Chapter 1

Main Report

2009

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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), Japan proposed to undertake a 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[2]. 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 by the Working Group (WG) for Analysis of Energy Saving Potential in East Asia. Subsequently this WG was reconvened and the study was revised and extended in 2008/2009 to incorporate more recent information and estimation procedures and incorporate further information about energy saving potentials and energy efficiency goals, action plans and policies. 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[3].

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

[3] 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' Resolutions 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 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 between 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, Philippines, Singapore, Thailand and Vietnam, and 6 other countries, namely: Australia, China, India, Japan, Republic of Korea and New Zealand.[4] 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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[4] 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).

Table 1. Geographic, Demographic, and Economic Profiles, 2006

	Land Area (thousand sq.km.)	Population (thousands)	Population Density (persons/ sq.km.)	GDP (Billion 2000US$)	GDP per Capita (US$/person)
Australia	7,682	20,701	2.69	481.6	23,265
Brunei Darussalam	5	382	76.40	7.0	18,325
Cambodia	177	14,197	80.21	6.3	444
China	9,326	1,311,798	140.66	2,095.9	1,598
India	2,973	1,109,811	373.30	703.3	634
Indonesia	1,812	223,042	123.09	219.3	983
Japan	365	127,756	350.02	5,087.8	39,824
Korea, Rep.	99	48,418	489.07	671.3	13,865
Lao PDR	231	5,759	24.93	2.5	434
Malaysia	329	26,114	79.37	118.4	4,534
Myanmar	658	48,379	73.52	15.0	311
New Zealand	268	4,185	15.62	63.6	15,197
Philippines	298	86,264	289.48	99.6	1,155
Singapore	1	4,484	4,484.00	121.6	27,119
Thailand	511	63,444	124.16	165.0	2,601
Vietnam	325	84,108	258.79	48.4	575

Source: World Bank 2008. *World Development Indicator CD-ROM 2008.* Washington DC.

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[5]). A large percentage of the people in developing countries still meet their energy needs mainly with traditional biomass fuels.

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.

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

Table 2. Economic Structure and Energy Consumption, 2006

	GDP (Billion 2000US$)	Share of Industry In GDP, %	Share of Services in GDP, %	Share of Agriculture in GDP, %	Energy Consumption (Mtoe)	Energy Consumption per Capita (toe/person)
Australia	481.6	28.0	69.0	3.1	121.2	5.9
Brunei Darussalam	7.0	73.4	25.9	0.7	2.8	7.3
Cambodia	6.3	26.2	43.7	30.1	1.6	0.1
China	2,095.9	48.4	39.9	11.7	1,654.6	1.3
India	703.3	27.9	54.6	17.5	440.8	0.4
Indonesia	219.3	47.0	40.1	12.9	135.3	0.6
Japan	5,087.8	29.9	68.6	1.5	527.5	4.1
Korea, Rep.	671.3	39.6	57.2	3.2	216.5	4.5
Lao PDR	2.5	32.5	25.5	42.0	0.5	0.1
Malaysia	118.4	49.9	41.3	8.7	66.7	2.6
Myanmar	15.0	9.7	33.1	57.2	4.7	0.1
New Zealand	63.6	24.9	65.7	9.4	17.4	4.1
Philippines	99.6	31.6	54.2	14.2	39.3	0.5
Singapore	121.6	34.7	65.2	0.1	30.7	6.8
Thailand	165.0	44.6	44.7	10.7	97.7	1.5
Vietnam	48.4	41.6	38.1	20.4	28.9	0.3

Sources: 1. World Bank (2008) *World Development Indicators CD-ROM 2008.* Washington DC.

2. International Energy Agency (IEA) (2008) *Energy Balances of OECD Countries 2008 and Energy Balances of Non-OECD Countries 2008,* Paris.

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[6].

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 savings and CO_2 emission reduction potentials in the East Asia Region. As a result, the Working Group (WG) for Analysis of Energy Saving Potential in East Asia was reconvened. 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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[6] 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 2008/2009, the WG continued to assess energy saving potentials in the EAS region using the goals, action plans and policies reported at the second EAS Energy Ministers Meeting (EAS-EMM2). The WG in 2008/2009 enhanced and extended the analysis that was undertaken in 2007. The WG conducted two meetings in Jakarta and one meeting in Singapore from October 2008 to May 2009.

During the first meeting, the WG discussed and developed the 2008/2009 research plan and provided updates on revised energy saving goals, action plans and policies of each EAS country. The WG also discussed the policy development process in each country in relation to energy efficiency goals, action plans and policies. 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[7], 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

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

energy efficiency and conservation goals, action plans and policies could be implemented as planned by the EAS countries.

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 (EAS) region on energy consumption by fuel and sector and greenhouse gas emissions.

Specifically a business as usual (BAU) scenario was developed for each country outlining future sectoral and economywide energy consumption assuming no significant changes to government policies. An alternative policy scenario (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 low emissions technologies 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 14-16 October 2008 in Jakarta. At the meeting, the 2008 research plan was developed and discussed and a wide ranging discussion on the following issues was had: a. methodology for estimating energy savings b. 2008 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 and e. energy efficiency indicators.

The 2nd WG meeting was held on 10-12 February 2009 in Jakarta. IEEJ and the members who conducted their own energy outlook modelling presented their energy outlooks and incorporated feedback where appropriate. In addition, IEEJ made a brief presentation on other ERIA projects on: a. energy conservation in the iron & steel sector b. data collection in the transport sector c. issues on the sectoral approach to energy efficiency improvement recommended by Japan and d. clean coal technologies. The WG members welcomed these projects and also recognized the importance of potential synergies for the WG.

The 3rd WG meeting was held on 20-22 May 2009 in Singapore. 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-EMM3 through ERIA. 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 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, 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-EMM2 held in August 2008 in Bangkok, Thailand or that are currently, or likely to be, under consideration. Increased uptake of low emissions technologies was also considered in the APS.

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 saving 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. Further, the need for capacity building to assist countries to develop and practically implement energy saving goals, action plans and policies was recognised.

2.2. The Definition of Energy Saving Potential and 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[8] 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 2008 published by the World Bank[9]. 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*[10]. Following successful capacity building exercises the ASEAN 10 countries utilised their own energy models for this 2008/2009 study. 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 model was then used to develop energy projections for these countries.

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

Australia: Australian projections were developed using the Global Trade and Environment Model (GTEM) at the Australian Bureau of Agricultural and Resource Economics (ABARE). GTEM is a computable general equilibrium model of the world economy with detailed sectoral and regional representation. In the electricity, transport and iron and steel sectors, detailed technological and fuel representation is incorporated.

Korea: Korean projections were developed using the KEEI-LEDS (KEEI Long-term

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

[9] World Bank (2008) *World Development Indicator CD-ROM 2008.* Washington DC.

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

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 10 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 by energy and sector and future macroeconomic assumptions.

Other countries: The IEEJ model used for this analysis has a macro-economic module that calculates values 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 values 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 2007 Study

In 2007 a study[11] 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 2008/2009 to incorporate more recent information and estimation procedures and incorporate further information about energy saving potentials and energy efficiency goals, action plans and policies. This is the report of that study. Specifically, the following new information was

[11] ERIA Research Project Report 2007, No. 6-1, Analysis on Energy Saving Potential in East Asia

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;
- additional illustrative scenario which analyses 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 successful capacity building exercises the ASEAN 10 countries utilised their own energy models for this 2008 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.

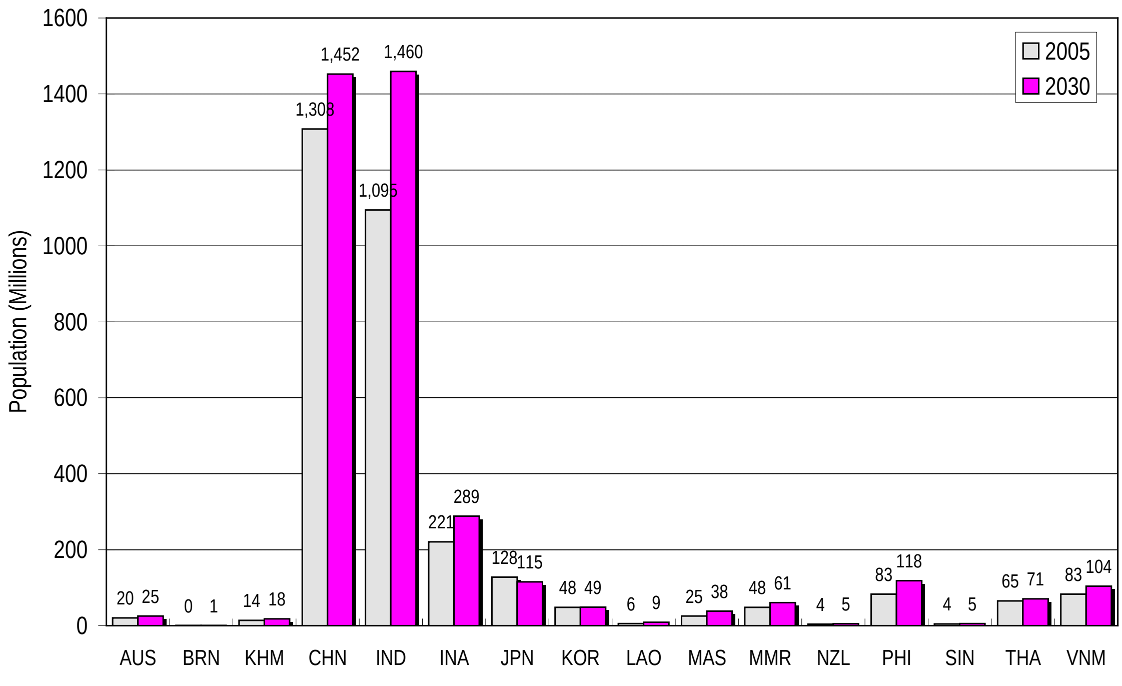
In this section assumptions regarding key socioeconomic indicators and energy policies over the projection period 2005-2030 are discussed for the EAS countries.

3.1. Population

In the model 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[12] were used for Malaysia, Singapore and China.

