Chapter 1

Trends and Prospects for the Renewable Energy Sector in the EAS Region

Yanrui Wu

UWA Business School, University of Western Australia

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CHAPTER 1

Trends and Prospects of the Renewable Energy Sector in the EAS Region

YANRUI WU

UWA Business School
University of Western Australia

The rising prices of fossil fuels and the deteriorating world environment have made renewable energy the brightest business prospect in the energy sector. In fact, as the world's fossil fuel resources are limited and gradually depleting, renewable energy could be the main source of energy in the future. Thus, developments in the renewable energy sector could have important implications for the world. In particular, the East Asia Summit (EAS) countries as a group are net energy importers and hence have a keen interest in renewable energy development. This is not only related to energy consumption in the region but is also linked with the goal of promoting energy market integration within the EAS group. The objectives of this study are twofold, namely, a) to present a review of the trends in the renewable energy sector and b) to shed light on the prospects of development and growth in this sector within the EAS area. Specifically, this project will review the status and trends of renewable energy development among the EAS members. It will provide a comparative perspective in renewable energy policy and business development in the EAS region. It will explore the prospects of future development and growth in renewable energy and the role of renewable energy in energy market integration within the EAS energy sector.

Key words: Renewables, EAS group, energy market integration
JEL classification: Q40, Q42, Q47

1. Introduction

With the rising awareness of environmental degradation and rapid depletion of fossil fuel resources, renewable energies (REs or renewables) have attracted the attention of policy makers as well as energy experts worldwide. The East Asian Summit (EAS) nations as major energy consumers are also keen to develop their RE sectors. Many EAS countries have adopted specific policies to promote their RE sectors.[1] To gain more insight into the RE industry, this paper aims to present an overview of the status and trends of development in the RE sectors among EAS members. It will also discuss the implications of RE development for energy market integration (EMI) policy and business in the EAS region.

The rest of the paper starts with a review of the worldwide RE industry (Section 2). This is followed by discussion of the RE sector in the EAS economies (Section 3). The outlook for REs and the potential drivers for and hindrances to RE growth in the EAS region are then explored (Section 4). The key findings and policy recommendations are presented in Section 5.

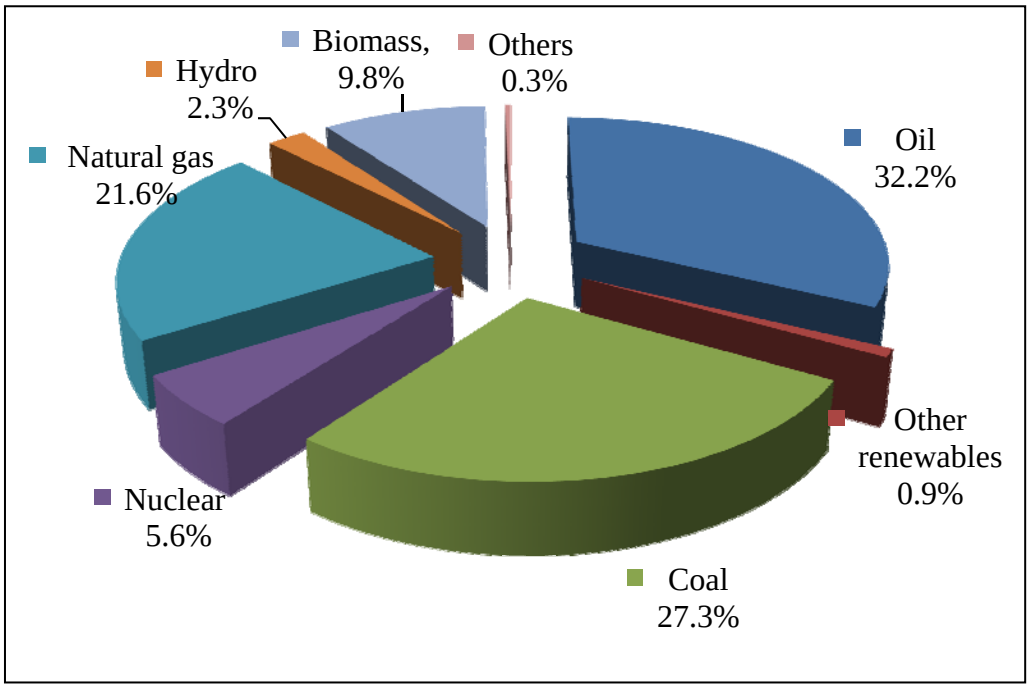
2. The Global RE Industry

REs broadly include energies sourced from sunlight (solar), water (hydro), wind, biomass, marine (wave), tides (tidal) and geothermal heat. In the existing literature the exact coverage of REs is not without controversy. For example, biomass can be divided into traditional and modern biomass. Traditional biomass includes wood, charcoal, crop residues and animal dung mainly used for cooking and heating, while modern biomass refers to biogas and liquid biofuels (such as biodiesel and biogasoline). The use of biomass could be sustainable or unsustainable (Goldemberg and Coelho 2004). Hydropower is generally classified into traditional or large hydroelectric power and small hydropower. The latter is assumed to be more environment-friendly. The measurement of REs by several key organizations also

