Chapter 1

Main Report

March 2010

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1. INTRODUCTION

Responding to the Cebu Declaration on East Asia Energy Security on 15 January 2007 by the leaders of the 16 countries of the East Asia Summit (EAS), the EAS Energy Cooperation Task Force (ECTF) was established and one of the agreed areas for cooperation was the Energy Efficiency and Conservation. Japan proposed to undertake the key study of the energy savings and CO_2 emission reduction potential in the EAS region. The study would quantify the total potential savings under the individual energy efficiency goals, action plans and policies of each country above and beyond Business As Usual[1]. The study would provide insights to national energy ministers for establishing goals, action plans and policies to improve energy efficiency in their respective countries. The first study was undertaken in 2007 and was updated in 2008 to incorporate more recent information and estimation procedures and incorporate further information about energy saving potentials and energy efficiency goals, action plans and policies. The study was again undertaken in 2009 to reflect the energy efficiency goals and actions plans submitted by the energy ministers during the 3rd EAS Energy Minister's Meeting (EMM) held in Mandalay, Myanmar on 28 July 2009. This is the report of that study.

The Cebu Declaration outlined the potential energy challenges the region could face in the future driven by a number of factors including: the limited global reserves of fossil energy, fluctuating world fuel oil prices, worsening energy related environmental and health issues and the urgent need to address climate change[2].

For these reasons, the EAS leaders resolved to enhance regional cooperation in various areas to achieve: improved energy efficiency and environmental performance of fossil fuel use and reduced dependence on conventional fuels through intensified energy efficiency and conservation programs, hydropower, and expansion of renewable energy, biofuels, and civilian nuclear power. See Box 1 for the complete list of EAS leaders' resolutions under the Cebu Declaration.

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[1] Ministry of Economy, Trade and Industry (METI) (2007) "EAS Cooperation on Energy Efficiency and Conservation" Submitted to the 3rd ECTF Meeting in Tokyo in June 2007.

[2] ASEAN Secretariat (2007) *Cebu Declaration on East Asian Energy Security 2007.* Jakarta: http://www.aseansec.org/19319.htm (accessed February 27, 2008)

Box 1. EAS Leaders' Resolution under the Cebu Declaration

1. Improve the efficiency and environmental performance of fossil fuel use;
2. Reduce dependence on conventional fuels through intensified energy efficiency and conservation programmes, hydropower, expansion of renewable energy systems and biofuel production/utilisation and for interested parties, civilian nuclear power;
3. Encourage the open and competitive regional and international markets geared towards providing affordable energy at all economic levels;
4. Mitigate greenhouse gas emissions through effective policies and measures, thus contributing to global climate change abatement; and
5. Pursue and encourage investment on energy resource and infrastructure development through greater private sector involvement.

Source: ASEAN Secretariat (2007) *Cebu Declaration on East Asian Energy Security 2007.* Jakarta: http://www.aseansec.org/19319.htm (accessed February 27, 2008)

1.1. The East Asia Summit

The East Asia Summit (EAS) is a collection of diverse countries. There are wide variations among them in terms of per capita income, standard of living, population density, energy resource endowments, climate, and energy consumption per capita. It is composed of the 10 member countries of the Association of Southeast Asian Nations (ASEAN), namely: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, and 6 other countries, namely: Australia, China, India, Japan, Republic of Korea and New Zealand.[3] Table 1 shows the geographic, demographic and economic profiles of the 16 EAS countries. Table 2 shows their economic structure and energy consumption profile.

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[3] The Ministry of Foreign Affairs of Japan (2005) *Kuala Lumpur Declaration on the East Asia Summit, 2005.* Tokyo: http://www.mofa.go.jp/region/asia-paci/eas/joint0512.html (accessed February 27, 2008).

While some EAS countries have what might be called mature economies, the majority have developing economies. Several counties have a per capita GDP of less than 1000 US$ (in 2000 prices[4]). Countries with mature economies have higher energy consumption per capita, while developing countries generally have lower energy consumption per capita. A large percentage of the people in the latter countries still meet their energy needs mainly with traditional biomass fuels.

Table 1. Geographic, Demographic, and Economic Profiles, 2007

	Land Area (thousand sq.km.)[1]	Population (thousands)	Population Density (persons/ sq.km.)	GDP (Billion 2000US$)[2]	GDP per Capita (US$/person)
Australia	7,682.30	21,015	2.74	503.02	23,936
Brunei Darussalam	5.27	389	73.86	6.98	17,944
Cambodia	181.04	14,446	79.80	7.15	495
China	9,327.49	1,318,310	141.34	2,387.68	1,811
India	2,973.19	1,124,787	378.31	771.09	686
Indonesia	1,811.57	225,630	124.55	233.10	1,033
Japan	364.50	127,771	350.54	5,206.01	40,745
Korea, Rep.	98.73	48,456	490.79	734.48	15,158
Lao PDR	230.80	6,092	26.40	2.74	450
Malaysia	328.55	26,550	80.81	132.99	5,009
Myanmar	657.55	48,783	74.19	16.94	347
New Zealand	267.71	4,228	15.79	64.18	15,178
Philippines	298.17	88,718	297.54	106.62	1,202
Singapore	0.69	4,589	6,659.80	133.92	29,185
Thailand	510.89	66,979	131.10	173.77	2,594
Vietnam	310.07	85,155	274.63	52.56	617

Note: [1] Information on the land area data of Cambodia was provided by the Cambodian government.
[2] GDP data of Myanmar is for 2006 as there is no information for 2007.

Source: World Bank 2008. *World Development Indicator CD-ROM 2008*. Washington DC and Government of Cambodia.

These differences partly explain why energy efficiency and conservation goals, action plans and policies are assigned different priorities across countries. While countries with developed economies may be very keen on reducing energy consumption, developing countries tend to put more emphasis on economic growth and improving standards of living. It should be noted that developing countries generally have less energy consumption per capita compared to developed countries. However, as the economies of these countries grow, it should be expected that energy consumption per capita will grow as well.

[4] All US$ (US Dollar) in this document are stated at constant year 2000 values unless specified.

Despite the differences among the 16 countries, the EAS leaders agree that the EAS "could play a significant role in community building", which could be an important cornerstone for the development of regional cooperation in the years to come[5].

Table 2. Economic Structure and Energy Consumption, 2007

	GDP (Billion 2000US$)	Share of Industry In GDP, % [1]	Share of Services in GDP, % [1]	Share of Agriculture in GDP, % [1]	Energy Consumption (Mtoe)	Energy Consumption per Capita (toe/person)
Australia	503.02	27.0	69.6	3.3	122.0	5.8
Brunei Darussalam	6.98	71.0	28.3	0.7	2.4	6.3
Cambodia	7.15	26.8	41.3	31.9	1.3	0.09
China	2,387.68	48.5	40.4	11.1	1,497.4	1.1
India	771.09	29.5	52.4	18.1	379.6	0.3
Indonesia	233.10	46.8	39.5	13.7	135.1	0.6
Japan	5,206.01	30.1	68.4	1.5	526.1	4.1
Korea, Rep.	734.48	37.1	60.0	2.9	218.5	4.5
Lao PDR	2.74	30.7	29.4	39.9	0.6	0.09
Malaysia	132.99	47.7	42.0	10.2	58.6	2.2
Myanmar	16.94	16.2	35.4	48.4	4.1	0.08
New Zealand	64.18	24.9	68.3	6.8	17.3	4.1
Philippines	106.62	31.6	54.2	14.2	37.0	0.4
Singapore	133.92	30.5	69.4	0.1	30.7	6.7
Thailand	173.77	45.5	42.6	11.8	89.9	1.3
Vietnam	52.56	41.6	38.1	20.3	27.3	0.3

Note: [1] Sectoral shares to GDP of Australia, Japan, Myanmar and New Zealand are the values in 2004, 2006, 2004 and 2003, respectively due to absence of more up to date data.

Sources: World Bank (2008) *World Development Indicators CD-ROM 2008*. Washington DC and International Energy Agency (IEA) (2008) *Energy Balances of OECD Countries 2008 and Energy Balances of Non-OECD Countries 2008*, Paris.

1.2. Background

The Economic Research Institute for ASEAN and East Asia (ERIA) approved the proposal of the Japanese government to conduct a study on energy saving and CO_2 emission reduction potentials in the East Asia Region. As a result, the Working Group (WG) for the Analysis of Energy Savings Potential was convened. Members from all of the 16 EAS countries are represented in the WG with Mr. Shigeru Kimura of The Institute of Energy Economics, Japan (IEEJ) as the leader of the group.

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[5] The Ministry of Foreign Affairs of Japan (2005) *Prime Minister Junichiro Koizumi Attends the EAS, ASEAN+3, and Japan-ASEAN Summit Meetings, (Overview and Preliminary Evaluation)*, 2005. Tokyo: http://www.mofa.go.jp/region/asia-paci/eas/summary0512.html (accessed February 28,2008)

In 2009, the WG continued to assess energy saving potentials in the EAS region using the goals, action plans and policies reported at the 3rd EAS Energy Ministers Meeting (EAS-EMM3). The WG in 2009 enhanced and extended the analysis that was undertaken in 2007 and 2008. The WG conducted two meetings in Jakarta and one meeting in Bangkok from September 2009 to March 2010.

During the first meeting, the WG discussed and developed the 2009 research plan and provided updates on revised energy saving goals, action plans and policies of each EAS country reported in 2009. The WG also discussed the policy development process in each country in relation to energy efficiency goals and action plans. In addition, the collection and use of energy efficiency indicators and their contribution to monitoring the success of policies was discussed. The 2nd and 3rd meetings were devoted to reaching agreement on outlook assumptions and to reviewing the newly developed energy projection pathways generated by IEEJ and WG members.

1.3. Rationale

The rationale of this study is derived from the Cebu Declaration[6], which highlighted a number of goals including the following:

- improving the efficiency and environmental performance of fossil fuel use;
- reducing the dependence on conventional fuels through intensified energy efficiency and conservation programmes, hydropower, expansion of renewable energy systems and biofuel production/utilisation, and for interested parties, civilian nuclear power; and
- mitigating greenhouse gas emissions through effective policies and measures, thus contributing to global climate change abatement.

To be able to design an action plan or policy measures to reduce energy consumption, projections of energy consumption by sector are required. Hence, Japan suggested the preparation of an energy outlook for the EAS region, including an estimate of the energy savings and CO_2 emission reduction potential if current and proposed national energy efficiency and conservation goals, action plans and policies could be implemented as planned by the EAS countries.

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[6] ASEAN Secretariat (2007) *Cebu Declaration on East Asian Energy Security (2007)*. Jakarta: http://www.aseansec.org/19319.htm (accessed February 27, 2008).

1.4. Objective

The objective of this study is to analyse the potential impacts of proposed additional energy saving goals, action plans and policies in the East Asia Summit region on energy consumption by fuel and sector and greenhouse gas emissions.

Specifically a BAU scenario was developed for each country outlining future sectoral and economy-wide energy consumption assuming no significant changes to government policies. An APS was also designed to examine the potential impacts if additional energy efficiency goals, action plans or policies were developed that are currently, or likely to be, under consideration. Increased uptake of renewable energy sources and nuclear energy was also considered in the APS. The difference between the BAU and APS represent potential energy savings.

In addition, collaboration between EAS countries on energy modelling and policy development was a key objective of the WG.

1.5. Organization of the Working Group and Meeting Summaries

Experts from research institutions and government offices in the EAS region were invited to join a working group created for this project. The invited experts were energy analysts and government officials who have experience in the preparation of energy outlooks in their respective countries.

The 1st WG meeting was held on 29 September to 01 October 2009 in Jakarta. At the meeting, the 2009 research plan was developed and discussed and a wide ranging discussion on the following issues was made: a. methodology for estimating energy savings b. 2009 model assumptions on socioeconomic indicators, energy related data and energy saving goals, action plans and policies c. definition of the BAU scenario and APS d. required capacity building for the development of energy saving goals, action plans and policies e. energy efficiency indicators. During the first meeting the leaders of the newly created sub-working groups on energy efficiency design and civilian use of nuclear energy as well as those of the 5 energy efficiency projects participated in the meeting. The leaders presented their research plan to the WG.