In 2005, the total population in the EAS region was assumed to be about 3.15 billion – around 50 per cent of total world population.[13] 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 3.82 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



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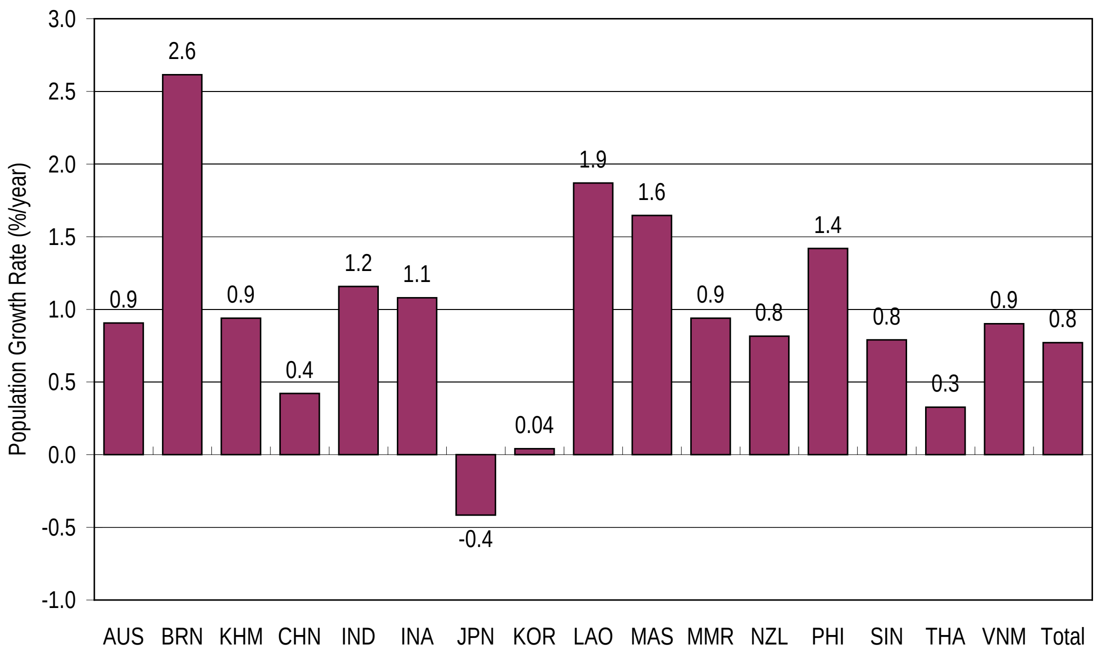
[12] United Nations (2006) *World Population Prospects: The 2006 Revision Population Database*, New York.

[13] World Bank (2008) *World Development Indicator CD-ROM 2008*. Washington DC.

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.

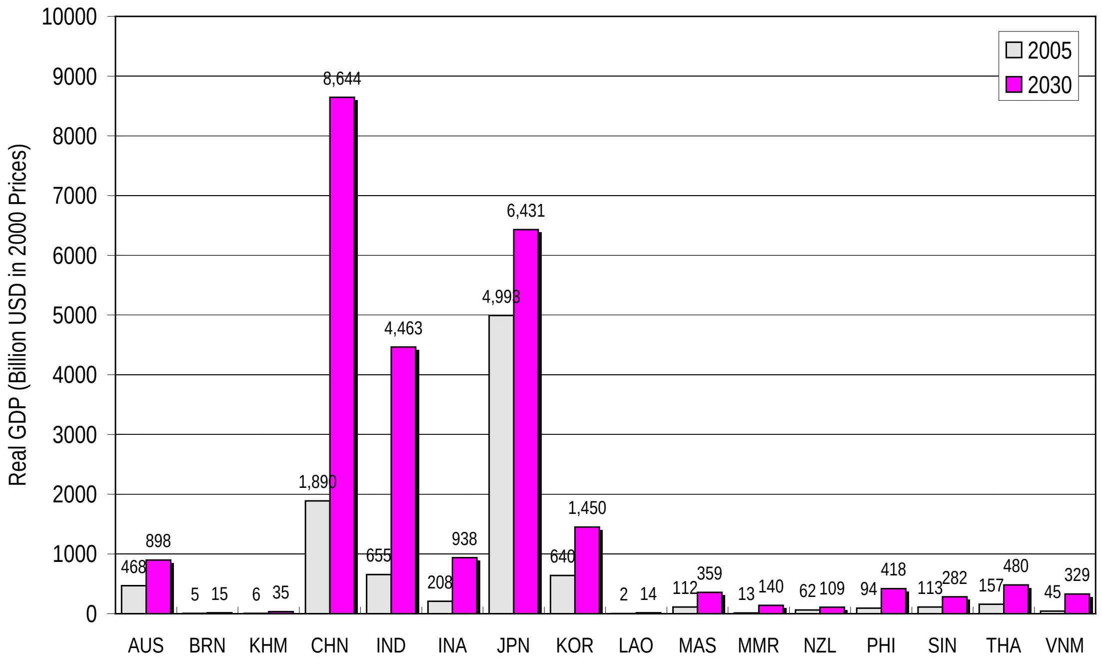
Figure 2. Assumed Average Annual Growth in Population, 2005 to 2030



3.2. Economic Activity

In the model used for this study, assumed changes in economic output to 2030 are set exogenously. Base year 2005 gross domestic product (GDP) data (in 2000 US$) were obtained from the World Bank.[14] 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 scenario and APS.

Figure 3. Assumed Economic Activity in the EAS Region, 2005 and 2030



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 4.0 percent from 2005 to 2030. This implies that by 2030 total GDP in the EAS region will reach about 25.0 trillion in 2000 US$.

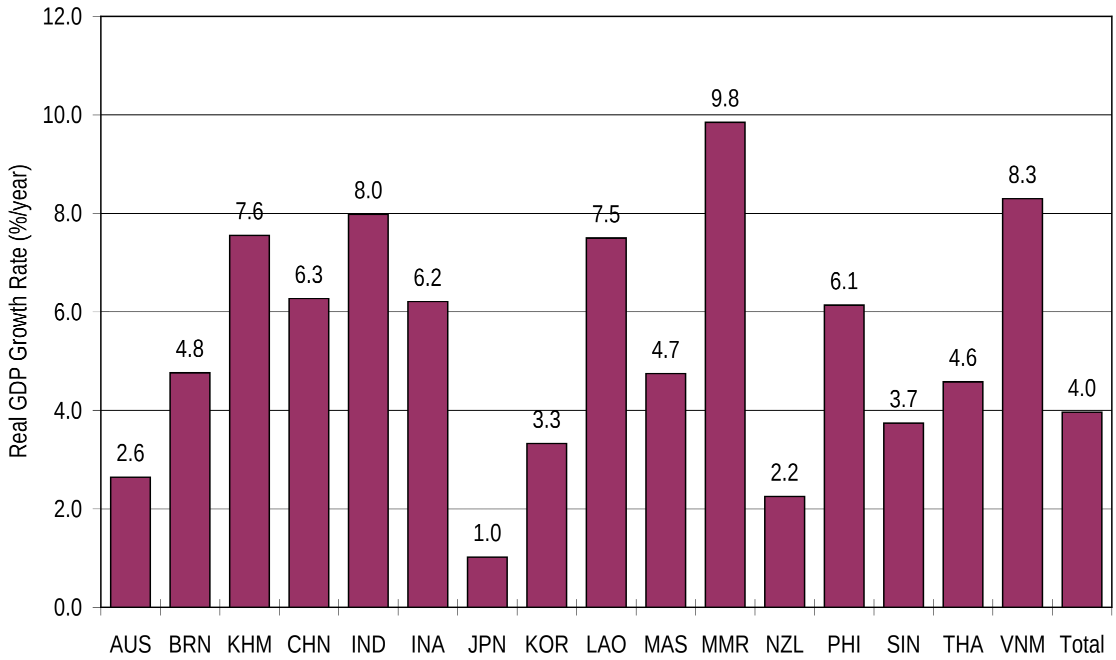
In 2005, Japan was the largest economy by far in terms of total economic output: 5.0 trillion 2000 US$. However, by 2030 China is projected to be the largest economy with an estimated GDP of about 8.6 trillion 2000 US$. Japan and India are projected to be the next largest economies with projected GDPs of about 6.4 trillion 2000 US$ and 4.5 trillion 2000 US$ respectively in 2030. See Figure 3.

As shown in Figure 4, long term economic growth rates are assumed to be quite high in

[14] World Bank (2007) *World Development Indicator CD-ROM 2008.* Washington DC

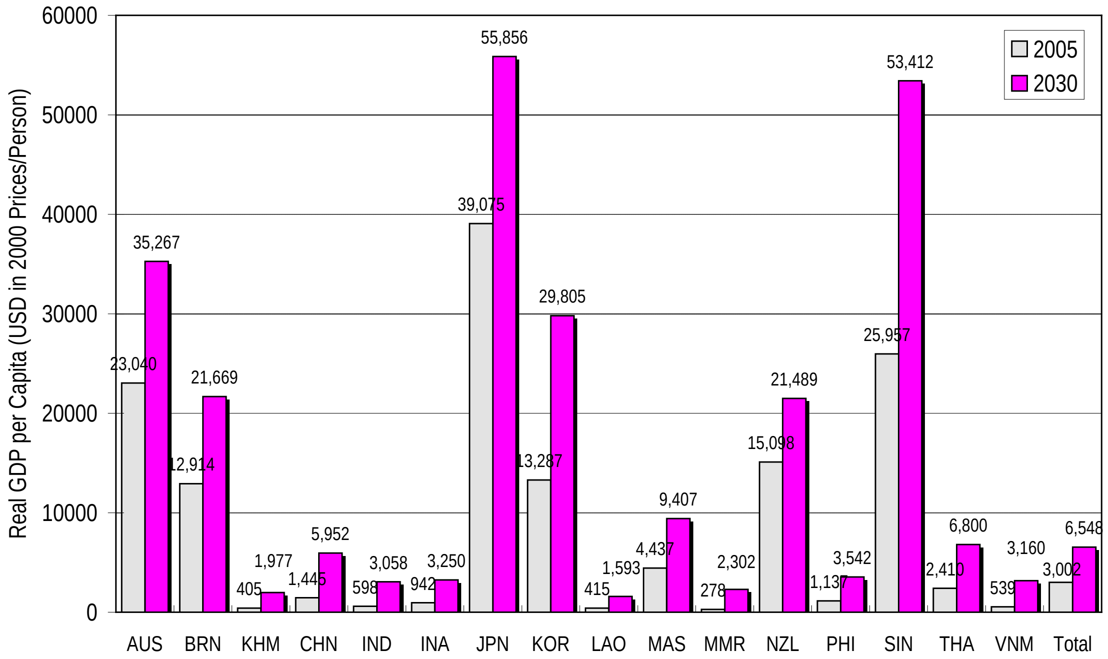
the developing countries, with the highest growth rates in Myanmar, Vietnam, India, Cambodia and Lao PDR. Economic growth in other developing countries is also assumed to be relatively rapid. Due to the large size of their economies, the rapid growth in China, India, and Indonesia is likely to be especially 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.

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



Average GDP per capita in the EAS region is assumed to increase from about US$3,000 in 2005 to about US$6,500 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$278 in Myanmar to about US$39,075 in Japan. In 2030, per capita GDP is assumed to range from about US$1,593 in Lao PDR to about US$55,856 in Japan.

