Chapter 1

Main Report

June 2012

This chapter should be cited as
Working Group for Analysis of Energy Saving Potential in East Asia (2012), 'Main Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2011-18, Jakarta: ERIA, pp.1-70.

CHAPTER 1

Main Report

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 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[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 annually to incorporate more recent information and on member country's energy saving potentials and energy efficiency goals, action plans and policies. The 2011 study was again updated to undertake the following:

- Reflect the energy efficiency goals and actions plans submitted by the energy ministers during the 5th EAS Energy Minister's Meeting (EMM) held in Jerudong, Brunei Darussalam on 20 September 2011 in the latest energy outlook until 2035;
- Conduct phase 2 of the pilot end-use energy consumption survey in the residential sector in recognition of the need for more detailed energy statistics in the estimation of the energy saving potential in the sector as well as determine the seasonality of demand in both urban and rural areas; and

[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.

- Review the impact of the possible change in nuclear policies of EAS countries in the aftermath of the Fukushima nuclear accident.

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.

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]

While some EAS countries have what might be called mature economies, the majority have developing economies. Several countries have a per capita GDP of less than 1000 US$ (in 2000 prices[4]). Countries with mature economies have higher energy

---

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

[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).

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

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.

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. However, as the economies of these countries grow, it should be expected that energy consumption per capita will grow as well. Table 1 shows the geographic, demographic and economic profiles of the 16 EAS countries. Table 2 shows their economic structure and energy consumption profile.

Table 1: Geographic, Demographic, and Economic Profiles, 2009

	Land Area (thousand sq.km.)[1]	Population (million)	Population Density (persons/ sq.km.)	GDP (Billion 2000US$)[2]	GDP per Capita (2000US$/ person)
Australia	7,682	21.95	2.86	535.2	24,382
Brunei Darussalam	5.3	0.39	74.35	6.7	17,092
Cambodia	181	13.98	77.23	7.3	522
China	9,327	1,331.38	142.74	2,940.2	2,208
India	2,973	1,207.74	406.21	866.7	718
Indonesia	1,812	237.41	131.05	258.6	1,089
Japan	365	127.56	349.95	4,814.8	37,746
Korea, Rep.	97	48.75	502.03	752.9	15,445
Lao PDR	231	6.11	26.48	3.2	518
Malaysia	329	27.95	85.07	137.1	4,905
Myanmar	654	47.60	72.84	19.3	406
New Zealand	263	4.32	16.39	62.4	14,459
Philippines	298	91.70	307.55	119.9	1,307
Singapore	0.7	4.99	7,125.14	141.9	28,445
Thailand	511	68.71	134.48	173.9	2,531
Vietnam	310	86.03	277.44	58.8	684

Note: [1] Information on the land area data of Cambodia was provided by the Cambodian government.
[2] GDP data of Myanmar in 2008 and 2009 are estimated based on real GDP growth rate obtained from Asian Development Bank's National Accounts Statistics. GDP of Australia was provided by the Australian WG member.

Source: World Bank (2011) World Databank: http://databank.worldbank.org/ddp/home.do. Washington DC (accessed: August 19, 2011), Government of Australia and Government of Cambodia.

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].

[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)

Table 2: Economic Structure and Energy Consumption, 2009

	GDP (Billion 2000US$)	Share of Industry In GDP, %[1]	Share of Services in GDP, %[1]	Share of Agriculture in GDP, %[1]	Primary Energy Consumption (Mtoe)	Energy Consumption per Capita (toe/person)
Australia	535.2	21.3	76.4	2.4	138.1	6292.1
Brunei Darussalam	6.7	74.1	25.3	0.6	3.1	7965.0
Cambodia	7.3	23.1	41.3	35.7	1.6	114.28
China	2,940.2	46.2	43.4	10.3	2,055.5	1543.9
India	866.7	27.0	55.3	17.8	511.6	423.6
Indonesia	258.6	47.7	37.0	15.3	154.0	648.7
Japan	4,814.8	26.7	71.9	1.4	469.5	3680.7
Korea, Rep.	752.9	36.8	60.4	2.8	226.7	4650.2
Lao PDR	3.2	25.5	39.3	35.2	1.0	158.90
Malaysia	137.1	43.8	46.7	9.5	55.4	1982.2
Myanmar	19.3	24.5	37.4	38.1	6.1	128.40
New Zealand	62.4	24.8	69.5	5.6	17.4	4032.3
Philippines	119.9	31.7	55.2	13.1	40.7	443.5
Singapore	141.9	28.3	71.6	0.0	19.7	3948.6
Thailand	173.9	43.3	45.2	11.5	100.3	1459.9
Vietnam	58.8	40.2	38.8	20.9	39.1	453.9

Note: [1] Sectoral shares to GDP of Brunei Darussalam are 2008 values while those of New Zealand are 2006 values.

Sources: World Bank (2011) World Databank: http://databank.worldbank.org/ddp/home.do. Washington DC (accessed August 19, 2011); International Energy Agency (IEA) (2009) Energy Balances of OECD Countries 2009 and Energy Balances of Non-OECD Countries 2009, Paris.

1.2. 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.

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

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.

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.

1.3. 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.

1.4. Working Group Activities in 2011

In 2011, the WG continued to assess energy saving potentials in the EAS region using the goals, action plans and policies reported at the 5th EAS Energy Ministers Meeting (EAS-EMM5). The WG in 2011 enhanced and extended the analysis that was undertaken from 2007 to 2010. The WG conducted two meetings, one in Lao PDR in August 2011 and one meeting in Beijing in March 2012.

During the first meeting, the WG discussed and developed the 2011 research plan and provided updates on revised energy saving goals, action plans and policies that each EAS country reported in 2011. The research plan included the conduct of phase 2 small survey in the residential sector using a questionnaire and estimation of end-use energy consumption using the results of the small survey. During the meeting the WG redesigned the questionnaire to be used in the small survey and the WG members were asked to survey 10 respondents in the urban areas and 10 respondents in the rural areas in their respective countries.

During the second meeting, the WG members presented the preliminary results of the energy saving potential analysis and submitted the accomplished questionnaires from their respective countries. The questionnaires were processed using a computer program developed by IEEJ and the WG discussed the results. It was noted that the redesigned questionnaire is still not simple and respondents would need the assistance of experts to be able to respond to it. More spaces were also needed in the questionnaire to be able to account for all types of appliances used in the households. The WG members were also asked to revise the questionnaires in view of the apparent overestimation in the consumption of LPG and biomass.

The contents of the research report were also discussed and decided during the second meeting along with the responsibilities of each WG members and IEEJ in the writing of the report.

1.5. Additional Research Studies

In 2011, research studies related to energy efficiency and emission reduction were commissioned by Japan. These are the following:

- Policy recommendations for reducing CO_2 emissions in the road transport sector
- Clean coal technologies

- Promoting climate change finance – leveraging private capital through public-private fund scheme

In addition, the WG on Standardization of Bio-fuels in EAS (Biofuels WG) conducted a demand projection of biofuels in the region. It was suggested that the Biofuels WG use the oil demand projections of the Energy Efficiency WG for consistency on the projections of both WGs.

The meeting also took note of the other studies on energy conducted by ERIA. These are the following:

- Energy Market Integration
- Energy Security Indices

Brief descriptions of these studies are also presented in the latter part of this report.

Phase 2 of the Pilot Residential End-Use Energy Consumption Survey

Recognizing the need to collect more detailed data in the assessment of energy saving potential, the WG decided to conduct a study on appropriate questionnaire for energy consumption surveys in industry, residential and commercial sectors. For the 2010 research study, it was decided to concentrate first on the residential sector by conducting a pilot survey on end-use energy consumption to determine the energy consumption profile of the sector. The results could be used to determine the residential end-use which has the largest energy saving potential. This exercise is considered to give an idea to countries that have not yet charted their energy efficiency plans on how to collect data for the analysis.

For the 2011 research study, the questionnaire was revised to capture seasonal changes in energy demand as well as the differences in energy consumption in the urban and rural areas. The WG members from the ASEAN and China were also requested to conduct the survey for 6 months (September 2011 to February 2012) and were asked to collect at least 10 samples in urban households and 10 samples in rural households.

The following are the revisions made to the questionnaire:

- Power rating: In view of the difficulty in reporting the power rating, the revised questionnaire used a national standard power rating table of each appliance
- Bill of electricity, LPG, Kerosene, Natural gas and coal briquette collected on monthly basis will be used to accurately record the monthly consumption of the fuels
- Detailed questions on electricity will be conducted at least once during the survey but more if possible.

2. Data and Methodology

2.1. Scenarios Examined

The study continued to examine two scenarios, as in the studies conducted annually from 2007 to 2010, 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 the EAS-EMM5 held in September 2011 in Jerudong, Brunei Darussalam or those 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 update 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.

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 does 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 are 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 Australia and Lao PDR. Australian 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 Bank's online World Databank - World Development Indicators (WDI) and Global Development Finance (GDF). 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. However, in 2011, the WG decided to use IEEJ's energy outlook on Korea in view of the non-participation of the country to the study. IEEJ also developed the projections for Brunei Darussalam using the assumptions used in the previous year. The remaining countries provided key assumptions to IEEJ 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 brief descriptions of the energy models in this study are provided.

Australia: Australian projections were developed using the country's E_4cast model, a dynamic partial equilibrium framework that provides a detailed treatment of the Australian energy sector focusing on domestic energy use and supply. The Australian energy system is divided into 24 conversion and end use sector and fuels comprise 19 primary and secondary fuels with all states and territories represented. Energy demand for each fuel is modelled based on econometrically estimated price and income elasticities.

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 forecasted using

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

energy demand equations by energy and sector and future macroeconomic assumptions. For this study, nine member countries used the LEAP model, of which one was developed by IEEJ.