The 2nd WG meeting was held on 15-17 December 2009 in Bangkok, Thailand. IEEJ and the members who conducted their own energy outlook modelling presented their energy outlooks and took note of the comments and suggestion from IEEJ and other WG members. The meeting also attempted to bring to consistency the electricity trade targets of the trading countries to ensure that the projected exports of each country is consistent with the projected imports of the other countries. The WG also confirmed the need for continued collaboration with Asia Pacific Energy Research Centre (APERC) regarding the APERC Peer-Review of Energy Efficiency (PREE) and Cooperative Energy Efficiency Design for Sustainability (CEEDS) projects.

The 3rd WG meeting was held on 01-02 March 2010 in Jakarta. At this meeting energy outlooks were finalized for the BAU scenario and APS for all of the EAS countries and policy recommendations were developed to be submitted to EAS-EMM4 through ERIA. The WG members agreed to further analyse their country results and develop an individual country report. IEEJ committed to further analyse the EAS regional level results and develop a report of the Working Group incorporating the individual country reports and regional level discussion and policy implications.

2. Data and Methodology

2.1. Scenarios Examined

The study continued to examine two scenarios, as in the 2007 and 2008 studies, a Business As Usual (BAU) scenario reflecting each country's current goals, action plans and policies, and an Alternative Policy Scenario (APS). The APS included additional goals, action plans and policies reported at EAS-EMM3 held in July 2009 in Mandalay, Myanmar or that are currently, or likely to be, under consideration.

One might be tempted to call the APS a 'maximum effort' case, however, that would not be accurate. One reason is that goals, action plans and policies for reducing energy consumption are still relatively new in most countries. There are still many potential EEC policies and technological options that have not been examined or incorporated in the APS.

While all of the EAS countries are actively developing and implementing EEC goals, action plans and policies, progress so far varies widely. Some countries are quite advanced in their efforts, while others are just getting started. A few countries already have significant energy savings goals, action plans and policies built into the BAU scenario. Conversely, others are currently unable to quantify their goals. However, significant potential does exist in these countries at the sectoral and economy-wide levels.

In every country, there is still a great deal to be learned from experience about what works and does not work. It is worthwhile to repeat this study periodically, as the quality and scope of the national goals, action plans and policies are likely to improve considerably over time allowing for valuable collaboration across countries. One of these collaboration activities is the implementation of the energy efficiency design by the sub-working group. Energy efficiency experts in Indonesia, Singapore and Thailand are assisting Indonesia, Brunei, Cambodia, Lao PDR, the Philippines and Vietnam in developing energy efficiency action plans and quantifying the impact of these action plans. Another sub-working group, the civilian use of nuclear energy sub-working group is facilitating the sharing of information among nuclear energy users and those that are planning to use nuclear energy. This could make those countries that are planning to use nuclear energy to learn from the experiences of the more advanced countries.

2.2. The Definition of Energy Savings Potential and Its Limitations

There are many definitions of energy saving potential, including 'technical potential' (what might be possible with current technology) and 'economic potential' (what might be economic with current technology). However, the outputs of this study do not match any standard definition.

Perhaps the best way around the difficulties in defining 'energy saving potential' is to recognise that a definition is not really necessary. Despite the name given to the Working Group, this study is not really focused on measuring 'energy saving potential' in the abstract. Instead, the focus is on analysing additional energy savings that might be achieved through the energy efficiency and conservation goals, action plans and policies of individual countries above and beyond BAU. The additional savings may be measured as the difference between the BAU and APS scenarios.

2.3. Data

For consistency, the historical energy data used in this analysis came from the International Energy Agency's (IEA) energy balances for OECD and non-OECD countries except for Korea and Lao PDR. Korean national energy data was converted from Gross Calorific Value (GCV) to Net Calorific Value (NCV) to be consistent with IEA energy balances. Estimations of national energy data from Lao PDR were made using the same methodology as IEA. The socio-economic data were obtained from the World Development Indicator CD-ROM 2009 published by the World Bank. Other data such as those relating to transportation, buildings, and industrial production indices were provided by the WG members from each EAS country, where these data are available. Where official data were not available, estimates were obtained from other sources or developed by IEEJ.

2.4. Methodology

In 2007, the primary model used was the IEEJ World Energy Outlook Model which is used by IEEJ in the preparation of their *Asia/World Energy Outlook*[7]. Following capacity building exercises in ASEAN, 9 of the 10 member countries utilised their own energy models with IEEJ support. In addition, Australia and Korea also used their own national models. The remaining countries provided key assumptions to IEEJ including on population and GDP growth, electric generation fuel mixes and EEC goals, action plans and policies. The IEEJ and the LEAP models were then used to develop energy projections for these countries.

In the next section a brief description of the energy models used is provided.

Australia: Australian projections were developed using the E4cast model at the Australian Bureau of Agricultural and Resource Economics (ABARE). E4cast is a dynamic partial equilibrium model of the Australian energy sector and incorporates 19 primary and secondary fuels as well as 24 conversion and end use sectors. E4cast incorporates ABARE's most recent commodity projections and current assumptions on the costs and characteristics of energy conversion technologies.

Korea: Korean projections were developed using the KEEI-LEDS (KEEI Long-term Energy Demand System) Model. The Korean KEEI-LEDS model is an energy-economy modelling system of Korean energy markets to 2050. The model projects primary and final energy consumption using assumptions on macroeconomic and demographic factors, world energy prices, behavioural and technological choice criteria and performance characteristics of energy technologies. GDP is endogenously determined and thus differs between the APS and BAU scenario.

ASEAN countries: The LEAP model is an accounting system used to develop projections of energy balance tables based on final energy consumption and energy input/output in the transformation sector. Final energy consumption is forecast using energy demand equations

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[7] Ito, K., Morita, Y., Koyama, K., Shen, Z., Yanagisawa, A., and Suehiro, S. 2007 *"Asia/World Energy Outlook 2007"*, October 2007, Tokyo.

by energy and sector and future macroeconomic assumptions. For this study, nine member countries used the LEAP model, of which 3 were developed by IEEJ. The remaining one member countries used IEEJ model.

Other countries: Other countries used the IEEJ model which has a macro-economic module that calculates coefficients for various explanatory variables based on exogenously specified GDP growth rates. The macro-economic module also projects prices for natural gas and coal based on exogenously specified oil price assumptions. Demand equations are econometrically calculated in another module using the historical data while future parameters are projected using the explanatory variables from the macro-economic module. An econometric approach means that future demand and supply will be heavily influenced by historical trends. However, the supply of energy and new technologies is treated exogenously. For electricity generation, the WG members were asked to specify assumptions about the future electricity generation mix in their respective countries by energy source. These assumptions were used to determine the future electricity generation mix.

2.5. Enhancing the 2008 Study

In 2008, a study[8] was undertaken to assess the potential energy savings in the EAS region that could be achieved through the implementation of energy saving goals, action plans and policies. Subsequently this study was revised and extended in 2009 to incorporate more recent information and estimation procedures and incorporate further information about energy saving potentials and energy efficiency goals, action plans and policies submitted during the EAS-EMM3 in Mandalay, Myanmar. This is the report of that study. Specifically, the following new information was incorporated in this study:

- revised recent energy saving goals, action plans and policies in each country;
- the potential impacts of the global economic and financial crisis on economic development and energy consumption;
- projected future oil prices;

[8] ERIA Research Project Report 2008, No. 8-1, Analysis on Energy Saving Potential in East Asia

- additional illustrative scenario which analysis the potential impacts of widespread uptake of carbon capture and storage, nuclear and biofuels technologies in addition to the measures already included in the APS; and
- discussion of energy saving goals, action plans and policies in the EAS region.

In addition, following capacity building exercises, 9 of the 10 ASEAN countries utilised their own energy models for this 2009 study. Further, Australia and Korea also used their own national models.

3. Socioeconomic Indicators And Energy Policies: Assumptions

Growth in energy consumption and greenhouse gas emissions is driven by a variety of socio-economic factors. In the EAS region, these factors, including increasing population, sustained economic growth, increasing vehicle ownership, and increasing access to electricity, will tend to increase energy demand. Together they create what might be called a huge growth 'headwind' that works against efforts to limit energy consumption. Understanding the nature and size of this 'headwind' is critical to any analysis of energy demand in the EAS region. However, an increase in consumption of energy services is fundamental for achieving a range of socioeconomic development goals.

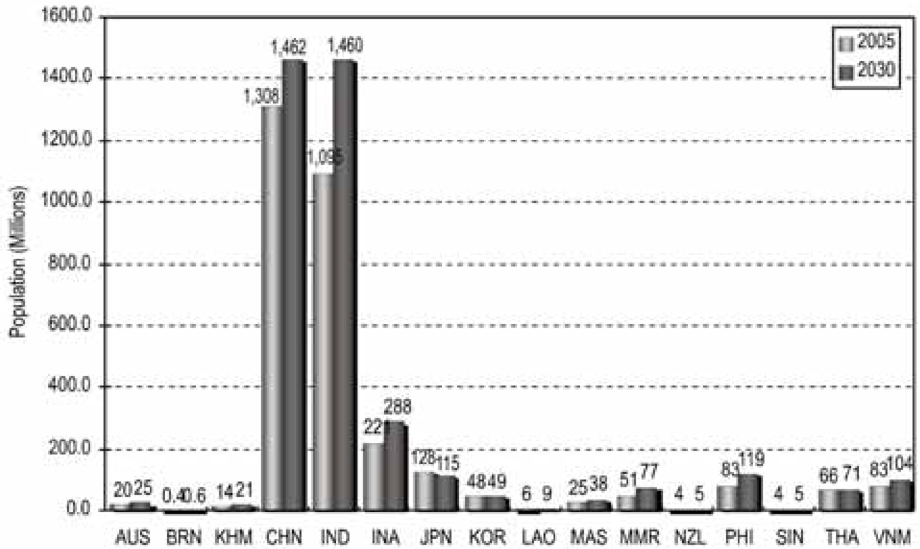
In this section assumptions regarding key socioeconomic indicators and energy policies over the projection period 2005-2030 are discussed for the EAS countries.

3.1. Population

In the models used for this study, changes in population to 2030 are set exogenously. There is assumed to be no difference in population between the BAU scenario and APS. Assumed changes in population were submitted by the following countries: Australia, Brunei Darussalam, Cambodia, India, Indonesia, Japan, Republic of Korea, Laos, Malaysia, Myanmar, New Zealand, the Philippines, Thailand and Vietnam. Population projections from the United Nations were used for Singapore and China.

In 2005, the total population in the EAS region was assumed to be about 3.16 billion - around 50 per cent of total world population. Based on the forecasts, population in the EAS region is projected to increase at an average annual rate of about 0.8 per cent reaching about 3.85 billion in 2030. Figure 1 shows the 2005 and projected 2030 population by country.

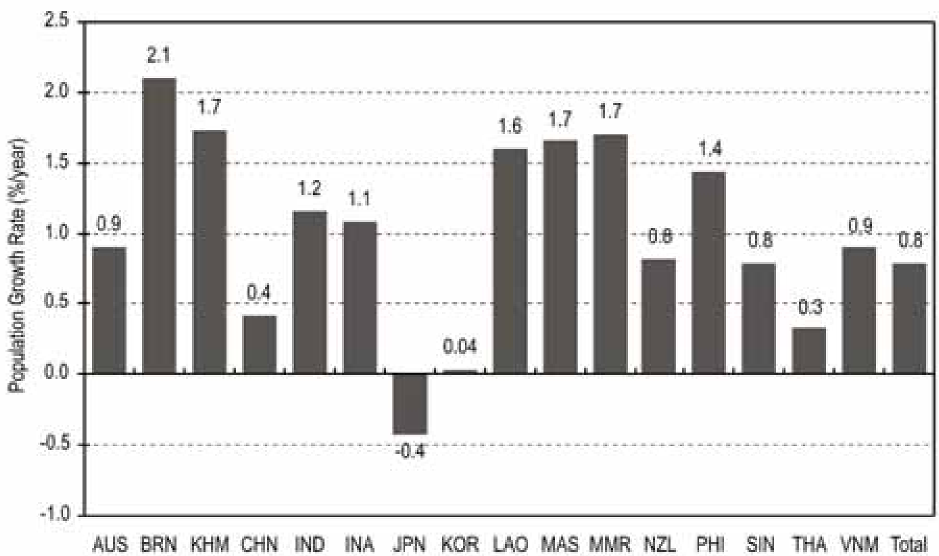
Figure 1. Assumed Population in the EAS Region, 2005 and 2030



As shown in Figure 2, growth in population is generally assumed to be fastest in developing countries. China and Thailand are notable and significant exceptions, as they are expected to have relatively modest population growth. Nevertheless, by 2030, India and China are assumed to account for about 75 per cent of the total population in the EAS region with populations of around 1.5 billion each.

