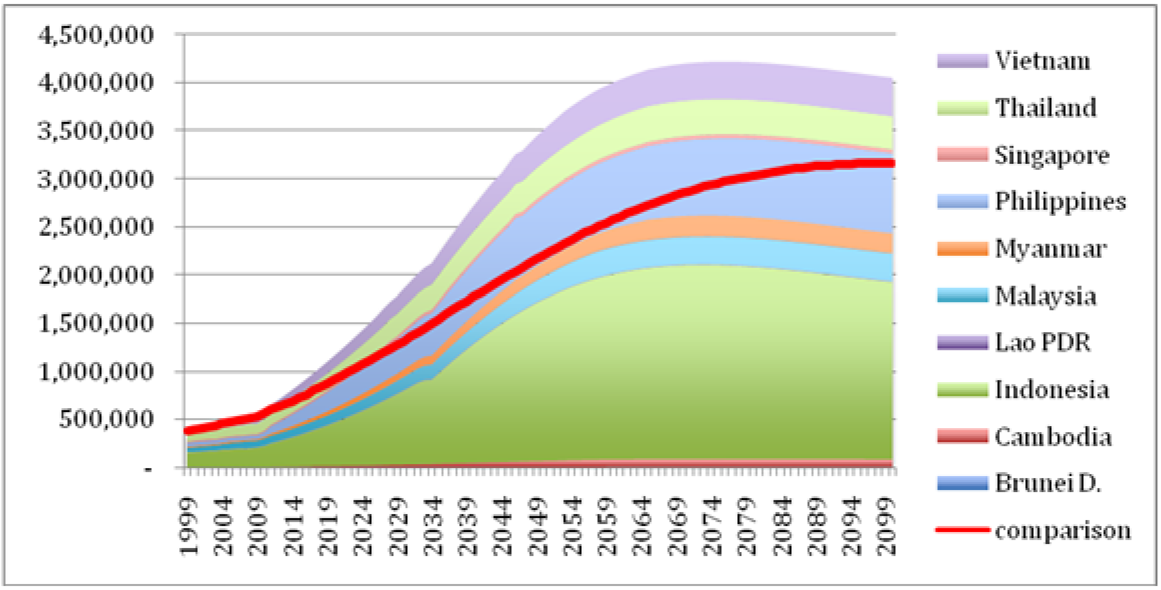
Table 2-1 Demographic and economic growth in relation to energy consumption per capita in ASEAN (GCOE, 2013; AEC, 2005)

Country	GDP [billion US$]			Population [thousand]			Energy consumption [KTOe/capita]			Total area
	1990	2010	Growth (20y)	1990	2010	Growth (20y)	1990	2010	Growth (20y)	Thousand sq km]
Brunei Darussalam	3.5	14	300%	252	399	58%	6.99	7.50	7%	5,765
Cambodia	2.2	11.24	411%	9,532	14,138	48%	n/a	0.32	n/a	181,035
Indonesia	114.4	706.6	518%	184,346	239,871	30%	0.55	0.73	33%	1,904,569
Lao PDR	0.865	7.29	743%	4,192	6,201	48%	n/a	n/a	n/a	236,800
Malaysia	44	237.8	440%	18,209	28,401	56%	1.21	2.02	67%	329,847
Myanmar	2	19	850%	39,268	47,963	22%	0.27	0.28	2%	676,578
Philippines	44.3	119.6	170%	61,629	93,261	51%	0.47	0.52	12%	300,000
Singapore	36.1	208.7	478%	3,017	5,086	69%	3.80	4.91	29%	683
Thailand	85.3	318.5	273%	57,072	69,122	21%	0.73	1.15	56%	513,115
Vietnam	6.5	106.4	1537%	743	1,124	51%	0.36	0.47	29%	331,689
World	21,900	63,120	188%	5,306,425	6,895,889	30%	2.27	3.12	37%	n/a

2.3 Future energy supply and demand in ASEAN

The true challenge in the region is not coming from its limited fossil fuel supply, the vast growing energy demand shows staggering fact to be faced for all nations in the region. The energy consumption prediction should show less disparities in order to optimize the regional energy policies. Study done in Kyoto University Energy Science as shown in Figure 2-1 by considering not only demographic and economic pictures as its variables but also considering the geographical and landscape challenge into the model, shows an approximate more than 5-15% higher energy consumption from year 2020 up to 2100 compare to the common forecast on energy consumption. With the assumption on the population and economic growth mentioned in table 2.1.

Table 2-2 Predicted energy demand between BAU and model in MTOe (red; BAU) (in MTOe) (GCOE, 2013)



When considering the potential future scenarios for energy in ASEAN, it is important to consider that all of these developing nations will at some stage attain 100% electrification rate and close to 100% share of modern fuels in residential energy mix. The crucial elements will be at what level of final energy consumption, what efficiency rate and from what mix of primary energy sources that energy will be provided (Keiichi et al., 2013). To transition from a fossil based energy system to a more sustainable system, strong policy to improve energy efficiency should be a high priority, as there is significant room for improvement in the current system.

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3. Global Energy Technology Perspective

3.1 Power Generation: Centralized and Decentralized

The past five years have seen major changes in power infrastructure development trends around the world. Emerging technologies like solar and wind have experienced dramatic price decreases – up to 80% decrease over a decade for wind power generation and up to 50% decrease over the past five years for solar power generation[21]. This trend of decreasing prices combined with technologies that are more robust, efficient and are increasingly able to generate power even in suboptimal conditions such as low wind speeds and low solar irradiation has moved renewable energy technologies from niche to mainstream[22] (IRENA, 2014). According to the IRENA report, *Rethinking Energy*, global renewable power capacity has reached 1,700 GW in 2013, constituting about 30% of all installed power capacity and renewables have accounted for more than half of net capacity additions in the global power sector since 2011.

Unlike large-scale power infrastructure like coal and hydropower technologies, emerging renewable energy resources are generally site-specific and mostly small-scale thus making this energy resource economically suitable for off-grid systems, micro-grid systems or for deployment at the distribution level. In rural or off-grid areas, this is served by renewables like biomass, biogas and wind power, while for urban areas decentralized power largely comes from solar power and combined heat and power systems (CHP) for providing electricity for example district cooling. In addition, solar power will be increasingly contributed to decentralized power in urban areas through rooftop and building integrated. As these power sources are located close to the point of consumption, electricity transmission losses are greatly reduced and energy security and flexibility is improved with a more diversified energy mix. The increase integration of variable renewable energy into the grid requires the transformation of the whole energy system (IEA, 2014b). The transformation of renewable energy requires many aspects e.g. smart grid, DSM, energy storage. The technology for the transformation of energy system already mainly exists but the economic aspects have yet to be how to optimize and to make use of various technologies. It requires energy regulatory in the country that affect to grid.

[21] GE Workout Presentation in KL

On the other hand, power grids are traditionally designed to allow only a unidirectional flow of electricity from source to load, which means that adding a power source at the load point can cause disruptions to the overall system, especially if the power source is intermittent. This challenge has generally been mitigated with improvements in smart grid, power grid and energy storage technologies.

In recent year, several events like the Fukushima Nuclear Accident in 2011, the shale gas revolution in United States and China's PM2.5 air pollution crisis has sparked public concerns on how energy is being extracted and generated and how it will impact public health and the environment. The ensuing pressure has encouraged more development and deployment of more sustainable energy technologies that include cleaner coal technologies, high efficiency thermal power technologies and research into carbon capture,utilization and storage (CCUS) technologies.

Coal thermal plants employing ultra-supercritical coal technology are now able to reach up to 46% thermal efficiency, with advanced technologies like integrated gasification combined cycle (IGCC) and pressurized fluidized bed combustion (PFBC) enabling even higher efficiencies, expected to be up to 50% in the future (WNA, 2014). Gas power plants are less controversial than nuclear, produce less emissions than coal combustions, has shorter start and shutdown times than both, and with the shale gas revolution and improving LNG technologies, is becoming more easily available and to transport. Furthermore, with its dispatchable and flexible operations, gas power plants can complement the variable nature of renewables, thereby enhancing the transition to a cleaner and more secure energy future.

For nuclear, the IEA Energy Technology Perspectives reports that global nuclear capacity is stagnating at this time. This is due to safety regulations and public opinion of this resource becoming stricter after the Fukushima Nuclear Accident in 2011, making it extremely difficult for new nuclear capacities to come online. In Japan, as of July 2014, all nuclear facilities are still offline and under inspection. On the other hand, the heightened scrutiny of nuclear power facilities have brought about more stringent safety and security protocols, which would ultimately ensure that the development of global nuclear power programs will take place in a safe, efficient, responsible and sustainable manner (IAEA, 2014).

In summary, it is clear that the power generation industry is in a state of transition, shifting from fossil fuels to renewables, moving towards higher efficiencies across the board and becoming more decentralized with the support of improved power grid and energy storage technologies. It is vital that this transition is managed holistically and effectively to ensure a sustainable future for all.

3.2 Industry

3.2.1 Technology penetration

According to the Energy Technology Perspective 2014 (IEA, 2014) the global industrial energy use reached 143 EJ in 2011, up 36% since 2000. The increase is largely fuelled by rising materials demand in non-OECD countries, which now use 66% of industrial energy, up from 50% in 2000. Growth in industrial energy use must be cut to 1.7% per year in the period from 2011-25 compared with 3.3% per year in 2000-11 to meet the 2DS (or the 2-degree Celsius scenario to mitigate climate change) targets set by the IEA for 2050 (IEA, 2014a).

Similarly, trends in industrial CO_2 emissions must be reversed: from 2007 to 2011, emissions grew by 17% by 2025, they must be reduced by 17% to meet 2DS targets (IEA, 2014a).

Improvements in energy efficiency have offset the upward effect of structural changes in the industrial sector, such that overall industrial energy intensity is decreasing; in 2011 most regions were below a level of ten gigajoules (GJ) per thousand USD purchasing power parity (PPP) of industrial value added. China (2.4%) and India (1.9%) have had the highest annual reductions since 2000. Thanks to high shares of new capacity. China is now among the world's most energy-efficient primary aluminum producers (IEA, 2014a).