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 2010 Study

From 2007 to 2010, a study was undertaken annually 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 2011 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-EMM5 in Jerudong, Brunei Darussalam. Specifically, the following new information is incorporated in this study:

- revised recent energy saving goals, action plans and policies in each country;
- projected future oil prices;
- results of the phase 2 of the pilot end-use energy consumption survey in the residential sector; and

2.6. Phase 2 of the Pilot Survey on Residential End-Use Energy Consumption

The Phase 2 of the pilot survey started with the redesigning of the questionnaire, conducting of survey, processing of the returned questionnaire and analysis of the results. It was agreed that WG members from ASEAN and China would survey at least 10 urban and 10 rural households in their respective countries to participate in the pilot survey.

2.6.1. Designing the Questionnaire

The questionnaire used in the initial pilot survey carried out in 2010 was revised to address the issue on the difficulty of the respondents in reporting the power rating of various household appliances. The revised questionnaire only requires the manufacturer, model and vintage of each household appliance. The power rating would then be obtained from catalogues of household appliances in each country.

2.6.2. Conducting Pilot Survey

During the first meeting, the WG leader asked the WG members from ASEAN member states and China to proceed with the second pilot survey for at least 10 urban and 10 local households in their respective countries. Initially, the WG leader requested the members to carry out the survey every month for six months (September 2011 to February 2012). However, considering the difficulty of carrying out six monthly surveys, it was decided that only one month will be surveyed but the respondents should also report their energy consumption in the other 5 months.

2.6.3. Processing the Returned Questionnaires

The IEEJ prepared a computer program to process the returned questionnaires. The objective was to get the average consumption of all the respondents per country and determine the most energy consuming end-use. The relationship between household and dwelling size to energy consumption was also analyzed.

3. Socio-economic Indicators and Energy Policies: Assumptions

Growth in energy consumption and greenhouse gas (GHG) 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.

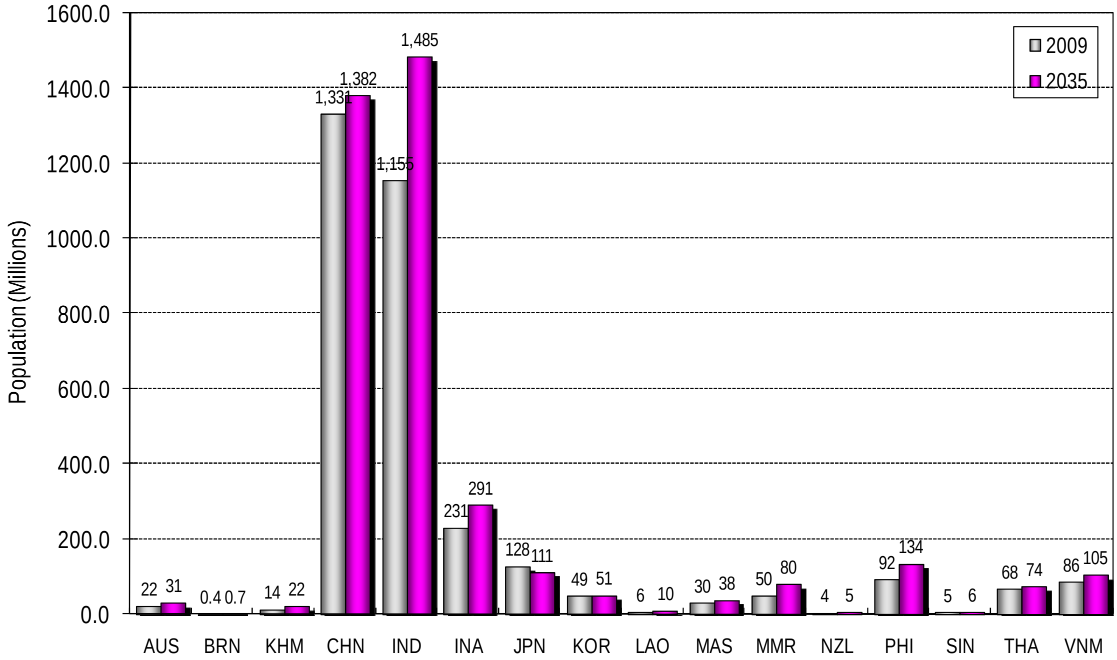
In this section assumptions regarding key socioeconomic indicators and energy policies until 2035 are discussed for the EAS countries.

3.1. Population

In the models used for this study, changes in population to 2035 are set exogenously. It is assumed to be no difference in population between the BAU scenario and APS. Assumed changes in population were submitted by the EAS countries except China where the population projections from the United Nations were used.

In 2009, the total population in the EAS region was about 3.3 billion – around 48.5 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 0.6 per cent reaching about 3.83 billion in 2035. Figure 1 shows the 2009 and projected 2035 population by country.

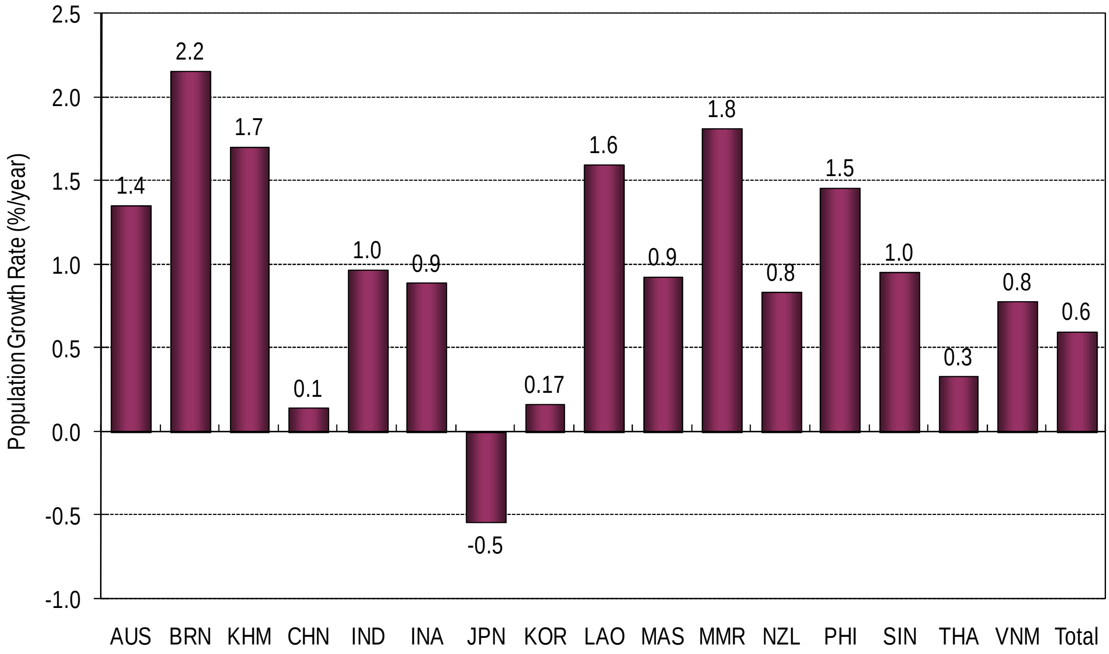
Figure 1: Assumed Population in the EAS Region, 2009 and 2035



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 2035, India and China are assumed to account for about 75 percent 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, 2009 to 2035



3.2. Economic Activity

In the models used for this study, assumed changes in economic output to 2035 are set exogenously. GDP data (in 2000 US$) were obtained from the World Bank.[8] Assumed GDP growth rates to 2035 were submitted by all the EAS countries. In general these assumptions took into account the actual GDP growth rates from 2005 to 2011 which are already reflective of the economic recession in the United States and other countries in the world and the recovery experienced in 2010. No difference in growth rates was assumed between the BAU and APS scenarios.

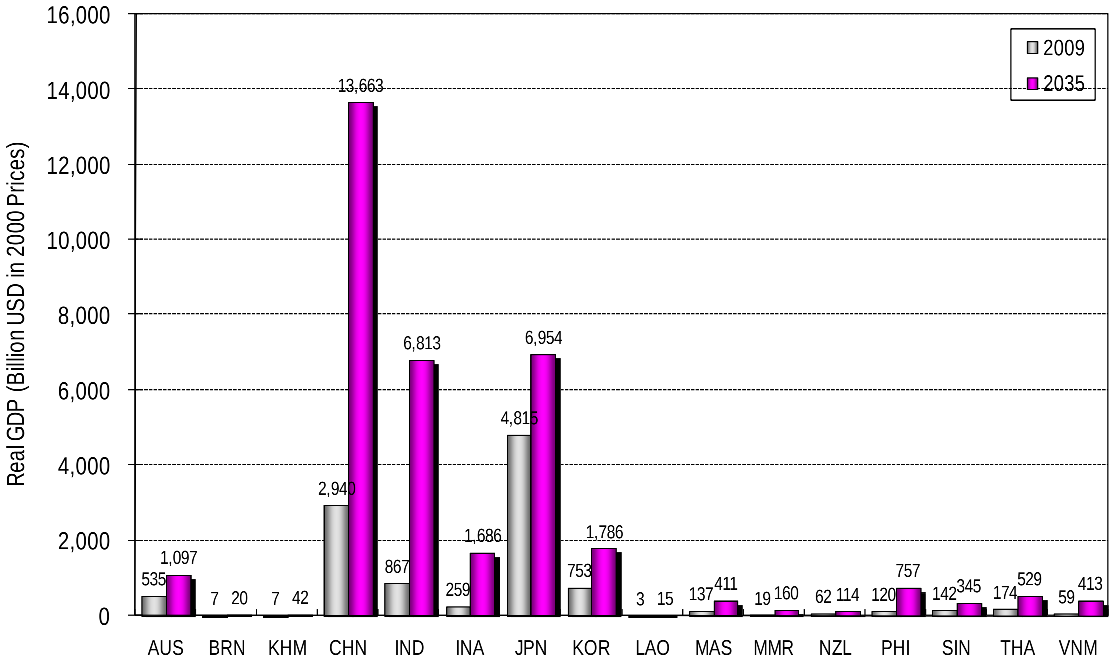
In 2009 total GDP in the EAS region was about 10.9 trillion in 2000 US$ and it accounted for about 27 percent of global GDP. The GDP of the EAS region is assumed to grow at an average annual rate of about 4.6 percent from 2009 to 2035. This implies that by 2035 total GDP in the EAS region will reach about 35.0 trillion in 2000 US$.