Figure 5. Per Capita Income in EAS Region, 2005 and 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 IEEJ model used in this study, energy demand by all forms of transport is modelled. However, road vehicle ownership is a key exogenous input. Therefore, future road vehicle ownership of China, India, and Japan were also estimated in the model's macroeconomic module. 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.

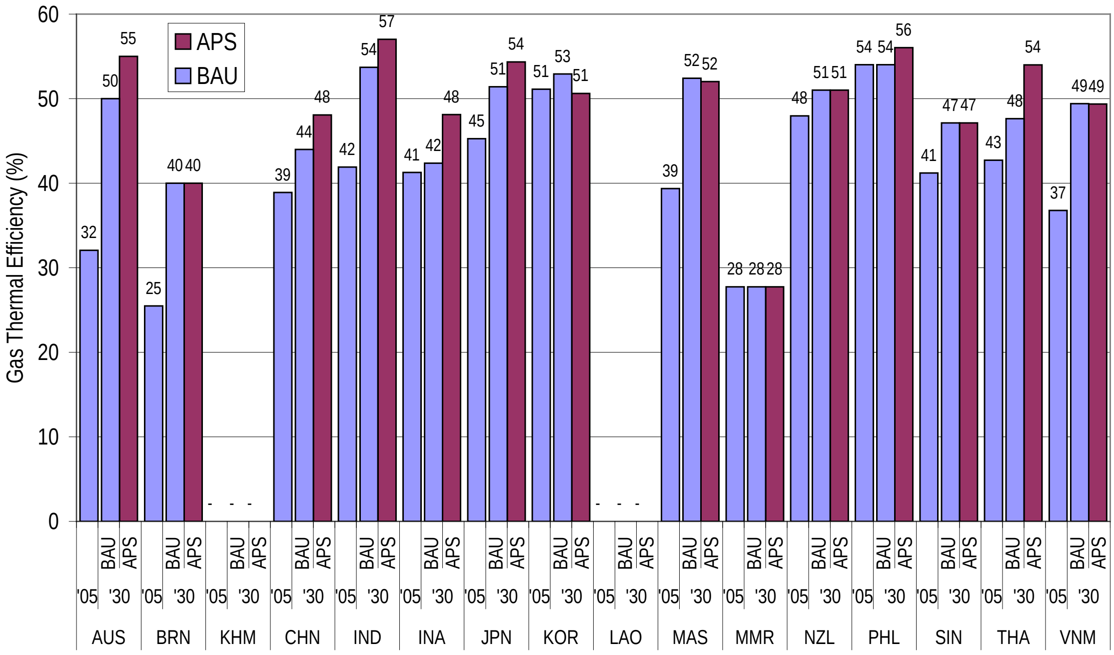
Per capita vehicle ownership is projected to increase in the EAS region. However, vehicle ownership on a per capita basis is projected to vary significantly between countries.

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[15]. 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.*

Figure 6. Thermal Efficiencies of Gas Electricity Generation



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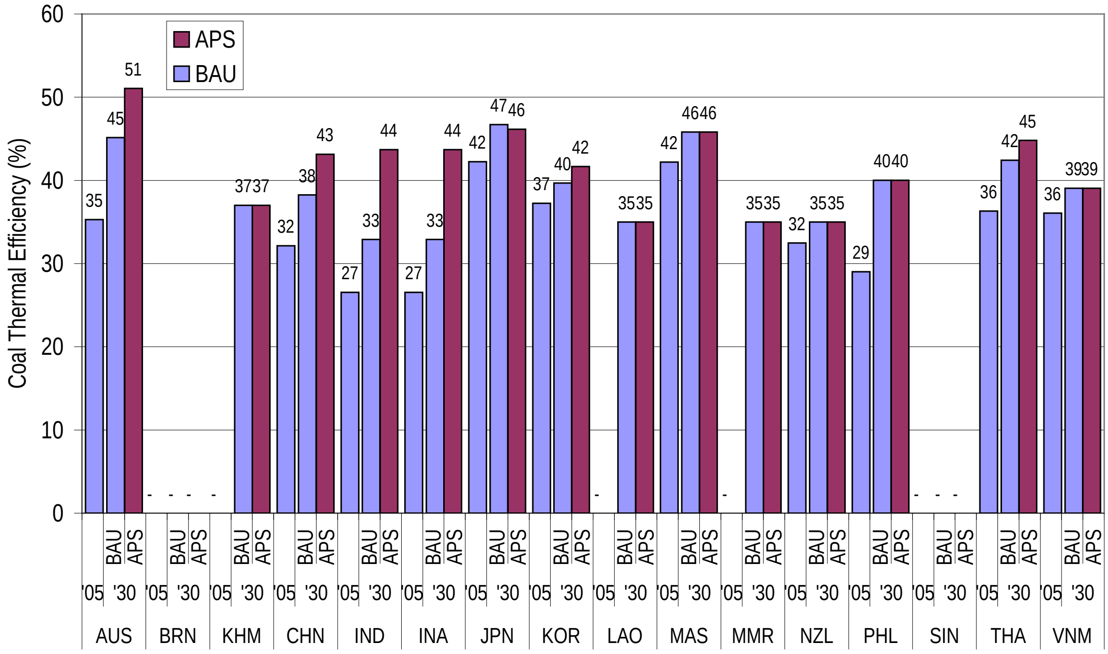
15 IEA (2008) *Energy Balances of OECD Countries 2007 and Energy Balances of Non-OECD Countries 2007*. Paris.

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 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. Figure 6 and Figure 7 show the assumed improvements in thermal efficiency for gas and coal fired electricity generation. Oil is not shown as it represented less than 7 percent of electricity generation in the EAS region in 2005 and this share is expected to decline to less than 2 percent by 2030. It can be seen that there are large differences between the least and most efficient countries. This suggests there are significant opportunities to improve generation efficiency in some countries.

Figure 7. Thermal Efficiencies of Coal Electricity Generation

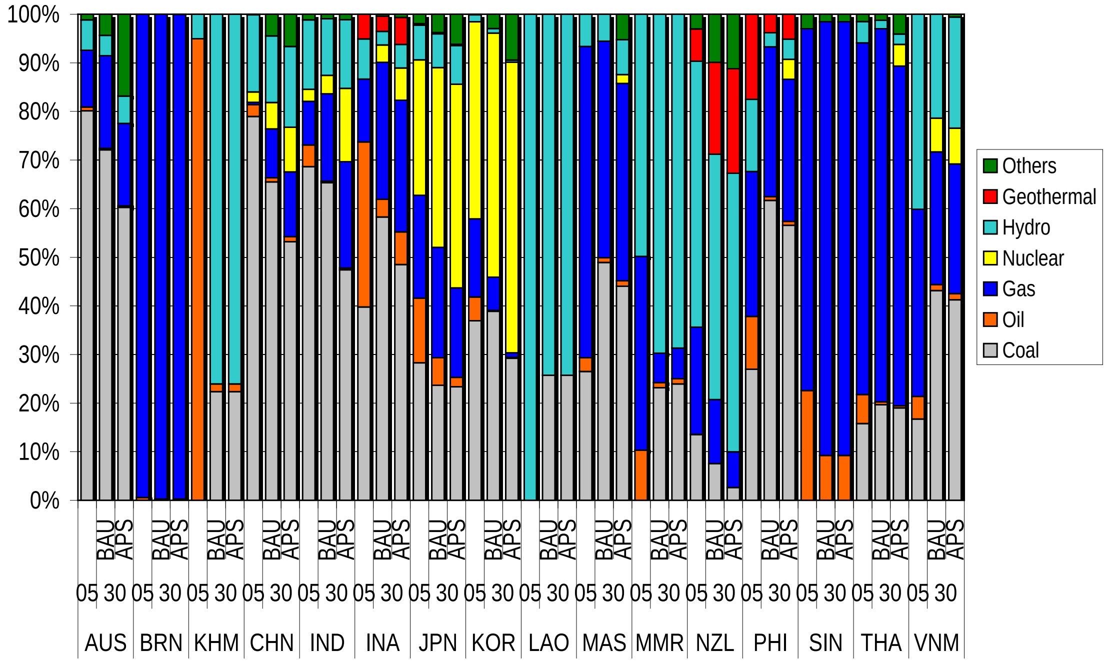


3.4.1 Electricity Generation Fuel Mix

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 scenario and APS. However, the share of coal in electricity generation in the EAS region is projected to decline from about 58 per cent in the BAU scenario to about 46 per cent 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. As mentioned in Section 3.4.1, the use of oil in electricity generation is assumed to decline to almost negligible levels across the EAS region as a whole.

3.4.2 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 members from 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 the 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 the 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 2011 - 2015 2016 - 2025	Biofuel utilization in 2% of energy mix or 5.29 million KL. Biofuel utilization in 3% of energy mix or 9.84 million KL. Biofuel utilization in 5% of energy mix or 22.26 million KL.
Japan	2005-2030	No biofuel targets submitted.
Republic of Korea	2012 2020 2030	Replace 1.4% of diesel with biodiesel. Replace 6.7% of diesel with biodiesel. Replace 11.4% of diesel with biodiesel.
Lao PDR	2006-2030	No targets for 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	Law requires 10% gasoline/bioethanol blend and 2% diesel/biodiesel 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 biofuel targets.