Countries with more mature economies tend to have slower population growth. Australia, New Zealand, and Singapore are assumed to have low, but still significant, population growth. The Republic of Korea's population is assumed to be roughly stable. Japan's population is assumed to decline slowly throughout the projection period as the population continues to age.

Figure 2. Assumed Average Annual Growth in Population, 2005 to 2030



3.2. Economic Activity

In the models used for this study, assumed changes in economic output to 2030 are set exogenously. Base year 2005 GDP data (in 2000 US$) were obtained from the World Bank.[9] Assumed GDP growth rates to 2030 were submitted by all the EAS countries. In general these assumptions took into account the effects of the recession in the United States and other major economies in the world. No difference in growth rates was assumed between the BAU and APS scenarios.

In 2005 total GDP in the EAS region was about 9.5 trillion in 2000 US$ and it accounted for about 22 percent of global GDP. The GDP of the EAS region is assumed to grow at an average annual rate of about 3.8 percent from 2005 to 2030. This implies that by 2030 total GDP in the EAS region will reach about 24.0 trillion in 2000 US$.

In 2005, Japan was the largest economy by far in terms of total economic output: 5.0 trillion 2000 US$. However, by 2030 China is projected to be the largest economy with an estimated GDP of about 9.2 trillion 2000 US$. Japan and India are projected to be the next largest economies with projected GDPs of about 6.3 trillion 2000 US$ and 3.1 trillion 2000 US$ respectively in 2030. See Figure 3.

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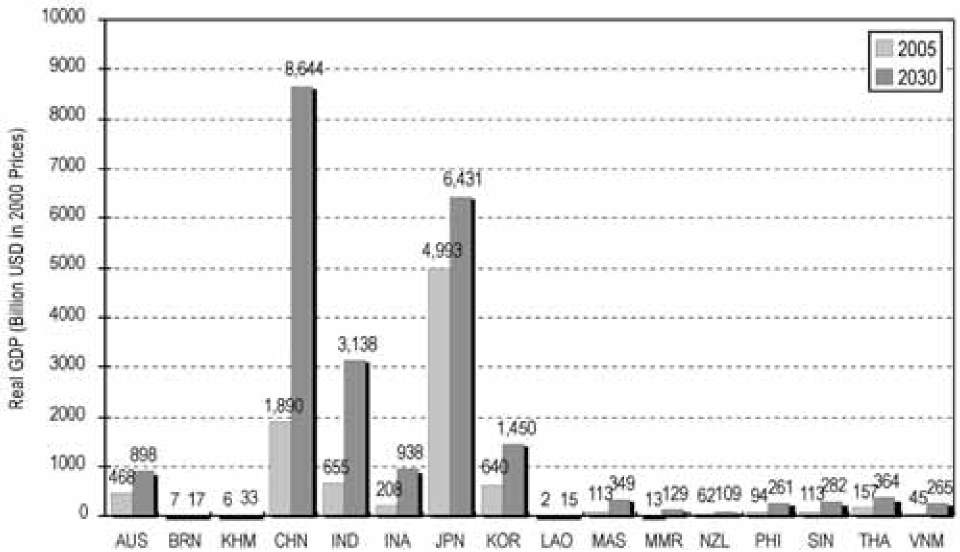
[9] World Bank (2009) *World Development Indicator CD-ROM 2009*. Washington DC

Figure 3. Assumed Economic Activity in the EAS Region



As shown in Figure 4, long term economic growth rates are assumed to be quite high in the developing countries, with the highest growth rates in Myanmar, Vietnam, India, Cambodia and Lao PDR. Economic growth in other developing countries is also assumed to be relatively rapid. Due to the large size of their economies, the rapid growth in China, India, and Indonesia is likely to be especially significant for energy demand. Countries with more mature economies — Australia, Brunei, Japan, Korea, New Zealand, and Singapore — are assumed to experience slower, but still significant, economic growth.

Average GDP per capita in the EAS region is assumed to increase from about US$3,000 in 2005 to about US$6,200 in 2030. However, as shown in Figure 5, there is, and will continue to be, significant differences in GDP per capita. In 2005, per capita GDP ranged from about US$264 in Myanmar to about US$38,960 in Japan. In 2030, per capita GDP is assumed to range from about US$1,550 in Cambodia to about US$54,905 in Japan.

Figure 4. Assumed Average Annual Growth in GDP, 2005 to 2030

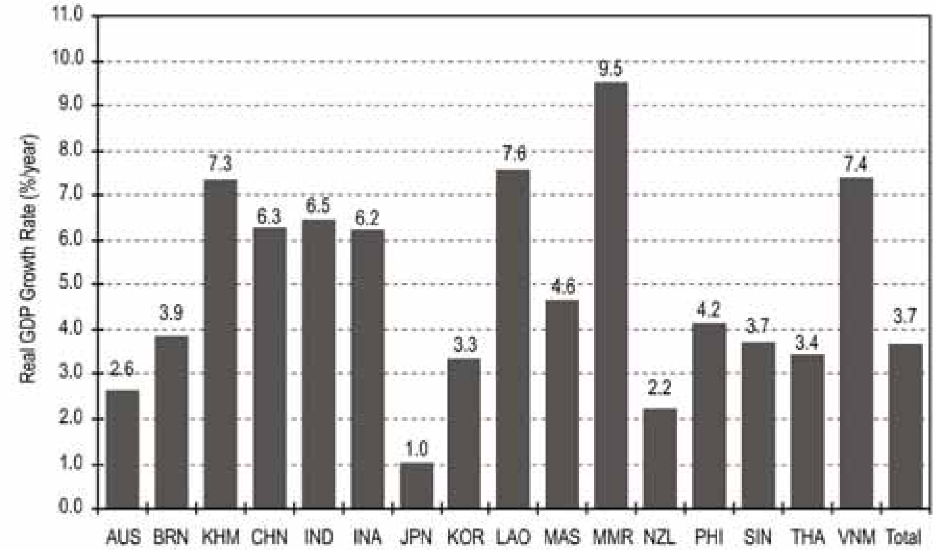
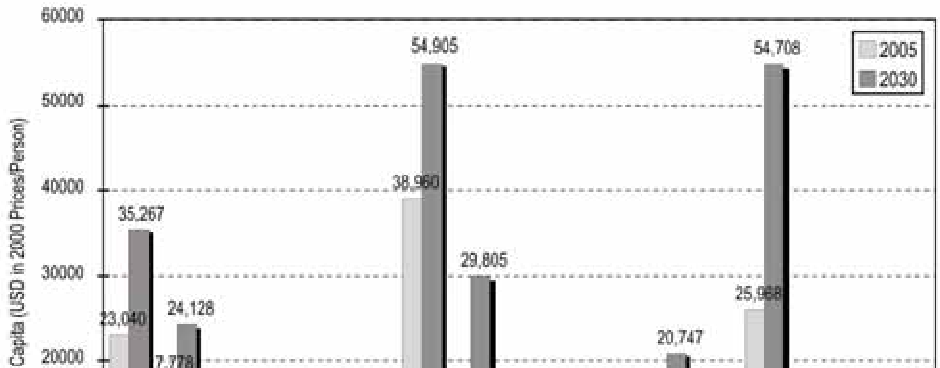


Figure 5. Real GDP per Capita, 2005 to 2030



3.3. Vehicle Ownership

Growth in the transport sector is one of the primary drivers of growth in energy consumption, and the major driver of oil consumption. In the model used in this study, energy demand by all forms of transport is modelled. However, road vehicle ownership is a key exogenous input. Assumed changes in road vehicle ownership were made for China, India, Japan, Republic of Korea, There is assumed to be no difference in road vehicle ownership between the BAU scenario and APS.

Strong population and economic growth is projected to drive significant increases in demand for transport services in India and China. By 2030 the number of road vehicles in China and India is projected to increase to about 234 million and 216 million respectively. However, in both countries, despite the huge growth in road vehicles, rail is expected to meet an increasing share of total transport demand.

Per capita vehicle ownership is projected to increase in the EAS region. However, vehicle ownership on a per capita basis is projected to vary significantly between countries.

3.4. Electricity Generation

3.4.1. Electricity Generation Thermal Efficiency

The thermal efficiency of electricity generation reflects the amount of fuel required to generate a unit of electricity. Thermal efficiency was another exogenous assumption used in this study. Base year 2005 thermal efficiencies by fuel type (coal, gas, and oil) were derived from International Energy Agency data . Thermal efficiency projections by fuel (coal, gas, and oil) were submitted by the following countries: Australia, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Thailand and Vietnam, and growth rates in thermal efficiency were derived from these projections. For the remaining countries, assumptions about the potential changes in thermal efficiency were based on IEEJ *Asia/ World Energy Outlook 2007.*

Thermal efficiencies may differ significantly between countries due to differences in technological availability, age and cost, temperatures and the cost and availability of fuel inputs. Thermal efficiency in the EAS countries is expected to improve considerably over

[10] IEA (2008) *Energy Balances of OECD Countries 2007 and Energy Balances of Non-OECD Countries 2007*. Paris.

time in the BAU scenario as more advanced generation technologies such as natural gas combined cycle and supercritical coal plant are implemented. In many countries, there are also assumed to be additional improvements in the APS. See Figure 6 and Figure 7.

Figure 6. Thermal Efficiencies of Gas Electricity Generation

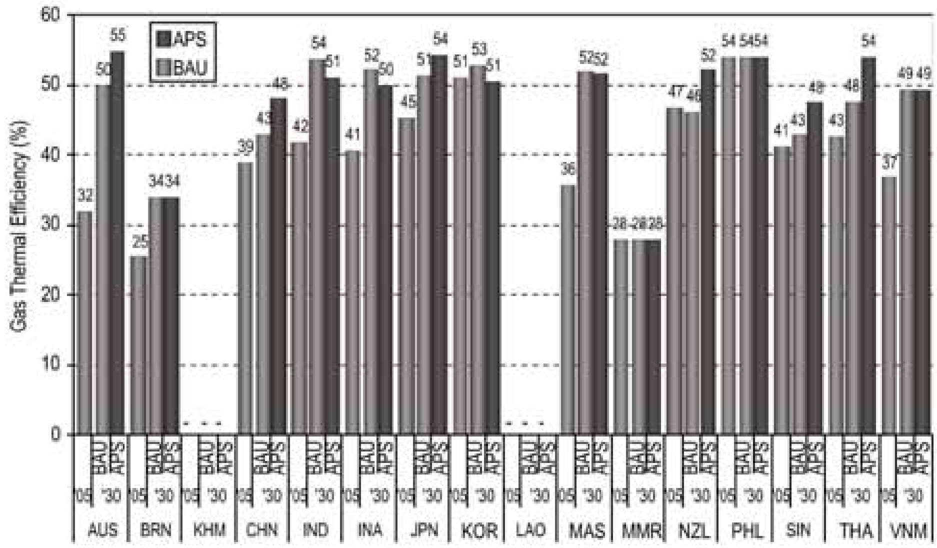
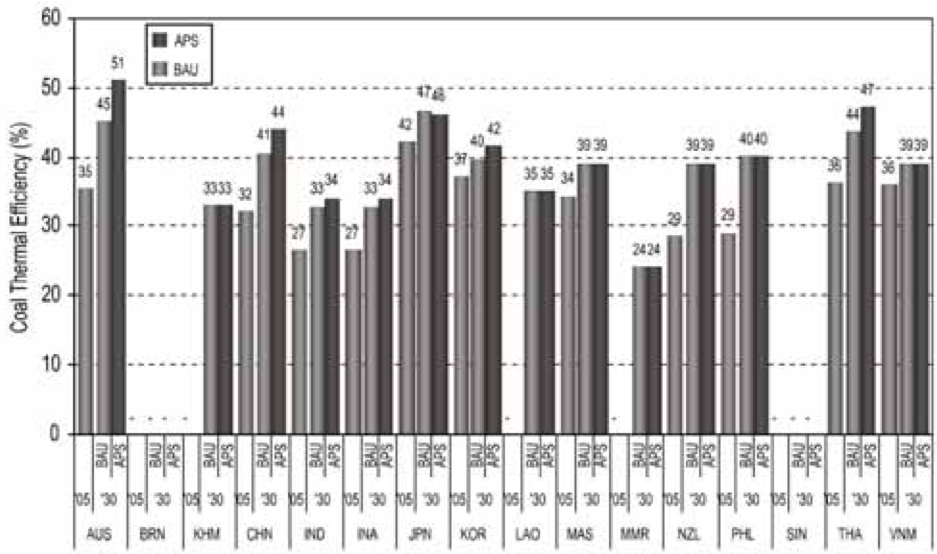


