Chapter 5B

Engendering Energy Resiliency and Security towards a Resilient and Green ASEAN

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CHAPTER 5B
Engendering Energy Resiliency and Security Towards a Resilient and Green ASEAN

Introduction

The continued increasing use of fossil fuels in ASEAN and East Asia has substantial impact on energy security and the rise in CO2 emissions. ASEAN, China and India are already shifting the centre of gravity of the global energy demand towards Asia. In addition, the total population of about 3.3 billion in the 16 countries of ASEAN and East Asia puts pressure on future energy consumption and security in the region. ASEAN alone has about 600 million people; thus, there remains a great scope for ASEAN's energy consumption to rise in virtually all sectors especially industrial, transportation, residential and commercial.

The ASEAN and East Asia region relies heavily on imports of fossil fuel from the Middle East to fuel the region's economies. This puts the region in a vulnerable situation in case of disruption in the supply of oil and gas arising from the deterioration of political instability in the Middle East. Demand for fossil fuels in some major energy consumers within the region is growing faster than domestic production leading to greater import dependency particularly on oil and natural gas; thus, the growing concern on energy resiliency and security in the region.

To further energy security in the region, the heads of State of the Member Countries of the Association of Southeast Asian Nations (ASEAN), Australia, China, India, Japan, Republic of Korea and New Zealand adopted the Cebu Declaration on energy security during the Second East Asia Summit on 15 January 2007 in Cebu, Philippines. The Leaders agreed to promote Energy

Efficiency (EEC), New Renewable Energy (NRE) and clean use of coal, together with improved oil stockpiling, as the key means of engendering energy resiliency and security in the region.

The promotion of EEC, NRE, and clean use of coal also supports the drive towards a green ASEAN and East Asia. The pursuit of Green ASEAN growth will focus not only on reducing the dependence on fuel imports but also on fuel use efficiency and on the diversification of fuel sources, especially raising the share of renewable energy in the total energy consumption in the region. Thus, ASEAN's drive to improve its energy efficiency, tap renewable sources, and encourage more efficient use of coal for power and natural gas and bio-fuels for transportation will contribute not only to regional energy resiliency and security but also to a Green ASEAN.

Nonetheless, there is some trade-off between the pursuit of energy resiliency and of green development in ASEAN in the short term. For example, ASEAN is abundant in coal and the region is expected to rely more on coal for its power needs given the relatively lower price of coal. However, the upfront cost of clean coal technology is much higher than technologies that emit high carbon emission. Thus, ASEAN may need to voice common concern in the international arena to ensure greater affordability and access to clean technologies by developing countries like most AMSs.

This chapter focuses on the importance for ASEAN and East Asia to pursue Energy Resiliency and Green Development by looking into the region's resource potentials, the strategic use of those resources towards energy resiliency and security while at the same time being supportive of the long term goal of Green Development for more sustainable and equitable growth in the region.

Energy Consumption and the Economic Impact of Energy Conservation

Primary Energy Consumption

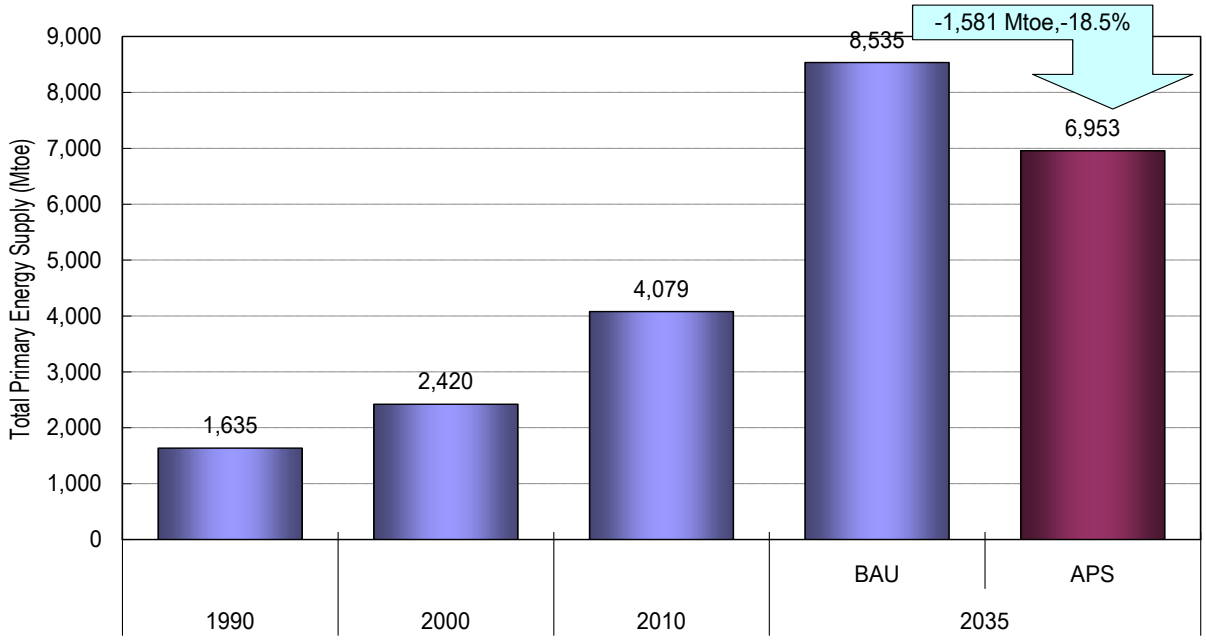
ERIA's Energy Efficiency and Saving Potentials project (ERIA, 2013) shows

that primary energy consumption until 2035 in EAS (East Asia Summit)[1] countries is projected to increase from 4079 Mtoe (million tons of oil equivalent) in 2010 to 8533 Mtoe in 2035 in the Business as Usual Scenario (BAU) case and to grow at 3.0 percent per year on average (see **Figure 5B.1**). The EAS primary energy consumption is projected to be 6953 Mtoe by 2035 under the Alternative Policy Scenario (APS) case, 18.5 percent lower than in the BAU case. Note that the 1,581 Mtoe reduction in 2035 in primary energy consumption in the APS case compared with the BAU case is three times bigger than ASEAN's primary energy consumption in 2010. The BAU scenario reflects each country's current goals, action plans and policies while the APS includes additional goals, action plans and policies as reported at the EAS-EMM6 held in September 2012 in Phnom Penh, Cambodia or those that are currently, or likely to be, under consideration.

In terms of the composition of primary energy consumption, **Figure 5B.2** shows that coal will still constitute the largest share of primary demand in the next two decades due to increased power generation. The share of coal in total primary energy consumption was 54.1 percent in 2010: its share is expected to decline to 48.3 percent in 2035.