[1]For detailed discussions of RE policies in the EAS region, see Olz and Beereport (2010), Ipsos (2012) and IRENA (2013b).

varies. A major problem is the measure of non-commercial–energies, which are dominated by traditional biomass. It is argued that about 20-40 per cent of biomass use is not reported in official energy statistics (IPCC 2012). Due to this complication, BP (2012) reports traded or commercial energy statistics only. According to the International Energy Agency (IEA), REs accounted for about 13.0 per cent of the world's total energy production in 2010, including 9.8 per cent from biomass, 2.3 per cent from hydroelectricity and 0.9 per cent from other REs (Figure 1). In recent years (2006-2010), REs globally recorded an average annual rate of growth of 3.05 per cent which is higher than the growth rate (2.31 per cent) of the world's total primary energy supplies (TPES) in the same period.[2]

Figure 1: Composition of Global Energy Production in 2010



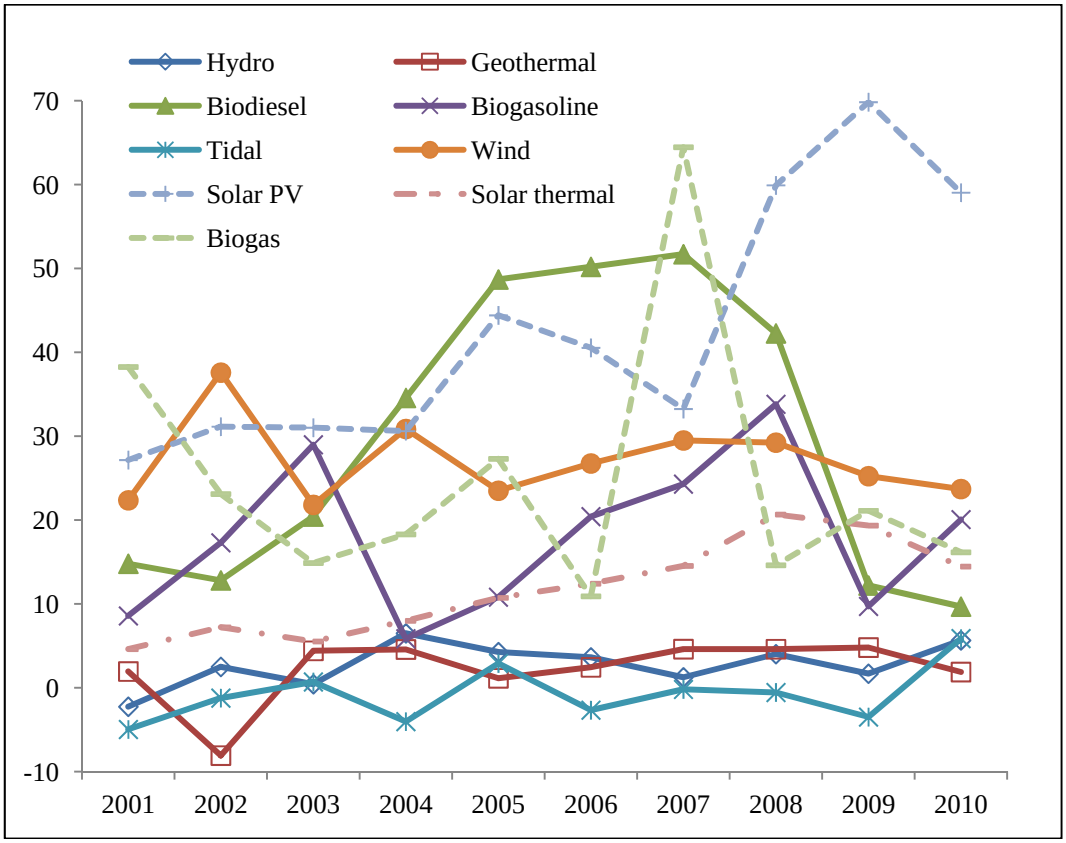
Source: IEA (2012a).

In absolute terms all RE supplies in 2010 totaled about 1657 million tonnes oil equivalent (Mteo) of which three-quarters are generated by biomass and renewable wastes, 18 per cent by hydro and 7 per cent by other REs (IEA 2012a). The latter include geothermal (4.0 per cent), wind (1.8 per cent) and solar and tide (1.2 per cent). Though the "other REs" have the smallest share, some products in this

[2] These growth rates are computed using data from the OECD (2013).

category have recorded high growth in production in recent years. For example, growth has been exceptionally high for solar photovoltaic (PV) and wind (Figure 2). Other products with two-digit growth rates include biofuels (biogases and liquid biofuels) and solar thermal energies, according to the same source. The main driving force for the rapid growth in REs is their declining production cost and hence falling RE prices in recent years.

Figure 2: Annual Growth Rates, 2001-2010



Note: The percentage growth rates are computed using data from the OECD (2013).