Substantial potential to further improve energy efficiency exists. By applying current best available technologies (BATs), the technical potential to reduce energy use in the cement sector is 18%, 26% in pulp and paper, and 11 % in aluminum (IEA, 2014a).

These potentials are unlikely to be fully tapped by 2025 due to slow turnover of capacity stock, high costs and fluctuation in raw material availability. Meeting 2DS targets will also require resolving challenges related to increased use of alternative fuels and clinker substitutes, and greater penetration of waste heat recovery (WHR) in the cement sector, among others (IEA, 2014).

3.2.2 Market creation

Energy management systems (EnMS) can be effective tools to enable energy efficiency improvements, but in most countries they are still voluntary. In 2013, China mandated provincial-level implementation of energy management program in companies covered by the Top-10 000 Program, an energy conservation policy for large energy users. In the United States, pilot companies in the Superior Energy Performance program on average improved their energy performance by 10% in 18 months. The Australian Energy Efficiency Opportunities program, which is mandatory for large energy users, was estimated to have enabled 40% energy savings in participating firms (IEA, 2014). A growing number of industrial sites have certified EnMS (ISO 50001) in place: 6 750 in 70 countries in March 2014, up by more than 300% over the previous year (Peglau, 2014).

3.3.3 Technology developments

Innovative energy-saving technology developments have been relatively slow in energy-intensive industries over the last decade and need to accelerate: in the 2DS for instance, deployment of CCS starts before 2025. To stimulate investment in CCS, industry is investigating opportunities for CO_2 use in EOR and developing processes that use CO_2 as a feedstock (e.g. in polymer production). In pulp and paper, the Confederation of European Paper Industries (CEPI) announced in 2013 promising lab-scale results of deep eutectic solvents (DES) allowing the production of pulp at low temperatures and atmospheric pressure, Applying DES-based pulp making throughout the sector could reduce CO_2 emissions by 20% from current levels by 2050 (CEPI, 2013).

3.3 Buildings

The global trend for energy performance of building is to achieve near zero net energy (NZEB). This means the import and export ratio of energy tends toward 1:1. This vision in achieving NZE for building is considered highly challenging and the measure used for determining this energy balance is still being debated (Crawley, 2009; Deng, 2014). Despite the ambiguity, different economic zones, like the European Union (EU), has introduced the EU energy performance of buildings directive which sets targets achieving near NZEB buildings (EU, 2014).

Energy technology for NZEB comes in the forms of building designs, equipment, and control. In building designs, the form factor, tightness, envelope materials, and orientation, all combine to determine the heat transfer between the outside and inside of the building (Sadineni, 2011; Sozer, 2012; Pacheco, 2012). The technologies targeted on the envelope materials, involves new designs and new materials, for example composite cavity walls infused with phase change materials (PCM). The use of coatings will be dominant as this approach is effective for existing building. Coating technology has the function of reducing thermal conduction and solar heat gain, these parameters are measured in terms of U-value, and g-value, respectively. Building integrated energy harvesting claddings are increasingly being used as building envelopes.

To achieve NZEB, the energy use intensity has to be improved, and renewable energy harvesting capabilities has to be installed (Li, 2013; Oliveiri, 2014; Andersonn, 2013; IPCC, 2014). The control system, or more commonly refer to as the energy management system (EMS), plays an important role in binding the equipment and the renewable energy sources.

The matrix of benefits versus risk, prepared by Anderson&Roberts (2013), showed the high impact and low risk technologies are centred on climate control. The use of combined cooling, heating and power (CCHP), and a combination of renewable energy sources will dominate, as standalone systems, or as a collective community level system.

3.4 Transport

To respond to the global challenge of climate change, energy technologies in the transport sector are always deemed an important component of greenhouse gas emissions reduction options. These technologies are widely examined by an analytical approach called ASIF (Facanha et al., 2012, Bongardt et al., 2013, Sims et al., 2014)

- ***Avoiding or shortening journeys (A)*** by, for example, densifying urban landscapes, sourcing localized products, internet banking, internet shopping, and utilising information and communication technologies (ICTs), such as tele-conference, navigator system. Smart land-use planning in a compact city could save energy in a sustainable manner for long-term periods.
- ***Mode shift (S)*** to lower-carbon transport systems – encouraged by increasing investment in public transport, walking and cycling infrastructure, improving railways, water transport, logistic systems to become more attractive for users. Mass rapid transit system (MRT) which is well-connected with feeder systems (e.g., light rail transit, bus) is crucial to shift private car users to public transport for a large city. Bus rapid transit system (BRT) a bus service with dedicated lanes that can be a backbone system for a small to medium-sized city, instead of MRT, which can be developed with lower investment and shorter period of construction. However, preserved spaces on roads for the BRT system is needed to avoid future objection from private car users.
- ***Lowering energy intensity (I)*** by enhancing vehicle and engine performance, using lightweight materials, increasing freight load factors and passenger occupancy rates, deploying new technologies such as electric-drive vehicles; hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), and battery electric vehicles (BEV). HEV has been fully commercialised in many countries. BEV is promising technology to reduce oil-based fuels and pipe-line emissions,

but cost-effective electricity supply infrastructure and storage for vehicles are still the main challenges for the widespread use. Combining batteries and internal combustion engines (ICE), i.e. PHEV would be a solution during the transition period (IEA, 2014a). Technologies for on-road vehicles such as idling stop system, fuel-efficient tyres can improve energy efficiency in the range of 3-10% (Sims et al., 2013 and Kojima, 2012)

- ***Fuel choice (F)*** by shifting to efficient and low-carbon content fuels, including electricity and hydrogen.

3.5 Carbon dioxide capture and storage (CCS)

Carbon-dioxide capture and storage (CCS) technologies could reduce carbon dioxide equivalent (CO_{2eq}) life-cycle emissions of fossil power plants, and their deployment in both power and industry is critical to address climate change. Indeed at the global level, atmospheric greenhouse gas mitigation scenarios reaching 450 ppm CO_{2eq} by 2100 (to prevent exceeding the two-degree Celsius rise in global temperature) are characterized by tripling to nearly quadrupling of the share of zero and low carbon energy supply from renewables, nuclear energy, and fossil energy with CCS (IPCC, 2014). Although all of the components of integrated CCS systems exist and are in use today by various industry sectors and significant progress is being made in demonstrating elements of capture, transport and storage, CCS has not yet been applied at scale to a large, commercial fossil-fired power plants. As of end-2013, eight large-scale CCS projects – all using anthropogenic CO2 for enhanced oil recovery (EOR) - are in operation. However two of the first projects built in the electricity sector are among nine large-scale projects that are under construction (IEA, 2014a). Applying CCS in an electricity generation facility incurs substantial efficiency penalty and addition capital investment. Up scaled commercial operation of CCS in this sector is therefore unlikely without stringent limits on GHG emissions or regulatory mandates requiring the installation of CCS. In addition, there are other significant barriers, including concerns about the operational safety and long-term integrity of CO_2 storage as well as transport risks. There is, however, a growing body of literature on how to ensure the integrity of CO_2 wells, on the potential consequences of a pressure build-up within a geologic formation caused by CO_2 storage (such as induced seismicity), and on the potential human health and environmental impacts (IPCC, 2014 and IEA, 2014a)

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4. Current Stock of Energy Technology in Use in ASEAN

4.1 Power production and distribution

Since 2002, the number of people in the ASEAN region without access to electricity has decreased by around 60 million, despite the growth in population. While this is a positive achievement, yet, access to modern energy services is still limited for several ASEAN member states, with the exception of Brunei Darussalam, Malaysia, Thailand and Singapore. In 2011, as many as 134 million people in Southeast Asia, or 22% of the region's population, still do not have access to electricity and around 280 million people rely on the traditional use of biomass for cooking, almost half of the region's population (see Table 4-1). These numbers actually exceeds the global average in the same year whereby the share of world population without access to electricity is 19% while the share of world population that still relies on biomass for cooking is 39% (IEA, 2011).

Table 4-1 Access to modern energy services in ASEAN (IEA, 2013)

	Population without access to electricity		Population relying on traditional use of biomass for cooking*	
	Million	Share (%)	Million	Share (%)
Brunei Darussalam	0	0%	0	0%
Cambodia	9	66%	13	88%
Indonesia	66	27%	103	42%
Lao PDR	1	22%	4	65%
Malaysia	0	1%	1	3%
Myanmar	25	51%	44	92%
Philippines	28	30%	47	50%
Singapore	0	0%	0	0%
Thailand	1	1%	18	26%
Vietnam	3	4%	49	56%
Total ASEAN	**134**	**22%**	**279**	**47%**

* Preliminary estimates based on IEA and World Health Organization (WHO) databases. Final estimates for 2011 will be published online at *www.worldenergyoutlook.org*.

At the same time, ASEAN is a fast growing region and IEA predicts that the regional GDP will nearly triple between 2011 and 2035, while population will expand by almost one-quarter (IEA, 2013). Both these factors will drive energy demand to increase by over 80% over the same time horizon. For the power sector, electricity demand will more than double from about 600 TWh in 2011 to about 1500 TWh in 2035 (IEA, 2013). The technology stock in place and in planning now will dictate how electricity will be generated and transmitted over the next 20 to 50 years, which would then have significant ramifications on the energy security and energy sustainability in the region. Ideally, the current and new stock chosen will be of the latest and most efficient technology available but as will be seen in the following discussions, this may not always be the case.

4.1.1 Conventional power production technology

Traditionally, electricity is produced and managed centrally by utilities and the technology utilized depends on the resources availability in the country, which could either mean exploiting already existing resources or imports. This is obviously reflected in ASEAN, for instance, Brunei Darussalam as a major gas producer relies almost exclusively on gas power technologies for its electricity supply whereas Singapore with limited resources on its own imports fuel from neighboring countries and abroad. The power capacity developed would then depend on the expected demand requirements of the country.