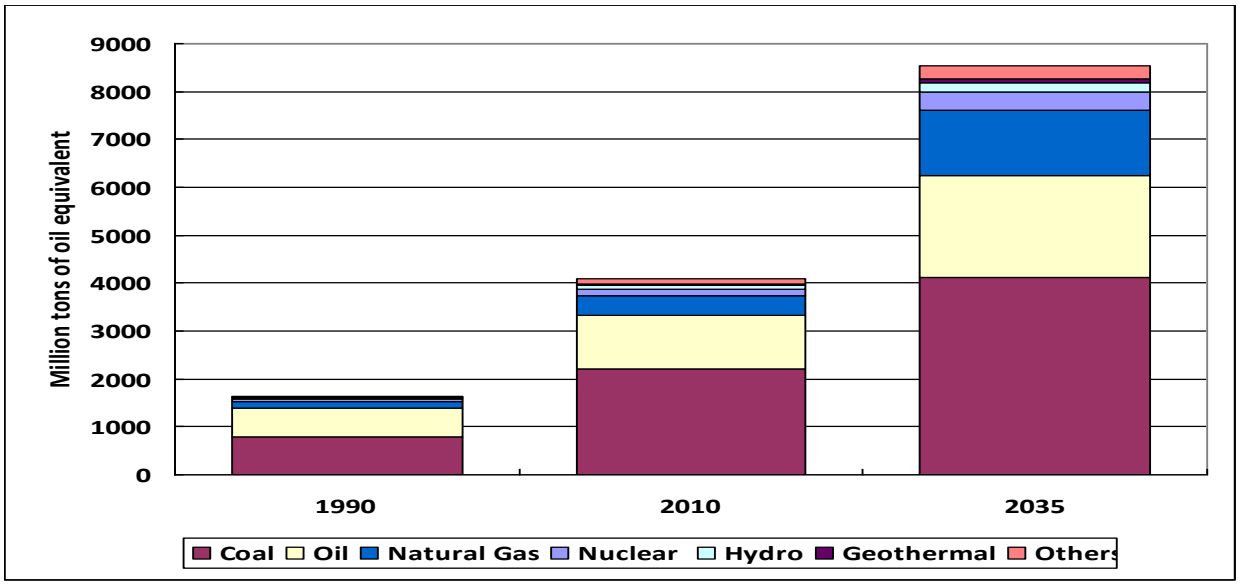
[1]The East Asia Summit (EAS) is a collection of diverse countries. It is composed of the 10 member countries of the Association of Southeast Asian Nations (ASEAN) namely: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam, and 6 other countries, namely: Australia, China, India, Japan, Republic of Korea and New Zealand.

Figure 5B.1: Total Primary Energy Consumption



Source: Kimura, 2013.

Figure 5B.2: Primary Energy Consumption in EAS, 1990 to 2035



Source: Kimura, 2013.

The growth of power generation in EAS is projected to grow at 3.7 percent per year on average from 2010 (7740 TWh) to 2035 (18,999 TWh). The share of coal–fired generation is projected to continue to be the largest and will remain above 55 percent of the total until 2035. Natural gas share is projected to increase from 12.7 percent in 2010 to 17.3 percent in 2035 along with those of nuclear (6.9 percent in 2010 to 7.5 percent in 2035), geothermal (0.4 percent to

0.7 percent) and others (wind, solar, biomass at 1.7 percent to 5.4 percent). The shares of oil and hydro are projected to decrease slightly from 2.8 percent to 1.1 percent and 13.4 percent to 11.7 percent, respectively, during the same period. **Figures 5B.3 and 5B.4** show the shares of each energy source in electricity generation in 1990, 2010 and 2035.

Figure 5B.3: Power Generation in EAS

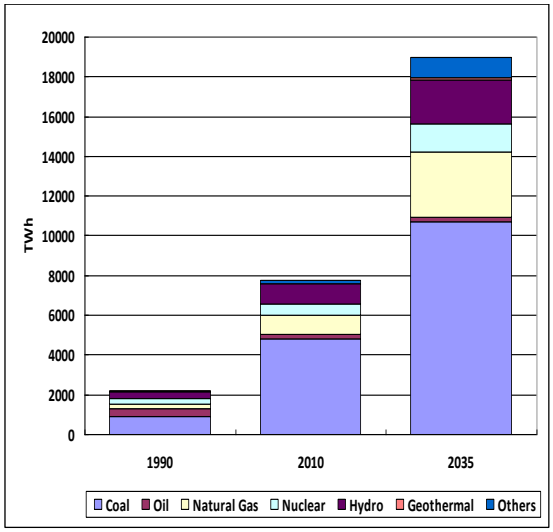
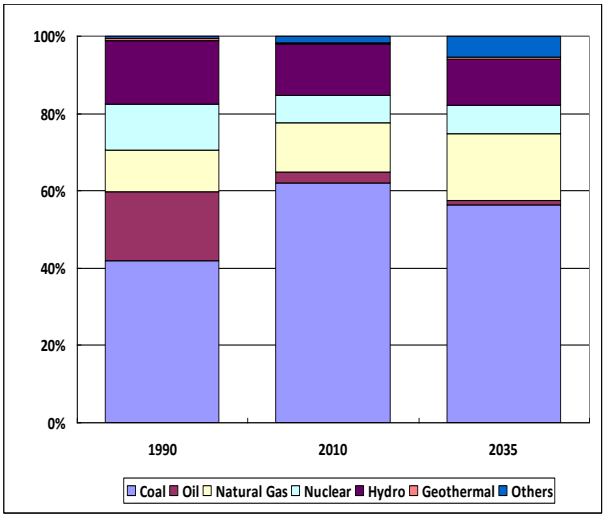


Figure 5B.4: Power Generation Share in EAS



Source: Kimura, 2013.

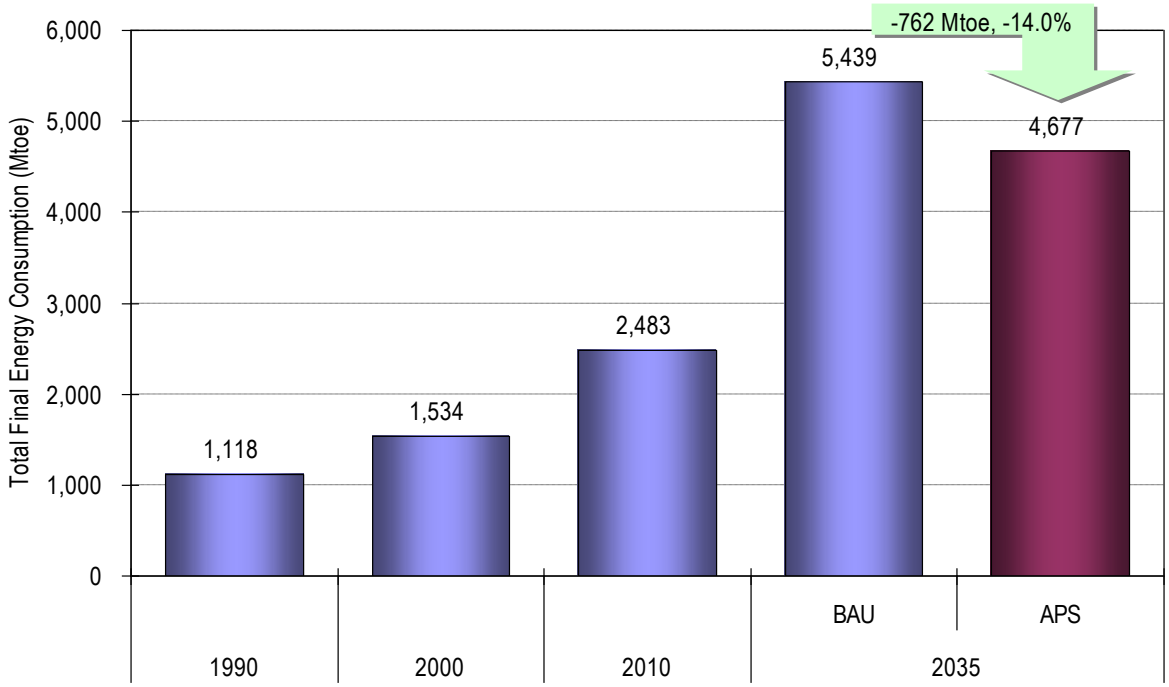
The result of the Southeast Asia Energy Outlook (IEA & ERIA, 2013) shows that electricity generation in ASEAN would grow by 4.2 percent per year on average, from 696 TWh or (176 GW) in 2011 to almost 1, 900 TWh (460 GW) in 2035. Coal's share rises from 3 to 47 percent during the projection 2011-2035 period while gas' share shrinks from 44 to 29 percent. Coal-fired generation grows faster than every other source of generation.

The strong increase in coal demand is driven by its relative abundance in the region and low coal prices, which lead to coal being preferred over oil and natural gas, particularly in power generation where substantial new capacity is required. Many of the region's gas-producing basins are located far from demand centres, thus gas demand throughout the region will be met increasingly by LNG imports, which promise to be more expensive relative to coal.