Regional shares of TPES and REs are presented in Table 1. As shown in this table, the underperforming regions (where RE shares are lower than their TPES shares) are the Middle East, OECD, and non-OECD Europe and Eurasia. In Africa, Latin America and Asia, REs have relatively high shares largely due to the use of biomass in these regions. In addition, the world's major energy consumers (top-5) accounted for about 52.7 per cent of the world's TPES in 2010 while their RE production share was only 37.5 per cent in the same period according to Table 1. Thus, the world's

large energy consumers should boost their efforts to promote RE production and consumption.

Table 1: TPES and RE Shares by Region and in Selected Countries, 2010

Region/countries	TPES (%)	REs(%)
Latin America	5.0	11.1
Middle East	5.1	0.2
Africa	5.5	20.4
Non-OECD Europe and Eurasia	9.0	2.6
Asia	31.9	40.3
OECD	43.5	25.4
World	100.0	100.0
China	19.7	16.9
United States	17.8	7.5
Russian Federation	5.6	1.1
India	5.5	11.0
Japan	4.0	1.0
Sub-total	52.7	37.5

Note: TPES and RE are abbreviations for total primary energy supplies and renewable energy, respectively. The numbers are calculated by the author using raw data from the IEA (2012a).

The share of REs in TPES also varies across the groups. REs have relatively high shares in Africa, Asia and Latin America due to the dominant use of biomass (Table 2). For example, in Africa, biomass amounted to 96.9 per cent of total REs. In these regions, as commercial energies become more affordable, the share of biomass in TPES and REs is expected to decline and thus, the share of REs over TPES is also likely to decline over time. Globally, traditional biomass share over total REs fell from 50 per cent in 2000 to 45 per cent in 2010 (IEA 2012b).

Table 2: RE shares of Total Primary Energy Supplies (TPES) in 2010

Regions/countries	RE/TPES (%)	Biomass/RE (%)	Hydro/RE (%)	Others/RE (%)
Middle East	0.5	14.7	46.4	38.8
OECD	7.8	57.4	27.6	15.0
United States	5.6	67.2	18.0	14.7
Japan	3.3	36.1	42.6	21.3
Non-OECD Europe and Eurasia	3.9	36.4	61.8	1.8
Russian Federation	2.6	16.7	80.9	2.4
Africa	49.4	96.9	2.7	0.5
Latin America	29.8	65.6	32.5	1.9
Asia	37.1	81.0	12.6	6.4
China	11.4	72.1	22.2	5.7
India	26.5	93.5	5.4	1.1
World	13.0	75.2	18.0	6.8

Notes: TPES and RE are abbreviations for total primary energy supplies and renewable energy, respectively. The numbers are calculated by the author using raw data from the IEA (2012a).

There is also considerable variation among individual countries, reflecting the impact of energy policies and differences in resource endowment. As the largest energy consumer, China is also the largest RE producer and consumer (Table 1). In relative terms, REs only have a share of total consumption of less than 10 per cent in the US, Japan and Russia. If biomass is excluded from the REs, RE shares of TPES in 2010 were 3.2, 2.2, 2.1, 1.8 and 1.7 per cent in the world's top five energy consuming economies (China, Russia, Japan, the US and India), respectively. Therefore the role of REs is still small among the world's major energy players.

In absolute terms, China not only tops the list of the world's largest RE producers but is also the largest supplier of biomass and hydropower, and is second to the US in terms of other RE supplies (wind, solar and so on) (Table 3). In 2010, about 19.4 per cent of the world electricity was generated from REs (IEA 2012a). However, REs play the dominant role in power generation in some countries. For example, the percentage shares of electricity production from REs in 2010 were 100 in Iceland, 95.7 in Norway, 73.3 in New Zealand, 66.4 in Austria and 60.9 in Canada (IEA 2012a).

Table 3: Top-10 RE Supplies in the World (MTOE), 2010

Ranking	Total		Biomass		Hydro		Others	
1	China	280.3	China	202.1	China	62.2	United States	18.4
2	United States	124.9	Nigeria	94.8	Brazil	34.7	China	16.0
3	Brazil	116.7	United States	84.0	Canada	30.2	Mexico	5.9
4	Nigeria	95.4	Brazil	81.4	United States	22.5	Italy	5.9
5	Canada	42.9	Ethiopia	31.0	Russia	14.3	Germany	5.2
6	Germany	32.5	Pakistan	28.9	Norway	10.1	Spain	4.8
7	Pakistan	31.6	Germany	25.5	Venezuea	6.6	Iceland	3.3
8	Ethiopia	31.4	Congo	22.2	Sweden	5.7	Turkey	2.6
9	Congo	22.9	Tanzania	17.8	France	5.4	El Salvador	1.3
10	France	21.0	France	14.6	Paraguay	4.7	Kenya	1.2

Source: OECD (2013).