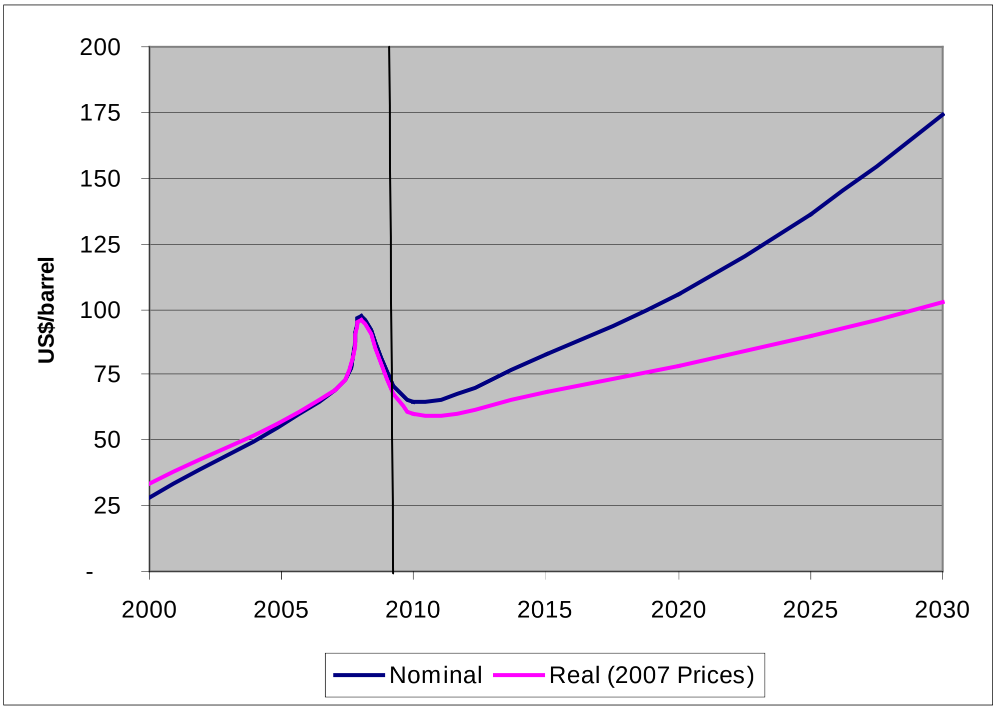
3.6 Crude Oil Price

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$95.48 a barrel in 2008 to US$102.92 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[16]. 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

[16] IEA (2008) *World Energy Outlook 2008.* Paris

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 socioeconomic 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

<table>
<tr><th></th><th>BAU Scenario</th><th>APS</th></tr>
<tr><td>Australia</td><td colspan="2">Australia has no official energy savings goals but has committed to implementing a domestic emissions trading scheme – the Carbon Pollution Reduction Scheme (CPRS) – in 2011. Australia is committed to reducing its’ greenhouse gas emissions by between 5 and 25 percent below 2000 levels by 2020. Improvements in energy efficiency are expected to make a major contribution to these emissions reductions. The Commonwealth Government has a range of policy measures in place to stimulate the uptake of energy efficient and lower emissions intensive technologies and practices. The overarching program of work for promoting energy efficiency within the Australian economy is the National Framework for Energy Efficiency (NFEE). Energy efficiency measures in Australia span the commercial, residential and industrial sectors and include:
• Minimum Energy Performance Standards for a range of appliances and equipments;
• The Energy Efficiency Opportunities program which requires Australia’s largest energy users to undergo rigorous energy use assessments; and
• A range of building standards and rating tools.
In addition, Australia’s States and territories have a large number of programs aimed at improving energy efficiency. On 2 July 2009 the Council of Australian Governments signed the National Partnership Agreement (NPA) on Energy Efficiency, which is a comprehensive 10-year strategy to accelerate energy efficiency improvements. The NPA will deliver a nationally-consistent and cooperative approach to energy efficiency, and NPA encompasses the current activities of the NFEE, and also covers the transport sector.</td></tr>
<tr><td>Brunei</td><td></td><td>Reduce BAU energy consumption in the industrial, residential, commercial and transport sectors by 5% by 2010 and 10% by 2030 through the following strategies:
• Awareness and education program;
• Energy efficiency and conservation standards and labelling;
• Shift to more energy-efficient technologies; and
• Energy audits in buildings and industries.</td></tr>
</table>

<table>
<tr><th></th><th>BAU Scenario</th><th>APS</th></tr>
<tr><td>Cambodia</td><td colspan="2">There are the following energy efficiency goals but without quantified energy savings:
Achieve sustainable market transformation towards more efficient energy use;
Facilitate increased access to financing of energy efficiency projects; and
Establish and implement regulatory frameworks that are supportive of energy efficiency.</td></tr>
<tr><td>China</td><td></td><td>20% reduction in energy intensity by 2010 with declines of 2.2% per year between 2006 and 2010 and additionally, 3% per year between 2010-2020.</td></tr>
<tr><td>Indonesia</td><td>10-15% saving potential (in final energy consumption) with little or no cost.</td><td>30% saving potential with investment (in final energy consumption).</td></tr>
<tr><td>Japan</td><td>Final energy consumption of 372 Mtoe in 2005 will decrease to 325 Mtoe in 2030.</td><td>Final energy consumption of 372 Mtoe in 2005 will decrease to 300 Mtoe in 2030.</td></tr>
<tr><td>India</td><td></td><td>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 achieved via a modal shift from road to rail and from private to public transportation as well as energy efficiency improvements in vehicles.</td></tr>
</table>

	BAU Scenario	APS
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.	• Further reduce primary energy intensity to 0.2 Mtoe/thousand US$ by 2030.
Lao PDR		• An energy efficiency and conservation programme in the government sector aims to reduce the government's energy consumption in APS by about 10% relative to BAU scenario from 2010 to 2030 (Government Offices).
Malaysia	• Industry sector will encourage the implementation of energy efficiency measures to improve plant, equipment and processes as well as through the increased use of high-efficiency motors. • Energy efficiency programmes will focus on efficient lighting and air conditioning systems in the residential and commercial 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.

	BAU Scenario	APS
New Zealand	The historical energy efficiency improvement of 0.5-1.0% per year is expected to continue in the BAU.	▪ Reduce primary energy demand by 12.7% at 2030 in the APS relative to the BAU through measures including: ▪ Switching to more efficient vehicles particularly electric vehicles and ▪ Improving insulation and increasing uptake of more efficient appliances in the residential and commercial sectors.
Philippines		▪ Reduce electricity consumption by 6% in the industry sector and 10% in the residential and commercial sectors by 2030 in the APS relative to BAU through various energy efficiency programs. ▪ Reduce oil consumption in the industry, residential and commercial sectors by 5% in 2030 in the APS relative to BAU through various energy efficiency programs. ▪ Reduce oil consumption in the transportation sector by 6.5% by 2030 in the APS relative to BAU through the adoption of more efficient vehicles.
Singapore		▪ Reduce primary energy intensity by 20% in 2020 and 35% in 2030 from the 2005 level.

	BAU Scenario	APS
Thailand		Reduce total final energy consumption by 15.7% in the APS relative to BAU through the following: • Technology development and uptake in the manufacturing sector; • Promotion of public energy efficiency awareness and energy efficiency labelling in the residential and commercial sectors; and ▪ Development of a metropolitan railway network in Bangkok as well as improvements in the energy efficiency of vehicles.
Vietnam		• Aims to reduce 3-5% of total energy consumption in the 2006 -2010 period (equivalent to 5 Mtoe) and 5-8% (equivalent to 13.1 Mtoe) in the 2011-2015 period by energy efficiency measures. • Industry: aims to reduce 5% of industrial sector energy consumption (equivalent to 2.6 Mtoe) in 2006-2010 and 8% (equivalent to 6.4 Mtoe) in the 2011-2015 period. • Building sector: apply compulsory control to 100% of all buildings that are constructed from 2006 in accordance with Vietnamese Construction Standards of Energy Efficiency and Conservation Buildings legislation.. • Compile and publish standards on minimum energy efficiency for fluorescent lamps, fluorescent lamp ballasts, electric fans, electric motors, air conditioners and refrigerators.

3.8 Key Insights

Economic growth in the EAS countries is needed to provide for the regions' growing population. 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 cleaner 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 low emissions technologies 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 urgently needs to be addressed.

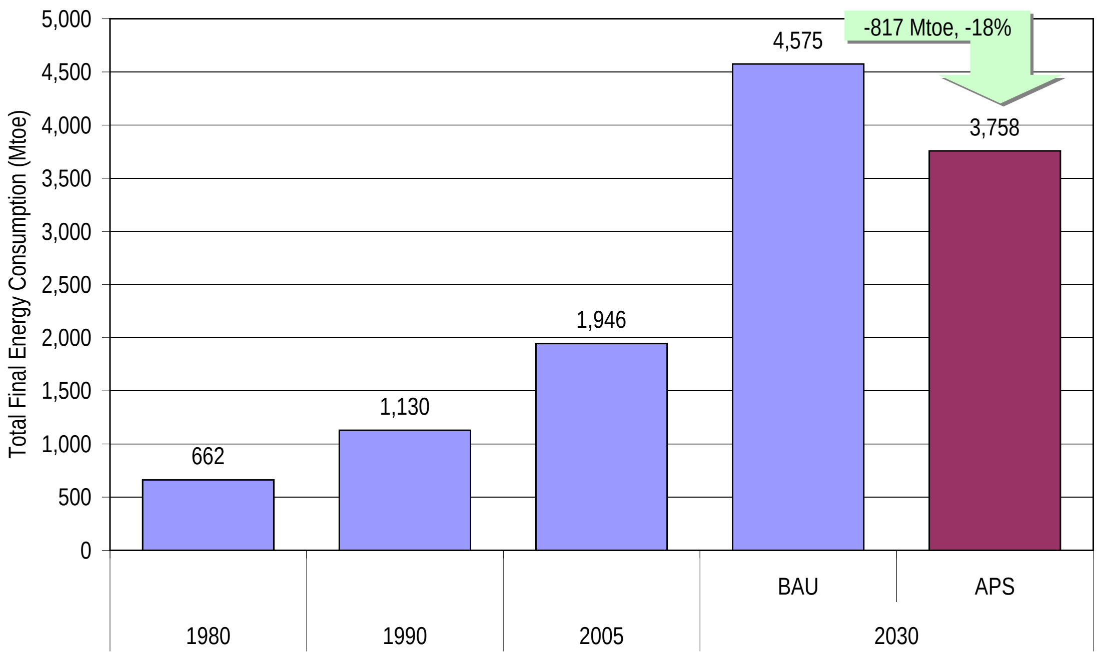
4. ENERGY AND ENVIRONMENTAL OUTLOOK FOR THE EAS REGION

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 scenario, final energy consumption is projected to increase from 1,946 Mtoe in 2005 to 4,575 Mtoe in 2030, an increase of 3.5 percent per year on average. In the APS, final energy consumption is projected to rise to 3,758 Mtoe, 18 percent less than in the BAU scenario 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.