Final Energy Consumption

The ERIA Energy Efficiency and Saving Potentials study (ERIA, 2013) shows that the final energy demand in the BAU scenario is projected to increase from 2483 Mtoe in 2010 to 5439 Mtoe in 2035 (see **Figure 5B.5**) at an average annual growth rate of 3.2 percent during the period. In the APS case, final energy consumption is projected to rise to 4677 Mtoe, which is 762 Mtoe or 14.0 percent lower than in the BAU case in 2035. This is due to the various energy efficiency plans and programs in both the supply and demand sides that are to be implemented by EAS countries. **Figure 5B.5** shows the evolution of final energy consumption from 1990 to 2035 in both the BAU and APS scenarios.

Figure 5B.5: Total Final Energy Consumption

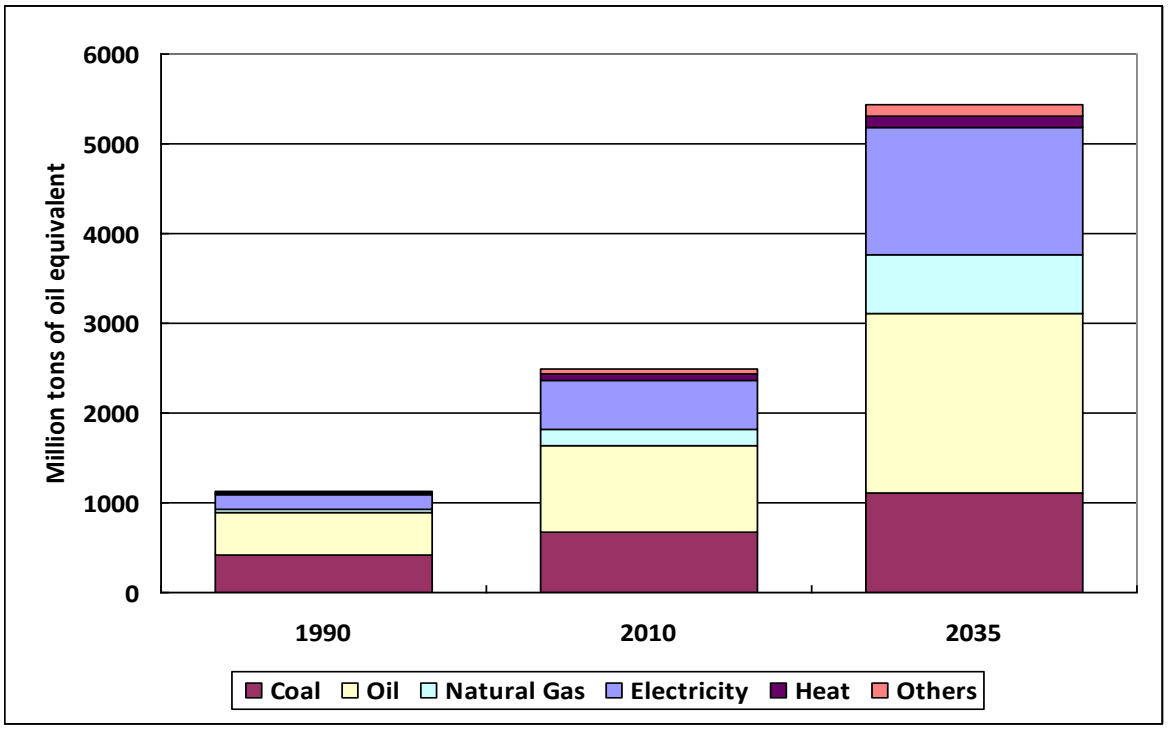


Source: Kimura, 2013

The natural gas demand in the BAU scenario is projected to exhibit the fastest growth, increasing by 5.3 percent per year, from 180 Mtoe in 2010 to 657 Mtoe in 2035 (see **Figure 5B.6)**. Although oil will retain the largest share of total final energy demand followed by coal, it is projected to grow at a much lower rate of 2.9 percent per year, reaching 1999 Mtoe in 2035. Demand for electricity will grow at a relatively fast rate of 3.8 percent per annum. Its share will increase from 22.3 percent in 2010 to 25.9 percent in 2035.

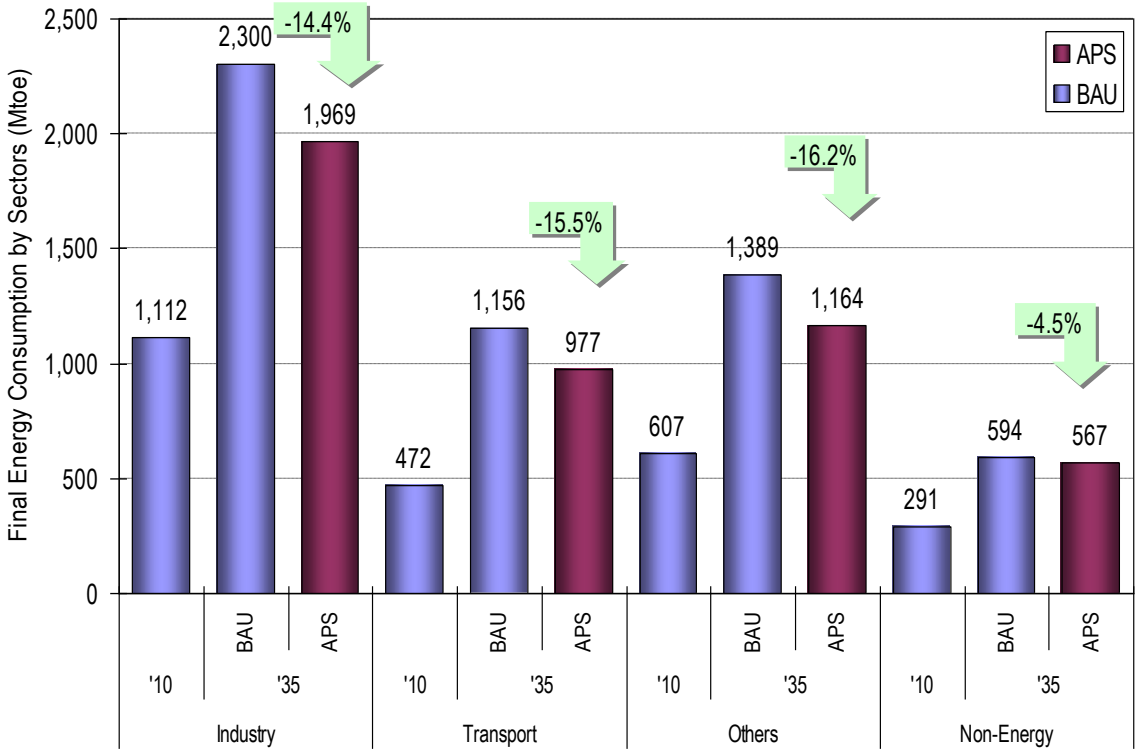
Final energy consumption in most sectors is significantly reduced in the APS case compared with the BAU case (see **Figure 5B. 7**). In percentage terms, the reduction is largest in the other sectors at 16.2 percent, followed by the transport sector at 15.5 percent and industry at 14.4 percent. Non-energy consumption will also be lower in the APS by 4.5 percent as compared to the BAU.

Figure 5B.6: Final Energy Consumption by Energy



Source: Kimura, 2013.

Figure 5B.7: Final Energy Consumption by Sector



Source: Kimura, 2013.

Economic Impacts from Investments on Energy Efficiency and Conservation

The results from ERIA's study on Economic Impact from Investments on Energy Efficiency and Saving (ERIA, 2013) found that additional investments on energy saving and low-carbon emitting technologies will significantly reduce energy demand, especially the coal demand in the EAS countries, and push down the prices of fossil fuel in both domestic and global markets.