Due to resource and technology constraints there are considerable variations in the role of RE products among countries. For example, wind power generation has a significant share in total electricity generation in Denmark (21%), Portugal (18%), Spain (15%), Ireland (10%)and Germany (6%); geothermal sources account for more than a quarter of total electricity generated in Iceland, and more than a fifth in El Salvador and Kenya.[3]

In terms of consumption, REs are dominantly used in the residential, commercial and public sectors (with a share of 52.5 per cent in 2010). This is largely due to the use of biomass for cooking and heating in developing countries. Only 28.5 per cent of REs were used for electricity and heat production and 3.5 per cent were consumed in the transport sector. However, about a half of RE use in OECD countries is constitutes the production of electricity and heat (IEA 2012a). Overall, the role of REs in world energy has expanded and is still increasing. There are large differences across the country groups and between the RE products. In general, growth in hydro and geothermal energies is modest and that in traditional biomass has shown a declining trend. Further growth in REs will rely on biofuels, wind power and solar energies.

[3]These shares are calculated using the data of electricity production from the World Bank (2012), wind energy supply from IEA (2012a) and geothermal energy supply from the OECD (2013).

3. REs in the EAS Economies

In 2010, EAS economies as a group accounted for 35.7 per cent of the world's TPES (Table 4). In the same year the group also supplied 38.6 per cent of the world's REs.[4] In terms of product mix, EAS economies have done proportionately better in biomass and other REs according to Table 4. Three EAS members, namely China, Japan and India, are among the world's top-5 energy consumers as shown in Table 1. However neither Japan nor India is listed as the world's top-10 RE producers (Table 3). Several relatively low income countries, such as, Myanmar, Cambodia and the Laos still rely largely on biomass as the main source of energy supplies (Table 4).

Overall, about 14 per cent of the EAS group's TPES were drawn from REs in 2010. This figure is compatible with the world average (13 per cent) 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 (Table 4). These variations, in terms of country as well as product mix are described in detail below.

[4] This figure is estimated using the numbers in Table 4.

Table 4: RE shares in EAS Economies, 2010

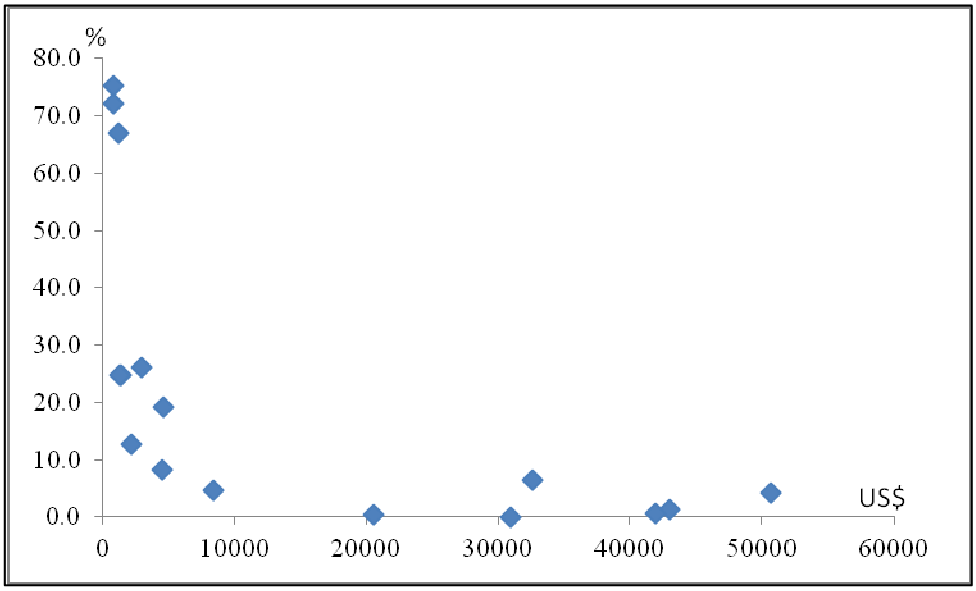
Members	TPES (MTOE)	Shares (%)			
		Bio	Hydro	Other REs	Non-REs
China	2438	8.3	2.6	0.7	88.5
India	688	24.8	1.4	0.3	73.5
Japan	497	1.2	1.4	0.7	96.7
Korea	250	0.5	0.1	0.1	99.3
Indonesia	208	26.0	0.7	7.8	65.5
Australia	125	4.1	0.9	0.5	94.5
Thailand	117	19.3	0.4	0.0	80.3
Malaysia	73	4.7	0.8	0.0	94.5
Vietnam	59	24.8	4.0	0.0	71.2
Philippines	38	12.6	1.8	22.3	63.4
Singapore	33	0.6	0.0	0.0	99.4
New Zealand	18	6.5	11.7	20.8	61.0
Myanmar	14	75.3	3.1	0.0	21.6
Cambodia	5	72.0	0.1	0.0	27.9
Brunei	3	0.0	0.0	0.0	100.0
Lao PDR	2	67.0	13.0	0.0	20.0
EAS	4568	11.0	1.9	1.1	86.0
World	12782	9.8	2.3	0.9	87.0

Source: Author's own calculations using data from the IEA (2012a) and IRENA (2013a).

3.1. Biomass

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. This trend is evident in Figure 3 which clearly shows the declining trend of biomass shares of total energy supplies as per capita income rises among the EAS economies. Thus, it is anticipated that biomass as a share of TPES is likely to fall in countries such as Myanmar, Cambodia and the Lao PDR which currently rely on biomass as the main source of energy for households. The same may also occur in Indonesia, India, Vietnam and Thailand, which currently obtain about one-quarter of their energy supplies from biomass (Table 4).