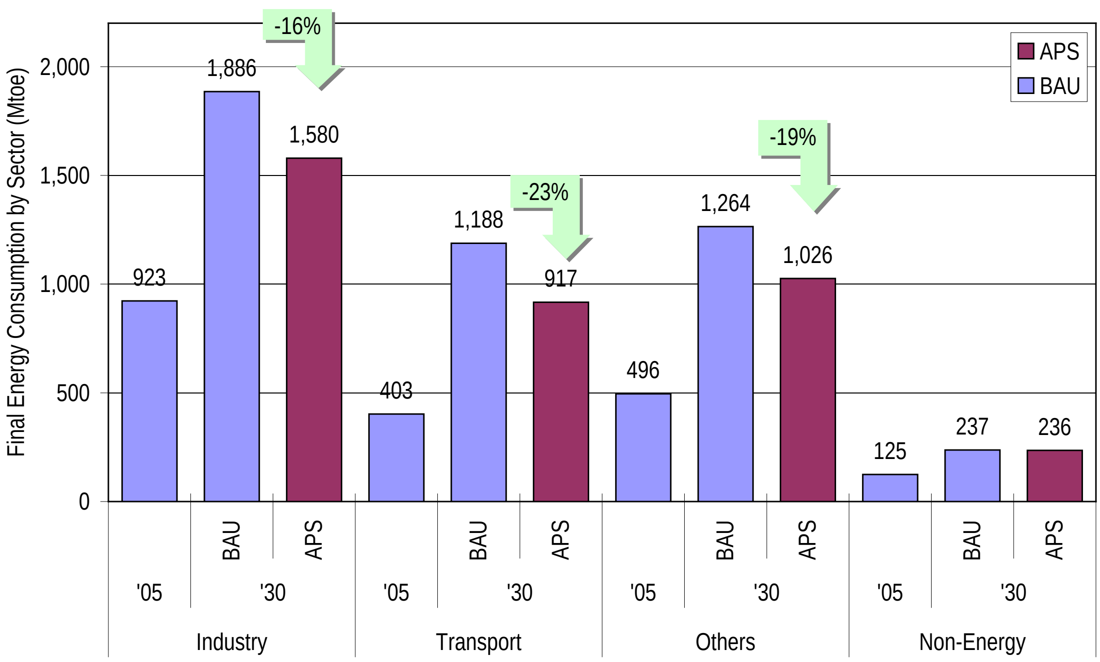
Figure 10. Total Final Energy Consumption



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 for, electricity, and rising living standards made possible by economic growth. Final energy consumption in most sectors is significantly reduced in the APS compared to the BAU scenario. In percentage terms, the reductions are larger in the transport and ‘other’ sectors than in industry.

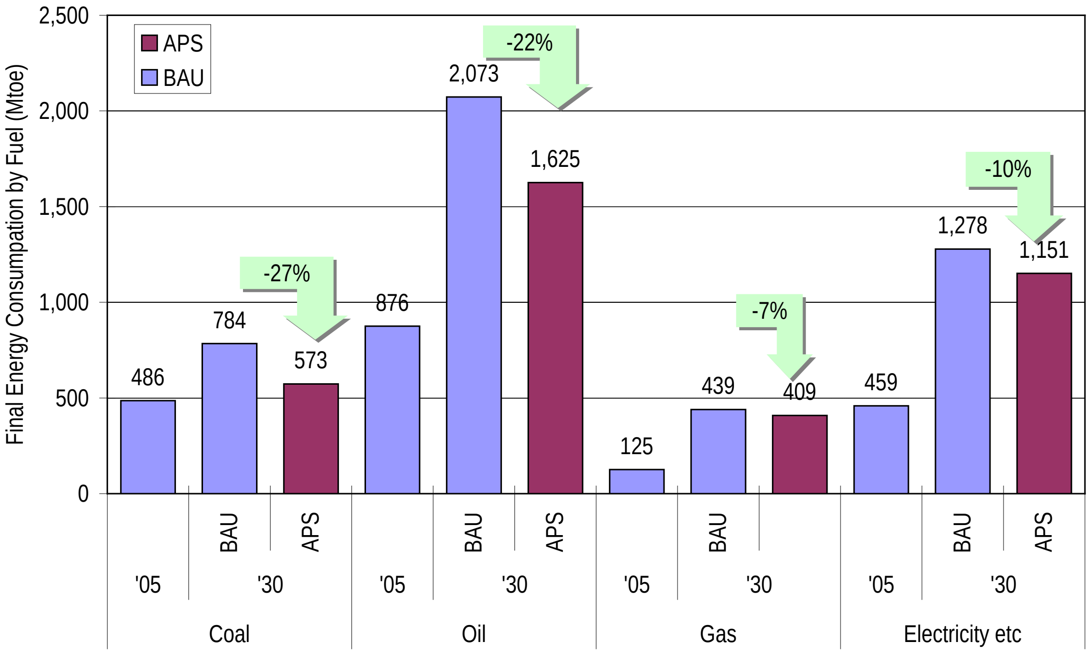
Figure 11. Final Energy Consumption by Sector



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 3.5 percent per year on average between 2005 and 2030. Electricity consumption increases even more in percentage terms, but not in Mtoe, with demand growing on average by 4.3 percent per year between 2005 and 2030. Natural gas is the fastest growing final energy source increasing on average by 5.1 percent per year between 2005 and 2030. However, by 2030, it still achieves only about a 10 percent market share. Final energy use of coal is projected to grow on average by 1.9 percent per year, which means that it loses market share compared to other fuels. In the APS, growth in final demand for all fuels is reduced compared to the BAU scenario.

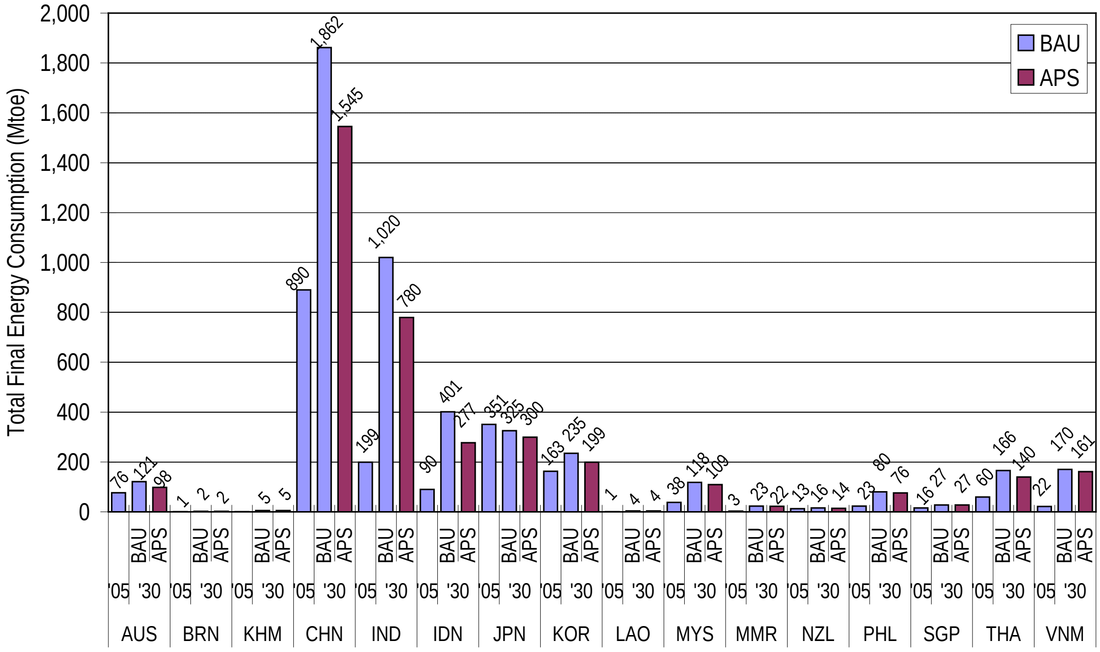
Figure 12. Final Energy Consumption by Fuel



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 (63 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 84 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 80 percent of the growth in energy demand of the entire EAS region between 2005 and 2030. In the APS, 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 76 percent of the growth in energy demand in the EAS region between 2005 and 2030.

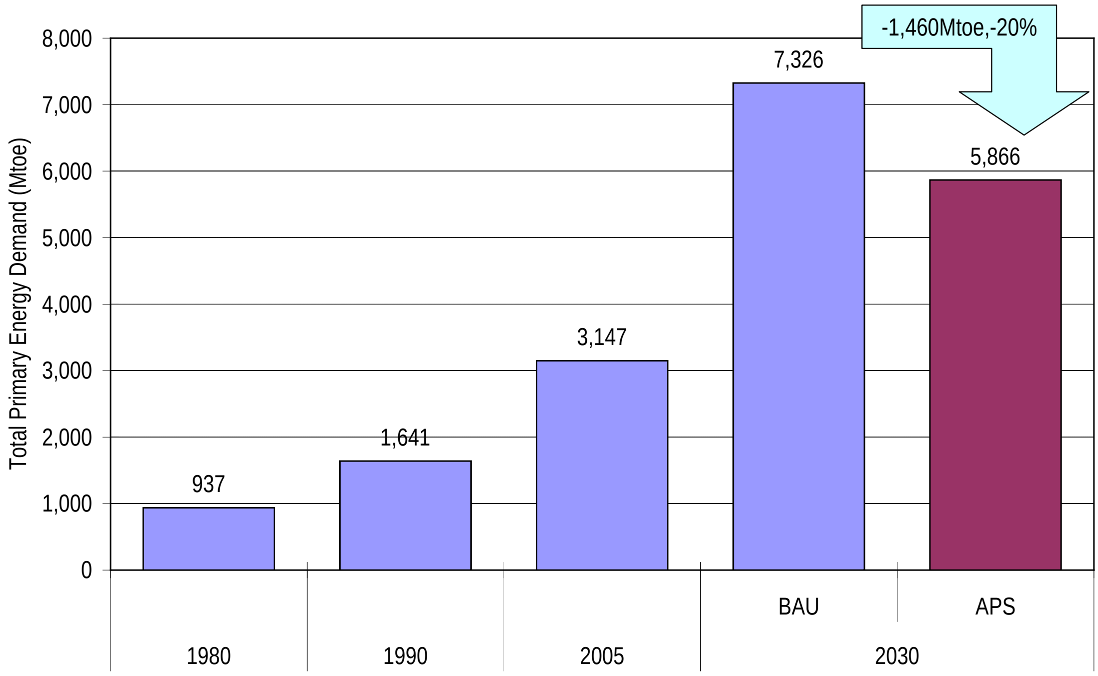
Figure 13. Total Final Energy Consumption by Country



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 3,147 Mtoe in 2005 to 7,326 Mtoe in 2030 in the BAU scenario, an increase on average of 3.4 percent per year. In the APS, demand is projected to grow to 5,866 Mtoe by 2030, 20 percent less than in the BAU scenario. The reduction in 2030 primary energy demand in the APS compared to the BAU scenario of 1,460 Mtoe is roughly equivalent to China's current consumption. The fact that the percentage growth in primary energy demand is less than the growth in final energy consumption in both the BAU and APS primarily reflects improvements in thermal efficiency in electricity generation between 2005 and 2030.