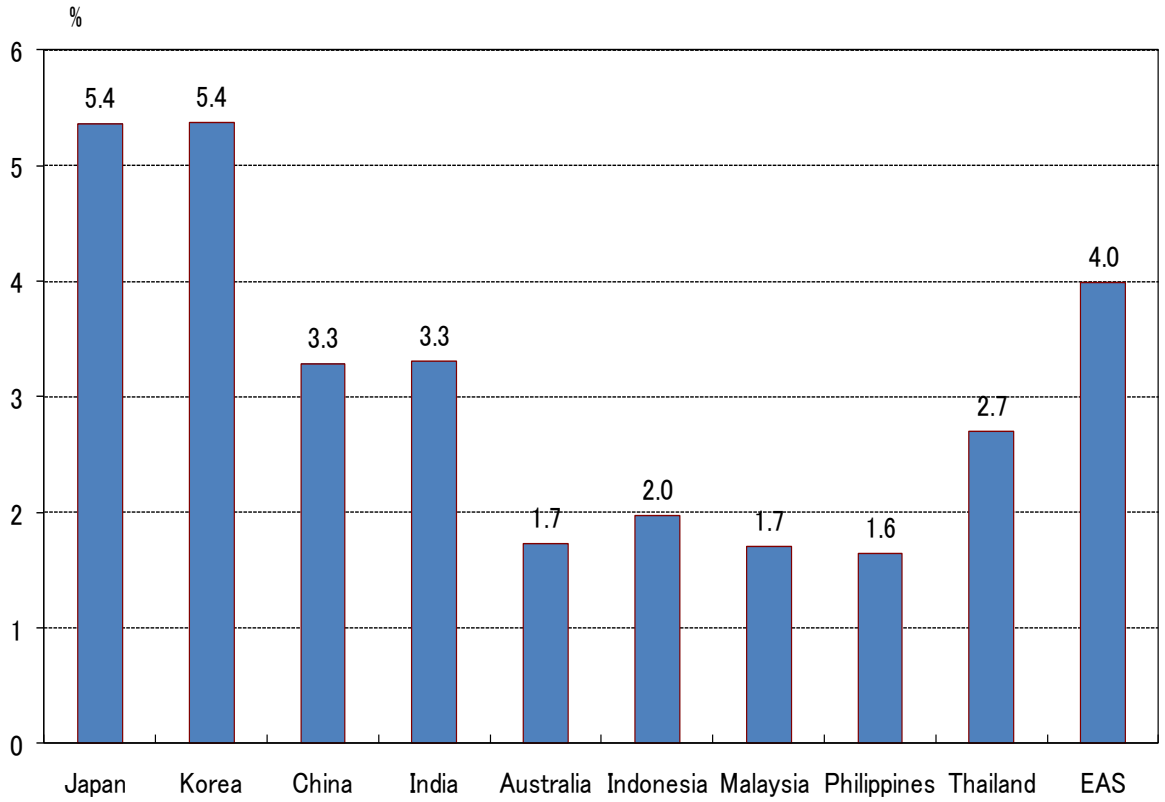
Most strikingly, the results found that in the case of implementing all of energy saving and low-carbon emitting measures in the whole EAS region, the total GDP of the EAS countries would increase at 4.0 percent under Alternative Technologies (ATS) scenario compared with that under the BAU scenario. With the comprehensive effect of additional energy investment, Japan and Korea will get the largest GDP growth rate at 5.4 percent; China and India at 3.3 percent; Thailand at 2.7 percent, Indonesia at 2.0 percent; Malaysia at 1.7

percent; the Philippines at 1.6 percent, and Australia at 1.7 percent (see **Figure 5B.8).**

Moreover, because of GDP increases in ASEAN and East Asia, the rest of the world also benefits; the GDP of the world would be 1.8 percent higher under the APS scenario compared with the BAU scenario.

At base, the cause for the positive output impact of energy efficiency and conservation is that, given that the EAS is a major market globally, the reduction in demand in EAS leads to lower global prices of fossil oil and energy, thereby beneficially feeding into the fabric of the EAS economies and the world.

Figure 5B.8: GDP change rates of major EAS countries



Source: Kimura, 2013.

Towards Energy Resiliency and Green Development in ASEAN

Stockpiling for energy security

The region in ASEAN and East Asia is diverse in terms of resources and potentials. According to the ERIA energy outlooks being used for the analysis of energy saving potentials in ASEAN and East Asia, oil and gas consumption will surely increase due to robust economic growth and rapid motorisation. Thus, getting away from fossil fuel dependency will not be easy. Hence, countries stockpile oil as part of their national energy security to deal with oil and gas disruption.

EAS countries differ in their stockpiling capability. Countries with strong economy like Japan, Republic of Korea, and China which are very dependent on oil for their energy have higher stockpiles. Thus, for example, Japan held some 591 million barrels (mb) of oil stocks at the end of January 2013, equivalent to 166 days of 2011 net-imports (92 days of government stocks and 74 days of industry stocks). Similarly, Korea meets its stockholding obligation to the International Energy Agency (IEA) by holding government stocks and by placing a minimum stockholding obligation on industry. In addition, diversification of energy fuel sources (energy mix), diversification of import sources of crude oil and LNG, further build-up of SPR (government stocks), expansion of storage capacity for oil and gas, and promotion of domestic and overseas E&P activities have been the main pillars in the energy security policy of Korea.

China imported over 5 mb/d of crude oil, accounting for about 54 percent of its total demand. More than 50 percent of the total crude oil imports came from Middle East countries. To prevent a potential shock to the economy caused by an oil supply disruption, the Chinese government has been steadily building an oil stock reserve system. China has completed four stockpiling facilities with a capacity of around 103 mb in the first phase of its Strategic Petroleum Reserve (SPR) plan, and has begun construction of its second phase, which comprises eight storage sites that will reportedly have a combined capacity of around 207 mb. The third phase is expected to boost total SPR capacity to approximately

500 mb by 2020. Stockholding obligations for industry may be considered, but are not now a formal part of the emergency response system, authorising legislation for which is still in preparation. Although China does not have government gas stocks or mandatory industry stocks, the government promotes the expansion of commercial inventories. So far, some storage facilities have been built for coping with seasonal demand fluctuations.

ASEAN countries do not meet the 90-day stockholding obligation of the IEA. Only Thailand and Singapore have done much better of having more than 70 days and 60 days, respectively, of oil stockpiling. The rest of the ASEAN have 30 days of oil stock pilings or little more or less than this.

In view of the comparatively low oil reserves at the national level and to help address energy security in ASEAN, ASEAN signed the new ASEAN Petroleum Security Agreement (APSA) which is a covenant among Member States that establishes a petroleum sharing scheme aimed at assisting Member State(s) in time of emergencies due to petroleum supply shortages. To date, APSA has already been fully ratified by ten Member States. Its aim is to enhance petroleum security among Member States by providing emergency petroleum sharing scheme through its Annex - Coordinated Emergency Response Mechanism (CERM) -- during times of critical supply shortages. Although APSA is in place, its implementation is constrained in terms of its operation guidelines. Furthermore, the region has not adequately experienced how APSA is going to work in practice. The idea to localise and apply APSA at the regional and national levels has been thought by ASCOPE in consultation with IEA and assisted by ERIA.

Cleaner Use of Coal in ASEAN Region

Coal outlook in ASEAN. The result of the Southeast Asia Energy Outlook (IEA and ERIA, 2013) shows that ASEAN coal demand triples from 2011 to 2035, growing at 4.7 percent per year on average. It overtakes natural gas after 2020 to become the second biggest component of Southeast Asia's energy mix, its share reaching 27 percent in 2035. While this counters the shift away from coal in most regions of the world, the trend is consistent with what was experienced during periods of rapid economic and energy demand growth in other major developing countries in Asia, notably China and India.