As of 2011, ASEAN electricity is largely fueled by fossil fuels, namely coal, gas and oil. Gas currently dominates the mix, but cheaper coal will likely overtake gas in the future given the large number of units being added around the region within the next decade. One example is Indonesia with plans to add over 10 GW of coal power capacity under the 10,000 MW Accelerated Power Program Phases I and II.

According to IEA, the existing stock for coal power in ASEAN has an average efficiency of about 34% (IEA, 2013), which is quite low considering that current ultra-supercritical coal technologies are able to reach up to 46% efficiency. This is due to the proliferation of subcritical coal power plants already existing in the ASEAN power systems, and which will remain in operation for at least another 20-30 years. The choice of how efficient the technology to be added depends largely on the cost and highly efficient cleaner coal technologies (CCT) can be prohibitively expensive, and some are still in demonstration process. Cleaner coal technologies describe technologies and industry practices that enhance coal derived generation efficiency including coal gasification, carbon capture and storage, and conversion of coal to chemical fuels.

The resulting trade-off from choosing less efficient technologies will be higher fuel costs and increased emissions; especially over the long term as coal power plants have a technical lifetime of over 30 years. However, given the rapidly growing electricity demand in the region, particularly to cater for the population newly gaining access to electricity and the urbanizing population, power planners are under pressure to provide capacity as quickly, securely and as economically as possible; so this may also be a factor to mature coal technologies being chosen rather than new, more efficient cleaner coal technologies.

To accelerate the deployment of cleaner coal technologies in ASEAN, its member countries have listed 4 strategies under the Coal and Clean Coal Technology Program Area of the ASEAN Plan of Economic Cooperation 2010-2015 which are:

- Strengthen Institutional and Policy Framework and build an ASEAN Coal Image
- Promote coal and Clean Coal Technologies (CCT)
- Promote Intra-ASEAN Coal Trade & Investment
- Enhance environmental planning and assessment of coal projects

For gas power technologies, there are still a number of open-cycle turbines in operation around the region, but with increasing realization of the benefits of the more efficient combined-cycle gas turbines, there has been a definite shift towards this technology over the past decade which will likely continue in the future. Other factors like dwindling gas reserves and increasing gas prices may also play a role in this development, for instance, gas producer Malaysia and Thailand have begun to import LNG in 2013. Thus, it makes economic sense for these countries to begin repowering or replacing open-cycle turbines with combined-cycle gas turbines and thus improve fuel utilization. Instead of using inefficient open-cycle gas turbines for meeting peak load, the economy could consider employing demand side management or RE to shave or shift demand peaks, or dispatching the hydropower stations available under its portfolio to meet peak demand.

Besides fossil fuel technologies, hydro also plays a small but significant role in ASEAN electricity mix, up to 10% of the electricity generation in 2011 was hydropower. ASEAN has significant potential in this area, and there are already several large-scale hydropower projects in operation and under construction especially in the Greater Mekong sub-region. The ASEAN Power Grid (APG) project is a big factor driving this development as in enables countries with limited energy resources to purchase electricity from countries with abundance of hydro resource, but lower demand. However in some countries, particularly Thailand, plans to build large storage dams for hydropower have met with strong public resistance. Here improving the efficiency of existing hydropower plants and building more eco-friendly alternatives like run-of-river type power plants should be investigated. Such strategies have been widely adopted in the US and Europe.

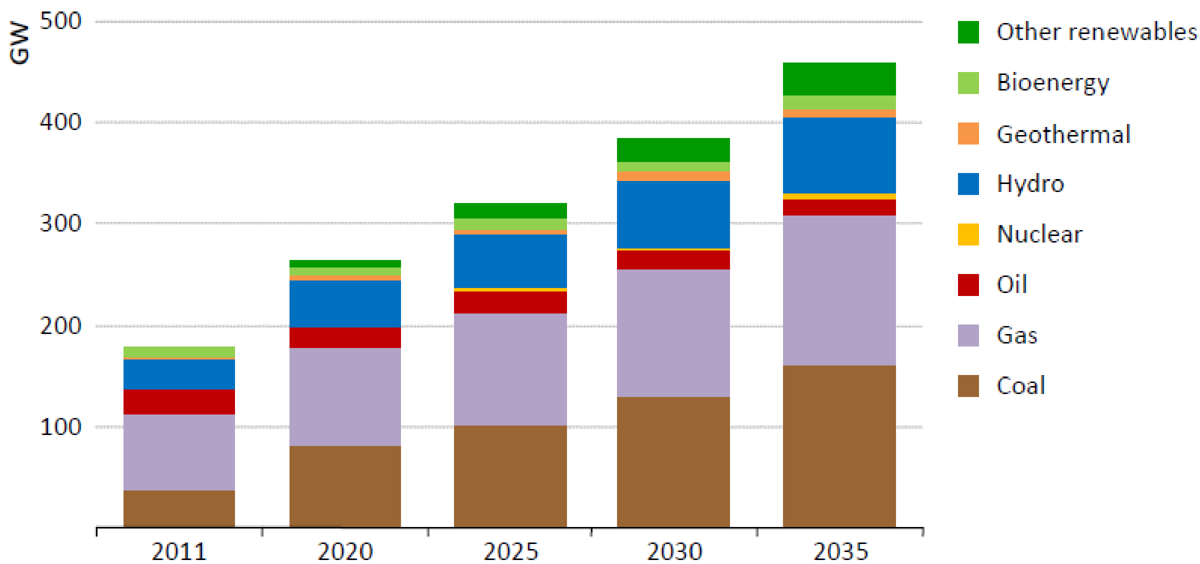
A third type of existing power technology is nuclear, for now, ASEAN does not have any nuclear power capacity. Prior to the Fukushima Nuclear Accident 2011, several ASEAN member states were in the early stages of feasibility studies towards adding nuclear power capacity to their electricity mix, this includes Indonesia, Malaysia, Thailand and

Vietnam, with concrete dates of commissioning for the early 2020s. After May 2011, these plans have been reconsidered; with only Vietnam forging ahead with the first 2GW plant in Phuoc Dinh expected to begin construction in 2017 or 2018 (WNA, 2014)

4.1.2 Renewable energy technology

ASEAN has a fast growing energy demand driven by its economic and demographic growth. ASEAN's primary energy requirement (Reference Scenario) is projected to triple between 2005 and 2030 by an average annual growth rate of 4%. While being highly dependent on oil and gas imports, the issue on climate change mitigation will pose constraints on the use of coal, which is the dominant energy source of the region. Therefore, meeting the region's energy needs is a challenge and diversification of energy resources as well as seeking for any available and possible energy resources should be pursued. In 2011, the contribution of renewable energy share in ASEAN power generation was 29.3%. Biomass is the second largest source of renewable energies after hydropower and accounts for 3.6% of total power generated, as shown in Figure 4-1.

Figure 4-1 ASEAN electricity generation capacity (IEA, 2013)



4.1.2.1 Biomass and Bioenergy

Biomass is an important energy source since it is renewable, widely available, carbon-neutral and has the potential to provide significant employment in the rural area. The utilization of biomass as an essential energy resource is increased continuously. In ASEAN, energy from biomass such as wood and agricultural residues represents about 12.41% of total renewable energy consumption in 2011. Wood and agricultural wastes are widely used as fuels in the domestic sector and small-scale industries for cooking and heating, while modern biomass systems including combined heat and power generation and large-scale power plants are also adopted in many countries such as Indonesia, Malaysia, the Philippines and Thailand. Sugar/starch rich and oil rich plants have also been used as raw materials for bioethanol production mainly in Thailand and biodiesel mainly in Malaysia, Indonesia and Thailand. Nevertheless, energy production from biomass still has a significant potential since a large portion of biomass is still under-utilized. Moreover, increasing potential of energy crops and development of plant yield improvement technology will extend the bioenergy potential even more. Therefore, biomass is considered as a major issue in both national and regional future strategic energy planning as an alternative primary energy source for the energy demand.

Among biomass technologies for heat and power generation, combustion is most commonly used in all ASEAN countries, except Brunei and Singapore which do not have or have a limited biomass resource. Biomass combustion applications include tradition uses for cooking and heating, heat and steam generation or combined heat and power generation (CHP) in industry and large-scale power plants. In some countries like Malaysia, Thailand and Vietnam, biomass combustion for electricity, heat and CHP is considered as fully commercial with local capability for manufacture. However, very high efficiency boilers and related components are still imported from China, Japan and Europe. Large-scale biomass power plant projects are also implemented in Laos and Philippines solely by foreign companies. Types of technology are mainly grate fired and some are fluidised bed.

Apart from combustion, biomass gasification has also been adopted for heat and power production but for smaller scales with many for rural energy purposes. Many countries in ASEAN have developed gasification technology in different stages. The technologies are found to come from imports as well as self development. The major barriers for biomass gasification for power generation are similar in all countries, including the problem of high tar content in product gas, the lack of technical skills and the need of local development to reduce the cost of technology.

Anaerobic digestion of organic wastewater to produce biogas for heat and power production has also been in practice in household and industrial sector. Among ASEAN countries, Thailand and Malaysia are considered as the technology leader for both development and implementation of biogas production.

4.1.2.2 Geothermal

Unlike other renewable resources, geothermal is a mature technology that is dependable as a base-load. However, development is tied to locational potential. Out of the ten ASEAN economies, the Philippines and Indonesia have the biggest geothermal resource potential. The Philippines currently ranks second in the world after the US for the highest geothermal capacity. Indonesia is building up several geothermal capacities, about 49% of the 10,047 MW of new capacity to be built under the 10,000 MW Accelerated Power Program Phase II will be geothermal-based. Malaysia will also be exploring its geothermal resource for the first time next year.