Figure 14. Total Primary Energy Demand

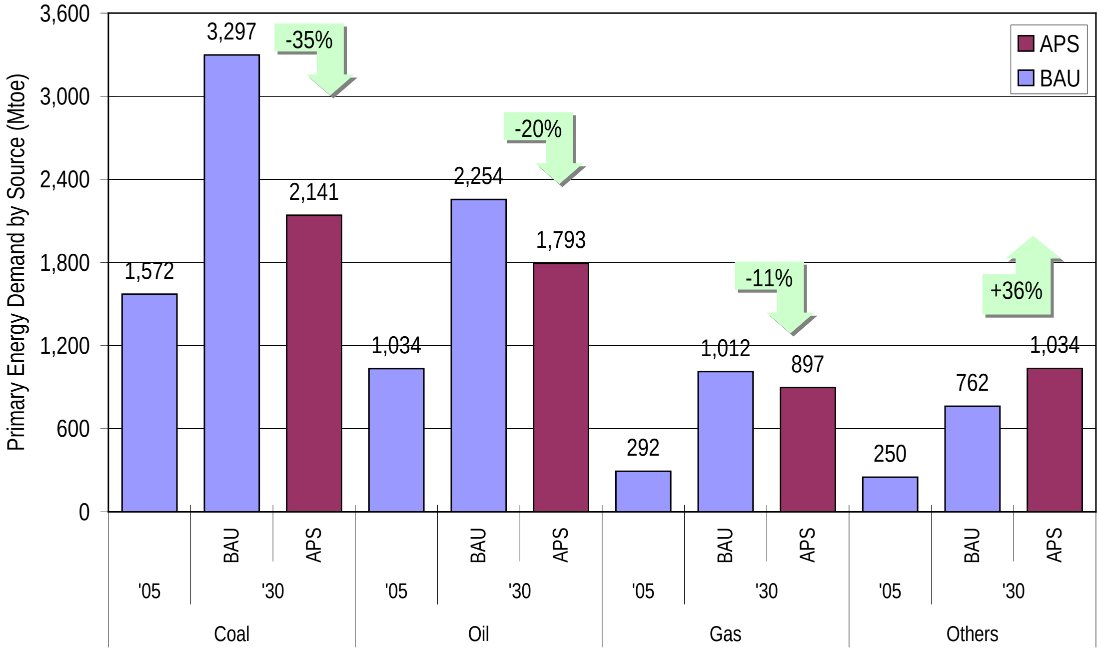


4.1.6. Primary Energy Demand by Source

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 still be the largest in 2030. Coal is also projected to have the largest growth over this period in the BAU scenario as measured in Mtoe (1,725 Mtoe), but not in terms of the growth rate (up 3.0 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 (1,220 Mtoe), and a faster growth rate (up 3.2 per cent per year on average). This growth is mainly due to rising automobile ownership and transport demand. The highest growth rate is projected to be in natural gas, up 5.1 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 3.7 percent per year on average), but is still projected to account for only about 5 percent of EAS region primary energy in the year 2030.

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

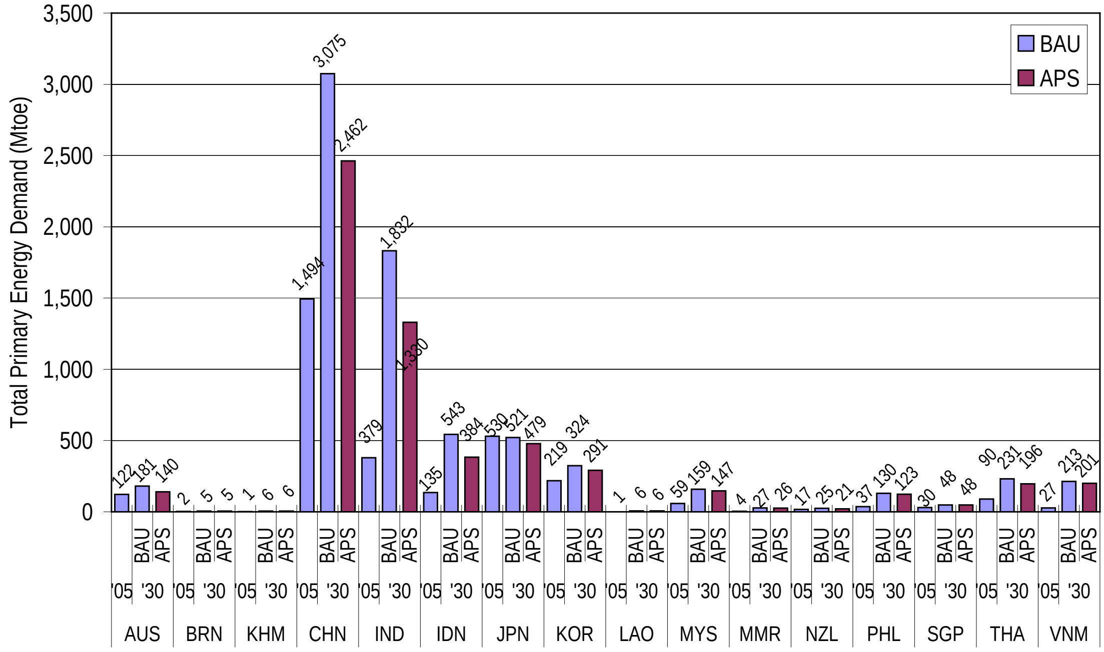
Figure 15. Primary Energy Demand by Source



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 Figure 13. Five countries - China, India, Indonesia, Japan, and the Republic of Korea - are projected to account for 86 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 82 percent of the growth over the period from 2005 to 2030. In the APS, growth in primary energy demand in most countries is significantly reduced, relative to the BAU scenario, but the pattern of dominance of demand by five countries and of growth by three countries remains the same.

Figure 16. Primary Energy Demand by Country



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	-22.3	-40.0
Brunei Darussalam	504	318	297	-6.5	-36.9	-41.1
Cambodia	225	164	164	0	-27.1	-27.1
China	790	356	285	-19.9	-54.9	-63.9
India	579	418	307	-27.4	-27.8	-47.0
Indonesia	650	564	400	-28.9	-13.2	-38.5
Japan	106	81	74	-8.1	-23.6	-30.2
Korea	342	223	179	-19.6	-34.8	-47.7
Lao PDR	245	409	408	-0.2	66.9	66.5
Malaysia	521	443	411	-7.2	-15.0	-21.1
Myanmar	323	196	186	-2.5	-39.3	-42.4
New Zealand	271	225	197	-12.7	-17.0	-27.3
Philippines	392	311	295	-5.1	-20.7	-24.7
Singapore	268	172	172	0	-35.8	-35.8
Thailand	573	482	403	-16.4	-15.9	-29.7
Viet Nam	609	649	611	-5.9	6.6	0.3
Total	333	292	233	-20.4	-12.3	-30.0

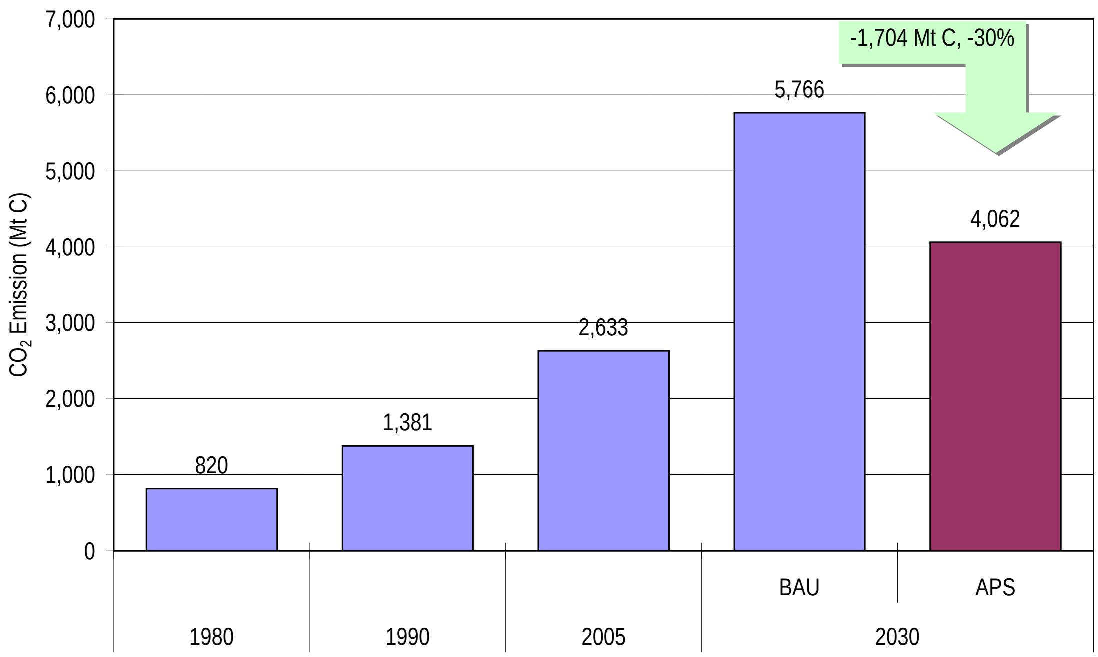
4.2. Carbon Dioxide (CO_2) Emissions from Energy Consumption

4.2.1. CO_2 Emission Results

As shown in Figure 17, CO_2 emissions from energy consumption in the BAU scenario are projected to increase from 2,633 million tonnes of carbon (Mt C) in 2005 to 5,766 Mt C in 2030, implying an average annual growth rate of 3.2 percent. This is slightly lower than the growth in total primary energy demand of 3.4 percent per year indicating regional improvement in emissions intensity. In the APS, CO_2 emissions are projected to be 4,062 Mt C in 2030, 30 percent lower than under the BAU scenario.

While the emission reductions under the APS are significant, CO_2 emissions from energy consumption in the APS 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) 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 in the 2000-2015 time period 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. Even to keep temperature rises in the 3^{o}C range, CO_2 emissions would need to peak in the 2010-2030 time period and be 70 to 105 percent of year 2000 levels by 2050.[17]

Figure 17. Total CO_2 Emissions



Although much depends upon the mitigation that is possible at later dates, and on the response of other regions, it would appear unlikely that global emissions could meet either of these profiles given the contribution of the EAS region to global emissions under the APS results. Yet the consequences of insufficient reductions in emissions could be severe. For example at 2^{o}C compared to 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^{o}C,