The strong increase in coal demand is driven by its relative abundance in the region and low coal prices, which lead to coal being favoured over oil and natural gas, particularly in power generation where substantial new capacity is required. Many of the region's gas-producing basins are located far from demand centres, thus gas demand throughout the region will increasingly be met by LNG imports, which promise to be more expensive relative to coal.

Southeast Asia will continue to be an important actor in global coal markets, with Indonesia being one of the world's largest producers and exporters, and the region as a whole being a major centre of demand in the coming decades. At end-2011, Southeast Asia had 27.9 billion tonnes in total coal reserves that would be sufficient to sustain current rates of production for 80 years. Southeast Asia's reserves are predominately lignite and sub-bituminous/bituminous coals of low and medium energy content, making them well-suited for use in power generation. The large bulk of coal reserve is located in Indonesia, which contains significant hard coal and brown coal. At end of 2011, Indonesia had 13.5 billion tonnes of hard coal reserves and 9.0 billion tonnes of brown coal reserves, by far the largest in Southeast Asia. Its reserves have risen significantly as a result of intensive exploration efforts. Indonesia's coals have modest energy content, making them well-suited for blending with other coals that have higher energy content. Additionally, they are generally low in ash and sulphur (but high in volatile matter and high moisture contents). In sum, these characteristics make Indonesian coals very attractive to steam coal export markets.

Coal production in Southeast Asia was 357 million tonnes of coal equivalent (Mtce) in 2011, rising by 9.8 percent year-on-year. Indonesia accounted for 85 percent of the region's total output. Southeast Asia features a mix of net importers (Thailand, Malaysia and the Philippines) and net exporters (notably Indonesia, and also Viet Nam). As a whole, its net exports were 220 Mtce in 2011, up by 11 percent than the previous year. Southeast Asia lies at the geographical nexus of global coal trade, its seaways serving as key transport routes for shipments between major importers in Asia (such as China, India, Japan and Korea) and major exporters (such as Australia and South Africa).

Since coal is abundant in ASEAN and EAS especially the low ranked coal, the strategic usage of coal will contribute to economic growth and also provide

energy security in the medium term. Thus, the choice of coal-fired generating technology will have significant implications for investments, efficiency, fuel inputs and costs. Presently, subcritical designs continue to be a popular choice for new plants despite the improved performance of supercritical and high efficiency technologies such as ultra-supercritical and integrated gasification combined-cycle designs. Lower capital costs are a key factor that makes subcritical plants attractive to generators in Southeast Asia, many of which are capital-constrained as a result of state ownership and implicit subsidies to end-users that lead to an under-recovery of revenues. This makes them less able to pay higher upfront investment costs for supercritical and high efficiency technologies, even if the economics are favourable in the long term. An additional factor is that subcritical plants are technologically simpler and faster to build, which can be an important consideration for governments wishing to reduce energy deficiency as quickly as possible.

Promoting clean coal technology. Supercritical and high efficiency plants, however, offer significant benefits in the long term. Their higher efficiency (about 5-12 percent higher relative to subcritical plants) results in substantial fuel savings, which translate to savings on fuel costs and emissions. The fleet of coal plants in Southeast Asian is gradually shifting towards supercritical and high efficiency technologies although significant subcritical capacity is still installed and locked in for the remainder of its technical lifetime (40-50 years). The ASEAN average efficiency of coal-fired generation rises from 34 percent in 2011 to 39 percent in 2035. More efficient price signals and stable investment frameworks could help to reduce the weighted average cost of capital, thereby encouraging investments to factor in costs over the long term. Southeast Asia's shift towards coal in power generation stems from the lower price of coal compared with natural gas as well as the higher value of gas as an export. Combining fixed costs, operational and maintenance costs, and fuel costs of new power plants allows total costs per unit of electricity generated to be compared across different technologies and cost assumptions.

For the sustainable usage of coal, the dissemination of Clean Coal Technology (CCT) for clean and efficient usage of coal in the ASEAN and EAS region is of pressing importance. In addition, in order to facilitate the economic development within the region, a cost effective and sustainable electricity supply system, with CCT at its heart, should be promoted. While the necessity

for the dissemination of CCT has been recognised, inefficient technology is still being widely used. It is therefore a concern that should this situation continue, valuable coal resources will be wasted by inefficient technology, environmental impact will not be sufficiently reduced, and sustainability will be harmed.

Table 5B.1 presents the comparisons of different technologies [Ultra Super Critical (USC), Super Critical (SC) and Sub-critical (C) boiler types] for utilising coal in terms of thermal efficiency, investment costs, maintenance costs, fuel consumption and CO2 emissions. The results show that the USC technology of Japan is the most beneficial because it has very high thermal efficiency, lower fuel consumption, lower CO2 emission, lower operations and maintenance cost, and lower generation cost compared to SC and C technologies. However, the barrier of deployment of the USC is the higher upfront investment cost.

Table 5B.1: Cost by types of technologies

	Boiler Type		
	Ultra Super Critical (USC)	Super Critical (SC)	Sub-critical (C)
Thermal Efficiency	41.5% ~ 45.0%	40.1% ~ 42.7%	37.4% ~ 40.7%
Initial Cost	1,298 mln USD	991 ~ 1,240 mln USD	867 ~ 991 mln USD
Fuel Consumption	2,229,000 tons/year (100%)	2,275,000 tons/year (+2.1%)	2,413,000 tons/year (+8.3%)
CO2 Emission (ton/year)	5,126,000 tons/year (100%)	5,231,000 tons/year (+2.11%)	5,549.000 tons/year (8.3%)
O&M Cost	3.42 mln USD/year	4.1 mln USD/year	5.0 mln USD/year
Generation Cost at USD 100/ton (USD cent/kWh)	4.03 cent/kWh (100%)	4.19 cent/kWh (+3.9%)	4.44 cent/kWh (+10.2%)
Examples	✓ "Isogo" J-POWER ✓ "Tachibanawan" J-POWER ✓ "Nordjylland", Denmark ✓ Xinchang, China	✓ "Takehara" J-POWER ✓ "Matsushima" J-POWER	✓ Taichung Power Plant ✓ Thai Binh 2

Note: Operation is assumed at 75%. Thermal efficiency is LHV. API 6 Newcastle FOB coal = 6,000 kcal/kg. CO2 emission = 2.30-CO2/kg.
Source: ERIA, 2013a

In conclusion, ASEAN countries may also wish to use the clean technology. In this regard, lowering the upfront cost investment through appropriate financial and support framework will help ASEAN countries to have greater access to

the USC or IGCC technology. Currently, Japan has implemented the Bilateral Off-set Credit Mechanism (BOCM) which can further promote the use of high technology in ASEAN countries by reducing the upfront cost. BOCM is one of the financial options to reduce cost for ASEAN to apply CCT. Thus, it will need to be promoted in ASEAN with regard to how said mechanism is used. At the same time, ASEAN should produce a common voice saying that deployment of the clean technology is something beyond the financial affordability of most AMSs and therefore there is a need to have a support mechanism from the world to ensure affordable access to such technologies.

Promoting Renewable Energy

Renewable Energy (RE) development potentials in ASEAN and East Asia region. In 2010, EAS economies as a group accounted for 35.7 percent of the world's Total Primary Energy Supply (TPES). In the same year, the group also supplied 38.6 percent of the world's REs. In terms of product mix, East Asia economies have done proportionately better in biomass and other REs. Three EAS members, namely China, Japan and India, are among the world's top-5 energy consumers. Several relatively low income countries such as Myanmar, Cambodia and Lao PDR still rely largely on biomass as the main source of energy supplies (see **Table 5B.10**).

Overall, about 14 percent of the EAS group's TPES were drawn from REs in 2010. This figure is compatible with the world average (13 percent) in the same year. Similar to the world trend, biomass dominates REs in the EAS region as well. In general, the EAS as a group follows the global trend in RE development, although some EAS members such as Brunei, Singapore, South Korea, Japan, Australia and Malaysia seem to be lagging behind.