4.1.2.3 Solar and Wind

Several ASEAN countries are offering attractive incentives like feed-in tariffs and tax exemptions to encourage solar and wind development, particularly for solar PV since ASEAN countries are located near the equator with reliable solar irradiance throughout the year. As a result, a large number of solar PV systems are now already in operation in different forms, including solar rooftop installations (solar PV are placed on the roof, this is very popular for residential buildings and factories), building-integrated systems installations (solar PV modules are integrated into the building, acting as walls or roofs) and solar farms installations (ground installed modules). Thailand and Malaysia are also exploring the potential for concentrated solar technology, although this is still in experimental stage since the technology is more suited for desert climate, where direct radiation is more intense.

4.1.3 Carbon Capture, Utilization and Storage

Carbon Capture and Storage (CCS) is a technology that can capture up to 90% of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes (CCSA, 2014), and their deployment in both power and industry is critical to address climate change. Indeed at the global level, atmospheric greenhouse gas mitigation scenarios reaching 450 ppm CO2eq by 2100 (to prevent exceeding the two-degree Celsius rise in global temperature) are characterized by tripling to nearly quadrupling of the share of zero and low carbon energy supply from renewables, nuclear energy, and fossil energy with CCS (IPCC, 2014). The CCS chain typically consists of three components:

1. Capturing the carbon dioxide
2. Transporting the carbon dioxide
3. Securely storing the carbon dioxide emissions either underground in depleted oil and gas fields or deep saline aquifer formations.

Although all of the components of integrated CCS systems exist and are in use today by various industry sectors and significant progress is being made in demonstrating elements of capture, transport and storage, CCS has not yet been applied at scale to a large, commercial fossil-fired power plants.

According to the Global Status of CCS Report released in February 2014, there are 21 'active' large-scale CCS projects (those in operation or under construction) globally with twelve already in operation. Seven of the projects in operation are in the US, 2 in the EU, one in Canada and one each in South America and Africa (GCCSI, 2014). Two of the projects nearing completion in North America will be the first developed for the power sector.

So far, there have been no definite plans yet towards installing CCS facilities in any of the ASEAN member states, but the technology has generated a lot of interest and feasibility studies. An ADB report released last year identified possible key sites for CCS development in four out of the ten ASEAN countries: Indonesia, the Philippines, Thailand and Vietnam.

4.2 Current stock of Energy Technology in Use in ASEAN

The concept of green building is well understood in ASEAN, and this is reflected by the various localized forms of sustainable building assessment standards found in ASEAN. The technology used to achieve energy savings and sustainability are off the shelves products widely available and the global market.

4.2.1 Commercial

In the commercial sector, the energy saving of buildings are benchmarked using local measures like Green Mark, Lotus, TREES, or using standards from outside the ASEAN region such as CASBEE or LEED. As space cooling takes up 60% of the energy use of buildings, the technology for control and CCHP are main focus. Several organizations provide the guidelines and standards for the 6 member countries (TGBI, 2014; VGBC, 2014; BCA, 2014a; PHIBC, 2014; MGBI, 2014; GBCIN, 2014). Currently, only 6 out of 10 ASEAN member countries have working energy performance measurement standards. There is no indication of a regional ASEAN standard, like the EU energy performance of building directive.

Buildings achieving green or sustainable status based on local or regional measures like Green Mark, Lotus, TREES, or those based on standards outside ASEAN like, CASBEE and LEED are all commercial or public buildings. As space cooling takes up 60% of the energy use of buildings, the technology for control and CCHP are the main focus.

4.2.2 Residential

The focus on energy saving on residential buildings are mainly for high rise tower blocks rather than small, below 500 sq.m. floor area, standalone buildings (BCA, 2014b). The use of building integrated solar photovoltaic and solar thermal are popular for the residential sector (Sharpe, 2014).

4.3 Industry

Industry is presently the largest end-use sector in ASEAN, with energy demand accounting for 30% of total final consumption in 2011. Industry has seen rapid growth in energy consumption in line with a move towards more energy-intensive manufacturing activities at the expense of agriculture. In the New Policies Scenario* of the IEA Special Report on Southeast Asia Energy Outlook, final energy consumption in this sector is projected to grow at an average annual rate of 2.7% through 2035, driven by a continued structural shift from labor-intensive activities to more energy- intensive ones (IEA, 2013).

In ASEAN'S major economies (primarily Indonesia, Thailand, Vietnam, Malaysia and the Philippines), a growing manufacturing sector is increasing demand for cement, steel, brick/ceramic, glass, pulp and paper, plastics, chemicals, food processing, and textiles. The manufacture of these products involves energy-intensive processes and, taken together, they make up a very high proportion of total energy demand in the industry sector. In Thailand, for example, the non-metallic materials (cement, ceramics and glass), food & beverage, chemicals, paper & pulp and basic metals sectors combined make up about 85% total industry energy demand (EPPO, 2011). In comparison to world best practices (WBP), the average specific energy consumptions (SEC) or energy demand per ton of products of these industries are generally quite high, even in the case of modern cement and chemical plants. Table 4-2 compares the average Thai SEC of some industries with WBP, and with Thai best practice (TBP). It is shown that while some production processes are already quite efficient with SEC/WBP of around one, other processes still consume up to 2-3 times the amount of energy needed for WBP. Note that in the chemical/petrochemical industries, the product range and specifications vary widely, it is difficult to compare the SEC with WBP. The best that could be done is to compare the average SEC with the local best, in this case, the TBP, which shows a wide gap. Therefore there is much room for energy efficiency improvement in the industry sector in Thailand and in ASEAN as a whole both in existing processes and in new plants to be installed (Roland, 2011).

Table 4-2 Average Specific Energy Consumption in major energy consuming industries in Thailand (JGSEE, 2011)

Production process or product type	Comparison to WBP (times)	Production process or product type	Comparison to TBP
Cement (raw materials preparation)	3.1	Chemicals	
Cement (kiln)	1.3	(primary products)	1.0 – 2.2
		(downstream products)	> 4
Ceramics (floor tiles)	1.1	Petrochemicals	
Ceramics (sanitary products)	2.3	(midstream products)	1.1
		(downstream products)	3 - 15
Flat glass	2.3		
Scrap metal arc furnace (different products)	1.2 – 1.4		
Billet heating (different forms of metal)	1.2 – 2.2		
Food (sugar)	1.3		
Food (Canned vegetables/fruits)	1.9 – 2.1		
Food (Frozen seafood)	1.1		
Feed meals	1.1 – 1.3		

Note: WBP = World Best Practices, TBP = Thai Best Practices

**The New Policies Scenario is the central scenario of the IEA report, which incorporates policies and measures that had been adopted as of mid-2013 that affect energy markets, as well as other relevant commitments that have been announced.*

4.4 Transport

4.4.1 Alternative fuels

Alternative fuels that are currently used for transportation in ASEAN are biodiesel and ethanol. Major biofuel-producing countries include Indonesia, Malaysia, Philippines and Thailand. Indonesia and Malaysia are two largest palm oil producers – jointly producing 85% of world's production, while Thailand is leading in ethanol production in the region. Main drivers for the development of biofuels in the region are energy security and socio-economic concerns; reducing oil import dependence at the same time to boost up income generation for farmers, while, climate change is a minor driver. Current blending ratios of biodiesel for Malaysia, Indonesia and Thailand are 5% and 2% for Philippines. Palm oil is major feedstock to produce biodiesel, while Philippines use coconut oil. Cassava main is feedstock to produce ethanol in Thailand, while Philippine use sugarcane (Kumar, 2013). Thailand has a mandate for E10, while, E20 and E85 are already available at 2,888 stations nationwide, as of July 2014. Furthermore, Thailand has concrete targets to utilize biofuels; ethanol for 9.0 million litres per day and biodiesel for 7.2 million litres per day, by 2021. This target is equal to 15% of the aggregate total of gasoline (includes ethanol) and diesel (include biodiesel). Thailand also has tax reductions for flexible-fuel vehicles (FFV), which are designed to run on a blend of 20-85% ethanol.

4.4.2 Energy efficient vehicles

Energy efficiency policies in the transport sector have shown signs of improvement, though no country in the region has introduced fuel economy standards (IEA, 2013). Thailand is developing mandatory standards and has introduced a tax reduction for the purchase of cars with average fuel consumption of no lower than 20 km/litre and meeting at least Euro 4 emissions standards for passenger vehicles which is so called Eco-cars. Governments in ASEAN are promoting green and environmental friendly technology. Indonesia is considering fuel-economy standard, while Singapore has already the mandatory fuel economy labeling and rebates for cars with low carbon emissions and penalty for cars with high emissions. Since 2009, green car demand has been growing at an average of 130% p.a. in ASEAN; 6% penetration in Malaysia and 17% in Thailand (Frost & Sullivan, 2014). Hybrid cars are being promoted with tax incentives in Thailand, Malaysia and Philippines.