Figure 3: Biomass shares over TPES and GDP per capita, 2010



Notes: The biomass shares are from Table 4. GDP per capita was drawn from the World Bank (2012).

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. However, there is potential growth in the production of biofuels in the EAS area. One example is the production of palm biodiesel which could be based on the large palm oil sector in Southeast Asia. In fact, several EAS members have started the production of biodiesel in recent years. In 2010, Thailand was the largest producer with a production output of 454 kilotonnes oil equivalent (ktoe) followed by Indonesia with an output of 356 ktoe (OECD, 2013). In addition, within the EAS group, China is the largest producer of biogasoline with a production output of 1035 ktoe in 2010. In terms of biofuels, their environmental impacts have to be assessed so that their production in relevant areas does not lead to negative impacts on the local ecological system and hence is sustainable in the long run. Thus, environmental consideration is an important factor underlying the development of biofuels. Furthermore, biogas can be produced from organic waste, animal manure and sewage sludge, and is often used for heating and electricity generation in rural communities.

3.2. Hydro

EAS members are well endowed with hydro resources. During the decade 2001-2010, hydro energy production in the EAS group grew at an average annual rate of 8.12 per cent which is well above the world average rate of 2.77 per cent during the same period.[5] Lao PDR and New Zealand obtained 13 and 11.7 per cent of their countries' total energy supplies from hydropower, respectively, which are the highest among the EAS group. Vietnam (4 per cent), Myanmar (3.1 per cent) and China (2.6 per cent) are the other three which achieved relatively good shares. In absolute terms, China is the world's largest producer of hydroelectricity with a share of 21 per cent of the world total in 2010 (see Table 3). The country's hydro power also enjoyed an average annual rate of growth of 12.8 per cent during 2001-2010. There is still potential for growth in the hydro power sector in the EAS area. In particular, as resource endowment varies across countries, cross-border trade in hydro power has appeared and can be further expanded.

3.3. Geothermal

Apart from biomass and hydropower, other forms of RE have also been produced in the EAS area. According to Table 5, EAS as a group accounted for 35.3 per cent of the world's installed wind capacity, 15.1 per cent of solar capacity and 40.4 per cent of geothermal capacity. While EAS has a relatively large share of the world's geothermal capacity, growth of this product is limited due to resource and technology constraints. For example, over the past decade (2002-2011), the average rate of growth in the installed capacity of geothermal energy was modest in both the EAS group (2.2 per cent) and the world (3.1 per cent). The world's growth in installed capacity was very much driven by that in the United States which has been the largest producer of geothermal energy for decades and has been growing at the average rate of 4.0 per cent since 2002 according to BP (2012). 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 per cent over the world

[5]These rates of growth were calculated by the author using the statistics downloaded from the OECD (2013).

total in 2011. However, the installed capacity in the top three countries (US, the Philippines and Indonesia) remains almost unchanged in recent years.

In terms of geothermal energy production, the EAS group is more impressive with a share of 53.4 per cent of the world total in 2010 (Table 6). Indonesia and the Philippines have been the world's largest producers since 2002. Substantial production was also recorded in China, New Zealand and Japan. During the decade 2001-2010, production output in the EAS group grew at an average rate of 3.3 per cent which is higher than the world's average growth rate of 2.2 percent during the same period. In particular, during 2001-2010, China and Indonesia achieved an average annual growth rate of 9.1 per cent and 7.0 per cent, respectively.

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

Countries	Geothermal	Solar	Wind
Australia	1.1	1344.9	2476.0
China	24.0	3000.0	62412.0
India		427.0	16078.0
Indonesia	1189.0		
Japan	502.0	4914.1	2595.0
Malaysia		12.6	
New Zealand	769.3		603.0
Philippines	1967.0		
South Korea		747.6	370.0
Thailand	0.3		
EAS	4452.7	10446.2	84534.0
World	11013.7	69371.1	239485.0
EAS (%)	40.4	15.1	35.3

Source: BP (2012).

Table 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

Note: The raw data are downloaded from the OECD (2013).

3.4. Wind

Due to technology advance and the resultant fall in production costs, both the world and EAS group have experienced rapid expansion in wind farms. During the past decade (2002-2011), the average annual rate of growth in capacity was 25.5 per cent in the world and 43.6 per cent in the EAS group.[6] China has been growing at an average rate of 70 per cent since 2002 and overtook the United States to have the world's largest capacity for wind energy production in 2010. China's rapid expansion in wind energy capacity sets a good example for other developing countries. The country's growth took off in 2007 when China's first renewable energy law was implemented. The Law provides a legal framework for the operation and development of renewable energy technologies in the country. Grid companies are required to prioritize renewable energies over other sources of power (IRENA 2012). India, with the world's fifth largest capacity also recorded a high rate of growth, at 27.6 per cent annually during 2002-2011. This growth benefited from the RE purchase obligations mandated under the Indian Electricity Act and through the implementation of the so-called renewable purchase specification (RPS). A

[6]The rates of growth cited in this paragraph are derived by the author using the statistics from the BP (2012).

renewable energy law is yet, however, to be enacted in India. In terms of wind energy production, the EAS as a group achieved 22.2 per cent 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.