Traditionally, biomass has been a popular energy source for cooking and heating in Asia. As energy consumption increases and resources deplete rapidly, biomass as a source of energy will decline. Thus, it is anticipated that biomass as a share of TPES is likely to fall in countries such as Myanmar, Cambodia and Lao PDR, which currently rely on biomass as the main source of energy for households. The same may also occur in Indonesia, India, Viet Nam and Thailand, which currently obtain about one-quarter of their energy

supplies from biomass (**Table 5B.2**). The decline in the use of traditional biomass is due to its inefficiency and un-sustainability. With an increase in income levels, the consumers tend to use more commercial energies.

Table 5B.2: RE Shares in EAS Economies, 2010

Members	TPES (MTOE)	Shares (%)			
		Bio	Hydro	Other REs	Non-REs
China	2438	8.3	2.6	0.7	88.5
India	688	24.8	1.4	0.3	73.5
Japan	497	1.2	1.4	0.7	96.7
Korea	250	0.5	0.1	0.1	99.3
Indonesia	208	26	0.7	7.8	65.5
Australia	125	4.1	0.9	0.5	94.5
Thailand	117	19.3	0.4	0	80.3
Malaysia	73	4.7	0.8	0	94.5
Vietnam	59	24.8	4	0	71.2
Philippines	38	12.6	1.8	22.3	63.4
Singapore	33	0.6	0	0	99.4
New Zealand	18	6.5	11.7	20.8	61
Myanmar	14	75.3	3.1	0	21.6
Cambodia	5	72	0.1	0	27.9
Brunei	3	0	0	0	100
Laos	2	67	13	0	20
EAS	4568	11	1.9	1.1	86
World	12782	9.8	2.3	0.9	87

Source: Kimura, *et al.*, 2012.

However, there is potential growth in the production of biofuels in the EAS area. ASEAN and East Asia perceive biofuel as one of the possible options to address the oil security issue since expanding the use of biofuel will not only result in oil demand reduction but also contribute to the diversification of liquid fuels' import sources. Moreover, biofuel production also provides an additional way to increase farmers' incomes. The ASEAN and East Asia countries are endowed with potential growth in biofuel. The total bioethanol demand of the 16 countries of ASEAN and East Asia in 2035 is projected to be 49 million toe and biodiesel, 37 million toe, while the supply potential of bioethanol and

biodiesel is estimated to be 70 million toe and 57 million toe, respectively [ERIA, 2013]. This implies that the region as a whole would hold enough supply potential to cover biofuel demand driven by the countries' biofuel policies of promoting the use of biofuels.

EAS economies have plans to increase the contribution of biofuels in the transport fuel mix to enhance energy security. The largest increases in consumption of biofuels are expected in India and China. The rest of the EAS economies will need to double their target to increase the blending rate for the biofuel uses in the transportation sector. **Table 5B. 3** summarises the targets of biofuels of AMSs and the rest of EAS economies.

Table 5B.3: Assumptions/Targets on Biofuels – Summary by Country

Country	Period	Assumptions
Australia	2010	No targets on biofuels.
Brunei Darussalam		No targets on biofuels.
China	2030	BAU: 20 billion liters, APS 60 billion liters
India	2017	20% blending of biofuels, both for bio-diesel and bio-ethanol.
Cambodia	2030	10% of road transport diesel and 20% of road transport motor gasoline will be displaced by biodiesel and bioethanol, respectively
Indonesia	2025	Bioethanol: 15% blend from 3-7% in 2010 Bio-diesel: 20% blend from 1-5% in 2010
Japan	2005-2030	No biofuel targets submitted.
Republic of Korea	2012	Replace 1.4% of diesel with biodiesel.
	2020	Replace 6.7% of diesel with biodiesel.
	2030	Replace 11.4% of diesel with biodiesel.
Lao PDR	2030	Utilise bio-fuels equivalent to 10% of road transport fuels
Malaysia	2030	Replace 5% of diesel in road transport with biodiesel
Myanmar	2020	Replace 8% of transport diesel with biodiesel.

New Zealand	2012-2030	Mandatory biofuels sales obligation of 3.4% by 2012.
Philippines	2025-2035	BAU: The Biofuels Law requires 10% bio-ethanol/gasoline blend and 2% biodiesel/diesel blend 2 years from enactment of the law (roughly 2009). APS: Displace 20% of diesel and gasoline with biofuels by 2025
Thailand		Biofuels to displace 12.2% of transport energy demand
Viet Nam	2020	10% ethanol blend in gasoline for road transport

Source: ERIA, 2013b.

Hydropower in the EAS members grew at an average annual rate of 8.12 percent during the period 2001-2010 (Kimura, *et al.*, 2013), which is well above the world average rate of 2.77 percent. Lao PDR and New Zealand obtained 13 and 11.7 percent of their countries' total energy supplies from hydropower, respectively, which are the highest in the EAS region. Viet Nam (4 percent), Myanmar (3.1 percent) and China (2.6 percent) are the other three countries which achieved relatively good shares. In absolute terms, China is the world's largest producer of hydroelectricity with a share of 21 percent of the world total in 2010 (*Ibid*.).

There is still potential for growth in the hydropower sector in the East Asia region. In particular, as resource endowment varies across countries, cross-border trade in hydropower has appeared and can be further expanded due to the current speed of the regional initiatives under the Greater Mekong Sub-region (GMS) linking infrastructures in the South East Asia including the power connectivity. Further, if the current Master Plan on ASEAN Connectivity (MPAC) could be realised, the ASEAN as a whole will likely benefit about US$ 12.1 billion from power generation saving (Kutani, 2013b).

ASEAN is naturally endowed with hydropower resources. Myanmar alone has a high potential of hydropower production capacity of ***108,000 MW*** (ERIA, 2013d). There are 135 hydroelectric projects identified in the hydropower database for the Lower Mekong basin (Cambodia, Viet Nam, Lao PDR and Thailand) so far [see **Table 5B. 4**].

These projects have an aggregate annual energy potential of 134 TWH which, to put in perspective, is approximately 85 percent of the current power demand in Thailand. Only about 7 percent of that potential is in operation, another 12 percent is under construction and the rest in various stages of development. The distribution by country is very uneven. Of the projects in operation, 95 percent of the production is in Viet Nam and Lao PDR, 5 percent in Thailand and negligible in Cambodia.

Table 5B.4: Database Projects

COUNTRY		PROJECT STATUS				
		IN OPERATION	UNDER CONSTRUCTION	UNDER LICENSE	PLANNED	TOTAL
LAOS	Projects	10	8	22	60	**100**
	Capacity (MW)	662	2,558	4,126	13,561	**20,907**
	Annual Energy (GWh)	3,356	11,390	20,308	59,502	**94,556**
	Investment (Million US$ 2008)	1,020	3,256	8,560	26,997	**39,832**
CAMBODIA	Projects	1	0	0	13	**14**
	Capacity (MW)	1	0	0	5,589	**5,590**
	Annual Energy (GWh)	3	0	0	27,125	**27,128**
	Investment (Million US$ 2008)	7	0	0	18,575	**18,582**
VIETNAM	Projects	7	5	1	1	**14**
	Capacity (MW)	1,204	1,016	250	49	**2,519**
	Annual Energy (GWh)	5,954	4,623	1,056	181	**11,815**
	Investment (Million US$ 2008)	1,435	1,312	381	97	**3,225**
THAILAND	Projects	7	0	0	0	**7**
	Capacity (MW)	745	0	0	0	**745**
	Annual Energy (GWh)	532	0	0	0	**532**
	Investment (Million US$ 2008)	1,940	0	0	0	**1,940**
ALL COUNTRIES	Projects	**25**	**13**	**23**	**74**	**135**
	Capacity (MW)	**2,612**	**3,574**	**4,376**	**19,199**	**29,760**
	Annual Energy (GWh)	**9,846**	**16,013**	**21,365**	**86,808**	**134,031**
	Investment (Million US$ 2008)	**4,402**	**4,568**	**8,941**	**45,669**	**63,580**

Source: MRCS, 2010

Apart from biomass and hydropower, other forms of RE have also been produced in the East Asia region. According to **Table 5B. 5** and **Table 5B.6**, EAS as a group accounted for 35.3 per- cent of the world's installed wind capacity, 15.1 percent of solar capacity and 40.4 percent of geothermal capacity. While EAS has a relatively large share of the world's geothermal capacity, the growth of this product is limited due to resource and technology constraints. Two EAS members, namely, the Philippines and Indonesia, in turn have the world's second and third largest geothermal energy capacity with a joint share of 28.7 percent over the world total in 2011. During the decade 2001-2010, production output in the EAS group grew at an average rate of 3.3

percent which is higher than the world's average growth rate of 2.2 percent during the same period.