In 2009, Japan was the largest economy by far in terms of total economic output: about 4.8 trillion 2000 US$. However, by 2035, China is projected to be the largest

[8] World Bank 2011. *World Databank - World Development Indicators (WDI) and Global Development Finance (GDF).* http://databank.worldbank.org/ddp/home.do (accessed: August 18, 2011).

economy with an estimated GDP of about 13.7 trillion 2000 US$. Japan and India are projected to be the next largest economies with projected GDPs of about 6.9 trillion 2000 US$ and 6.8 trillion 2000 US$ respectively in 2035. See Figure 3.

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 Cambodia, China, India, Indonesia, Lao PDR, Myanmar, Philippines and Viet Nam. 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, 2009 to 2035

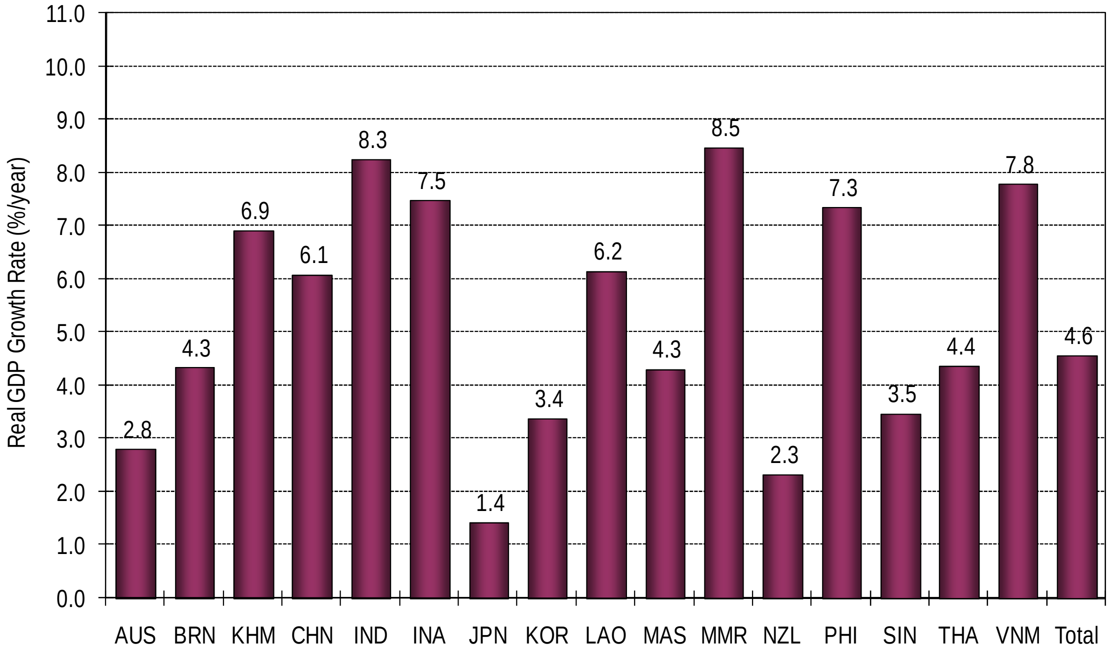
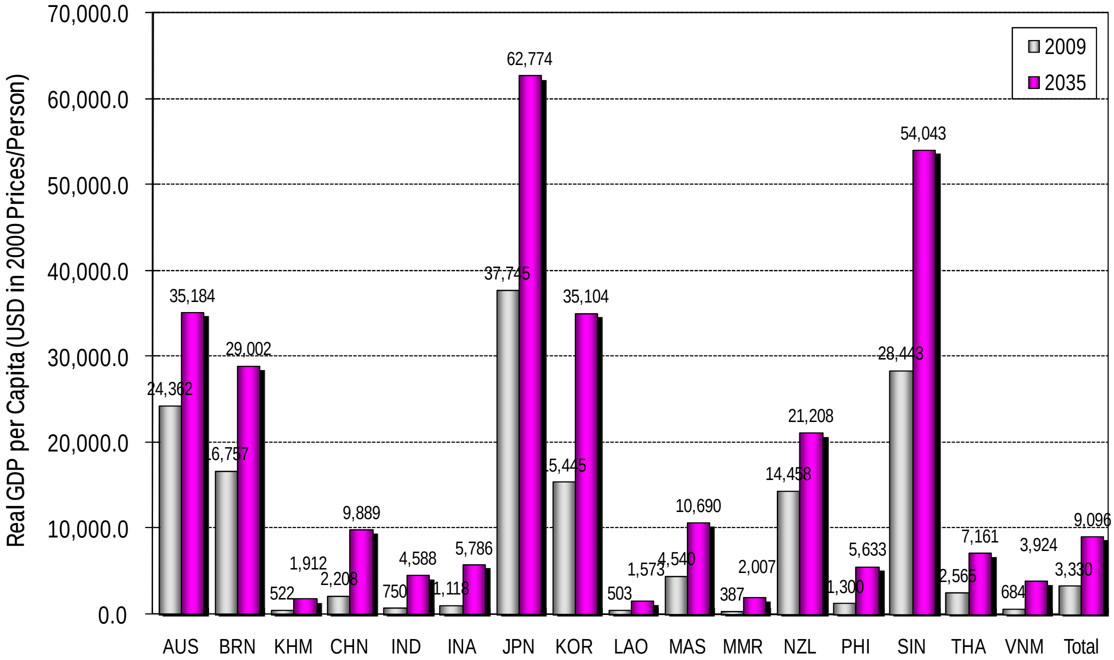


Figure 5: Real GDP per Capita, 2009 to 2035



Average GDP per capita in the EAS region is assumed to increase from about US$3300 in 2009 to about US$9100 in 2035. However, as shown in Figure 5, there is, and will continue to be, significant differences in GDP per capita. In 2009, per capita

GDP ranged from about US$400 in Myanmat to about US$38,000 in Japan. In 2035, per capita GDP is assumed to range from about US$1600 in Laos to about US$63,600 in Japan.

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 2035 the number of road vehicles in China and India is projected to increase to about 264 million and 158 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 among countries.

3.4. Electricity Generation

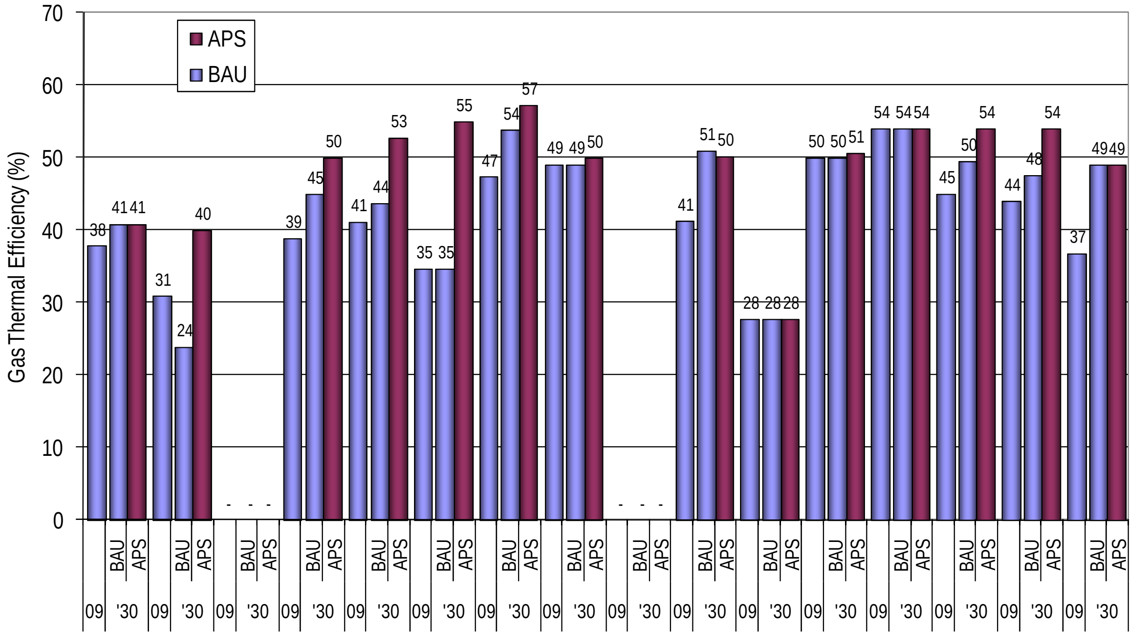
3.4.1. Electricity Generation Thermal Efficiency

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 2009 thermal efficiencies by fuel type (coal, gas, and oil) were derived from International Energy Agency data[9]. Thermal efficiencies by fuel (coal, gas, and oil) were projected by the following countries: Australia, Indonesia,

[9] IEA (2011) *Energy Balances of OECD Countries 2011 and Energy Balances of Non-OECD Countries 2010*. Paris.