3.5. Solar

The production of solar energy has also expanded rapidly in the EAS group. During the period 2002-2011, the average annual rate of growth in installed photovoltaic (PV) capacity was 36.0 per cent, though this is lower than the world average rate of growth of 45.4 per cent (BP 2012). A main factor underlying this growth in EAS is the rapid expansion in capacity in China in recent years. While it started at a low base, China's installed capacity expanded from 100 megawatts (MW) in 2007 to 300 MW in 2009. It reached 3000 MW in 2011 according to BP (2012). High growth was also recorded in Australia (with an average annual growth rate of 92.7 per cent during 2007-2011) and India (with an average annual growth rate of 79.8 per cent during 2007-2011).

Due to the increased capacity, the output of solar PV power in the EAS area grew at an average annual rate of 30.5 per cent during 2001-2010 (OECD, 2013). However, this rate is lower than the world's average growth rate of 42.7 per cent in the same period. As a result, the EAS share of the world total solar PV power declined from its peak of 50.3 per cent in 2003 to 18.3 per cent in 2010. During the same period (2001-2010), production in solar thermal energy has also been growing at an average rate of 17.5 per cent. The EAS share of the world total solar thermal power has expanded from 37.7 per cent in 2000 to 62.0 per cent in 2010.

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.[7] In general the share of REs of total energy supplies in the EAS area is similar to the world average. The share of

[7]In 2011, only three countries- France, Canada and Korea- recorded energy output in the category of "tide, wave and ocean" according to the OECD (2013). France dominates this sector.

biomass over of 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.

4. RE Outlook and Implications for EMI

4.1. Growth Prospects

In 2012, the world celebrated the International Year of Sustainable Energy for All (SE4ALL) initiated by the United Nations (IRENA, 2013b). One of the SE4ALL objectives is to double the 2010 RE share of the world energy mix by 2030. The realization of this goal would result in an RE share of at least 26 per cent in 2030 according to IEA statistics. To reach this goal, combined with other energy efficiency improvement commitments, RE production in the EAS area would have to grow at an average annual rate of 5-6 per cent according to the forecasts in Table 7. This rate would be much higher than the average rate of 1.9 per cent achieved by the region in the past decade (2001-2010). In recent years, only Korea, New Zealand and Thailand recorded RE growth rates close to this predicted rate. Furthermore, if there is no efficiency improvement (i.e. 'business as usual'), the growth rate would have to be even higher (at 9.0 per cent). During the decade 2001-2010, only Korea achieved such a high growth rate. The main sources of growth will in turn be wind, solar and biofuel products. By 2030, the output of wind energy would probably exceed that of solid biofuel.

Table 7: Average RE Growth Rates (%), 2011-2030

Products	2001-2010		2011-2030		
	World	EAS	I	II	III
Wind	27.1	40.3 (7)	27.1 (784)	27.1 (784)	31.5 (1559)
Solar PV	42.7	30.5 (1)	30.5 (103)	30.5 (103)	42.7 (614)
Biodiesel	29.7	87.9 (2)	22.0 (81)	25.0 (132)	29.7 (279)
Solar thermal	11.8	17.5 (9)	11.8 (87)	17.5 (236)	17.5 (236)
Solid biofuel	1.6	0.6 (490)	0.3 (519)	0.3 (519)	0.6 (549)
Hydro	2.8	8.1 (89)	4.1 (196)	4.1 (196)	5.4 (254)
Geothermal	2.2	3.3 (35)	2.2 (54)	2.2 (54)	3.3 (66)
Sub-total	2.5	1.9 (631)	5.5 (1824)	6.0 (2024)	9.0 (3557)

Notes: The numbers in parentheses are the output values in the final year of each period, namely 2010 and 2030, and expressed in million tons oil equivalent (Mtoe). The raw data for the period 2001-2010 are drawn from the OECD (2013). The three scenarios for the period 2011-2030 are based on three predicted rates of growth in TPES, namely, 2.2% in Asia Pacific by BP (2013), 2.8% in Asia by ADB (2013) and 5.6% in EAS (the 'business as usual' case).

In general EAS countries are well-endowed with RE resources. There is considerable scope for further growth in REs, with the exception of Singapore, which is poorly endowed with RE resources. The RE policy of the government of Singapore is to focus on modest solar projects, production of biofuels using raw material from neighboring countries and most importantly the establishment of the country as a R&D centre for REs. For other EAS members, the stated national RE goals and policies are mixed (Table 8). The stated goals refer to RE shares of electricity production in most countries but some are defined as shares of primary energy supplies, installed capacity, total consumption and so on. The target periods vary too. These inconsistencies make bench-marking analysis and cross-country comparisons very difficult. Whether these predicted or stated goals are achievable depends upon several factors which can be either supportive (driving forces) or obstructive (challenges).