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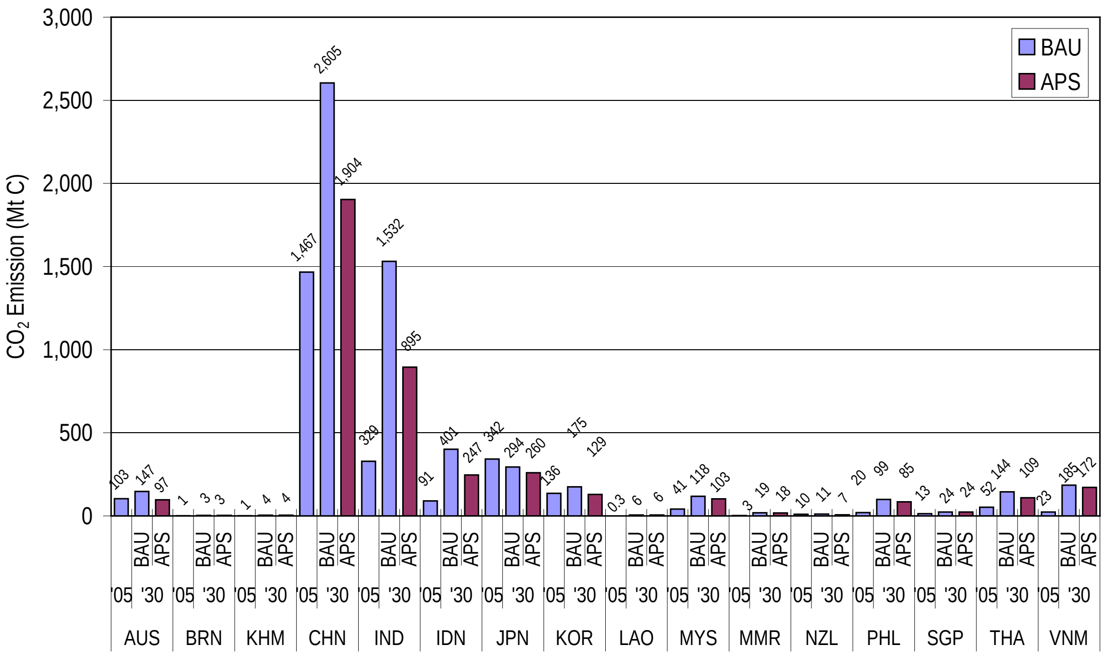
[17] See "Summary for Policymakers" in *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Table SPM.5.

millions of people could experience coastal flooding each year.[18]

As shown in Figure 18, emissions and emissions growth in the EAS region is projected to be dominated by China and India. In fact, China and India will account for 1,138 Mt C and 1,203 Mt C respectively of the projected 3,129 Mt C increase in EAS region emissions from 2005 to 2030 under the BAU scenario, or 75 percent of the total growth in the EAS region. Adding in Indonesia's growth of 307 Mt C, these three countries account for 4,535 Mt C or 85 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 scenario probably as a result of a decrease in population, improvements in energy efficiency and an increased share of lower emission fuels.

Figure 18. CO_2 Emissions by Country



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[18] 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^{o} C of temperature increase has already occurred, as per this same report, Figure SPM.1.

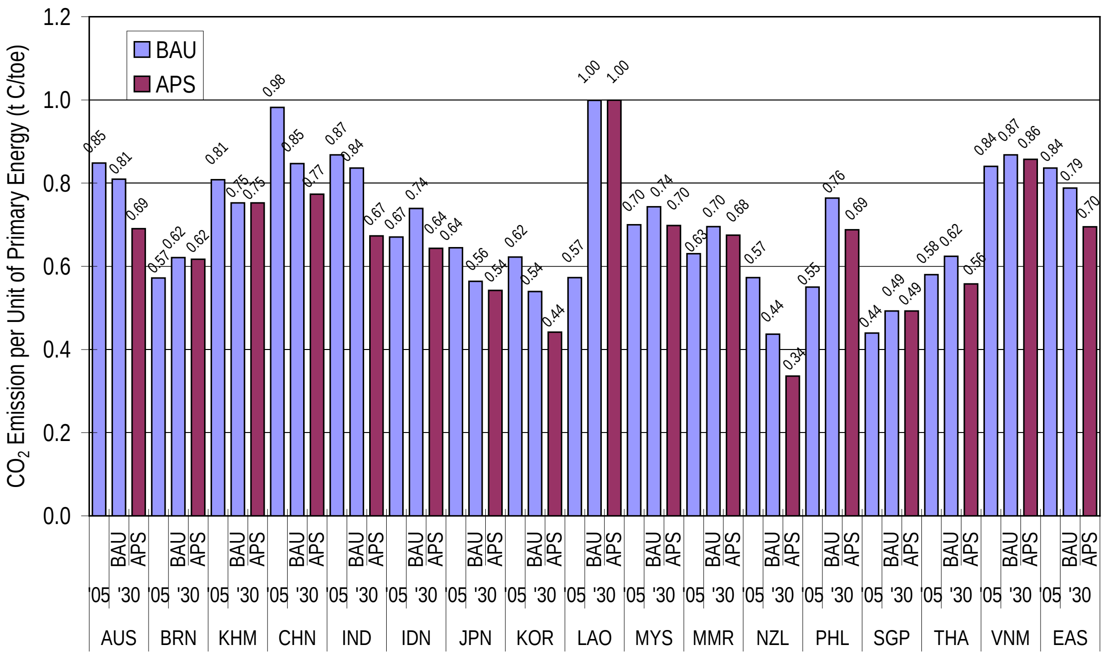
Under the APS, China and India are still dominant, accounting for 437 and 566 Mt C respectively of the projected 1439 Mt C growth in EAS region emissions from 2005 to 2030, or 70 percent. Adding in 166 Mt C from Indonesia accounts for 1169 Mt C or 81 percent of the EAS region total. No other country will account for more than 100 Mt C. Emissions from Australia, Japan, Republic of Korea, and New Zealand are expected to decline under the APS relative to 2005 levels.

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 a chain 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.

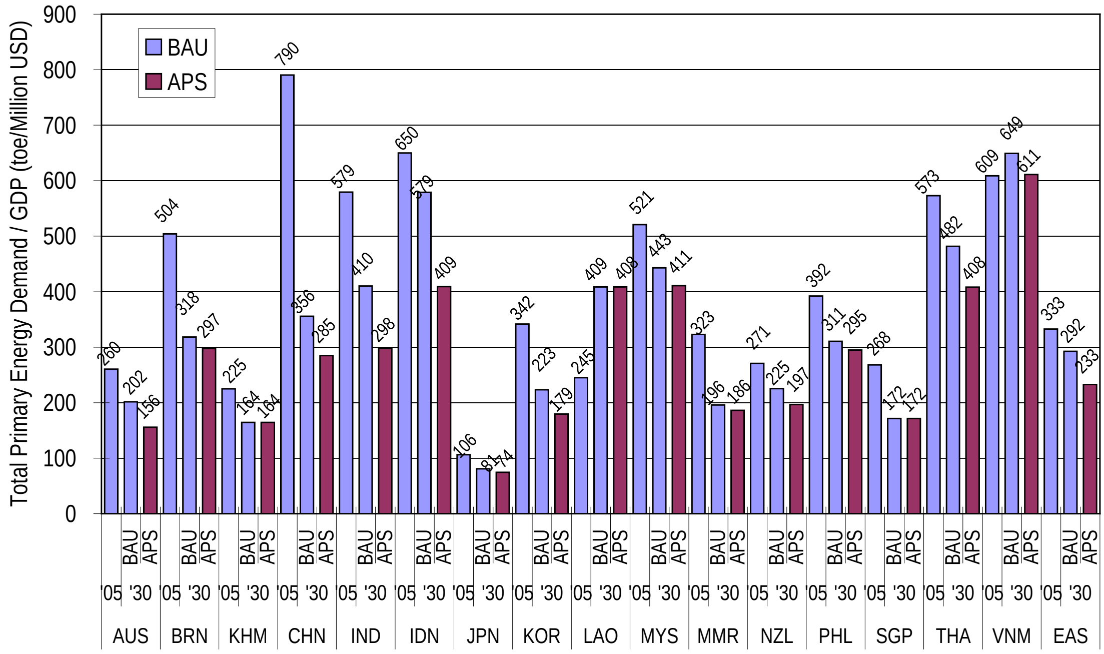
i) Emissions per unit of primary energy are projected to decline modestly from 0.84 t C/toe in 2005 to 0.79 t C/toe in 2030 under the BAU scenario, or by 6 percent. Under the APS, the decline is larger: to 0.70 t C/toe in 2030, or by 13 percent (Figure 19). The reduction under the APS reflects a shift away from coal and oil, the two most emission-intensive fuels.

Figure 19. CO_2 Emissions per Unit of Primary Energy



ii) Primary energy per unit of GDP is projected to decline modestly from 333 toe/million US$ in 2005 to 292 toe/million US$ in 2030 under the BAU scenario, or by 14 percent (Figure 20). Under the APS, the decline is larger, to 233 toe/million US$ in 2030, or by 20 percent. The reduction under the APS reflects projected improvements in energy efficiency. Looking at (i) and (ii) in combination, emissions per unit of GDP decline from 278 t C/million US$ in 2005 to 230 t C/million US$ in 2030 under the BAU scenario, or by 17 percent. Under the APS, the decline is larger, to 162 t C/million US$ in 2030, 42 percent lower than 2005 (Figure 21).

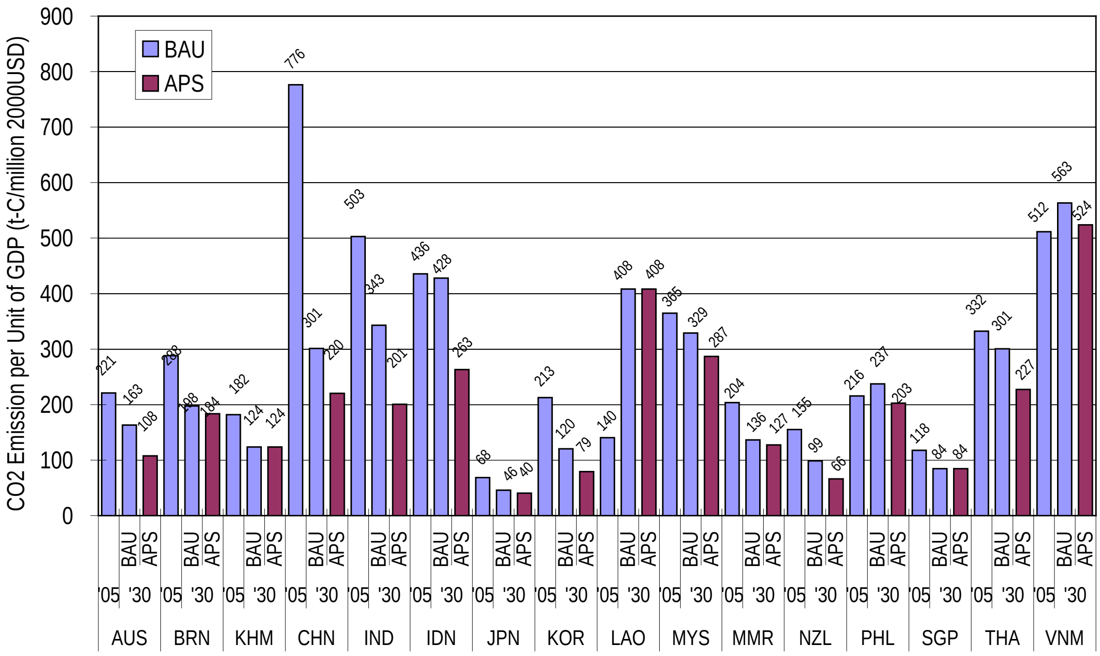
Figure 20. Primary Energy Demand per Unit of GDP



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$/person in 2005 to 6,500 US$/person in 2030, an increase of 167 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 0.84 t C/person in 2005 to 1.51 t C/person in 2030 under the BAU scenario, or by 74 percent. Under the APS, emissions rise to only 1.07 t C/person in 2030, or 26 percent higher than 2005. However, the rising emission per capita is associated with increases in

GDP/person and improvements in living standards.