4.4.3 Mass transit systems

Bus services are basic public transport system to move mass of people in ASEAN cities. Mass rapid transit (MRT) systems have been developed for several decades to alleviate traffic congestion in mega cities. However, progress is slow and largely limited by financial and governance factors, except Singapore which is leading in MRT systems in the region. Bangkok and Kuala Lumpur are expanding MRT lines to provide more coverage networks. ASEAN has increasingly focused on developing sustainable transport systems, and emphasized the development of cost-effective mass-transit systems, i.e., Bus rapid transit (BRT) systems. Indonesia is leading in BRT systems in the region, introduced the first BRT system in 2004 in Jakarta and led the launch of similar systems in other cities, such as Yogyakarta, Batam, and Bandung (Global Mass Transit, 2011)

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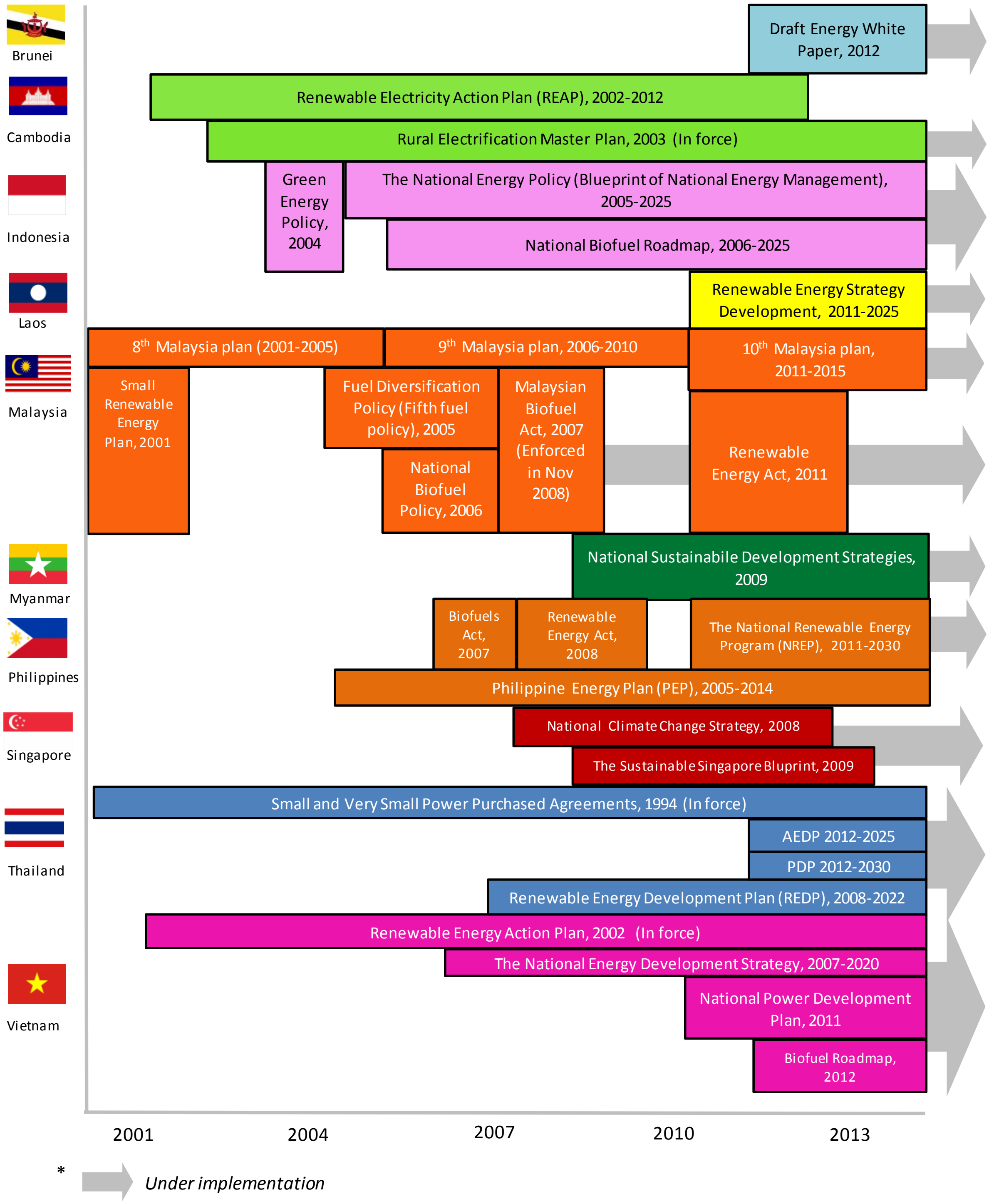
5. Energy Technologies with Potential for Applications in ASEAN by 2030

5.1 Power production and distribution – centralized and decentralized

Electricity generation capacity in Southeast Asia is expected to grow steadily, from 176 gigawatts (GW) in 2011 to almost 460 GW in 2035 (IEA, 2013). Coal will become more dominant fuel source for power plants, with 40% of new capacity additions. Gas (26%) and hydro (15%) also add significant capacity. Oil-fired capacity falls, largely because of deteriorating economics as a result of high fuel costs, though some is maintained to serve the region's isolated areas.

Since Southeast Asia also has diverse and abundant biomass feedstocks, ranging from agriculture and forestry residues to forestry products, most ASEAN countries have set policies and targets for renewable-based capacity and/or generation (JGSEE, 2013). Indonesia, Malaysia, the Philippines and Thailand also have financial support measures such as feed-in tariffs and tax exemptions to accelerate renewable energy deployment.

Figure 5-1 Renewable energy policies in ASEAN countries (JGSEE, 2013)



It should be noted that from the Figure 5-1, RE Act has replaced Small Renewable Energy Plan and Fifth fuel policy). The biofuel policy and the national biomass strategy are more current & relevant initiatives have been updated.

Table 5-1 **Renewable energy targets in ASEAN countries (JGSEE, 2013)**

Country	Biomass for heat & power targets	Biofuel mandates/targets
Brunei	No biomass target	No biofuel target
Cambodia	To achieve 100% level in village electrification from renewable energy by 2020	No biofuel target
Indonesia	8149 MW Biomass and 107.012 million m^3 biogas by 2025	3450 million liters ethanol and 9520 million liters biodiesel by 2025
Laos	58 MW Biomass, 51 MW Biogas and 36 MW Waste by 2025	150 million liters ethanol and 300 million liters biodiesel by 2025
Malaysia	1340 MW Biomass, 410 MW Biogas and 390 MW MSW by 2020	B5/Biofuel to replace 5% of diesel in road transport
Myanmar	To achieve a collective target of 15-18% of renewable energy in the total power installed by 2020	Biofuel to replace 8% of conventional oil in road transport by 2020 based on 2005 level
Philippines	276.7 MW Biomass by 2030	B20 and E20/E80 in 2030
Singapore	No biomass target	No biofuel target
Thailand	4800 MW Biomass, 3600 MW Biogas and 400 MW MSW by 2021	Ethanol 9 million liters/day, B10 7.2 million liters/day and BHD 3 million liters/day in 2021
Vietnam	400 MW Biomass by 2030	550 million liters of biofuel production by 2020

5.2 Industry

Energy technology development and its deployment in the industrial sector is nowadays a very complex field, where basic research institutions, applied research institutions and industry have to work closely together on an international level and beyond country borders. In addition successful commercialization of technologies requires that the share of private sector involvement in the development of technologies increase along the commercialization of the technologies.

For the ASEAN region technologies applied in their major industrial sectors should be considered first to be tackled in a joint ASEAN approach. Therefore applied research institutions active in the research areas of the resources unique to ASEAN are very important, e.g. energy technologies using biomass resources prevailing in ASEAN, like rice husk, rice straw, sugar cane, EFB, etc. just to name a few.

To bundle the energy technology development around these relevant resources and to identify which research institutions in ASEAN and which companies in ASEAN are important players in this field and are keen and capable to start and pursue applied research to improve existing or develop new energy technologies for these applications is an important first step to focus research activities for this sector.

For the industrial sector two different kind of energy technologies are of major importance; firstly the cross-cutting energy efficiency technologies for end-uses, like motors, fans, pumps, compressors, boilers, furnaces, heat exchangers just to name a few. (These cross-cutting technologies use more than 70% of all industrial energy use.) And secondly the process specific technologies for major industrial sectors like iron and steal or chemicals.

Cross-cutting technologies are normally manufactured by international companies and shipped all over the world. To determine which technologies shall get a special support within the ASEAN region for further development it is important to establish first which cross-cutting technologies are manufactured by regional companies in ASEAN in what amount and value and which of these companies have the potential for further own technology development in close cooperation with applied research institutions, such as boilers for biomass combustion or fans for industrial processes.

For process-specific technologies it is suggested to concentrate on some of the major industrial sectors in ASEAN, like chemicals, cement and iron and steel. In addition the agro-industry process sector shall get a special recognition, as it is of global importance. International companies, like Holcim® in the cement sector are installing world wide international standards for their production facilities irrespective of the country of production. Here the first and highest importance must be on accelerating the stock turn-over process through stricter environmental standards and application of better energy efficiency standards, like the BAT (Best available technology) concept of the EU, meaning the best energy efficiency improvement can be achieved by a new process plant in ASEAN, which fulfills international BAT standards.

In other sectors, like food processing, ASEAN companies are world leaders and their demand for further process technology development must be assessed to determine in which sector which technologies are required to be further developed. Here a sector-specific technology needs assessment is required.

5.3 Transport

The transportation sector is expected by IEEJ, ACE and ESSPA (IEEJ, 2011) that it will have the highest growth in energy demand of 5.6% per annum, while an average annual rate of energy demand in ASEAN is 4.4% up to 2030, in Business-as-usual (BAU) scenario. In Alternative policy scenario (APS), it also has the highest potential to be reduced by about 22% of BAU's energy demand. It is in line with the Efficient ASEAN scenario done by IEA and ERIA (IEA and ERIA, 2013) that transport energy demand can be reduced by 16% beyond that of the New Policies Scenario in 2035. This implies room for energy efficiency technology applications in ASEAN. It would be progressive improvements in energy efficiency in road transport, for example via mandatory fuel-economy standards, fuel-economy labelling, tax breaks and incentives. Importantly, ASEAN countries are trying to remove inefficient subsidies to fossil fuels that would help investment of mass transit development and encourage travellers to use more public transport. Biofuels as alternative fuels for transportation will play an important role of energy supply in the ASEAN countries. However, current use of biofuels rely on first generation biofuels; therefore, development of second generation biofuels is essential to address energy concern and ensure that there is no competition between energy and food productions.