Figure 7. Thermal Efficiencies of Coal Electricity Generation

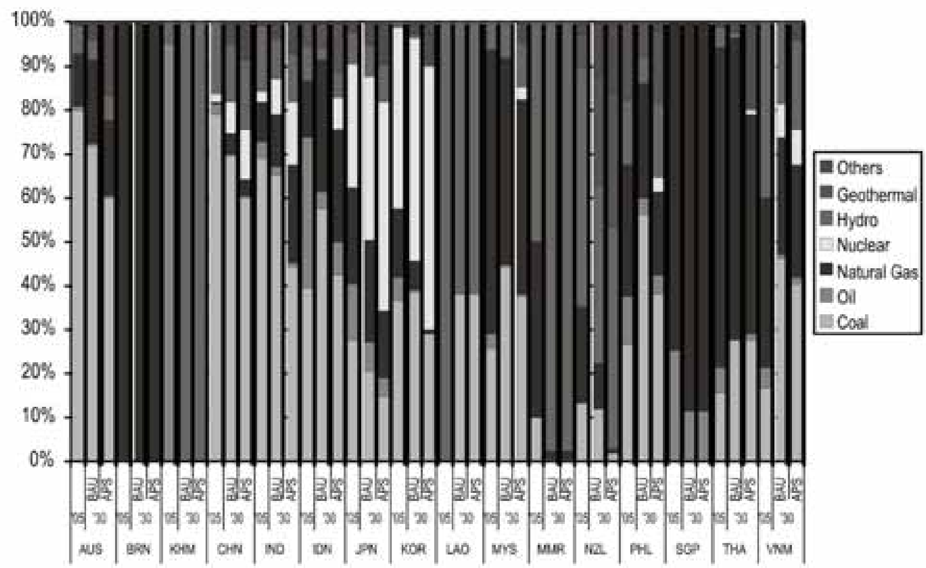


3.4.2 Electricity Generation Fuel Mix

The combination of fuels used in electricity generation differs between countries, reflecting both historical and current conditions, including access to and cost of resources and technology. It was, therefore, an exogenous input to the model. It is an important input, not only because it is a key driver of demand for primary fuels, but also because the fuel mix used can have important implications for greenhouse gas emissions. Only China did not provide electricity generation fuel mix assumptions for the BAU scenario. IEEJ developed their own estimates based on other sources for this country.

Across the EAS countries in the APS, it was initially assumed that hydro and nuclear output would remain the same as in the BAU scenario, and any reduction in electricity demand would be distributed among the other fuels in proportion to their BAU share. These initial APS results were then reviewed by the WG members from each country, who in some cases suggested additional changes. The projected electricity generation mix is shown in Figure 8.

Figure 8. Share of Fuel Type in the Electricity Generation Mix in the EAS Region



Coal is projected to remain the dominant source of electricity generation in the EAS region as a whole in both the BAU and APS. However, the share of coal in electricity generation in the EAS region is projected to decline from about 58.7 percent in the BAU scenario to about 47.2 percent in the APS by 2030 as countries are assumed to implement policies designed to reduce the emissions intensity of electricity generation. In the APS, the share of lower emission fuels such as natural gas, nuclear, and non-hydro renewable energy are expected to be higher than in the BAU scenario on average in the EAS region. The use of oil in electricity generation is assumed to decline to almost negligible levels across the EAS region as a whole.

3.4.3 Access to Electricity

Currently, many households in developing countries lack access to electricity, and eliminating this situation is a major development goal. At the WG meetings, a number of the developing countries reported on initiatives to significantly expand access to electricity in their countries by 2030. Although this increasing access to electricity is another one of the drivers of increasing energy demand in the EAS region, it was not explicitly represented in the model used for this study. Nevertheless, the impact of increasing access to electricity on electricity demand should be largely reflected through the increased demand for electricity as a result of the relatively rapid GDP growth that is assumed to be experienced in these same countries.

If this study is repeated in the future, it is recommended that WG members be asked to specify assumptions regarding percent of households with access to electricity. Even if this figure is not used as an input to the model, it is useful to know as an indicator of one key driver of electricity demand.

3.5 Use of Biofuels

WG members from each country were asked to submit information regarding the potential use of biofuels in the BAU scenario and APS. Some, but not all, countries in the EAS region have plans to increase the contribution of biofuels in the transport fuel mix to enhance energy security or meet other policy objectives. For China and Japan, the assumptions on the use of biofuels were based on IEEJ *Asia/ World Energy Outlook 2007.* Table 3 summarises the assumptions regarding use of biofuels.

The largest increases in consumption of biofuels in the APS are expected in India and China. In all countries, biofuels are expected to meet only a small portion of the transport fuel demand by 2030.

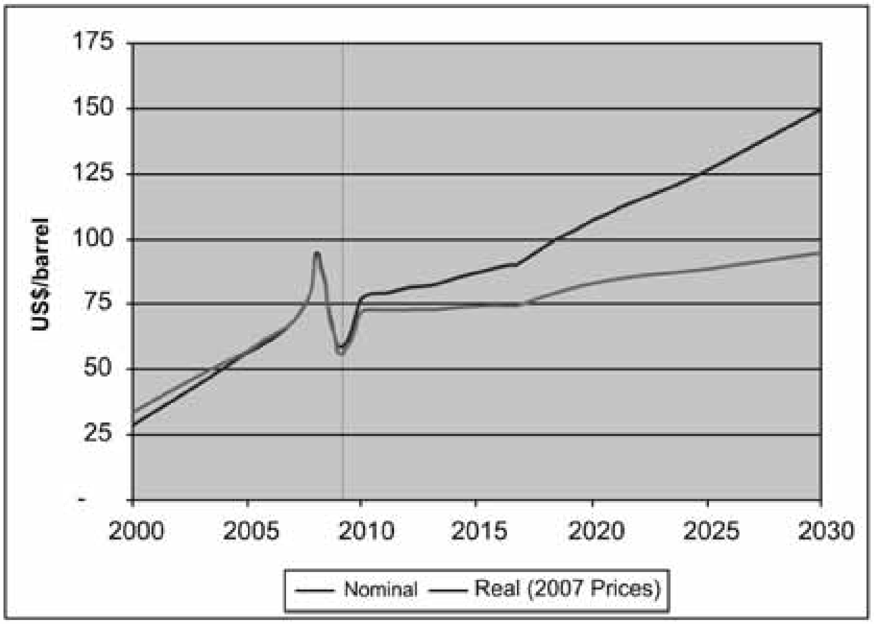
Table 3. Assumptions on Biofuels – Summary by Country

Country	Period	Assumptions
Australia	2010	Minimum: 1.1-1.4% of transport fuel; maximum 5% of transport fuel.
Brunei Darussalam		No targets on biofuels.
China		No biofuel targets submitted.
Cambodia		No targets for biofuels.
India	2011-12	Aims to produce enough biodiesel to achieve 20% blend for high speed diesel.
Indonesia	2005-2010	Biofuel utilization of 2% of energy mix or 5.29 million KL.
	2011-2015	Biofuel utilization of 3% of energy mix or 9.84 million KL.
	2016-2025	Biofuel utilization of 5% of energy mix or 22.26 million KL.
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	2006-2030	No targets on biofuels.
Myanmar	2020	Aims to replace 8% of transport diesel with biodiesel.
New Zealand	2012-2030	Mandatory biofuels sales obligation of 3.4% by 2012.
Philippines	2006-2030	The Biofuels Law requires 10% bio ethanol/gasoline blend and 2% biodiesel/diesel blend 2 years from enactment of the law (roughly 2009).
Thailand		Increase biofuels consumption to 4,300 ktoe (ethanol and biodiesel) by 2030.
Vietnam		No report on biofuels targets.

3.6 Crude Oil Price

Future changes in crude oil prices remain highly uncertain. In this modelling exercise the crude oil price, as measured by Japan's average import price (constant 2007 prices), is assumed to increase from about US$92.89 a barrel in 2008 to US$94.63 a barrel in 2030 (Figure 9). This projection is based on oil prices in the futures market to 2017. Beyond 2017 growth rates from the International Energy Agency's crude oil price projection in 2008 were applied. It is important to note that the impacts of changes in oil price assumptions on total energy demand in this study are likely to be modest, as oil is mostly used in transport and the elasticity of demand for transport fuels is notoriously low. However, if oil prices continue to rise (in real terms), that could be one socio-economic driver that would work for, rather than against, efforts to limit energy demand.

Figure 9. Oil Price Assumptions to 2030



3.7 Energy Saving Goals

Information about the potential energy savings achievable under specific policy initiatives to increase energy efficiency and reduce energy consumption was collected from each of the WG members from the 16 EAS countries. Each WG member specified which policy initiatives were existing policy, and should be applied to the BAU scenario, and which were proposed policies, and should apply only to the APS. Quantitative energy savings were estimated based on the country's own assumptions and modelling results.

Table 4. Summary of Energy Saving Goals, Action Plans and Policies Collected from each EAS WG Member

	BAU scenario	APS
Australia	Australia has detailed energy efficiency action plans embodied in its National Strategy on Energy Efficiency (NSEE) approved by all sectors of the economy. It outlines energy efficiency measures and plans to implement under: • Commercial and residential buildings; • Appliances and equipment; • Industry, businesses and government; • Transport; • Skills; • Innovation; and • Advice and education. The NSEE however, does not indicate the amount of savings that could be derived from the action plans. Australia has ratified the Kyoto Protocol and is expected to meet its emissions target of 108 percent of 1990 levels over the period 2008-2012 with domestic measures. Although not modelled in this exercise the Government has announced that a domestic emissions trading scheme - the Carbon Pollution Reduction Scheme (CPRS) will commence in 2011. The proposed CPRS will assist Australia to reduce its' greenhouse gas emissions by between 5 and 25 percent below 2000 levels by 2020. Australia also has a Mandatory Renewable Energy Target (MRET) which requires 20 percent of electricity to be sourced from renewable sources by 2020.	
Brunei Darussalam	Brunei Darussalam aims to contribute to the 25% improvement in regional energy efficiency by 2030 (with 2005 as baseline), as declared by APEC leaders in the Sydney Declaration on Climate Change and Energy. Sectoral Goals and Action Plan: • Industry sector: promote energy audit and usage of more efficient equipment and appliances. • Residential and commercial sector: introduce energy efficiency labelling for electrical equipment and appliances; regulate operating hours for air-conditioners in government buildings; introduce energy efficient building guidelines; and promote use of more energy efficient lightings, equipment and appliances. • Transport sector: promote techniques in energy saving driving and introduce fuel-efficiency labelling in vehicles • Electricity sector: improve power generation efficiency and improve efficiency of street lighting. • Continuous awareness and education program.	

Table 4 continued.

	BAU scenario	APS
Cambodia	The following energy efficiency action plans aims to reduce final energy consumption in existing industries by at least 10% by 2015 to increase to 15% by 2020: • In industry, Cambodia is promoting action plans for lighting, boilers, refrigeration, compressed air and electric motors efficiency improvement by improved design and utilization of more efficient technologies. • In the residential and commercial sectors, there are action plans for building design, cooking, lighting, space cooling, appliances, street lighting, water heating and air-conditioning. • In the transport sector, there are action plans form vehicle efficiency, fuel substitution and transport system efficiency. • Cogeneration will also be promoted in the industry and commercial sectors.	
China		• 20% reduction in energy intensity by 2010 with declines of 2.2% per year between 2006 and 2010 and additionally, 3% per year for the period 2010-2020.
India		• Projected 26% energy saving in APS in 2030 compared with BAU • TPES/GDP (kgoe/Rs GDP): 0.013 in 2030 • Industry: Improved efficiency to decrease energy consumption in APS in 2030 relative to BAU by: 9% in coal and coal products; 21% in petroleum products and 16% in electricity. • Residential and Commercial: Reduction in electricity consumption in APS of 25% relative to BAU in 2030 • Transportation: Reduction of energy consumption in APS by 17% relative to BAU from modal shift from road to rail and from private to public transportation as well as energy efficiency improvements in vehicles

Table 4 continued.