Figure 21. CO2 Emission per Unit of GDP (t C/million 2000 USD)



iv) Finally, population in the EAS region is expected to grow from 3,152 million in 2005 to 3,819 million in 2030, or by 21 percent. Combined, all these drivers lead to growth in emissions from 2633 Mt C in 2005 to 5762 Mt C in 2030 under the BAU scenario, or 118 percent. Under the APS, emissions grow to 4071 Mt C in 2030, or 55 percent.

5. ADDITIONAL RESEARCH ACTIVITIES

In 2008/2009 additional analysis was undertaken, relative to the 2007 study. Specifically an illustrative scenario was developed which assessed 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. Furthermore, the WG also explored a range of issues related to the development of energy saving goals, action plans and policies; energy efficiency indicators; and energy management systems. These additional research activities are discussed in this chapter.

5.1. Furthering emission reductions – an illustrative scenario with widespread uptake of low emissions technologies

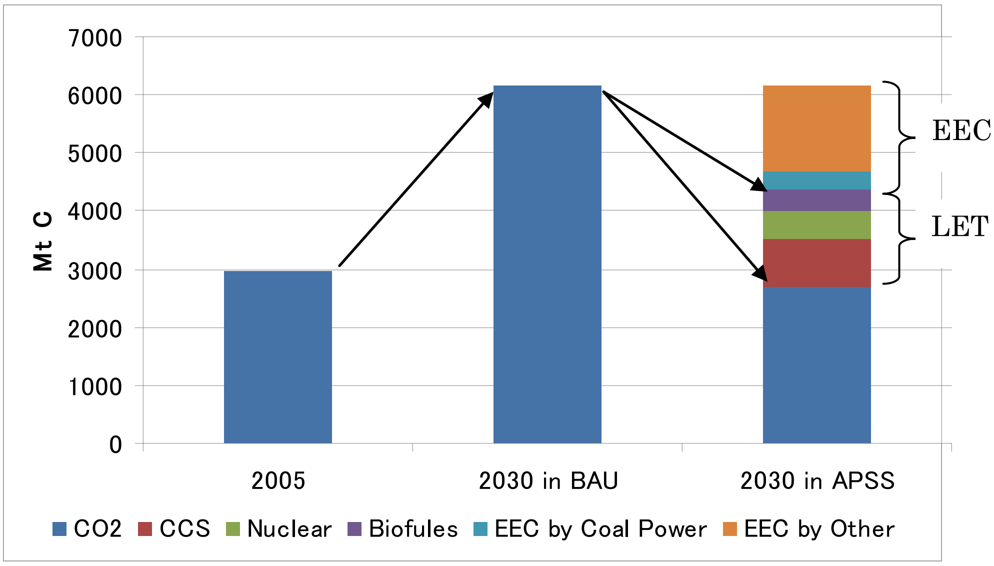
As discussed previously, the widespread implementation of energy saving goals, action plans and policies could contribute to significant reductions in energy consumption in the APS relative to the BAU scenario. Although reductions in greenhouse gas emissions are also achieved, scientific evidence indicates that further reductions in emissions are required to avoid dangerous climate change impacts. Given this, an additional illustrative scenario was examined at the EAS region level to assess the potential impacts of widespread uptake of carbon capture and storage, nuclear and biofuels technologies, or collectively low emission technologies (LET), in addition to the measures already included in the APS. It should be noted that this is an illustrative scenario (as are both the BAU scenario and APS) and as such should not be interpreted as a policy recommendation.

Specifically, in addition to the technologies and measures included in the APS, the following developments at the EAS region level were assumed in 2030:

- *Biofuels:* 85 per cent of gasoline consumption and 30 percent of diesel consumption is replaced by bioethanol and biodiesel;
- *Nuclear power generation:* Coal fired electricity generation is replaced by nuclear power in the electricity sector such that the level of nuclear power is twice that in the APS;
- *Carbon capture and storage (CCS):* CCS is implemented on all coal-fired power plants with a capture efficiency of 85 percent.

If these technologies are implemented at the EAS region level, CO_2 emissions could decline sharply – to below 2005 levels in 2030 (Figure 21). It is clear that LETs can contribute to significant CO_2 emission reductions. However, further research, development and demonstration are required so that they can be technically, socially and economically available in 2030.

Figure 22. Impact of Low Emission Technologies



5.2. Development of Energy Saving Goals, Action Plans and Policies

At the WG meetings, participating members outlined the policy development process in their countries and outlined potential areas for improvements in policy development and implementation in the context of the Cebu declaration. Generally, the following strategies on the promotion of energy efficiency and conservation in the EAS region were suggested:

- EAS countries should develop energy saving goals, action plans and policies;
- EAS countries should implement these energy saving action plans and policies; and
- EAS countries should monitor actual energy savings due to their implementation.

However, it is clear from the energy saving goals, action plans and policies that were reported at the 2nd Energy Ministers Meeting in August 2008 that progress towards achieving this objective varies widely. In addition, countries have chosen to focus on different policy areas reflecting varying priorities and country specific circumstances. Specifically the following issues were discussed:

- *Different targets:* Differences were noted in terms of the specific goal of policy.

For example, some countries specified improvements in energy intensity, absolute levels, energy elasticity or final and primary energy consumption.

- *Sectoral targets:* Many countries have specified goals in the industry sector. However, while many have focused policies, few have specific quantitative goals in transport and residential/commercial sectors.
- *Quantitative goals:* All EAS countries have energy efficiency and conservation policies but few countries have numerical goals.
- *Capacity building:* Many developing countries in the EAS region face challenges in developing energy saving action plans.

5.3. Energy Efficiency Indicators

In order to be able to assess and evaluate the effectiveness of policy measures designed to improve energy efficiency, EAS countries need access to detailed sectoral level energy efficiency data. However, many developing countries in the EAS region do not have appropriate data collection or interpretation facilities. The WG discussed this issue and recommended that:

- All EAS countries should collect end use energy consumption data to monitor the implementation and effectiveness of energy saving goals, action plans and policies;
- All EAS governments should continue their commitment to international activities related to energy efficiency data collection and studies; and
- Regional capacity building is required to develop more extensive and accurate data collection and interpretation facilities in some EAS countries.

5.4 Energy Management Systems

Undertaking energy audits and identifying the potential scope for improving energy efficiency can play a key role in improving energy use across all sectors of the economy. The scope of energy management systems differs across regions. In some countries, large energy users are required to undergo regular energy audits, whereas in other countries this is not required.

The WG discussed energy management systems across the EAS region and recognised the importance of these systems in identifying and driving the uptake of more energy efficient technologies and management practices. The WG recommends that greater uptake and training of energy managers in some countries in the EAS region is required.

6. CONCLUSIONS AND RECOMMENDATIONS

At the 3rd WG meeting, WG 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 socioeconomic factors, energy consumption, and carbon dioxide emissions in the BAU scenario and the APS, WG 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 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 great 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:
    - 20 percent in primary energy demand;
    - 20 percent in energy intensity; and
    - 30 percent in energy derived CO_2 emissions.
4. The share of carbon intensive energy such as oil and coal in the regional energy fuel mix is also reduced which can contribute to improvements in regional energy security.
5. It is recognized that further improvements in the uptake of energy efficient and low emissions technologies beyond those analyzed in this report are possible and

that more significant improvements in energy and emissions intensity are achievable.

6.2. Policy Implications

Following the extraction of the key findings, WG members also identified more than 20 policy implications and aggregated them into five major categories. The identified policy recommendations are based on a shared desire to enhance medium and long term national and regional energy efficiency; implement and monitor energy saving goals, action plans and policies; enhance energy management systems; increase capacity building on energy efficiency data and the evaluation of policies; and increase the development and uptake of lower emissions energy technologies and management practices. The recommendations of the WG 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 policies*
   - There is a strong need for medium and long term energy efficiency and conservation policies in some countries.
2. *Low emissions technologies*
   - Greater research, development, demonstration and transfer of lower emissions technologies are required within the region.
   - Explore the scope for expanding Clean Development Mechanism projects to a broader range of low carbon technologies such as nuclear, carbon capture and storage etc.
3. *Implementation and monitoring of energy saving goals, action plans and policies*
   - Strengthened institutional and regulatory frameworks for developing and implementing energy saving goals, action plans and policies and encouraging the uptake of lower emissions technologies are required.
   - Identify the barriers to the uptake of more energy efficient and lower emissions technologies and implement appropriate policy approaches.
   - Collect, maintain and interpret detailed sectoral end-use energy consumption data to monitor and evaluate the implementation of energy efficiency goals, action plans and policies.

- Governments should continue their commitment to international activities related to energy efficiency data and studies.

4. *Energy management systems*
   - Energy management is important for all sectors and given the rapid growth in energy consumption in the transport sector, there is a need for specific action plans for this sector in some countries.
   - Greater uptake and training of energy managers is required in some EAS countries.
5. *Capacity building and financial support*
   - Regional capacity building is required in data collection, maintenance and interpretation as well as in developing and implementing energy efficiency goals, action plans and policies.
   - Financial support is required in some countries to establish the capacity to develop policies and to incentivize the uptake of more energy efficient and lower emissions technologies and management practices.

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 laws, clean development mechanism projects, energy managers, labelling systems with energy efficiency standards, long term energy efficiency goals or plans, communication campaigns, performance and emission standards, renewable energy targets, 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.

This study indicates that if all of the energy saving and lower emission technology policies proposed at the 2nd Energy Ministers Meeting in August 2008 were implemented in EAS countries, total primary energy demand could be reduced by about 20 per cent in 2030, relative to the business as usual case. Carbon dioxide emissions from energy consumption are also projected to be reduced by about 30 per cent below business as usual levels at 2030. 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.

Although the projected level of energy savings and reductions in CO_2 emissions could be considered significant, it is not enough to mitigate all of the challenges posed by climate change. More aggressive energy saving goals, advanced technologies to reduce CO_2 emissions directly, such as carbon capture and storage technologies, and enhanced uptake of lower emission fuels are recommended. An illustrative scenario that assessed the potential impacts of widespread uptake of carbon capture and storage, nuclear and biofuels technologies across the EAS region, in addition to the measures already included in the APS, indicated that CO_2 emissions could be reduced to less than 2005 levels. However, this result is based on the assumption that these technologies would be technically, socially and economically available in 2030.

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 analysis was outside the scope of this study. It should be assessed in the near future.

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