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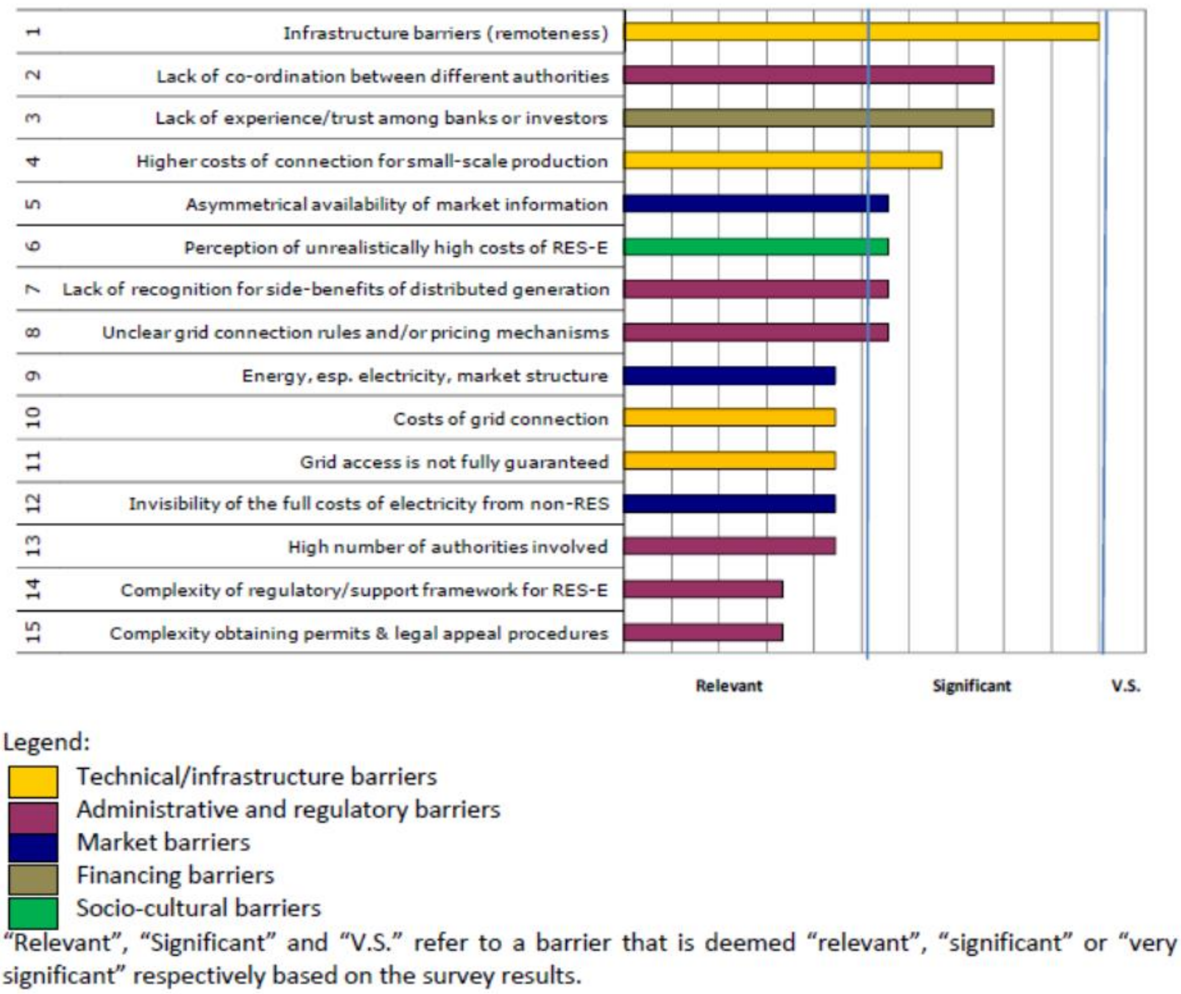
6. Barriers and Challenges

Innovation in energy technology is widely regarded as a basis for sustainable energy, which rests on two pillars: (i) energy from renewable sources, and (ii) energy efficiency (John and Rubbelke, 2011). Lee (2010) said that renewable energy needs to provide value added in terms of cost reduction (as compared to unsustainable path) and less greenhouse gas emissions. Energy technology is key to deep-cuts in anthropogenic greenhouse gas reductions required for climate change mitigation and energy efficiency also provide more space for easing the risk on energy shocks such as price vulnerability and supply shortage. Similarly Edenhofer et al (2011), outlined eight climate policies base on technology and innovation: (i) energy efficiency improvement; (ii) fuel switching to lower carbon fuels, (iii) bioenergy, (iv) other renewable energies; (v) carbon capture from fossil fuels and storage; (vi) nuclear (albeit with substantial risks and side-effects), (vii) reduction of non-CO2 greenhouse gases (multi-gas strategy), and (viii) land use related mitigation options. However, most developing countries such as Indonesia have difficulties to follow, adopt, and implement policies and strategies for the deployment of desired energy technologies to ensure energy security and access on the one hand, and to meet GHG reduction obligations on the other. This is mainly due to lack of promotional incentives system, human skills, technical information and technology support services, finance, and the government's science and technology policy (Thee, 1998).

For examples at the ASEAN level, 15-non economic barriers in promoting renewable energy have been identified (IEA, 2010). As seen from Figure 6-1, most of the top 5 barriers are related to government failures in providing infrastructure, leadership, reliable information, and incentives. This indicates that to be successful in promoting renewable energy government needs to de-bottleneck all the constraints. Then it is also essential to promote effective and coherent renewable energy policies with a long-term strategic perspective.

Figure 6-1 Ranking of non-economic barriers in selected ASEAN Countries (IEA, 2010)



6.1 Technical aspects

Through the value chain approach, Roland Berger Strategy Consultants (2011) identified five stages across four actors (see Figure 6-2). As seen from the figure, all the actors have their own barriers in promoting energy efficiency. This indicates that promoting energy efficiency needs an integrated approach both on organizational and institutional dimensions. Organizational dimension means that suppliers, producers, and governments need to share a common vision on the importance of energy efficiency. The institutional dimensions need to ensure that all parties (producers and consumers) obtain win-win solutions after implementing regulations. Because most of advanced technology is imported and it is usually produced following the global production networks, performance standards and product labeling, and certification of suppliers/ESCOs need to be prepared both globally and regionally. However, according to CSIS (2012), energy efficiency standards are mainly voluntary and where mandatory, are poorly enforced. Thus it is necessary to introduce new energy standards and strengthen existing standards for buildings, appliances and automobiles (CSIS, 2012).

Figure 6-2 Key barriers along the energy efficiency value chain as identified by companies needs (Roland, 2011)

VALUE CHAIN	1. Identification of demand	2. Manufacture and sale of products	3. Evaluation and Investment	4. Delivery and Installation	5. Long-term Operations and Maintenance
Governments	• Overall, lack of an effective overarching and comprehensive EE policy framework • Insufficient role as facilitator to integrate different stakeholders in the marketplace				
	• Insufficient provision of information channels to match users and suppliers		• Insufficient financial support and assistance	• Insufficient technical training provided	• Lack of standards on energy auditing methods • Room for improvement in awareness-raising efforts
Suppliers/ ESCOs	• Difficulty in identifying demand • Lack of commitment to pro-vide sufficient resources to gauge savings potential	• Difficulty in convincing clients of benefits of EE equipment		• Lack of technical know-how to carry out product installation	• Lack of integration into users' business lifecycle
Users	• EE often not regarded as a business priority	• Lack of confidence that equipment can achieve projected savings • Difficulty in identifying customized products to suit specific needs	• "Quick-win" investments favoured over EE projects with longer payback periods		• Lack of awareness on energy efficiency • Lack of consistent investment plans in EE products and technologies
Financial Institutions			• Lack of familiarity with EE financing • Lack of confidence in return on EE projects		

Note: ESCOs is energy service companies

6.2 Financial and investment barriers

As mentioned in the previous section, energy efficiency is one of the pillars of sustainable energy and ASEAN has a commitment to reduce regional energy intensity at least 8% by 2015 (based on 2005 level). A study by Roland Berger Strategy Consultants (2011), showed that by 2020, the estimated energy saving potential in the five Southeast Asian countries (Indonesia, Malaysia, Singapore, Thailand, and Viet Nam) is about USD 15 billion to USD 43 billion. The huge gap between the lower bound and upper bound of energy efficiency is due to different assumptions on energy subsidies and prices. However, ASEAN countries need to work hard to remove barriers to the deployment of energy efficiency technologies and measures. The governments should make more efforts to formulate energy efficiency target.

The benefits of energy efficiency are huge. While some technologies or measures can have short payback periods or low cost, others may involve substantial up front costs and long pay back periods. This will become a disincentive to the early state of investment. Further, the financial institutions may not find it attractive to finance energy efficiency projects due to lack of experience and technical expertise (Roland Berger Strategy Consultants 2011). This situation is problematic to small & medium enterprises, in particular, where there is a higher perceived risk than for large companies. Here again appropriate, measured government intervention is crucial.

In the case of renewable energy technologies, similar financial barriers exist and are well known. Although the cost of some renewable energy technologies has declined rapidly in recent years, some are still at much higher cost than conventional technologies IRENA (2012).

6.3 Cultural, institutional, and legal barriers

Often there are cultural barriers arising from conflicting objectives in promoting new technology, such as with the environment, employment, and other sectors. For example, there is always a conflict between geothermal power plants and forest conservation. Some new technologies that are imported may not create jobs in the domestic market, especially from manufacturing activities. There could even be significant competition between locally developed and imported technologies. Further, in some cases, promoting new technology may not benefit the poor. For example in the case of the Ulumbu geothermal power plant, which was commissioned in November 2011, the villagers that provide water to run the plant were only supplied with electricity by March 2014, after a prolonged struggle.

Basically communities are quite open to adopt new technologies because it is believed that new technologies will improve their quality of life. However, in many cases, new technologies arrive at the village without proper socio-economic-environmental assessment. The lack of information on the nature of the technologies, their likely impacts to the community and the proper handling of the waste after the life time of the equipment concerned is also seen as an important barrier.