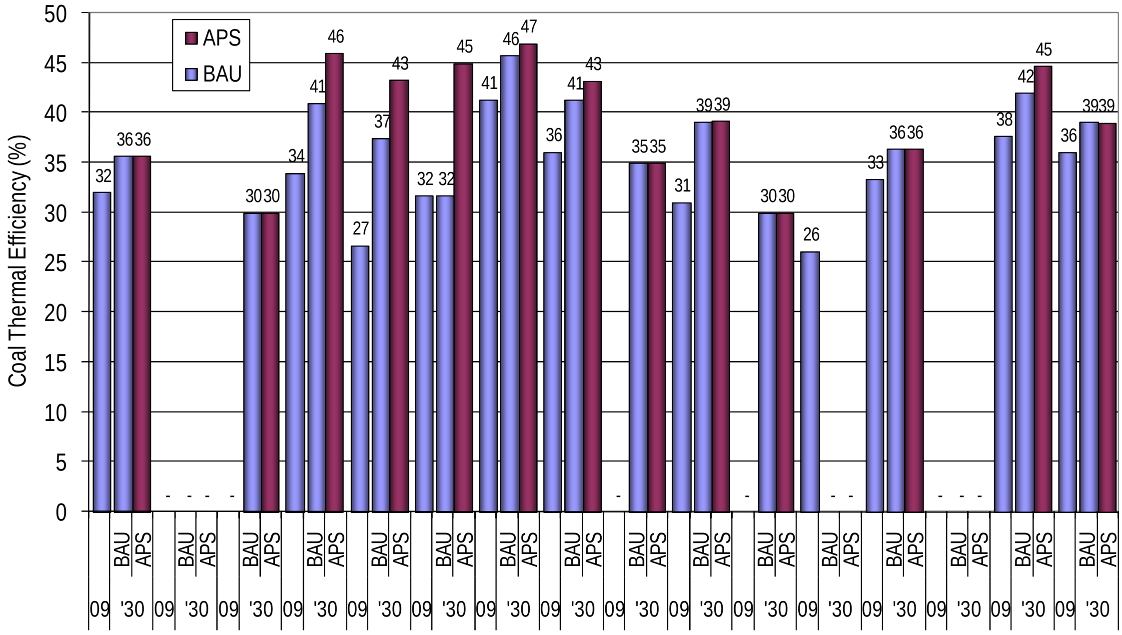
Japan, Korea, Malaysia, New Zealand, Philippines, Thailand and Vietnam, and growth rates in thermal efficiency were derived from these projections. For the remaining countries, assumptions about the potential changes in thermal efficiency were based on IEEJ *Asia/World Energy Outlook 2010.*

Figure 6: Thermal Efficiencies of Gas Electricity Generation



Thermal efficiencies may differ significantly between countries due to differences in technological availability, age and cost of technology, 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 become available. In many countries, there are also assumed to be additional improvements in the APS. See Figure 6 and Figure 7.

Figure 7: Thermal Efficiencies of Coal Electricity Generation

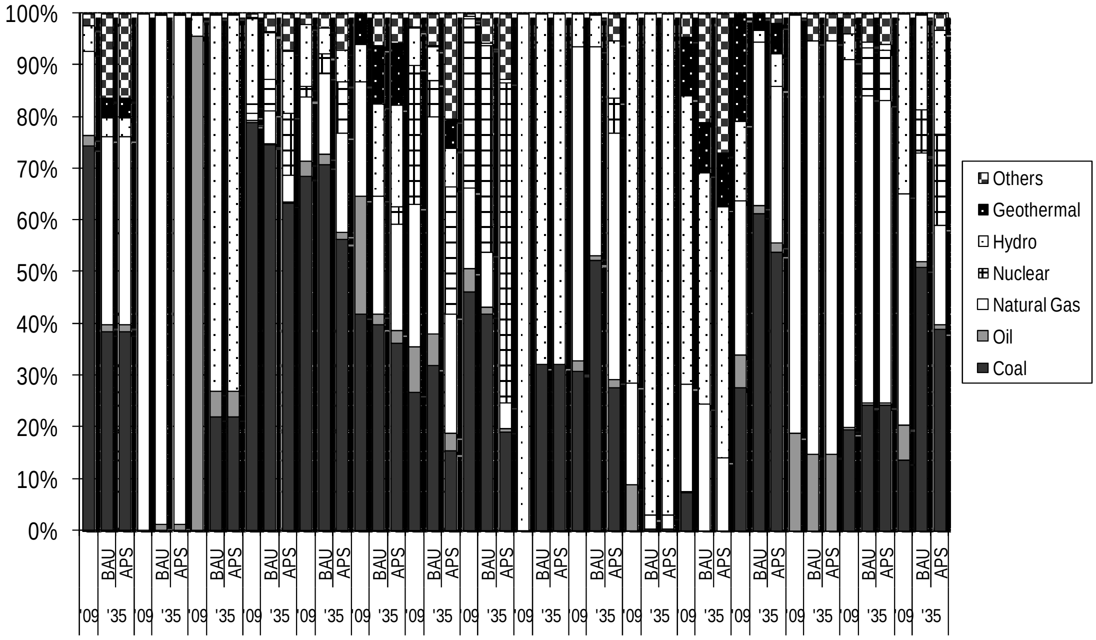


3.4.1 Electricity Generation Fuel Mix

The combination of fuels used in electricity generation differs among 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 64.9 percent in the BAU scenario to about 51.8 percent in the APS by 2035 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.

3.4.2 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 the developing countries reported on initiatives to significantly expand access to electricity in their countries by 2035. 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.

3.5. Use of Biofuels

The WG members from each country were asked to include 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 the IEEJ *Asia/ World Energy Outlook 2011*. Table 3 summarises the assumptions regarding use of biofuels.

Table 3: Assumptions on Biofuels – Summary by Country

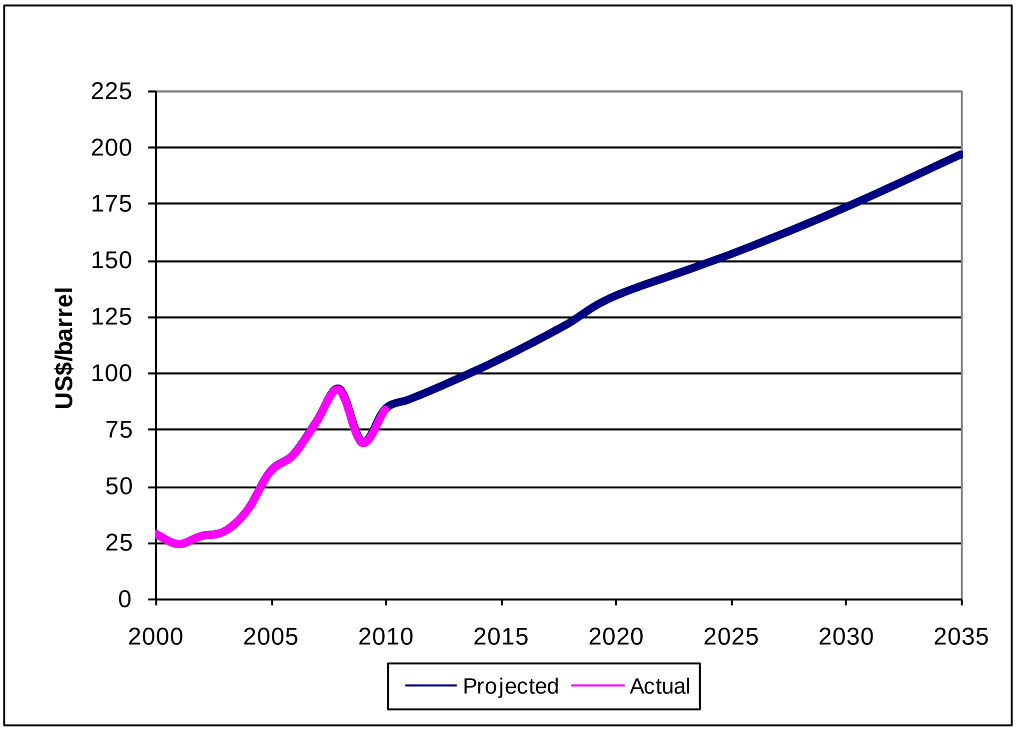
Country	Period	Assumptions
Australia	2010	No targets on biofuels.
Brunei Darussalam		No targets on biofuels.
Cambodia	2030	10% of road transport diesel and 20% of road transport motor gasoline will be displaced by biodiesel and bioethanol, respectively
China	2030	BAU: 20 billion liters, APS 60 billion liters
India	2017	20% blending of biofuels, both for bio-diesel and bio-ethanol.
Indonesia	2025	Bioethanol: 15% blend from 3-7% in 2010 Bio-diesel: 20% blend from 1-5% in 2010
Japan	2005-2030	No biofuel targets submitted.
Republic of Korea	2012	Replace 1.4% of diesel with biodiesel.
	2020	Replace 6.7% of diesel with biodiesel.
	2030	Replace 11.4% of diesel with biodiesel.
Lao PDR	2030	Utilize bio-fuels equivalent to 10% of road transport fuels
Malaysia	2030	Replace 5% of diesel in road transport with biodiesel
Myanmar	2020	Replace 8% of transport diesel with biodiesel.
New Zealand	2012-2030	Mandatory biofuels sales obligation of 3.4% by 2012.
Philippines	2025-2035	BAU: The Biofuels Law requires 10% bio-ethanol/gasoline blend and 2% biodiesel/diesel blend 2 years from enactment of the law (roughly 2009). APS: Displace 20% of diesel and gasoline with biofuels by 2025
Thailand		Biofuels to displace 12.2% of transport energy demand
Vietnam	2020	10% ethanol blend in gasoline for road transport

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 2035.

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 (current USD), is assumed to increase from about US$83.84 a barrel in 2010 to US$196.87 a barrel in 2035 (Figure 9). This projection is similar to the trend of the oil price assumption in Asia/World Energy Outlook 2011 of the Institute of Energy Economics, Japan.