Table 5B.5: Installed Capacity (megawatts) in EAS, 2011

Countries	Geothermal	Solar	Wind
Australia	1.1	1344.9	2476
China	24	3000	62412
India		427	16078
Indonesia	1189		
Japan	502	4914.1	2595
Malaysia		12.6	
New Zealand	769.3		603
Philippines	1967		
South Korea		747.6	370
Thailand	0.3		
EAS	4452.7	10446.2	84534
World	11013.7	69371.1	239485
EAS (%)	40.4	15.1	35.3

Source: Kimura, *et al.*, 2013.

Table 5B. 6: World Major Geothermal Energy Producers in 2010

Countries	Ranking	Output (Mtoe)
Indonesia	1	16.09
Philippines	2	8.54
US	3	8.41
Mexico	4	5.69
Italy	5	4.78
China	6	3.71
New Zealand	7	3.64
Iceland	8	3.35
Japan	9	2.47
Turkey	10	1.97
EAS		34.51
World		64.61

Source: Kimura, *et al.*, 2013.

In terms of wind energy production, the EAS as a group achieved 22.2 percent of the world total in 2010, with China and India being the second and fifth largest producers. Given the rapid growth in capacity, production is expected to expand significantly in the coming years.

The production of solar energy has also expanded rapidly in the EAS group. During the 2002-2011 period, the average annual rate of growth in installed photovoltaic (PV) capacity was 36.0 percent, though this is lower than the world average rate of growth of 45.4 percent (BP 2012). Due to the increased capacity, the output of solar PV power in the EAS area grew at an average annual rate of 30.5 percent during 2001-2010 (OECD 2013).

In summary, REs are rapidly expanding in the EAS economies. But the development varies a lot across countries and products. The main products in the EAS economies include biomass, hydro, geothermal, solar and wind energies. There is hardly any development in oceanic energies. In general, the share of REs to total energy supplies in the EAS area is similar to the world average. The share of biomass to REs is slightly higher in the EAS group than in the world average. However, past experience shows that biomass consumption is likely to decline relatively as economies develop. In addition, geothermal energy production has been stable in recent years. Hence the potential for growth in the near future lies in solar and wind energies.

Capturing the RE wave and the need for appropriate energy policy in ASEAN for energy resiliency and green development

There have been great cost reductions in renewable energy over the past five years. Because of the fast learning curve and the sharp drop of upfront investment cost on solar, wind and hydropower technologies, tens of Gigawatts of wind, hydropower and solar photovoltaic capacity are installed worldwide every year in a renewable energy market that is worth more than a hundred billion US dollars annually. Other renewable power technology markets are also emerging. Recent years have seen dramatic reductions in renewable

energy technologies' costs as a result of R&D and accelerated deployment (IRENA, 2012).

For solar PV, the costs of concentrated solar and solar PV are declining due to steep learning curves and large deployments in recent years. It is estimated that every doubling of solar PV installed capacity will yield a reduction in module costs of about 22 percent. Continued rapid cost reductions are likely due to the rapid growth in deployment, given that cumulative installed capacity grew by 71 percent in 2011 alone. The factory gate price of thin-film module had fallen below US$ 1/watt (W) in the beginning of 2012. The prices of crystalline silicon (c-Si) modules are more varied, but were typically in the range US$ 1.02 to US$ 1.24/W for the most competitive markets (IRENA, 2012). Solar-powered generation is projected to account for about 2 percent of global power supply by 2040 (Bloomberg, 2013).

The total installed cost of PV systems can vary widely within individual countries, and between countries and regions. Nonetheless, solar PV is already competitive with residential tariffs in regions with good solar resources, low PV system costs and high electricity tariffs for residential consumers. In addition, PV with storage is now virtually always cheaper than diesel generators for the provision of off-grid electricity. Countries which lack national power grids and distribution system can improve the electrification rate by solar PV. Countries with many islands such as Indonesia and the Philippines have already started considering the solar PV as an option for the improved electrification rate in remote islands. Thus, the policy to promote the deployment of the solar PV is critical in ASEAN.

The wind industry has observed significant cost- of- energy reductions and the cost of wind energy is expected to continue to fall (IEA, 2012). Performance improvements associated with continued turbine upscaling and design advancements are anticipated, and lower capital costs may also be achievable. The magnitude of future cost reductions, however, remains highly uncertain, although most recent estimates project that the Levelised Cost of Energy (LCOE) of onshore wind could fall by 20–30 percent over the next two decades.

The world's wind-power capacity increased 113-fold over the past 20 years and the price for a megawatt of wind power has dropped by almost half since 1991. The improved efficiencies of technology and scale and the industry's learning curve reduce wind-power prices by 7 percent every time installed capacity doubles (Bloomberg, 2013). By 2040, wind-powered generation is projected to account for about 7 percent of global power supply. Wind power is already among the most competitive renewable technologies. The levelised cost of electricity (LCOE) for new onshore wind farms ranges between US$0.05 to US$0.15/ kWh. In locations with good wind resources, onshore wind is becoming competitive with fossil fuel-based generation. This means that wind power is now cheaper than conventional energy sources, even without government subsidies.

Even as a relatively mature technology, hydro will continue to attract attention due to the advantages it offers such as lowest LCOE, grid stability, and potential for energy storage and complementarity with other renewables. Moreover, hydropower (including small hydro) provides options for building additional capacity at existing facilities or installing generation capacity at dam locations with no current generation at attractive marginal investment costs in the range of US$500 to US$800/kW.

ASEAN and East Asia countries are trying to increase the blending rate of bioethanol and biodiesel into the transportation fuels. ERIA has conducted a study on the future biofuel demands and supply potentials in the 16 countries and it shows that total bioethanol demand in 2035 will be 49 million toe and biodiesel 37 million toe, while the supply potential of bioethanol and biodiesel will be 70 million toe and 57 million toe, respectively. The results indicate that the region as a whole would hold enough supply potential to cover biofuel demand driven by the countries' biofuel policies to promote use of biofuels. It is also noted that more R&D is being conducted worldwide on the potentials of third generation biofuels. The current first and second generation biofuels like ethanol and biodiesel have a number of inherent limitations that make them less than ideal as a long-term replacement for petroleum. The primary feed stocks for first-generation ethanol (corn and sugarcane) and biodiesel (rapeseed, soybeans, and palm) are all food-based crops that compete for scarce cropland, fresh water, and fertilizers. If R&D can improve in the near future the "third-

generation biofuels" such as algae biofuels ad other non-edible plants, it will provide ideal promise of increasing biofuel share in the market.

The strategic importance of energy resiliency and a Green ASEAN implies the need to promote the learning on and deployment of Green Energy such as solar PV, wind, geothermal, hydropower, advanced biofuels and other renewable energy resources. Renewable power generation can help countries meet their sustainable development goals through the provision of access to clean, secure, reliable and affordable energy. Therefore, in order to push this learning curve, appropriate energy policies by governments are needed. Those policies include Feed-in-Tariff (FIT), Renewable Portfolio Standard (RPS) and policies that provide incentive to technology development. As the technologies on green energy have advanced in Europe and other developed countries, ASEAN will need to tap those and leverage them into the ASEAN context.