Table 8: Stated RE Policy Goals in the EAS area

Countries	Reserves	RE (2010)	Goals
Australia	H/G/S/W/O		20% electricity by 2020
Brunei	H		10% electricity generation by 2035
Cambodia	H/S		6.5% total electricity supply by 2015
			15% rural electricity supply by 2015
China	H/G/S/W/O		15% primary energy by 2020
India	H/G/S/W/O		20GW solar PV by 2022 (0.4GW in 2011)
			31GW wind by 2022 (16GW in 2011)
Indonesia	H/G/S/O		17% primary energy by 2025
Japan	H/G/S/W/O		20% final consumption by 2020
Korea	H/S/W		6.1% primary energy by 2020
Laos	H/G/S/W		10% transport energy by 2020
Malaysia	H/G/W/O		11% electricity generation by 2030
Myanmar	H/G/S/W		15% installed capacity by 2015
New Zealand	H/G/W/O		90% electricity generation by 2025
Philippines	H/G/S/W/O		Triple 2010 RE capacity by 2030
			40% electricity generation by 2020
Singapore	S		R&D centre for REs
Thailand	W/G/S		25% total energy consumption by 2022
			Triple capacity by 2030
Vietnam	H/S/W		6% electricity generation by 2030 (excluding hydro)

Sources: IRENA (2013a), Khaing (2012), Ipsos (2012), Nelson, *et al*. (2012), Poch (2013) and author's own compilations.

4.2. Driving Forces for RE Growth

Several factors could be the driving forces for further RE growth in the EAS area. First, the increasing awareness of global climate change demands urgent actions by governments to control and reduce carbon emissions. To date, various regulations have been introduced and enforced in the world, particularly within the OECD economies. EAS members are following or will have to follow the global trend. Furthermore, some EAS members have enjoyed high economic growth for decades. However, this is at the cost of a continuously deteriorating local and regional environments. Thus, for their own benefit, the EAS members need to change their

energy mix and use more clean energies, and REs are the best choice. So far many EAS members have adopted RE strategies or goals to guide future development. These include large players such as China, India, Japan and Australia (IEA 2012b).

Secondly, technological advance has led to a dramatic decline in the RE cost.[8] For example, it is reported that the selling price of PV cells dropped from US$1.5/watt in 2010 to US$0.60/watt in 2011 (UNEP, 2012). This decline will continue in the future and hence make REs more economically competitive with fossil fuels. Some REs are not luxuries anymore and are affordable by many low and middle income economies. For example, the lowest levelized cost for wind power in China is now close to the ceiling cost of nuclear and hydro power, and is projected to fall by 20-30 per cent from current level by 2030.[9] By then wind power would be nearly competitive with other forms of generation (ADB, 2013). In addition, the affordability of REs is also due to rising energy prices in recent years.

Thirdly, EAS countries, particularly the developing members, can or will increasingly be able to afford the development of RE products because of their robust economic performance and subsequently rising income. According to ADB (2013), developing Asian economies will maintain a growth rate of 6.6 per cent in the coming years. This rate is much higher than the industrial countries' average rate of 1.2 per cent (ADB, 2013). In particular, according to the same source, the relatively poor EAS members such as Cambodia and Laos will enjoy a rate of growth of 7.4 per cent and 7.7 per cent respectively.

Lastly, with rising income, consumers can afford to pay more for electricity. This provides the opportunity for the introduction of feed-in-tariffs (FiT) in several EAS countries. For example, the March 2011 Fukushima nuclear accident in Japan triggered a fundamental shift in the country's energy policy. The most immediate effect is the introduction of a series of clean energy FiTs. These tariffs are far higher than the retail commercial power price which averaged ¥14.59/kWh in the year to March 2012. In the year to March 2013, for example, the biomass tariff is ¥33.60/kWh for 20 years with wind generating ¥23.10/kWh and geothermal up to

[8]For comprehensive reviews of RE technology costs, see Hearps and McConnell (2011) and Kost, *et al*. (2012).

[9] The levelized cost of energy is defined as the cost of an energy generating system over its life time (IPCC, 2012).

¥42 for 15 years. The solar tariff is amongst the highest in the world, at ¥42 (US$0.53) (METI, 2013). FiTs have also been introduced in other EAS countries (such as Australia, China, India, Indonesia, Malaysia, the Philippines, Thailand and Vietnam). This kind of policy supports will certainly boost the development of REs within the EAS area.

4.3. Challenges for RE Development

While economic growth has increased the affordability of REs by many EAS members, several EAS economies are still at the early stage of development. Their governments are still struggling with the provision of universal access to modern energies for all citizens. Thus investment in REs is limited, not to mention government subsidies for RE initiatives. The latter played a key role in promoting REs in Europe and other parts of the world. According to the IEA (2012b), subsidies provided to RE projects in the world totaled about US$88 billion in 2011 and are expected to reach US$240 billion per year by 2035. The main recipients are producers - from the solar, wind and biofuel sectors. Furthermore, the expanded access to modern energies in some EAS member economies will essentially reduce the use of traditional biomass. As a result, it is even more challenging for those countries to meet the RE4ALL goal by 2030.