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	• Energy efficiency improvement is assumed to be 0.5% per year over the projection period for most fuels in non energy-intensive end-use sectors • For energy-intensive industries, improvement is assumed to be 0.2% per year.	
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.	• 1% reduction in BAU final energy consumption • Improvement of natural gas power plant efficiency to 40% from around 25% in the BAU
Cambodia		10% reduction of BAU energy consumption by 2015
China		• 16% energy intensity reduction from 2011 to 2015 40-~45% carbon intensity reduction from 2006 to 2020
India		• 20 to 25% improvement in CO2 Intensity by 2020 raltive to 2005 level

Indonesia		• Reduce energy intensity by 1% per year until 2025
		• Demand reduction relative to BAU by 2050
		  • Industry: 15-20%
		  • Transport: 15%
		  • Residential/commercial: 5-10%
		•

Japan		• 30% improvement in energy intensity in 2030 from 2005 level
Republic of Korea		• Reduce final energy intensity by 46% in 2030 from 2009 level
Lao PDR		• Reduce final energy consumption from BAU level by 10% from 2011-2015

Malaysia	Implementation of current policies by the government to promote energy efficiency in the industry, buildings and domestic sectors.	**1.** Residential Sector
		  • Relamping of incandescent bulbs with CFL
		  • Replacing inefficient refrigerators with 5-star refrigerators
		2. Commercial Sector
		  • Raise air-conditioned space temperature
		  • Relamping of T8 with T5 fluorescent tubes in government buildings
		  • Building energy audit
		3. Industrial
		  • Factory energy audit

Myanmar		Increase energy savings by 5% in APS relative to BAU in 2020 and 8% by 2030
New Zealand	The historical energy efficiency improvement of 0.5-1.0% per year is expected to continue in the BAU	By 2030, energy intensity will fall to just over half of that of 1990 level

Table 4 continued

	BAU scenario	APS
Philippines		To attain energy savings equivalent to 10% of annual final demand relative to BAU through various energy efficiency programs in all sectors of the economy.
Singapore		• Reduce energy intensity by 20% by 2020 and by 35% by 2030 from the 2005 level. • Cap CO2 emissions by 16% from BAU by 2020.
Thailand		• Reduce total final energy consumption by 20% relative to BAU by 2030
Vietnam		• Reduce energy consumption between 5%-8% by 2015 relative to BAU

3.8. Economic Growth and Climate Change Mitigation

Economic growth in the EAS countries is needed to provide for the region's growing population and improving living standards. Economic growth is assumed to exceed population growth in the 2009 to 2035 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.

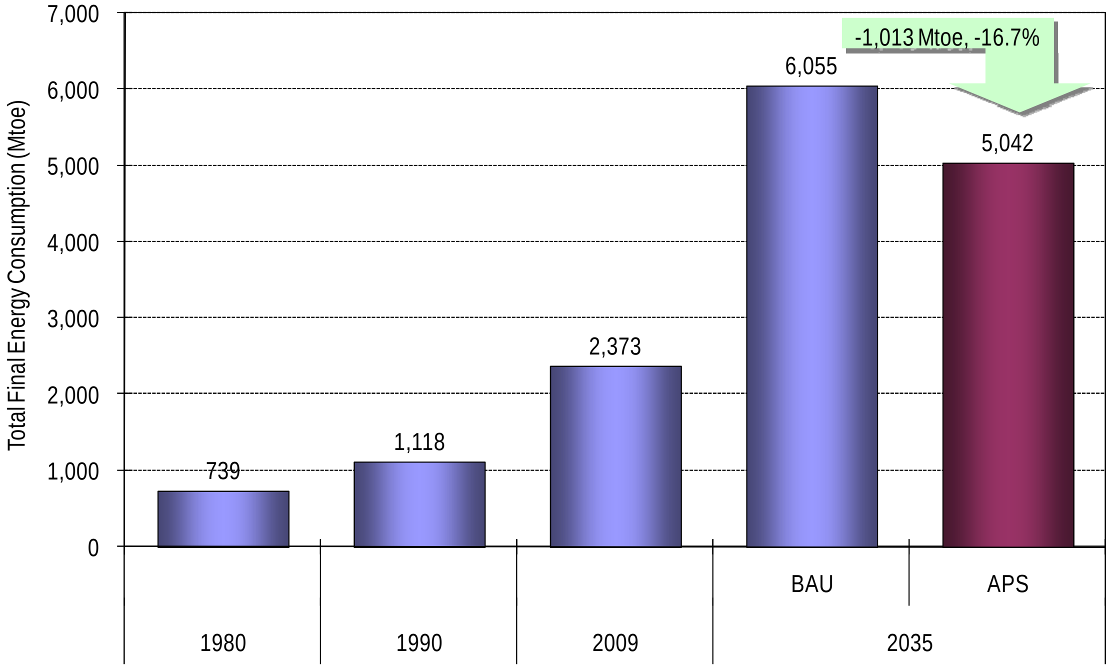
4. Energy And Environmental Outlook for the EAS Region

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 2035. These drivers include a 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 2373 Mtoe in 2009 to 6055 Mtoe in 2035, an increase of 3.7 percent per year on average. In the APS case, final energy consumption is projected to rise to 5042 Mtoe, 16.7 percent lower than in the BAU case in 2035. 'Final energy consumption' refers to energy in the form in which it is actually consumed, that is, including electricity, but not including the sources used to generate electricity.

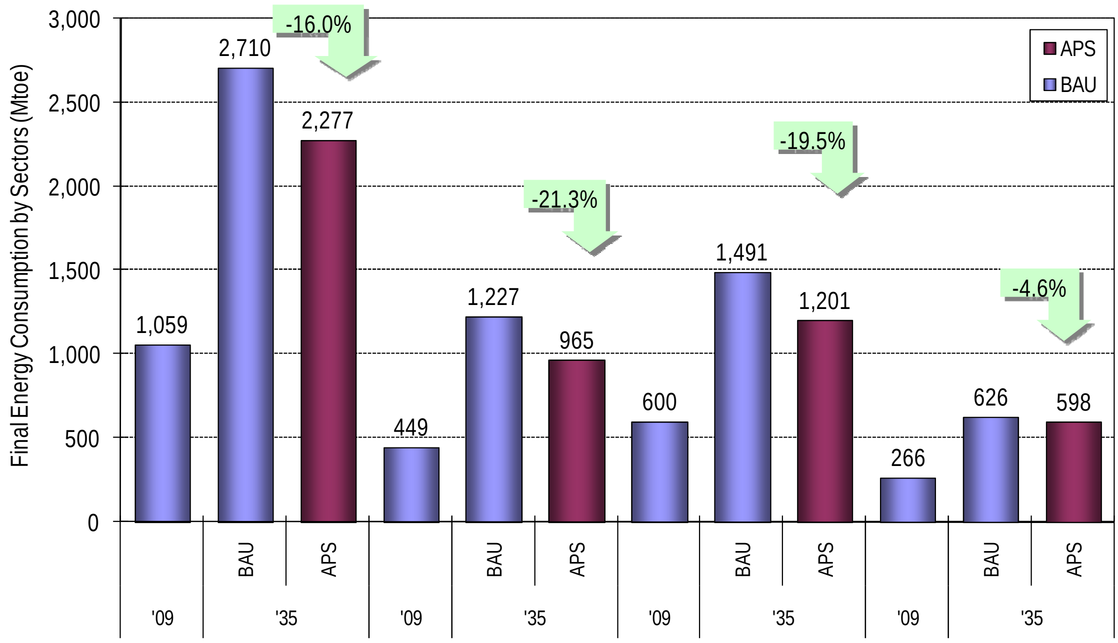
Figure 10: Total Final Energy Consumption



4.1.2. Final Energy Consumption by Sector

Figure 11 shows the composition of final energy consumption by sector. Final energy consumption in all sectors is projected to increase dramatically between 2009 and 2035. Consumption in the industry sector is projected to grow by 3.7 percent a year to 2170 Mtoe in 2035, but its share in final energy will remain unchanged at 45 percent. Transport sector consumption will exhibit the fastest growth at 3.9 percent per year and will form 20.3 percent of the total in 2035, increasing from 18.9 percent in 2009. This trend reflects the expectation of further industrial expansion and motorization in China brought about by 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 case compared with the BAU case. In percentage terms, the reduction is larger in the transport sector than in industry.

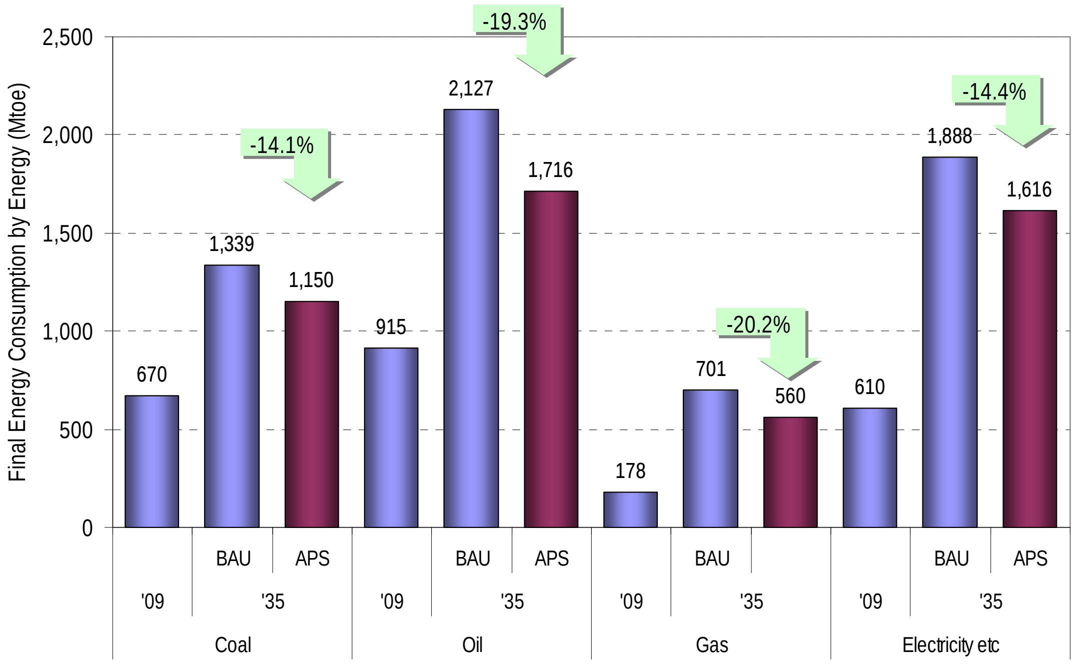
Figure 11: Final Energy Consumption by Sector



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 2009, with more than 38 percent share. This share is projected to decline to around 35 percent in 2035. Oil consumption is projected to increase by 3.3 percent per year on average between 2009 and 2035. Electricity consumption increases even more in percentage terms, with demand growing on average by 4.4 percent per year between 2009 and 2035. However, in absolute terms, electricity consumption will be lower than oil consumption in 2035 under the BAU case. Natural gas is projected to be the fastest growing final energy source, increasing on average by 5.4 percent per year between 2009 and 2035. However, by 2035, it is only expected to account for 12 percent of final energy consumption. Final use of coal is projected to grow on average by 2.7 percent per year. In the APS case, growth in final consumption for all fuels is lower compared with the BAU case.