Conclusions

According to the ERIA energy outlook studies, oil and gas consumptions will surely increase in ASEAN and East Asia due to robust economic growth, increased population and rapid motorisation. The continued growth of energy consumption and high reliance on oil and gas imports primarily from historically volatile Middle East region leave the ASEAN and East Asia region vulnerable to disruptions to global oil supplies and sharp spikes in price. The Cebu Declaration on energy security aims to strengthen ASEAN energy resiliency and security by emphasising energy efficiency and coordination, promotion of renewable energy, and fossil fuel stockpiling.

The diversification of energy sources and the implementation of APSA for the oil stockpiling are seen as important for ASEAN and East Asia in terms of energy security. ASCOPE is tasked to review the APSA mechanism. Further assistance on the operational guidelines and research on how APSA will be practically applied in ASEAN countries will be provided by the IEA and ERIA, respectively.

ASEAN and EAS countries perceive biofuel as one of the possible options to address the oil security issue. Expanding the use of biofuel will not only result in oil demand reduction but also contribute to diversification of liquid fuels'

import sources. The region itself is endowed with potential growth in biofuel that can hold enough supply to cover biofuel demand driven by the countries' policies promoting the use of biofuels. The current first and second generation biofuels like ethanol and biodiesel have a number of inherent limitations that make them less than ideal as a long-term replacement for petroleum. If R&D on "third-generation biofuel" such as algae biofuels and other non-edible plant succeeds, it will provide ideal promise of increasing biofuel share into the market.

The wind energy production in the ASEAN and EAS region reached 22.2 percent of the world total in 2010, with China and India being the second and fifth largest producers in the world. Given the rapid growth in capacity, production is expected to expand significantly in the coming years. The wind industry has observed significant cost–of-energy reductions, and the cost of wind energy has fallen and is expected to continue to fall. The improved efficiencies of technology and scale, particularly the industry's learning curve, help reduce wind-power prices by 7 percent every time installed capacity doubles. In locations with good wind resources, onshore wind is becoming competitive with fossil fuel-based generation.

The production of solar energy in the ASEAN and EAS region has also expanded with the average annual rate of growth in installed photovoltaic (PV) capacity at 30.5 percent compared with the global rate at 36.0 percent during the period 2002-2011. The costs of concentrated solar and solar PV are declining steadily due to steep learning curves and large deployments in recent years. Every doubling of solar PV installed capacity will yield a reduction in module costs of about 22 percent. Solar PV is often already competitive with residential tariffs in regions with good solar resources, low PV system costs and high electricity tariffs for residential consumers. Countries which lack national power grids and distribution system can improve the electrification rate by solar PV. Countries with many islands such as Indonesia and the Philippines have already started considering the solar PV as an option for the improved electrification rate in remote islands.

There is still potential for growth in the hydropower sector in the ASEAN and EAS region. In particular, as resource endowment varies across countries, cross-border trade in hydropower has appeared and can be further expanded

due to the current speed of the regional initiatives under the Greater Mekong Sub-region (GMS) and ASEAN Master Plan on ASEAN Connectivity. Myanmar alone has a high potential of hydropower production capacity of 108,000 MW. Cambodia, Lao PDR, Thailand and Viet Nam have hydropower production capacity of about 30,000 MW. Hydropower will continue to attract attention due to the advantages it offers such as the lowest LCOE, grid stability, and potential for energy storage and complementarity with other renewables. Further, hydropower (including small hydro) provides options for building additional capacity at existing facilities or installing generation capacity at dam locations with no current generation at attractive marginal investment costs in the range of US$500 to US$800/kW.

ASEAN and East Asia countries will need to speed up the production chains of the New Renewable Energy (NRE) industries such as wind, solar PV and biofuels. To have these industries set up in ASEAN countries will drive down upfront installment cost and gradually make unit cost electricity produced from the NRE more competitive with fossil fuel power plants. Thus, ASEAN needs to promote the use of NRE wisely.

Since coal is abundant in ASEAN and EAS, especially the low ranked coal, the strategic usage of coal will contribute to economic growth and also provide energy security in the medium term. Thus, the choice of coal-fired generating technology will have significant implications for investments, efficiency, fuel inputs and costs. Lowering the upfront cost investment through appropriate financial and support framework will help ASEAN countries to access Clean Coal technologies such as the USC or IGCC technology.

Currently, Japan has implemented the Bilateral Off-set Credit Mechanism (BOCM) which promotes the use of high technology in ASEAN countries by reducing upfront cost. BOCM is one of the financial options to reduce upfront cost for ASEAN to apply CCT as well as invest in EEC equipments and facilities. Thus, in addition to the promotion of mechanisms like BOCM, ASEAN may push for international support to ensure that deployment of the clean technology becomes affordable financially to most AMSs and much of the developing world.

Policy Recommendations

1. Sustainable, reliable and affordable energy are keys for the ASEAN and EAS region to pursue robust and green growth. The future Green ASEAN will need to come from Renewable Energy as ASEAN and EAS are endowed with renewable resource potentials in wind, solar, hydropower, biofuels and other Renewable Energy. Although leaders have committed to implement the Cebu Declaration and the UN Conference on Environment and Development (UNCED), **ASEAN and East Asia will need to foster RE aspirations and deployment targets. ASEAN and EAS members could also develop RE deployment goals for each country within a target period that reflects the reality in each member's economy**. In this regard, energy policies such as Feed-in-Tariff (FIT), Renewable Portfolio Standard (RPS) and incentive on technology development shall be formulated to promote NRE.

2. ASEAN and East Asia's leadership to implement EEC will bring large energy saving potentials and surely contribute to the regional security. Thus **ASEAN and EAS need to develop a framework to support the deployment/ utilisation of the efficient and low carbon technologies**.

3. The strategic usage of coal will contribute to economic growth and also provide energy security in the region. For the sustainable usage of coal, the dissemination of Clean Coal Technology (CCT) for clean and efficient usage of coal in the ASEAN and East Asia region is of pressing importance. Thus, **BOCM may need to be promoted more in ASEAN; at the same time, ASEAN should call for international support to ensure that deployment of clean technology is accessible to all AMSs**.

4. The new ASEAN Petroleum Security Agreement or APSA is a covenant among ASEAN Member States that establishes a petroleum sharing scheme aimed at assisting Member State(s) in time of emergencies due to petroleum supply shortages. To date, APSA has already been fully ratified, but its implementation faces a real constraint in terms of its operation guidelines. Furthermore, the region has not adequately experienced how APSA is going to work in practice. The idea to localise and apply APSA at the regional and national levels has been broached

by ASCOPE in consultation with the IEA and assisted by ERIA. In this regard, **ASEAN Leaders would need to empower ASCOPE, including the provision of financial means, to implement APSA through its operation guidelines once the revised guidelines are updated with the assistance from IEA and ERIA**.

5. Expanding the use of biofuel will not only result in oil demand reduction but also contribute to the diversification of liquid fuels' import sources. Thus, **ASEAN and EAS will need to foster the implementation of promoting biofuels for transportation**. In this regard, it is important to have a "**free trade" in goods and services of biofuel products** to ensure that supply of the feedstock is part of the energy market integration. Furthermore, **ASEAN and East Asia will need to join hands to further invest in R&D for the "third-generation biofuels"** such as algae biofuels and other non-edible plants that will provide ideal promise of increasing biofuel share in the market.

6. The development and financing mechanisms in RE are keys to reducing the lead time for RE deployment. Recognising each ASEAN country's level of development, ASEAN countries will need to have access to financial support in order to acquire technology development for the NRE. Thus, it is recommended that **financial cooperation and technology development incentives amongst ASEAN and East Asia countries shall be policy priorities; in addition, the world may need to support developing member countries to embark in RE development**.