6.4 Human capital capacity

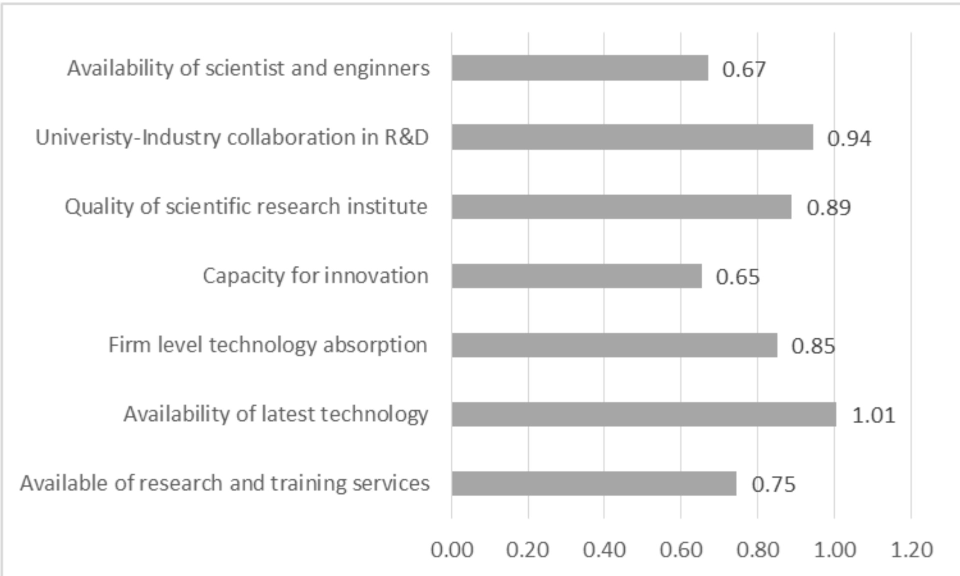
Lack of human capital is widely recognized as one of the key barriers to development, acquisition, deployment, and diffusion of sustainable energy technologies. There is increasing concern in the energy supply and final services sectors in many countries that the current educational system is not producing sufficient qualified workers to fill current and future jobs, which increasingly require science, technology, engineering, and mathematics (STEM) skills. This is true not only in the booming oil and gas and traditional power industries, but also in the rapidly expanding renewable energy supply sector. Developing the skills to install, operate, and maintain renewable energy equipment is exceedingly important for successful project implementation (NAS, 2013; IPCC, 2014).

Transfer of technology is also an important issue for energy sustainability. For example, Ulumbu geothermal power plant in East Nusa Tenggara Indonesia, was designed and constructed by engineers from outside Indonesia. Due to lack of capacity building during construct and start up of the power plant, the local engineers had to learn how to operate the power plant from "learning by doing", causing unnecessary delays in repair and maintenance. I obtained this information after discussion with engineers in Ulumbu Power Plant

In ASEAN, as seen from Figure 6-3, there is huge gap across member states in terms of access to the best available technologies and the capacity to innovate. In any case, there is a general lack of skilled workforce, technicians, scientists and engineers and R&D personnel, and a lack of linkage and interaction among academic and research institutions on the one hand, and industry and government on the other.

Apart from technical skills, institutional and human capacity for policymaking and planning, assessing and choosing technology and policy options, for sustainable energy development are also crucial (IPCC, 2014).

Figure 6-3 Standard deviation of global competitiveness score among the 10 ASEAN countries, for some selected indicators (WEC, 2014)



Note: Calculate from the global competitiveness report 2013-2014, standard deviation is calculated from value

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7. Recommendations on Strategies and Mechanisms

7.1 Effective policies around the world and their relevance to ASEAN

Policies to accelerate the utilization of renewable energy and improve energy efficiency in different end-use sectors have to be specified to the purpose. Therefore energy policies must be sector and energy end-use specific. In this part we will concentrate on policies to accelerate energy technology development for the application in the different end-user sectors.

To establish an energy technology development policy, a general energy policy is required. Because it is only when there is a clear general energy policy in place that achievable, long-term energy technology development and innovation can happen. A case in point is Germany, where the development of wind and PV technologies only took place once the government set a long-term feed in tariff policy (FiT) (launched in 1990), which was basically an industrial sector development policy. The FiT mechanism accelerated the uptake and helped to grow related manufacturing facilities and their R&D.

Viewed in this perspective, the authors offer some general recommendations as follows:

1. For any successful energy policy at the beginning the government has to set clear and achievable long-term goals/targets, that shall be achieved in 5, 10, 15 and 20 years. This policy should not be altered and if the targets are not achieved. It needed to be monitored every 2-3 years in order to determine if it is achieved according to its plan. The implementation strategies have to be directed to achieve these clear goals.
2. The government has to appoint responsible agencies/ministries/departments, that are responsible for the establishment of the different implementation strategies, their implementation (tendering of programs, evaluation of the programs) and finally of the monitoring and review for acceleration, if the goals were achieved as set.
3. In this context a specific energy technology development and innovation policy can be formulated. The definition and formulation of these policies around the world are based on firstly setting clear achievable objectives that are measured and reviewed after some time. The policies formulated are based on in-depth discussions with all relevant stakeholders: concerned industrial sector representatives, applied research institutions, basic research institutions,

universities and technology consultants/providers. Together with the respective ministries, such as the ministries of economics, industry, finance and energy, develop a well-defined technology development plan for 3-5 years.

4. Then the implementation of research programs and tendering of the R&D as joint projects for academic institutions in cooperation with industry is done. Once the result of the tendered research projects are presented in public workshops, the review of achieving the objectives is done and, if necessary, next round of research is tendered.
5. Governments do not formulate energy technology development targets, but facilitate their realization by enabling joint research projects from applied research institutions and industry. In addition governments provide easy finance access for innovation through various schemes, like the PFAN approach currently implemented by USAID in ASEAN.

Further energy technology development and innovation requires a comprehensive and coordinated approach with a clear focus on selected technologies in selected sectors, which shall be pushed forward at the ASEAN level.

Such an energy technology development policy (within an STI policy) is centered around the following process:

[1] Firstly, for the energy technologies in this segment, the respective research institutions and existing private or public companies, that are capable of applied research in ASEAN have to be identified, grouped and their capabilities and interest has to be established.

[2] Policies to promote energy technology development shall include the establishment of regular energy research programs that are tendered openly and transparently as research projects. Universities, applied research institutions and private sector shall be encouraged to form consortia by different players for the bidding for these tenders from the government. (Governmental research institutions can as well participate, but should not be the sole receiver of the research grants. The reason for this is, that in most OECD countries it has been found, that government research institutions are not effective in applied research if they are guaranteed receiver of research funds by government. The introduction of competition and open and transparent tendering of research projects has improved the effectiveness of applied research results.

[3] When all research projects of a specific energy research program are completed, normally after 3 years, open workshops where the results of all research projects are presented to all stakeholders shall be done.

[4] Once all results of research projects are published and disseminated to all stakeholders a new round of discussion shall be set, where based on the

results of the first round of research projects the next objective for the next research program is defined and discussed with all stakeholders and government.

[5] By tendering research projects it shall be guaranteed, that along the development of technologies an increasing participation of the private sector will result. With universities alone, without the private sector, which takes an increasing share in these research projects, hardly any new energy technology, or incremental improvement in technology can be developed and brought into the market.

With such a research tendering process the participation of the relevant institutions can be accelerated and most likely more relevant energy technologies can be developed in ASEAN region in the future. The handling of the energy research program shall not be done by the ministry itself, but an autonomous agency, that is held responsible for an effective and transparent handling and implementation of energy technology research programs.

7.2 Policies for acceleration of power production and distribution – centralized and decentralized

Effective policies for this segment shall consist of:

[1] Long term policy with targets for the different technologies, like x% wind, y% PV, z% co-gen, etc. which takes care of conventional power technologies , co-generation and on-grid renewables systems, like wind, PV and biomass.

[2] Responsibility assignment to an agency/ministry for their implementation and monitoring

[3] Promotion scheme, like a decreasing feed-in tariff for an off-take of technologies

[4] Removal of any subsidies for conventional energies to remove the disadvantage of renewable energy technologies and efficient conventional systems, like Co-gen systems

[5] City planning concept, that includes explicitly a plan for "district cooling", like the city energy plans for some major European and international cities.

[6] Supporting of demonstrations projects to disseminate knowledge and create confidence in this newer technologies of tri-generation, district cooling, etc.

[7] For off-grid and micro-grid systems first subsidies for diesel must be removed so that transparent power supply system must be installed. Policies shall support demonstration projects and monitor them over long time to show, that hybrid system consisting of diesel and a combination of PV/Wind/biomass/hydropower can be competitive and are more cost effective.

[8] For the respective energy technology development in this segment the respective research institutions and existing private or public companies, that are capable of applied research have to be identified.

7.3 Policies for Industry Sector

Effective policies to promote energy technology development and innovation in the industrial sector are centered around the following policies:

[1] Application of a BAT concept for major industrial sectors, like the EU has established now for several sectors

[2] Innovation policy for the development of specific promising technologies, like fuel cells, low temperature combustion burners, etc.

[3] Specific cross-cutting technologies deployment programs, like the compressor program in Germany or high efficient motors exchange program, etc.

[4] Sector specific technology and process optimization programs for selected industrial sectors, like the waste heat recovery program for the iron & steal sector.

7.4 Policies for Building Sector

Effective policies to promote energy technology development and innovation in the Building sector are centered around the following policies:

[1] Setting of mandatory energy building standards would be the most effective policy. These standards need to be developed, adopted and then tested. Then they should be applied and their use must be monitored and observed by e.g. the Ministry of housing or others. They must be enabled to evaluate building drawings and proposed energy demand of future building, done by energy simulation modelling. Investment decision for buildings shall be based on life cycle costing.

[2] These agencies/ministries should be allowed to deny and Energy impact assessment certificate, if certain energy standards is not achieved, like the EIA concept.

[3] Energy labeling of building is as well a suitable tool to encourage the development of respective energy technologies.

7.5 Policies for Transport Sector

Effective policies to promote energy technology development and innovation in the Transport sector are centered around the following policies:

[1] Setting MEPS for vehicles is a first and effective step.