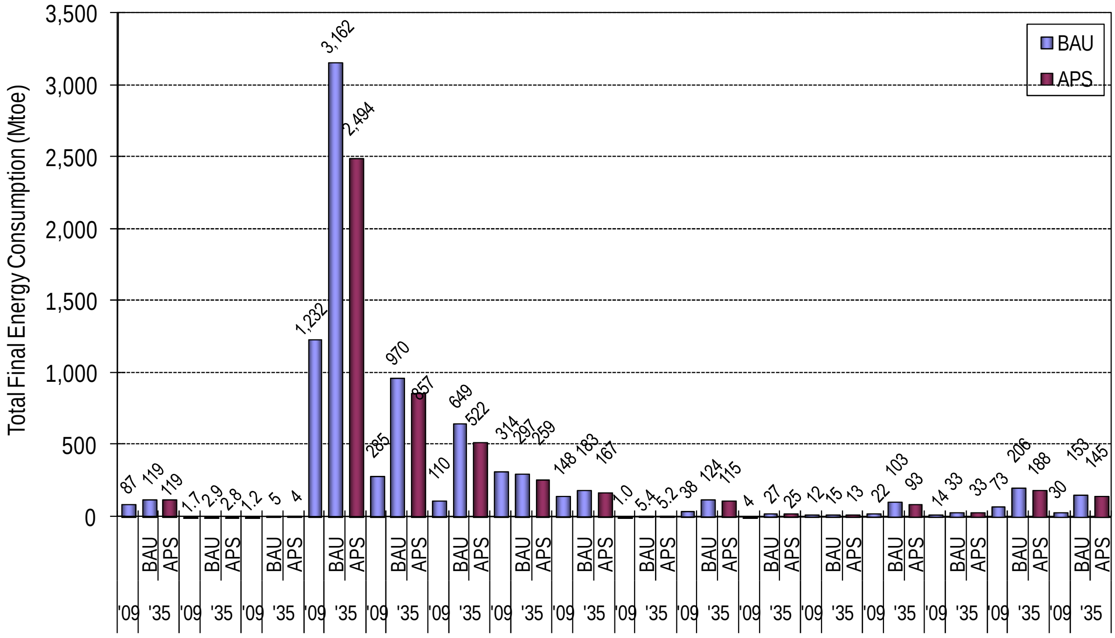
Figure 12: Final Energy Consumption by Fuel



4.1.4. Final Energy Consumption by Country

Figure 13 shows final energy consumption by country. The most striking result is that China is projected to continue to dominate EAS region final energy consumption until 2035. China is projected to account for about 52.2 percent of EAS region final energy consumption in 2035, up from about 51.9 percent in 2009. Just five countries—China, India, Indonesia, Japan, and Republic of Korea—are projected to account for 86.9 percent of EAS region final energy demand in 2035, 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 85.6 percent of the growth in energy demand for the entire EAS region between 2009 and 2035. In the APS case, growth in most countries, including the "big three", is significantly lower relative to the BAU scenario. However, the "big three" are still projected to account for 84.1 percent of the growth in energy demand in the EAS region between 2009 and 2035.

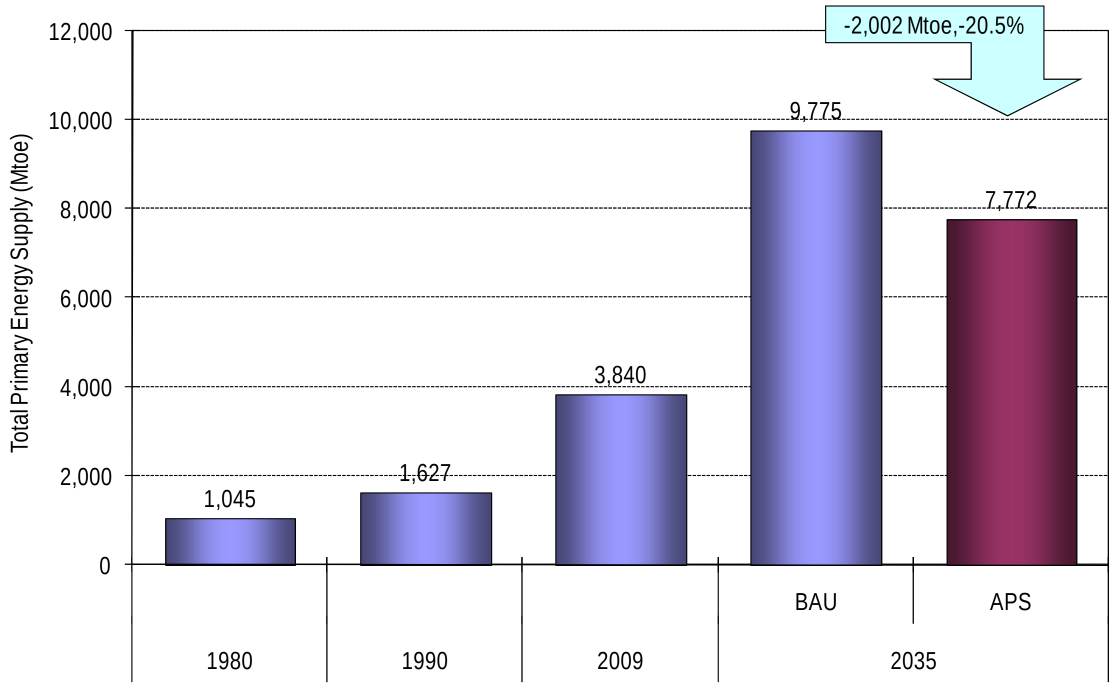
Figure 13: Total Final Energy Consumption by Country



4.1.5. Total Primary Energy Consumption

The pattern followed by primary energy consumption is, as one would expect, similar to final energy consumption. “Primary energy consumption” 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 3840 Mtoe in 2009 to 9775 Mtoe in 2035 in the BAU case, an increase on average of 3.7 percent per year. In the APS case, demand is projected to grow to 7772 Mtoe by 2035, 20.5 percent lower than in the BAU case. The reduction in 2035 primary energy consumption in the APS case compared with the BAU case of 2002 Mtoe is roughly equivalent to China’s consumption in 2009.

Figure 14: Total Primary Energy Consumption

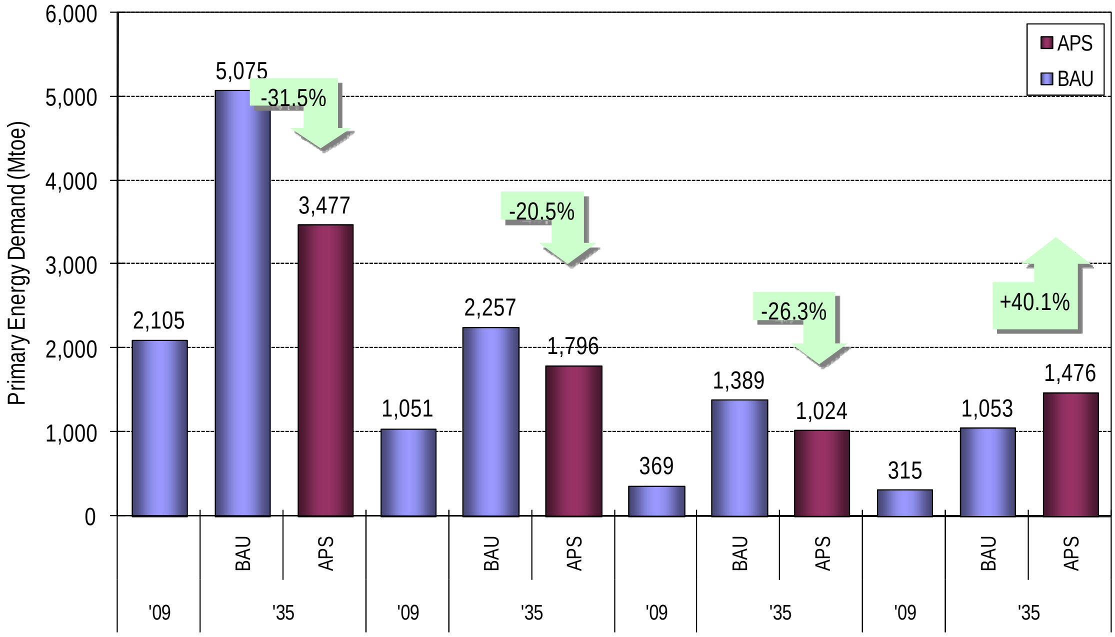


4.1.6. Primary Energy Consumption by Source

Figure 15 shows primary energy consumption by energy source. Coal is currently the largest source of primary energy in the EAS region, and is projected to remain the largest to 2035. Coal is also projected to exhibit the largest increase over this period under the BAU scenario as measured in Mtoe (2971 Mtoe), but not in terms of growth rate (up 3.4 percent per year on average). This growth is mainly the result of increased use of coal for electricity generation. Oil has the next largest growth as measured in Mtoe (1206 Mtoe), but at a relatively slow rate of growth (up 3.0 per cent per year on average). This growth reflects rising automobile ownership and transport demand. Natural gas is projected to grow by 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 (by 3.6 percent per year on average), but still projected to account for only about 3.5 percent of EAS region primary energy in the year 2035. Geothermal energy will also have a fast growth rate of 4.4 percent per year although its share in the total EAS primary energy will remain low at 1.1 percent in 2035.