	BAU scenario	APS
Indonesia		• Reduce energy to GDP elasticity to less than 1 by 2025. • Reduce energy intensity by 1% per year until 2025 Additional Savings by 2025 • 92.2 MTOE in the industrial sector • 63.9 MTOE in transport sector • 40.7 MTOE in the other sectors
Japan		30% improvement in energy intensity from 2003 by 2030 • Industry: reduce consumption by 34 MkLOE relative to BAU • Residences and Buildings: reduce consumption by 14 MkLOE relative to BAU • Transportation: Reduce consumption by 11 MkLOE relative to BAU
Republic of Korea	• Reduce primary energy intensity from 0.358 toe/thousands US$ from 2005 to 0.237 Mtoe/thousand US$ by 2030 from various sectoral energy efficiency and conservation programmes	• Reduce TPES by 46% in 2030 from 544 MTOE in the BAU to 300 MTOE through various sectoral action plans
Lao PDR		• An energy efficiency and conservation programme aims to reduce the government's energy consumption in APS by about 10% relative to BAU scenario from 2010 to 2030

Table 4 continued.

	BAU scenario	APS
Malaysia	• Energy efficiency and conservation policies and programmes are being implemented by the government to promote energy efficiency in the industry, buildings and domestic sectors.	• Reduce industrial electricity and oil consumption by 12% and 15%, respectively in 2030 in APS relative to BAU through improvements in the efficiency of manufacturing technologies • Reduce electricity consumption in the commercial and residential sectors by 15% in APS relative to BAU by 2030 through the utilization of more efficient electrical appliances and induce savings from energy management programs
Myanmar		• Increase energy savings by 5% in APS relative to BAU in 2020 and 8% by 2030 • In industry, improve energy efficiency by 10% in APS relative to BAU by 2020
New Zealand	The historical energy efficiency improvement of 0.5-1.0% per year is expected to continue in the BAU	• 30 PJ of savings in non-transport energy per year by 2025 • 20 PJ of energy savings in the transport sector by 2015 To reach these targets, New Zealand will need to have a 40% improvement in energy efficiency by 2025, or an annual improvement of 0.8% per year (base year 1995).
Philippines		To attain energy savings equivalent to 10% of annual final demand through various energy efficiency programmes in all sectors of the economy.
Singapore		Reduce primary energy intensity by 20% in 2020 and 35% in 2030 from the 2005 level

Table 4 continued.

	BAU scenario	APS
Thailand		Reduce total final energy consumption by 20%by 2011 relative to BAU through : ▪ Regulatory measures, financial measures, capacity building, as well as public and private partnership in the industrial and commercial sectors. ▪ Changing mode of transportation, change from private to public transport and change to alternative energy in the transportation sector ▪ Standard and labelling for household appliances, promotion of high efficiency lighting and youth programs in the residential sector. All of these will be supported by awareness and information campaigns in all sectors
Vietnam		Aims to reduce 3-5% of total energy consumption in the 2006 -2010 period and 5-8% in the 2011-2015 period by energy efficiency measures.

3.8 Key Insightts

Economic growth in the EAS countries is needed to provide for the regions' growing population and improving living standards. Economic growth is assumed to exceed population growth in the 2005 to 2030 time period. This relatively strong economic growth and rising per capita incomes in the EAS countries could mean significant declines in poverty and significant increases in living standards for hundreds of millions of people.

With economic growth will come increasing access to, and demand for, electricity and rising levels of vehicle ownership. The continued reliance on fossil fuels to meet the increases in energy demand may be associated with increased greenhouse gas emissions and climate change challenges unless low emission technologies are used. Even if fossil fuel resources are sufficient, much of the fuel is likely to be imported from other regions, and no assurance can be given that they will be secure or affordable. Fossil fuel consumption using today's technologies will lead to considerable increases in greenhouse gas emissions, potentially creating new longer-term threats to the region's living standards and economic vitality. Growing adverse health impacts throughout the region are also likely as a result of particulate emissions.

Given this, considerable improvements in energy efficiency and greater uptake of cleaner energy technologies and renewable energy are required to address a range of energy, environmental and economic challenges. Yet efforts to limit energy consumption and greenhouse gases will be very challenging given such strong growth. However, as will be discussed in Section 4.2, sharp reductions in greenhouse gases are being called for by scientists. This huge 'headwind' working against energy efficiency and conservation and emission reductions poses a challenge to the EAS region that needs to be addressed.

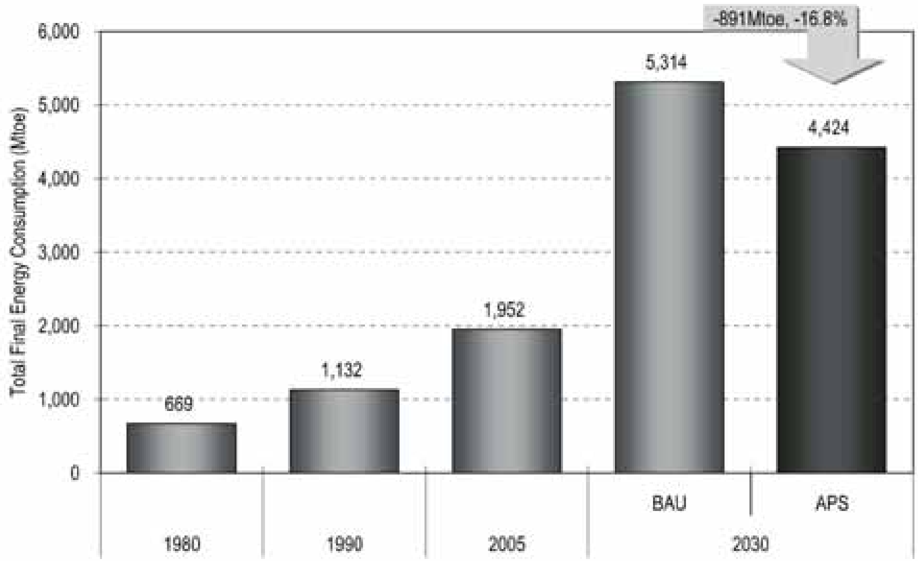
4. Energy and Environmental Outlook for the EAS Region

4.1. Energy Consumption

4.1.1. Total Final Energy Consumption

The previous chapter discussed the social and economic drivers that are expected to lead to a sustained increase in energy consumption in the EAS region to 2030. These drivers include rising population, rapid economic growth, increasing automobile ownership, and increasing access to electricity. The net result of these trends is illustrated in Figure 10 below. It shows that under the BAU case, final energy consumption is projected to increase from 1,952 Mtoe in 2005 to 5,314 Mtoe in 2030, an increase of 4.1 percent per year on average. In the APS case, final energy consumption is projected to rise to 4,424 Mtoe, 16.8 percent less than in the BAU case by 2030. 'Final energy consumption' refers to energy in the form in which it is actually consumed, that is, including electricity, but not including the fuels used to generate electricity.

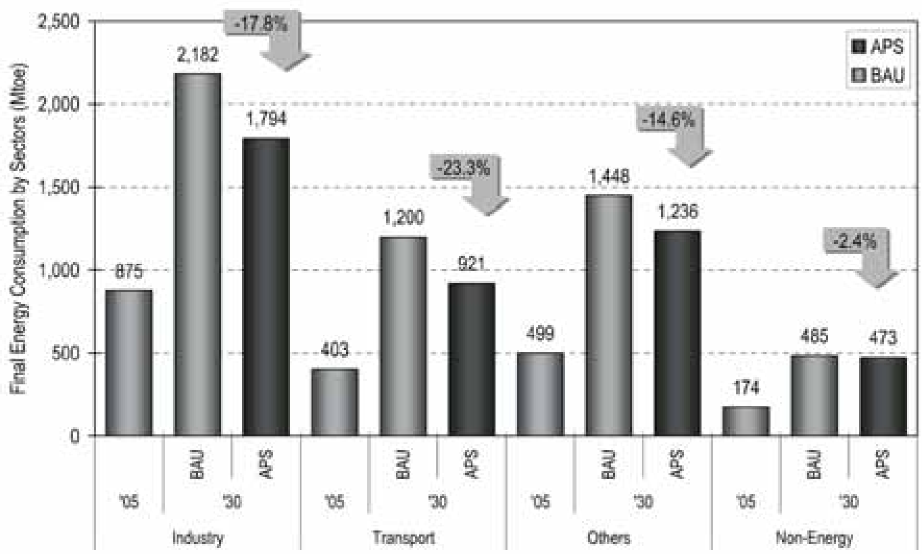
Figure 10. Total Final Energy Consumption



4.1.2. Final Energy Consumption by Sector

Figure 11 shows final energy consumption by sector. Final energy consumption in all sectors is projected to increase dramatically between 2005 and 2030. While in 2005, almost half of final energy consumption was for industry, by 2030, it is projected to be more evenly split between industry, transport, and 'other' (primarily residential and commercial). This trend reflects rising levels of automobile ownership, increased access to and demand of electricity, and rising living standards made possible by economic growth. Final energy consumption in most sectors is significantly reduced in the APS case compared to the BAU case. In percentage terms, the reduction is larger in the transport sector than in industry.

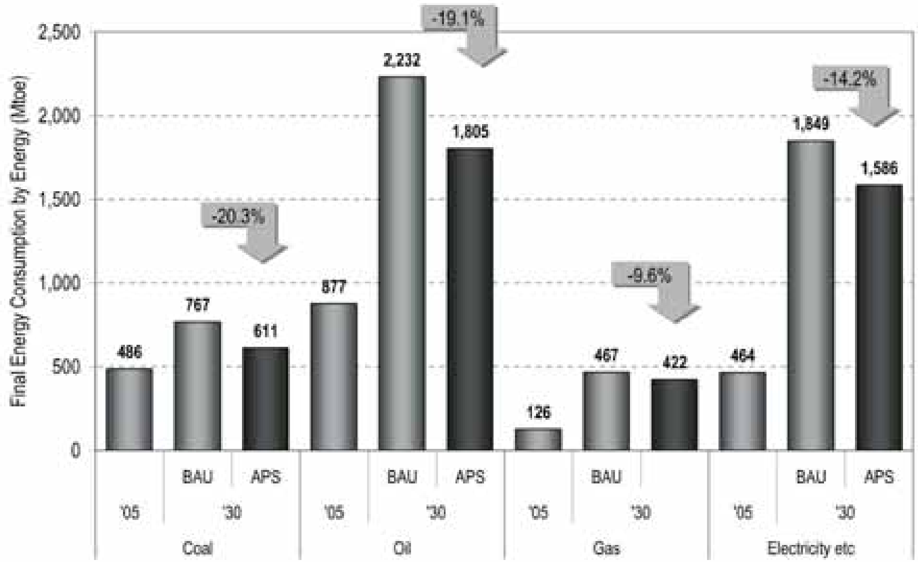
Figure 11. Final Energy Consumption by Sector



4.1.3. Final Energy Consumption by Fuel

Figure 12 shows final energy consumption by type of fuel. Oil was the largest final energy source in 2005, with a 45 percent market share. This share is projected to stay relatively stable to 2030. Oil consumption is projected to increase by 3.8 percent per year on average between 2005 and 2030. Electricity consumption increases even more in percentage terms, with demand growing on average by 5.9 percent per year between 2005 and 2030. However, in level terms, electricity consumption will be lower than oil consumption at 2030 in the BAU case. Natural gas is one of the fastest growing final energy source increasing on average by 5.4 percent per year between 2005 and 2030. However, by 2030, it still achieves only about an 8.8 percent market share. Final energy use of coal is projected to grow on average by 1.8 percent per year, which means that it loses market share compared to other fuels. In the APS case, growth in final demand for all fuels is reduced compared with the BAU case.