In addition, for EAS members who can afford more investment in REs, an important concern is the need for electricity storage and smart grids to support higher RE penetration levels in the electricity sector. Smart grid technologies are already making significant contributions to electricity grids in some countries (such as Puerto Rico, Jamaica, Denmark, and Singapore). However, these technologies are still undergoing continual refinement and improvement and hence are vulnerable to potential technical and non-technical risks. RE growth will thus be constrained by infrastructure development as well as by the evolution of technology. These also include capacities in assessing and predicting the availability of renewable energy sources. These capacities offer additional benefits, notably the promise of higher reliability and overall electricity system efficiency.

5. Key Findings and Recommendations

In the midst of global climate change and the rapid depletion of fossil fuel resources, REs provide a bright prospect for the world's energy sector. EAS countries will have to follow the same trend as the rest of the world and expand their RE industries. Through a review of the global RE industry, this paper helps gain important insight into the development of the RE sector in the world in general and the EAS area in particular. Several interesting findings can be summarized as follows.

5.1. Key findings

First, it is shown that, though REs globally have enjoyed faster growth than total energy production, their share of total output is still small. This share amounted to about 1 percent in 2010 if traditional biomass and hydroelectricity are excluded. The situation is similar in the EAS area. There are however substantial variations across the countries. Growth also varies considerably across the RE products.

Second, it is argued that great growth potential in the future will come from wind, solar and biofuel power which will be competitive with traditional fossil fuels due to technological advance. Among the EAS economies, there is also ample scope for growth in hydroelectricity, particularly in relatively less developed economies such as Cambodia, Myanmar and Lao PDR. In several EAS countries, there is also potential for growth in geothermal energy. However, environmental impacts have to be carefully assessed and hence taken into consideration when new projects, especially hydro and biofuel ones, are initiated.

Third, to reach the UN goal of doubling RE shares of total primary energy supplies by 2030, there are still challenges for many EAS members. These include technological constraints in the short run, the balance between RE investment and spending in providing energy for all (such as electrification), and the complex relation between economic development and environmental control.

5.2. Policy recommendations

For improved promotion of RE development within the EAS area, the following recommendations are made.

Recommendation 1: Strengthening regional institutional facilities

The International Renewable Energy Agency (IRENA) was founded in 2009, and is dedicated to the global promotion of renewable energies. Not all EAS countries have become IRENA members. It is thus necessary to set up a regional body which is exclusively responsible for the promotion of REs within the EAS region. This body can be a sub-unit of an existing regional institution or an independent inter-governmental organisation. Through such an organization, local policymakers and think-tanks can hold regular meetings to discuss regional cooperation in RE policies, investment, and technologies. This institution can also oversee the standardization and harmonization of RE rules and practices within the EAS area. At present, due to the lack of dialogues among members, the region's RE goals are quite diverse and inconsistent between the member economies.

Recommendation 2: Setting potential goals for RE development

It is common practice that potential goals are set for each member within economic blocks such as the EU. Through intergovernmental exchanges and consultations, EAS members could agree to some potential goals for each country within a certain period of time. These goals would reflect the reality in each member's economy. Setting such goals can help promote the awareness of REs in member countries. In addition, through information exchanges and strategic planning, policy makers in member countries can identify priorities in their RE development. The formation of regional goals can also help member countries better respond to the IRENA roadmap or simply to the global campaign for green energy development.

Recommendation 3: Promoting sub-regional coordination in RE development

As RE resources are unevenly distributed, sub-regional coordination could lead to more efficient allocation of resources in some areas such as hydroelectricity. In

particular, for large hydro projects near borders, sub-regional or cross-border cooperation could better protect the environment. Through cross-border cooperation, members involved could also benefit from the availability of more capital and potentially better technologies. The greater Mekong sub-regional (GMS) group is a good example.[10] The group held its 18th ministerial conference in December 2012 and has established the GMS Environment Operations Center (EOC) and Regional Power Coordination Center. It is expected to play a key role in developing hydro power and promoting EMI within the region. Similar coordination could be adopted to manage the production of palm oil which is a main input for biofuels and would be a threat to biodiversity in some regions.[11]

Recommendation 4: Boosting EMI through RE development

Policy makers have reached a consensus decision to promote energy market integration (EMI) within the EAS area.[12] As RE is a rapidly growing energy product, it could play an important role in the promotion of EMI. In terms of cross-country interconnectivity, hydroelectricity has been traded across the greater Mekong sub-region for several years. Thus RE is leading sub-regional EMI within the EAS. In addition, as REs are relatively new products in most EAS members, they are less constrained by the existing regulations and policies. It is thus relatively easy for members to reach consensuses and adopt the common standards and practices which are prerequisites for EMI.

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[10]The GMS involves Cambodia, Laos, Myanmar, Thailand, Vietnam and two provinces (Yunnan and Guangxi) of China.

[11] For a background review of the palm oil sector, see Pye and Bhattacharya (2012).

[12]For more detailed discussion of EMI, see Shi and Kimura (2010) and Wu, *et al*. (2012, 2013).

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