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

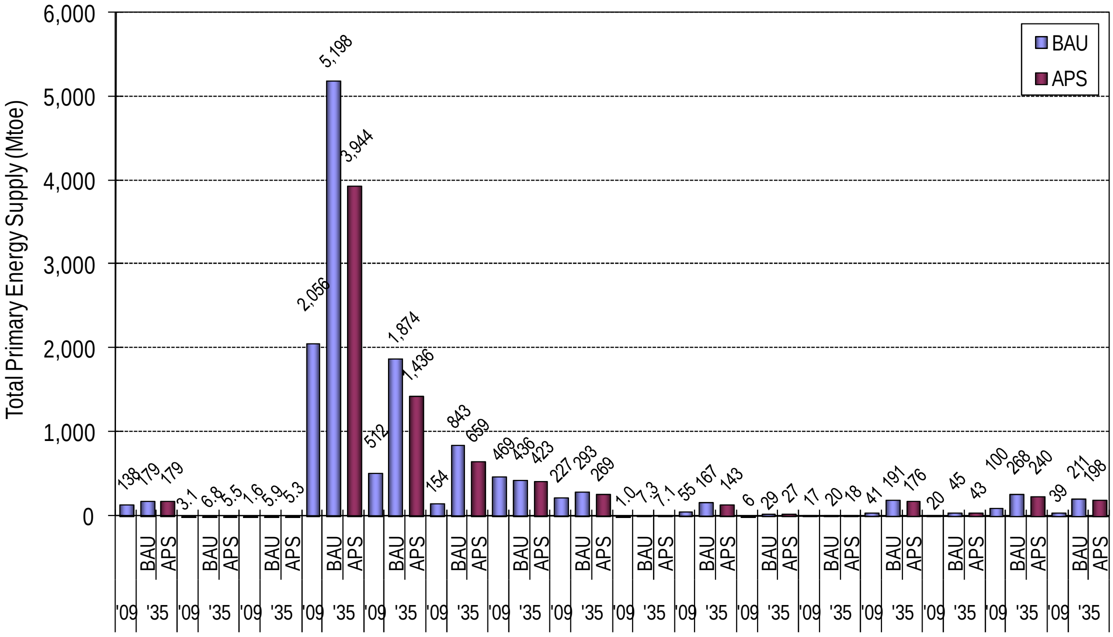
Figure 15: Primary Energy Consumption by Source



4.1.7. Primary Energy Consumption by Country

Figure 16 shows primary energy consumption 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 Republic of Korea - are projected to account for 88.4 percent of EAS region primary energy in 2035. The 'big three' - China, India, and Indonesia - will dominate the growth in EAS region primary energy, accounting for 87.5 percent of the growth between 2009 and 2035. In the APS case, growth in primary energy consumption in most countries is significantly lower, but the dominance of consumption by five countries and the relative importance of the growth in three countries remain unchanged.

Figure 16: Primary Energy Consumption by Country, 2009 and 2035



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 summarized. 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

	2009	2035		Variance		
		BAU	APS	APS/BAU	2009/2035 BAU	2009/2035 APS
	(toe/million US$)	(toe/million US$)	(toe/million US$)	%	%	%
Australia	258	163	163	0.0	-36.9	-36.9
Brunei Darussalam	466	337	272	-19.1	-27.7	-41.5
Cambodia	219	141	128	-9.6	-35.5	-41.7
China	699	380	289	-24.1	-45.6	-58.7
India	590	275	211	-23.3	-53.4	-64.3
Indonesia	596	500	391	-21.9	-16.0	-34.4
Japan	98	63	61	-3.1	-35.7	-37.7
Korea	301	164	151	-8.2	-45.5	-50.0
Lao PDR	307	492	477	-3.0	60.2	55.4
Malaysia	404	408	349	-14.5	0.9	-13.7
Myanmar	316	180	167	-7.1	-43.0	-47.1
New Zealand	279	177	157	-11.2	-36.4	-43.5
Philippines	339	252	232	-8.0	-25.7	-31.6
Singapore	139	130	126	-3.3	-6.5	-9.6
Thailand	577	507	453	-10.6	-12.1	-21.4
Viet Nam	664	512	481	-6.1	-23.0	-27.6
Total	352	281	223	-20.5	-20.3	-36.6

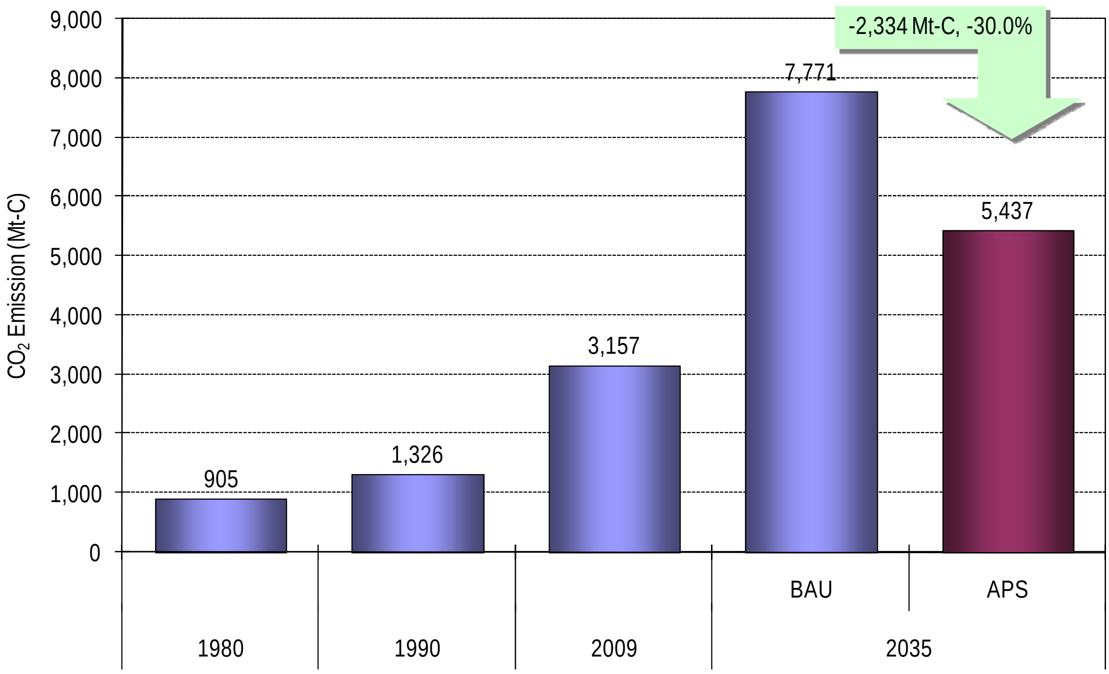
4.2. Carbon Dioxide (CO_2) Emissions from Energy Consumption

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 3157 million tonnes of carbon (Mt-C) in 2009 to 7771 Mt-C in 2035, implying an average annual growth rate of 3.5 percent. This is slightly lower than the growth in total primary energy consumption of 3.7 percent per year. In the APS case, CO_2 emissions are projected to be 5437 Mt-C in 2035, 30.0 percent lower than under the BAU case.

While the emission reductions under the APS are significant, CO_2 emissions from energy consumption under the APS case in 2035 will still be above 2009 levels and far above 1990 levels. Scientific evidence suggests that these reductions will not be adequate to prevent severe climate change impacts. Analysis by the Intergovernmental Panel on Climate Change (IPCC) (reference) suggests that to keep the increase in global mean temperature to not much more than 2^oC compared with 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^oC range, CO_2 emissions would need to peak between 2010 and 2030 and be 70 to 105 percent of year 2000 levels by 2050.[10]

Figure 17: Total CO_2 Emissions



Although much depends 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.[11]

As shown in Figure 18, emissions and emission growth in the EAS region is

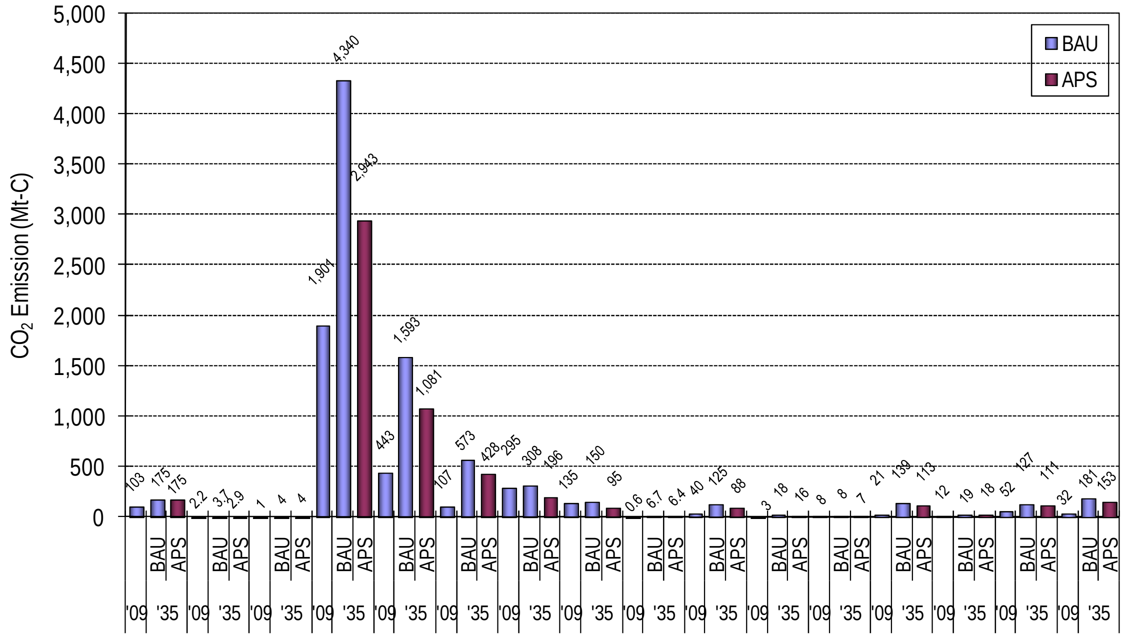
---

[10] 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.