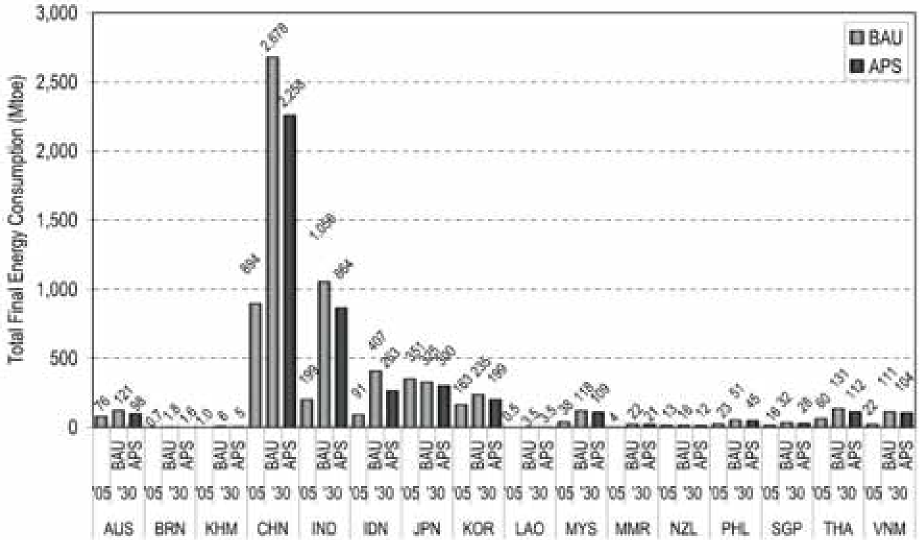
Figure 12. Final Energy Consumption by Fuel



4.1.4. Final Energy Consumption by Country

Figure 13 shows final energy consumption by country. The most striking result in this graph is that India and China are projected to dominate EAS region final energy demand by 2030. They are projected to account for about two-thirds of EAS region final energy consumption (62 percent) by 2030, up from about 56 percent in 2005. Just five countries—China, India, Indonesia, Japan, and Republic of Korea—are projected to account for 85 percent of EAS region final energy demand in 2030, with the growth in final energy demand concentrated in just three countries: China, India, and Indonesia. In fact, these "big three" countries are projected to account for 81 percent of the growth in energy demand of the entire EAS region between 2005 and 2030. In the APS case, growth in most countries, including the 'big three', is significantly reduced relative to the BAU scenario. However, the big three are still projected to account for 72 percent of the growth in energy demand in the EAS region between 2005 and 2030.

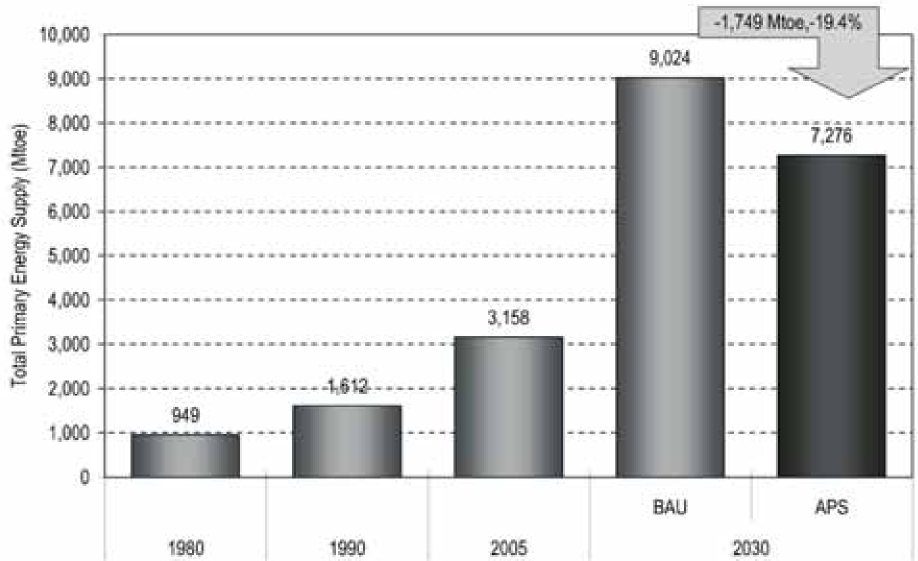
Figure 13. Total Final Energy Consumption by Country



4.1.5. Total Primary Energy Demand

The pattern followed by primary energy demand is, as one would expect, similar to final energy consumption. "Primary energy demand" refers to energy in its raw form, before any transformations, most significantly the generation of electricity. Figure 14 shows that total primary energy demand is projected to increase from 3,158 Mtoe in 2005 to 9,024 Mtoe in 2030 in the BAU case, an increase on average of 4.3 percent per year. In the APS case, demand is projected to grow to 7,276 Mtoe by 2030, 19.4 percent less than in the BAU case. The reduction in 2030 primary energy demand in the APS case compared to the BAU case of 1,749 Mtoe is roughly equivalent to China's current consumption. The fact that the percentage growth in primary energy demand is higher than the growth in final energy consumption in both the BAU and APS cases primarily reflects the faster increase of electricity demand compared to other sources between 2005 and 2030.

Figure 14. Total Primary Energy Demand

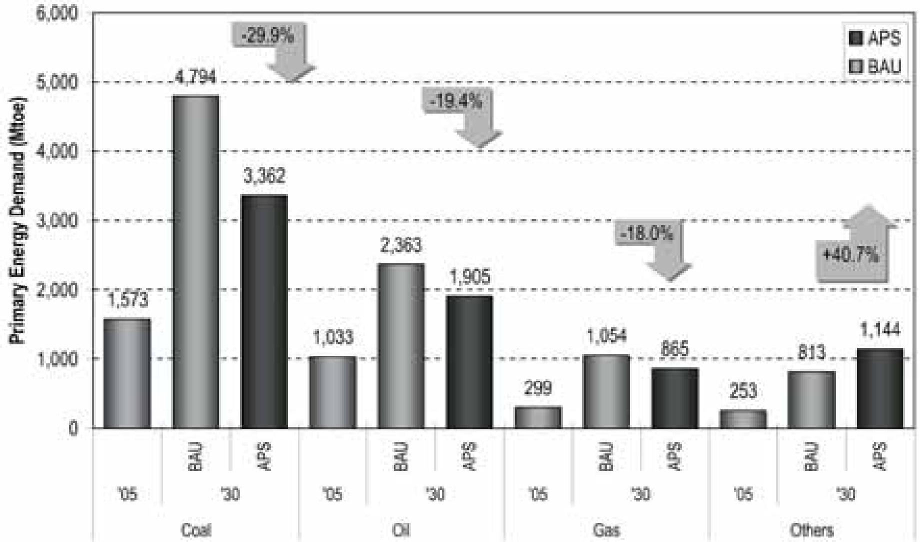


4.1.6. Primary Energy Demand by Source

Figure 15 shows primary energy demand by energy source. Coal is currently the largest source of primary energy in the EAS region, and is projected to remain the largest to 2030. Coal is also projected to have the largest growth over this period in the BAU scenario as measured in Mtoe (3,221 Mtoe), but not in terms of growth rate (up 4.6 percent per year on average). This growth is mainly due to increased use of coal for electricity generation. Oil has the next largest growth as measured in Mtoe (1,300 Mtoe), but a slower growth rate (up 3.4 per cent per year on average). This growth is mainly due to rising automobile ownership and transport demand. The highest growth rate, among fossil fuels, is projected to be in natural gas, up 5.2 percent per year on average, reflecting the growing use of gas in both electricity generation and as a consumer fuel. Nuclear is also projected to grow quickly (up 4.2 percent per year on average), but still projected to account for only about 4.2 percent of EAS region primary energy in the year 2030. Geothermal energy will also have a fast growth rate of 4.9 percent per annum although its share to the total EAS primary energy will remain below 1.0 percent in 2030.

In the APS scenario, growth in coal and oil primary consumption is projected to be sharply reduced. However, the reduction in average natural gas growth is much lower. These results reflect a shift from coal-fired electricity generation to natural gas and nuclear in the APS case, along with measures to reduce the demand for transport fuels.

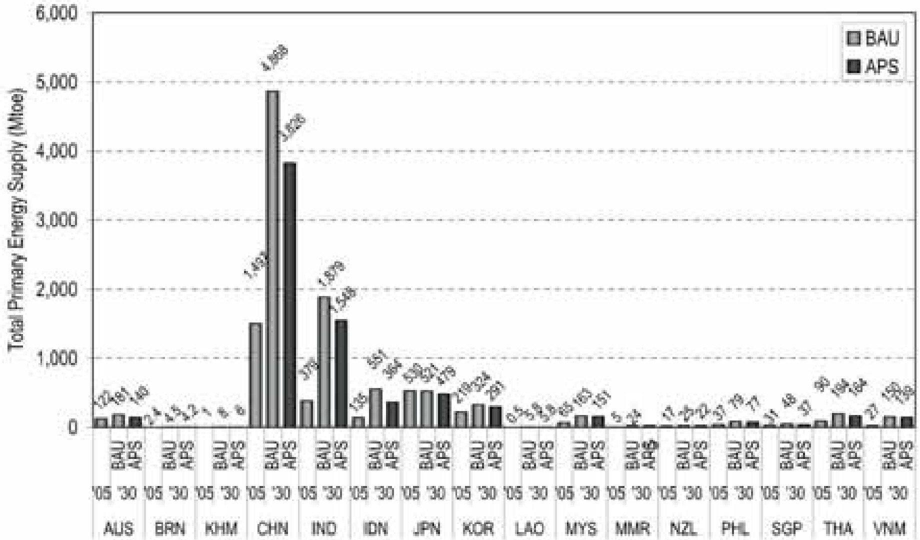
Figure 15. Primary Energy Demand by Source



4.1.7. Primary Energy Demand by Country

Figure 16 shows primary energy demand by country, which is similar to the pattern for final energy consumption by country shown in . Five countries - China, India, Indonesia, Japan, and Republic of Korea - are projected to account for 90 percent of EAS region primary energy in 2030. The 'big three' - China, India, and Indonesia - will dominate the growth in EAS region primary energy, accounting for 90 percent of the growth over the period from 2005 to 2030. In the APS case, growth in primary energy demand in most countries is significantly reduced, but the dominance of demand by five countries and the relative importance of the growth in three countries remain unchanged.

Figure 16. Primary Energy Demand by Country, 2005 and 2030



4.1.8. Primary Energy Intensity by Country

In Table 5 the impacts of the energy saving goals and policies submitted by each WG member on energy intensities are summarised. It should be noted that these results are illustrative of the potential energy savings that can be achieved and should not be interpreted as official country projections.

Table 5. Quantitative Impact of Energy Saving Goals and Policies: Illustrative Impacts

	2005	2030		Variance		
		BAU	APS	APS/BAU	2005/2030 BAU	2005/2030 APS
	(toe/million US$)	(toe/million US$)	(toe/million US$)	%	%	%
Australia	260	202	156	-22.7	-22.6	-40.1
Brunei Darussalam	366	261	243	-6.7	-28.8	-33.6
Cambodia	225	227	193	-15.0	0.8	-14.3
China	791	412	324	-21.4	-47.9	-59.0
India	578	416	343	-17.6	-28.0	-40.7
Indonesia	650	588	388	-34.0	-9.6	-40.3
Japan	106	81	74	-8.1	-23.8	-29.9
Korea	342	223	179	-19.6	-34.6	-47.5
Lao PDR	219	401	400	0.0	82.8	82.8
Malaysia	576	469	434	-7.4	-18.6	-24.6
Myanmar	343	183	174	-4.9	-46.5	-49.1
New Zealand	277	243	214	-11.9	-12.3	-22.7
Philippines	392	302	293	-2.8	-23.0	-25.2
Singapore	272	171	132	-22.8	-37.2	-51.5
Thailand	573	534	450	-15.7	-6.8	-21.5
Viet Nam	609	566	523	-7.6	-7.1	-14.1
Total	334	324	260	-19.9	-2.9	-22.2

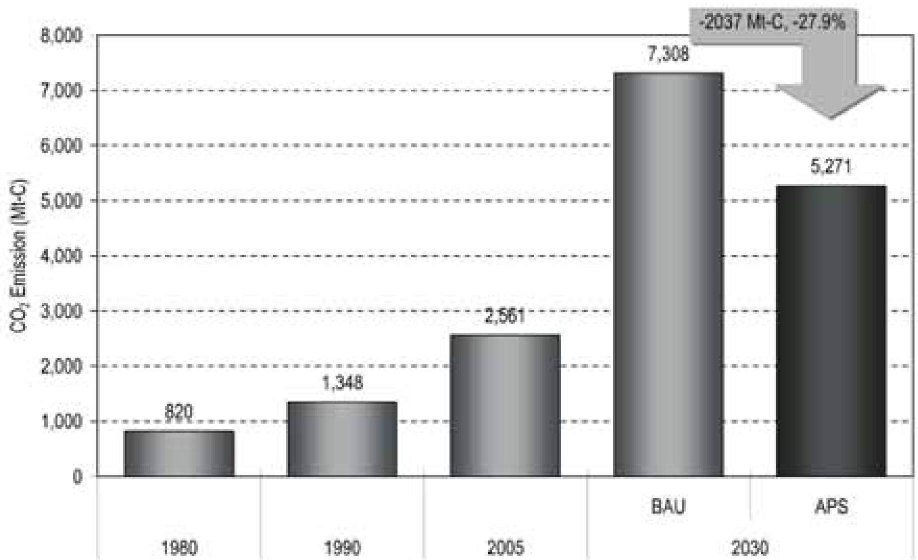
4.2. Carbon Dioxide (CO_2) Emissions from Energy Consumption

4.2.1. CO_2 Emission Results

As shown in Figure 17, CO_2 emissions from energy consumption in the BAU case are projected to increase from 2,561 metric tons of carbon (Mt C) in 2005 to 7,308 Mt C in 2030, implying an average annual growth rate of 4.3 percent. This is the same as the growth in total primary energy demand of 4.3 percent per year. In the APS case, CO_2 emissions are projected to be 5,270 Mt C in 2030, 27.9 percent lower than under the BAU case.