[2] In addition setting requirements fro regular technical inspection, like every two years of all rolling stock would improve the energy efficiency of the existing vehicles.

[3] Technology development in this segment is mainly done be the few international car manufacturing companies world wide. Here ASEAN could improve the situation by setting stringed environmental standards for vehicles and introduce MIPS. A special focus shall be given to the introduction of bio fuels in the vehicle fleet.
[4] For city transport non-vehicle transportation shall be encouraged, from public trains to bicycles)
[5] Here technology development requirements have to be established which are relevant to ASEAN

7.6 Feasibility of an ASEAN Clean Energy Technology Trust Fund

Because of the huge investment required – in the tune of billions of dollars – for providing access to and transitioning to secure and low-carbon energy systems and services, a number of international entities have introduced initiatives to improve access to and create incentives for financing and investments. Examples include the Private Financing Network (PFAN) implemented by USAID, ADB's Clean Energy Financing Partnership Facility (CEFPF), and the Clean Technology Fund (CTF), etc. CTF in particular is presently the largest multilateral mitigation fund, with a large capitalisation in grants and concessional loans. Its objective has been to achieve "transformational change" in developing countries towards low carbon development strategies through public and private sector investments. Administered by the World Bank and implemented through the World Bank Group and regional development Banks that include the ADB, the Fund aims to achieve this transformational change through financing the deployment of low carbon technologies at scale. The experience of the CTF offers important insights into what it takes to use diverse financial instruments at scale to support developing countries to respond to climate change. In addition to seeking to foster innovative approaches to delivering finance for climate change, it has made investments that seek to reduce the costs of promising new technologies (Smita Nakhooda and Amal-Lee Amin, 2013).

While these funds are useful and should continue to be accessed by ASEAN countries, it is felt that an ASEAN focused trust fund that would support ASEAN specific clean energy technology development and deployment agenda is desirable. Here we propose our first thougths on the setting up of an ASEAN Clean Energy Technology Trust Fund (CETTF).

7.6.1 Objectives

As key instrument to remove finanacial and other related barriers to the development and deployment of clean energy technologies at the ASEAN level, the objectives of CETTF are to encourage investments in clean energy technologies, to improve energy security in ASEAN countries, and to slow down the rate of carbon emission. The ASEAN Clean Energy Technology Trust Fund is designed to provide financial support on projects, to divert private investors' risks by leveraging with its own funds, and to offer technical assistance to investors. The promotion of clean technology will be implemented through the key mechanisms as;

1. project loans,
2. grants through clean energy technology trust fund,
3. technical knowledge provision and exchange.

7.6.2 Structure

The organizational establishment of ASEAN Clean Technology Trust Fund comprises two main functions, which are an advisory committee and a project management office.

[1] Advisory Committee : Representatives from members of ASEAN will form an advisory committee whose main responsibilities include;
 a. clearly define the roles and responsibilities of the trust fund,
 b. provide guidance on policy and strategy,
 c. recommend for new funding sources,
 d. ensure effective, efficient and transparent implementation of program.

[2] Project Management Office : Project Management Office (PMO) is led by the Director of the PMO, who is appointed by the advisory committee. Roles and Responsibilities of the project management office will be:
 a. management and coordination of the fund,
 b. establish strategy, policies, guidelines and standards for the fund management,
 c. ensure effectiveness of the implementation according to strategy, plans, policies, guidelines and standards of the trust fund,
 d. accounting, management and reporting of routine activities of the trust fund,
 e. maintain and share carbon data to national data center.

7.6.3 Sources of Fund

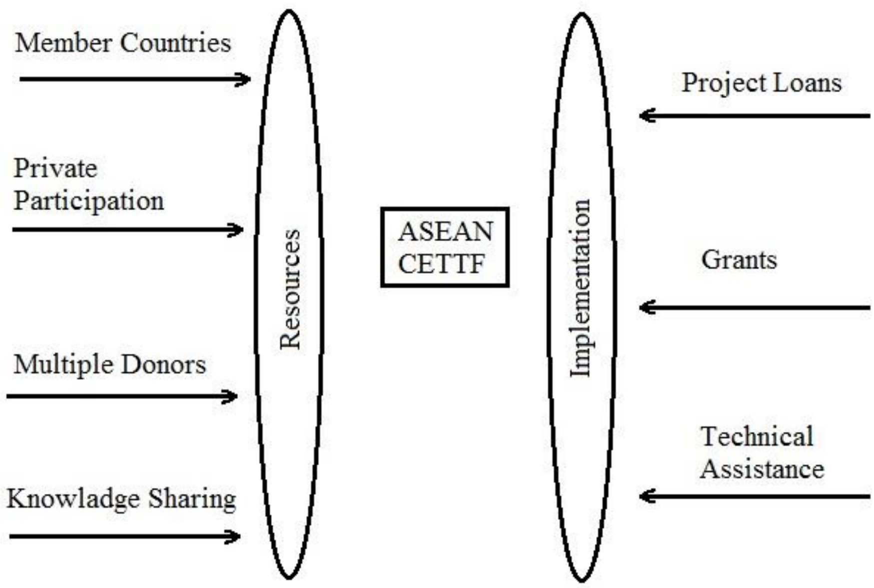
[1] The source of ASEAN Clean Energy Technology Trust Fund can start with seed funds from member countries. Although equal seed funds from member countries can be the basis of equal responsibility, ownership, and vote, unequal seed funds are acceptable for the fact of different economic situations of the members.

[2] Contributions to ASEAN Clean Energy Technology Trust Fund from individual sources, including private companies and foundations are welcome. Public sector can be the key player for public-private partnership programs that enhance the implementation of clean energy technology.

[3] Concessional loans that are provided on terms substantially more generous than market loans. They are available through interest rates below the market rate or by grace periods, or a combination of these. Concessional loans typically have long grace periods.

[4] In addition to monetary supports, knowledge sharing can be considered as a resource provision to ASEAN Clean Energy Technology Trust Fund.

Figure 7-1 ASEAN Clean Energy Technology Trust Fund Overview

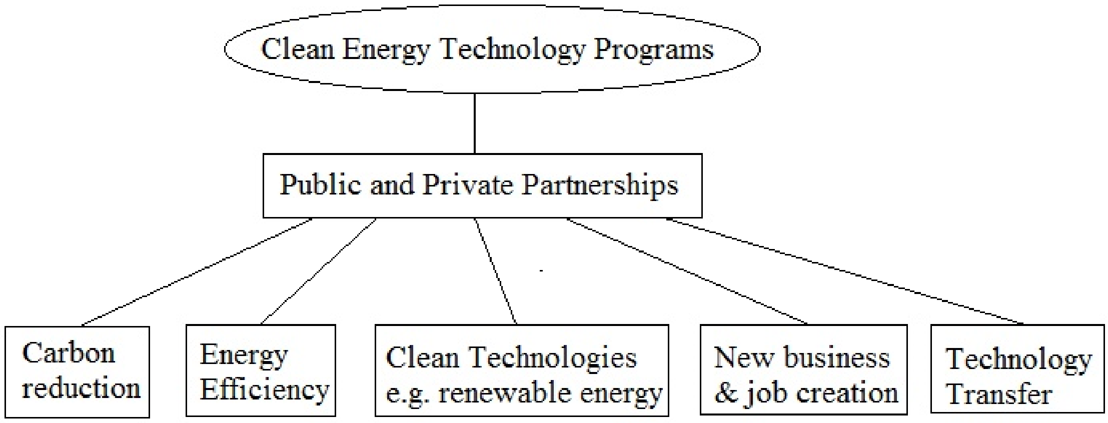


7.6.4 Procedure and Governance

ASEAN Clean Energy Technology Trust Fund aims to support projects which benefit the public and the economy, such as:

1. carbon reduction activities that improve the environment,
2. energy efficiency improvement and energy conservation projects,
3. job creation in both urban and rural areas,
4. activities that provide opportunities for new businesses,
5. emerging clean technologies relating to carbon reduction,
6. public and private investments that intend to maintain competitiveness of traditional industries with clean technologies.

Figure 7-2 Clean Energy Technology Programs & Partnerships



A. Investment Projects

ASEAN Clean Energy Trust Fund will invest in innovative and pioneering clean energy and low carbon projects. The trust fund can work out with private companies and governmental offices to identify and evaluate potential projects. The investment can help in the development of new technologies by reducing the cost, facilitating their deployment and lowering barriers. Possible qualified projects which will be financed, are as follows:

1. power station retrofits to improve generation efficiency,
2. upgrading of transmission and distribution systems to reduce system losses,
3. retrofit street lighting by energy efficiency technology,
4. urban mass transit that will result in reduced fossil fuel consumption,
5. agricultural waste and biomass energy projects,
6. manufacturing of lower cost solar cells,
7. development of wind generation for both private and public sectors,
8. refurbishment and management of high-quality, low carbon office space,
9. commercialization of organic photovoltaics (OPV) technology,
10. development of biofuel to commercialization,
11. design and manufacture of hydrogen energy systems for energy storage and clean fuel production,
12. reduction of cooling requirements for electronic data center and telecommunications equipment,
13. design and manufacture of energy-efficient power conversion products.

B. Technical Assistance

ASEAN Clean Energy Trust Fund will also be used for technical assistance, which helps in development of policies, regulations, standards, capacity building, and clean energy projects for financing, to support business decisions and engineering services as follows:

1. verification of clean energy to sustainable growth of economic sectors,
2. preparation of projects for investment,
3. cost sharing in clean energy investment programs between donors and private sectors,
4. transfer of technology, knowledge and experience; and
5. capacity building for potential stakeholders of clean energy investments and programs.

The concept of CETTF outlined above represent preliminary thoughts by the authors. A more detailed definition of the Fund based on broader stakeholder consultation needs to be conducted and in-depth investigation should be carried out to test and validate its feasibility and practicality, particularly with respect to the vast resources that are required, as well as technical assistance, which may be outside the ASEAN's own capacity, at least at the presesent stage of development.

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