While the emission reductions under the APS are significant, CO_2 emissions from energy consumption in the APS case in 2030 will still be above 2005 levels and far above 1990 levels. Scientific evidence suggests that these reductions will not be adequate to prevent severe climate change impacts. The analysis of the Intergovernmental Panel on Climate Change (IPCC) (reference) suggests that to keep the global mean temperature rise at not much more than 2°C compared to pre-industrial levels, global CO_2 emissions would need to peak between 2000 and 2015 and be reduced to between 15 and 50 percent of year 2000 levels (that is, a reduction of between 85 and 50 percent) by 2050. To keep temperature rises in the 3°C range, CO_2 emissions would need to peak between 2010 and 2030 and be 70 to 105 percent of year 2000 levels by 2050.[11]

Figure 17. Total CO_2 Emissions



Although much depends and on the mitigation achieved in other regions, it would appear unlikely that global emissions could meet either of these profiles given the contribution of the EAS region to global total emissions under the APS results. Yet the consequences of insufficient reductions in emissions could be severe. For example at 2°C above pre-industrial levels, up to 30 percent of species become at increasing risk of extinction, most corals become bleached, and droughts and water availability become an increasing problem worldwide. At 3°C, millions of people could experience coastal flooding each year.[12]

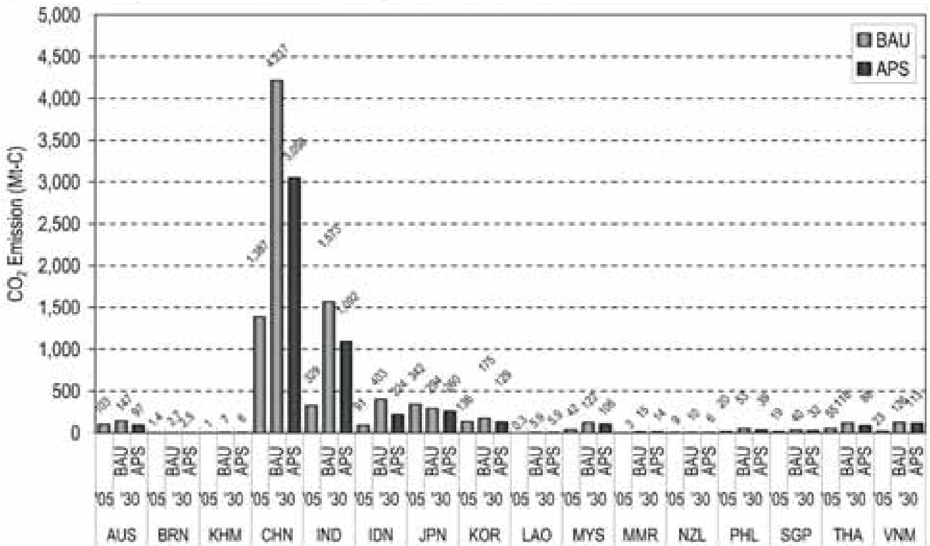
As shown in Figure 18, emissions and emission growth in the EAS region is projected to be dominated by China and India. In fact, China and India will account for 2,831 Mt C and 1,244 Mt C respectively of the projected 4,731 Mt C increase in EAS region emissions from 2005 to 2030 under the BAU case, or 86 percent of the total growth in the EAS region. Adding in Indonesia's growth of 312 Mt C, these three countries account for 4,387 Mt C or

[11] See "Summary for Policymakers" in *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Table SPM.5.

[12] These examples are taken from "Summary for Policymakers" in *Climate Change 2007: Synthesis Report. Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Figure SPM.7. The examples assume that 1° C of temperature increase has already occurred, as per this same report, Figure SPM.1.

93 percent of the total growth in EAS region. No other country will account for a growth of more than 185 Mt C. Japan is the only country in the EAS Region whose emissions are expected to decline under the BAU case probably as a result of a decrease in population, improvement in energy efficiency and increased share of lower emission fuels.

Figure 18. CO_2 Emissions by Country



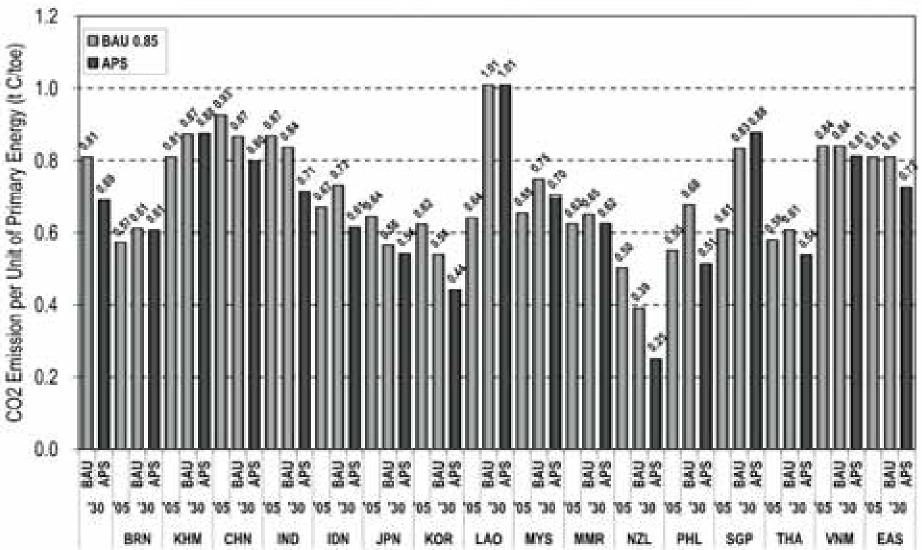
Under the APS case, China and India are still dominant, accounting for 1,671 and 762 Mt C respectively of the projected 2,702 Mt C growth in EAS region emissions from 2005 to 2030, or 90 percent. Adding in 133 Mt C from Indonesia accounts for 2,567 Mt C or 95 percent of the EAS region total. No other country will account for more than 100 MtÊC. Emissions from Australia, Japan, Republic of Korea, and New Zealand are expected to decline under the APS case relative to 2005 levels due to effective mitigation policies.

4.2.2. Fundamental Drivers of CO_2 Emissions from Energy Consumption

The CO_2 emission results discussed above may be viewed as the net result of four drivers, two of which are moving in a direction favourable to CO_2 emission reductions, and two of which are moving in an unfavourable direction.

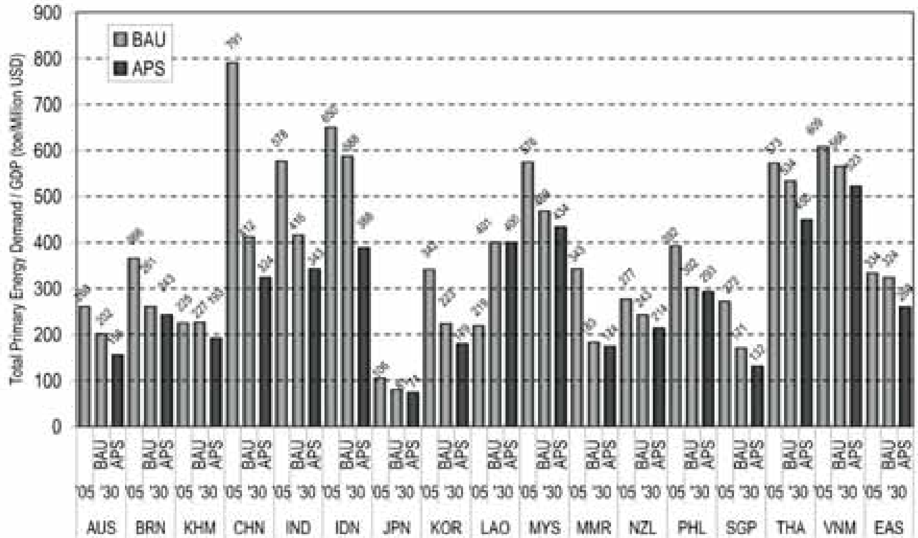
i) Emissions per unit of primary energy are projected to remain at 0.81 t C/toe from 2005 to 2030 under the BAU case. Under the APS case, this will decline to 0.72 t C/toe in 2030, or by 10 percent (Figure 19). The reduction under the APS case reflects a shift away from coal and oil, the two most emission-intensive fuels.

Figure 19. Emissions per Unit of Primary Energy



ii) Primary energy per unit of GDP is projected to decline modestly from 334 toe/million US$ in 2005 to 324 toe/million US$ in 2030 under the BAU case, or by 2.9 percent (Figure 20). Under the APS case, the decline is larger, to 259 toe/million US$ in 2030, or by 22 percent. The reduction under the APS case reflects projected improvements in energy efficiency. Looking at (i) and (ii) in combination, emissions per unit of GDP decline from 269 t C/million US$ in 2005 to 261 t C/million US$ in 2030 under the BAU case, or by 3 percent. Under the APS, the decline is larger, to 187 t C/million US$ in 2030, 30 percent lower than 2005.

Figure 20. Primary Energy Demand per Unit of GDP



iii) Working against these declines in emissions per unit of primary energy and primary energy per unit of GDP is the projected dramatic increase in GDP per person in the EAS region, from 3,000 US$/person in 2005 to 7,200 US$/person in 2030, an increase of 141 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 0.81 t C/person in 2005 to 1.89 t C/person in 2030 under the BAU case, or by 134 percent. Under the APS, emissions rise to only 1.37 t C/person in 2030, or 69 percent higher than 2005. However, the rising emission per capita is associated with increase in GDP/person and improvement in living standards.

iv) Finally, population in the EAS Region is expected to grow from 3,155 million in 2005 to 3,850 million in 2030, or by 22 percent. Combined, all these drivers lead to growth in emissions from 2,551 Mt C in 2005 to 7,281 Mt C in 2030 under the BAU case, or 185 percent. Under the APS, emissions grow to 5,256 Mt C in 2030, or 106 percent.

5. Additional Research Activities

In 2009 two (2) sub-working groups and five (5) satellite project teams were established under the energy saving potential working group to conduct the following research studies:

a. Energy Efficiency Design (sub-working group)
b. Civilian Nuclear Study (sub-working group)
c. Energy Saving Potential of Steel Industry in East Asia
d. Data Collection on Road Transport Sector in India and Thailand
e. Institutional Barriers on Applying the Sector Approach in Indonesia
f. Energy Saving Potential of Manufacturing Sectors in East Asia
g. Clean Coal Technologies

The results of the sub-working groups and the satellite projects were presented at the ERIA Energy Project Joint Workshop held on 3rd March 2010 hosted by ERIA at Sultan Hotel in Jakarta.

5.1. Sub-Working Groups

Energy Efficiency Design:

Ms. Yukari Yamashita of IEEJ, leader of the sub-working group for Energy Efficiency Design provided support to some EAS countries in setting up their energy saving goals and action plans in cooperation with energy efficiency consultants in EAS region. Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore and Vietnam requested for consultants to the sub-working group. Six consultants were chosen to work with the countries in terms of setting up of energy saving goals and action plans. So far, information sharing in terms of energy profile, energy outlook, key data, energy efficiency polices, energy saving target and action plan/roadmap is a major achievement of the sub-working group. Information sharing exercise should be continued, in so doing every country will be able to learn from each other which can lead to benchmarking. Finally, the group pointed out common barriers in this region which are: lack of energy efficiency and conservation legislation, reliable data, comprehensive programs and commitments, coordination among government organizations, collaboration between public-private sectors, financing scheme and human resources.

Civilian Nuclear Study:

This sub-working group led by Ms. Tomoko Murakami of IEEJ, studied the potential reduction of carbon dioxide emissions brought about by use of nuclear power generation and the future plans of nuclear power generation in East Asia region. Nuclear power policy makers from China, Japan, Korea, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand and Vietnam joined this sub-working group. The group identified important consideration on nuclear energy such as: public acceptance, technology transfer, financing scheme and nuclear waste. The possibility of nuclear technology for CDM application is also suggested by the joint working group because it supports energy security goals in ASEAN and Southeast Asia.

5.2. Satellite Projects

Energy Saving Potential of Steel Industry in East Asia:

This study was carried out by JFE-Technology Research Center of Japan through the leadership of Mr. Yutaka Suzukawa of JFE-Technology Research Center. The study classified the EAS countries into two groups, the first are those using the blast furnace technology and the second are those that use the electric arc furnace. EAS OECD countries, China and India are classified in the first group and ASEAN countries belong to the second group. The study showed the difference of energy intensity (TOE/ton) between Japan and other countries in both groups and estimated energy saving potential in steel industry of each EAS country referring to IEA data and local survey results. Based on the results, there is a need for a more reliable data especially in developing countries in EAS region. Also, training of human resources to handle the data is recommended. Comments from the audience include further study on application of new technologies such as the advanced electric arc furnace (AEAF) and regenerative burner heating (RBH) system in developing countries in terms of improving the understanding of technical and cost information and preparation of benchmarks.

Data Collection in Road Transport Sector in India and Thailand

India:

This study was conducted by the Japan Automobile Research Institute (JARI). Ms. Yukika Toda of JARI reported on the current share of carbon dioxide emissions in India and its projected rapid increase in share due to motorization referring to IEA World Energy Outlook 2008. According JARI's local survey, there was difficulty in collection of consumption by fuel and vehicle type, vehicle population by type and age, traffic volume and distance travelled (km). She concluded that there is a need to improve the city level automobile statistics through road traffic census and improvement of the vehicle registration system.

Thailand:

The study in Thailand was conducted by the Mitsubishi Research Institute (MRI) of Japan. Mr. Jun Akabane, representing MRI, reported on the results of the parking lot survey in Greater Bangkok. The survey outline consists of five hundred (500) samples, five (5) survey sites and four (4) vehicle types. The survey was conducted for 20 days, covering the period

December 1 to 20, 2009. In addition, an interview survey to large bus and truck companies was also conducted. Through this survey, the average distance travelled and fuel economy by vehicle type are estimated and used for decomposition analysis of carbon dioxide emissions. As a conclusion, he pointed out that improvement of fuel efficiency would be a key issue. Specific recommendations for improving fuel efficiency were listed. Several comments were raised during the presentation of the results such as: the survey should have included idling time, the effect of bypass roads and public transportation and the large difference of fuel efficiency between passenger cars and pick-up trucks. In response to the third comment, Mr. Akabane commented that one reason for the large difference of fuel efficiency between passenger and pick up truck is the small number of sample size used in the study.

Institutional Barriers on Applying the Sectoral Approach

The study was also conducted by MRI. Mr. Shingo Takahashi of MRI reported on the basic concept of the sectoral approach, CO_2 mitigation roadmap in Indonesia, possible reduction of carbon dioxide emissions in iron & steel and cement sectors as well as the study's conclusion. He mentioned that a bottom-up analysis based on specific technology would contribute to the analysis of mitigation of carbon dioxide emissions by specific sector. The CO_2 mitigation roadmap in Indonesia clearly describes that cement and steel industries are target sectors because they are the most energy-intensive sectors in Indonesia. He showed test calculation results of potential CO_2 emissions reduction brought about by application of new technologies in the both steel and cement sectors. In his conclusion, he pointed out that enhanced information infrastructure, data collection and management on energy and GHG emissions, and policy and regulation would be necessary in realizing the CO2 mitigation roadmap of Indonesia in these sectors.

Energy Saving Potential in Manufacturing Sectors in East Asia

This study was conducted by the Nomura Research Institute (NRI) of Japan. Dr. Junichi Yagi of NRI, reported on the energy saving potential in automobile and electric goods (appliances) sectors and identified energy saving processes in selected manufacturing sectors. The study focused on energy intensity (TOE/Yen) of the automobile and electric goods sectors of Japan and EAS countries and estimated the energy saving potential of the sectors in EAS countries based on current intensity levels. Measures that need to be implanted to enhance the effectiveness for energy conservation are also recommended. The study also showed detailed processes in selected manufacturing sectors and pointed out the potential for energy savings when energy efficiency technologies such as cogeneration are applied.

Clean Coal Technologies

This study was conducted by the Institute of Energy Economics, Japan (IEEJ). Mr. Koji

Morita of IEEJ, leader of the satellite project team, pointed out that coal would still be the major energy source in Asia region especially for thermal power generation until 2020 to 2030 referring to the latest World/Asia Energy Outlook prepared by IEEJ. He emphasized the use of low rank coal and high efficiency as well low-emission power plants as its important study points in East Asia. In addition, he stated the huge potential of low rank coal in the region. Accordingly, there exists new and high efficiency power plant technologies such as Super Critical (SC), Ultra-Super Critical (USC) and Integrated Gasification Combined Cycle (IGCC), carbon capture and storage technology, and flue gas treatment technology that could be used to improve the utilization of low rank coals. After his presentation, further study points were suggested by the audience, which included, cost information of each technology including investment cost, prospect of availability and cost information on coal to liquid technology, and possibility of application for CDM of these kinds of technologies.

6. CONCLUSIONS AND RECOMMENDATIONS

At the 3rd working group meeting, working group members discussed the key findings and implications of the analysis based on the two energy outlook scenarios, BAU and APS.

6.1. Key Findings

Based on the projected changes in socio-economic factors, energy consumption, and carbon dioxide emissions in the BAU scenario and the APS, the working group members identified a number of key findings. These are outlined below:

1. Sustained population and economic growth in the EAS region will lead to significant increases in energy demand as countries pursue their economic and development goals. The continued reliance on fossil fuels to meet this increased energy demand will also be associated with significant increases in greenhouse gas emissions.
2. Advanced energy efficient and low emissions technologies (including clean coal and biofuels) need to be widely deployed throughout the region for the simultaneous achievement of socioeconomic and environmental development goals and increased energy security.
3. Throughout the region there exists potential to increase energy efficiency and reduce the growth in energy consumption and greenhouse gas emissions. The results of this analysis indicate that by 2030 the implementation of currently proposed energy efficiency goals, action plans and policies across the EAS region could lead to reductions in the APS, relative to the BAU scenario of:

- 19.4 percent in primary energy demand;
- 19.9 percent in energy intensity; and
- 27.9 percent in energy derived CO_2 emissions

4. The share of carbon intensive energy such as oil and coal is reduced due to the 70% increase of the non-fossil energy shares such as hydro and nuclear in the APS in 2030. Therefore, the diversification of the regional energy fuel mix will contribute to the improvements in the regional energy security as well as the carbon intensity defined as emission divided by energy
5. It is recognized that the transport sector is a major energy consuming sector for the ASEAN region and also a challenging sector in terms of improved energy efficiency and emission reduction. In this regard, appropriate energy efficiency and conservation programs and low emission technologies are needed to contribute to energy saving and CO_2 emissions reduction.

6.2. Policy Implications

Following the extraction of the key findings, working group members also identified many policy implications and aggregated them into three major categories. The identified policy recommendations are based on a shared desire to enhance promotion of energy efficiency and conservation policies, increase low carbon energy such as biomass, monitor energy saving goals and action plans, and prepare accurate energy consumption statistics. The recommendations of the working group are listed here. It should be noted, however, that appropriate policies will differ between countries based on differences in country circumstances, policy objectives, and market structures and that not all members necessarily agreed to all recommendations.

1. *Energy efficiency and conservation and renewable energy policies*
    - Policymakers should set and continuously improve the energy saving goals and action plans for each sub-sector to have a basis in setting the target saving potential such as promoting mass transport system.
    - Policy mechanisms, which include incentives, to promote the use of renewable energy and implementation of energy efficiency and conservation programs is needed to be established.
    - Policies to remove subsidies to fossil fuel energy and provision of incentives will encourage further development of energy efficiency and conservation programs and renewable energy.

2. *Low emissions technologies*
   - Technology development supporting improvements in energy efficiency and reducing CO2 emissions is needed..
   - Measures to reduce CO2 emissions would include provision of subsidies for the application of low emission technologies such as PV and high efficient vehicles..
3. *Enhancing reliable energy statistics for monitoring of energy saving goals, action plans and policies*
   - Reliable sectoral energy statistics are necessary for understanding the current characteristics of the energy consuming sectors and to qualify and quantify energy efficiency and conservation policies and action plans.
   - Detailed surveys are required to acquire information and data on energy saving policies and current energy consumption.
   - Monitoring will be necessary using reliable energy consumption data.
   - Capacity building on data collection and modelling will be important to analyse the policy options for promoting EEC programs.

6.3. Recommendations

The analysis in this report indicates that there is significant potential for countries in the EAS region to reduce growth in energy consumption and carbon dioxide emissions by implementing policies across all sectors of the economy that encourage improvements in energy efficiency and conservation and increase the use of lower emission technologies and fuels.

It is clear that many EAS countries already have a variety of policies aimed at achieving energy saving goals. However, it is recommended that detailed action plans should also be developed which outline in a broad sense how these energy savings will be achieved. A range of policy options are available which could drive improvements in energy efficiency or the enhanced uptake of low emissions technologies. These policies include: government leadership and funding, energy conservation regulations, CDM projects, energy management systems, energy efficiency standards and labelling, long term energy efficiency goals or plans, communication campaigns, performance and emission standards, renewable energy portfolio standards (RPS), enhanced research and development funding, and explicit emission pricing instruments such as taxes and emissions trading. The choice of policies used in individual countries will depend on a range of country specific factors and other competing policy objectives.

A range of more energy efficient and lower emission technologies were identified for EAS countries. In particular, the use of more energy efficient vehicles and demand management strategies in the transportation, residential, and commercial sectors were key to achieving potential energy savings. Improvement in the efficiency of thermal electricity generation was also identified as being a key to achieving energy savings. International collaboration on technology development and transfer was identified as an opportunity for achieving future gains.

Lack of reliable energy statistics of the energy consuming sectors will impose barriers in monitoring and evaluating the energy saving targets and action plans in the EAS countries. Utilizing the IEA activity related to energy efficiency indicators is an option to improve the data collection at the sub-sectoral level and involves not only IEA member countries but also non-member countries. Encouraging EAS countries to participate in collecting energy statistics for the energy efficiency indicators are recommended.

The projected level of energy savings and reduction in CO2 emission will be significant if all of the energy saving and lower emission fuel policies proposed at the 3rd Energy Ministers Meeting in July 2009 were implemented in EAS countries. Although enhanced energy efficiency and an increase in the share of lower emission and renewable fuels in the energy mix may also have other benefits such as increasing energy supply diversity and enhancing energy security. But, these figures are not enough to mitigate all of the challenges posed by the climate change. The 28% reduction of CO2 emission below the business as usual levels at 2030 will still result in CO2 emission above the 2005 level. Therefore, more aggressive saving goals, advanced technologies to reduce CO2 emissions directly, such as carbon capture storage technologies, and enhanced uptake of lower emission fuels are recommended to further reduce the CO_2 emission.

In order to implement in depth analysis on energy saving potential, seven new research projects have started under this working group. They are: energy saving potential of steel industry in East Asia, data collection on road transport sector in India and Thailand, institutional barriers in applying the sectoral approach, energy saving potential of the manufacturing sector in East Asia, clean coal technologies, civilian nuclear study and energy efficiency design to support the energy saving action plans. The research results of these projects indicated that saving potential existed in the several manufacturing sub-sectors of EAS countries particularly the cement and iron and steel and road transport sector.

It was recommended that CDM should be applicable to clean coal technologies and nuclear power generation and that data collection will be crucial particularly in setting up the energy saving targets and action plans. Considering the beneficial outcome of these projects for the working group and its contribution in the energy saving potential of the EAS region, the expansion and addition of more research studies for these satellite projects is recommended.

Concrete action is required to facilitate inter-regional collaboration on technology development and transfer and policy implementation within the EAS countries and between the EAS countries and the rest of the world. It was also noted that additional upfront costs may be associated with implementing more energy efficient technologies and increasing the share of renewable energy sources. However, financial and economic analyses were outside the scope of this study. These issues should be assessed in the near future.

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