[11] 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.

projected to be dominated by China and India. In fact, China and India will account for 2438 Mt-C and 1150 Mt-C, respectively, of the projected 4614 Mt-C increase in EAS region emissions from 2009 to 2035 under the BAU case, or 77.8 percent of the total growth in the EAS region. Adding Indonesia's growth of 466 Mt-C, these three countries account for 4055 Mt-C or 87.9 percent of the total growth in EAS region. No other country will account for growth of more than 150 Mt-C. New Zealand is the only country in the EAS region whose emissions are projected to decline under the BAU case as a result of improved energy efficiency increased utilisation of renewable energy.

Figure 18: CO_2 Emissions by Country



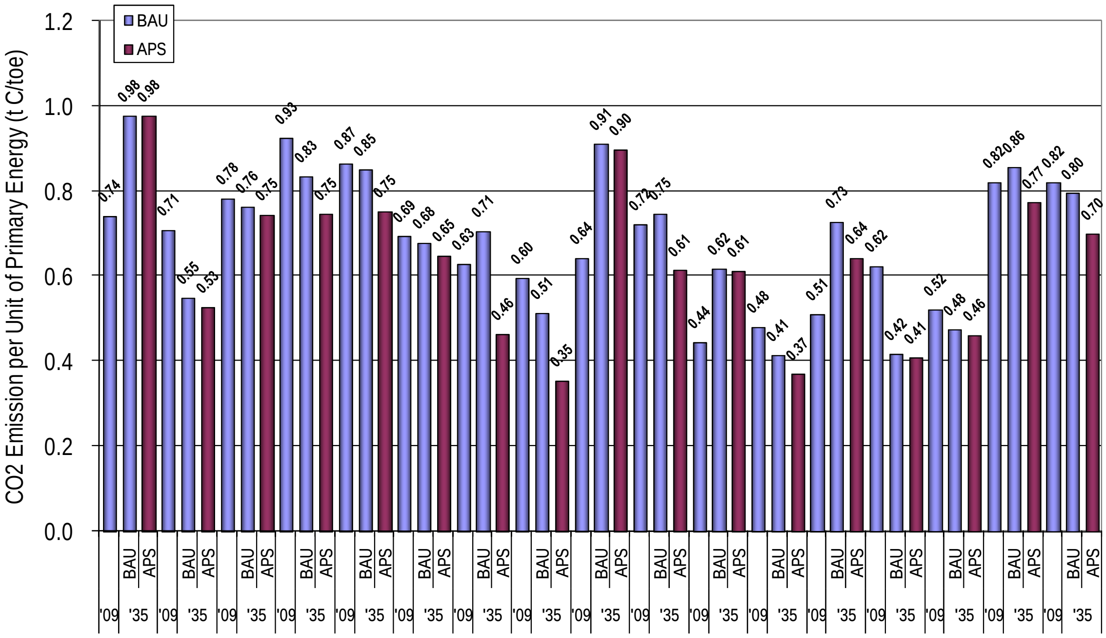
Under the APS case, China and India are still dominant, accounting for 1042 and 638 Mt-C, respectively, of the projected 2280 Mt-C growth in emissions in the EAS region between 2009 and 2035, or 73.7 percent. Adding 321 Mt-C from Indonesia, these three countries account for 2000 Mt-C or 87.7 percent of the EAS region total. No other country will account for a growth of more than 122 Mt-C. Emissions from Japan, the Republic of Korea, and New Zealand are expected to decline under the APS case relative to 2009 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 decline to 0.80 t-C/toe in 2035 from 0.82 t-C/toe in 2009 under the BAU case. Under the APS case, this will decline to 0.70 t-C/toe in 2035, equivalent to a decline of 14.6 percent from 2009 (Figure 19). The reduction under the APS case reflects a shift away from coal and oil, the two most emission-intensive fuels.

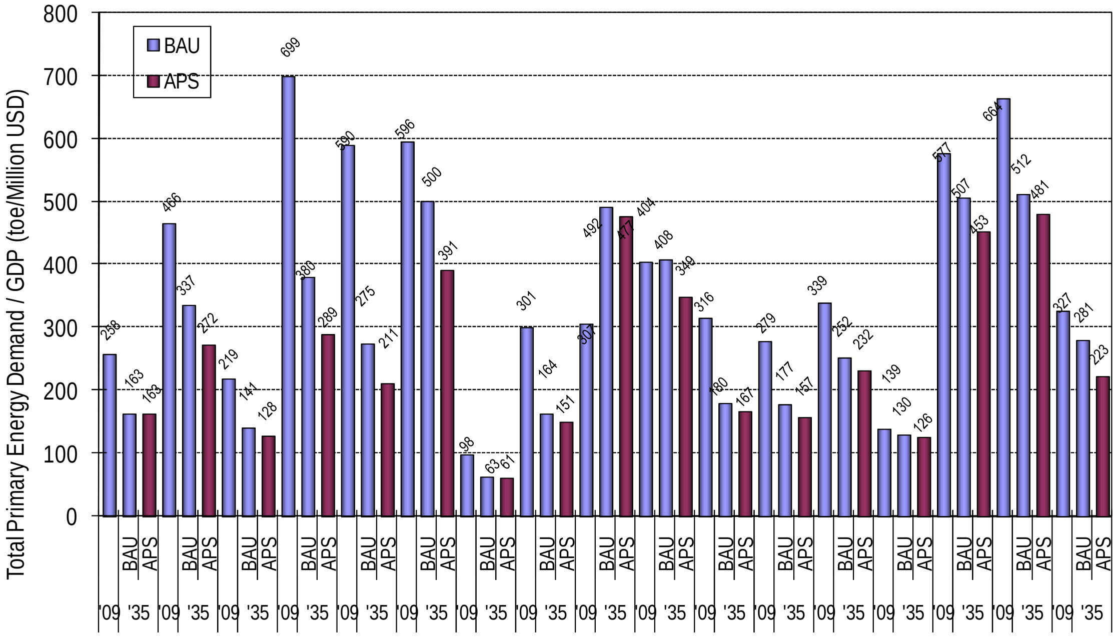
Figure 19. Emissions per Unit of Primary Energy



ii) Primary energy per unit of GDP is projected to decline from 357 toe/million US$ in 2009 to 281 toe/million US$ in 2035 under the BAU case, or by 21.3 percent (Figure 20). Under the APS case, this will decline to 224 toe/million US$ in 2035, or by 37.3 percent. The lower emissions under the APS case reflects projected improvements in energy intensity. Looking at (i) and (ii) in combination, emissions per unit of GDP will decrease from 290 t-C/million

US$ in 2009 to 223 t-C/million US$ in 2035 under the BAU case, or by 22.9 percent. Under the APS, this will decline to 156 t-C/million US$ in 2035, 46.1 percent lower than 2009.

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 significant increase in GDP per person in the EAS region, from around 3300 US$/person in 2009 to 9100 US$/person in 2035, an increase of 173.1 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 0.96 t-C/person in 2009 to 2.03 t-C/person in 2035 under the BAU case, or by 110.5 percent. Under the APS, emissions rise to only 1.42 t-C/person in 2035, or 47.3 percent higher than 2009. However, the rising emissions per capita are associated with increase in GDP/person and improvement in living standards.

iv) Finally, population in the EAS Region is expected to grow from 3273 million in 2009 to 3826 million in 2035, or by 16.9 percent. Combined, all these drivers lead to growth in emissions from 3157 Mt-C in 2009 to 7771 Mt C in 2035 under the BAU case, or 146.2 percent. Under the APS, emissions grow to 5437

Mt-C in 2035, or 72.2 percent.

5. The Effect of a Possible Change in the Nuclear Policy of EAS Countries

5.1. Research Objective

Following the incident at the Fukushima Daiichi Nuclear Power Station in March 2011, attitudes toward the use of nuclear power have changed. As a result, a number of countries in the EAS region are now reassessing their plans for the development of nuclear power plants. Since many of these countries have not made a final decision on the future of nuclear power, an evaluation of the effect on the energy mix under different nuclear scenarios has been conducted based on the energy outlooks prepared by working group members.

5.2. Methodology

The assessment has been based on three scenarios with different levels of nuclear penetration to evaluate the effect on the consumption of fossil fuels (coal and natural gas[12]) in 2035. The reference scenario has been based on the APS case in the 2011 EAS energy saving potential project, which has incorporated plans for nuclear expansion.

Under the APS scenario, 2243 TWh of electricity is projected to be generated using nuclear power in 2035, accounting for a 13 percent share of the total. The two scenarios for this analysis have been based on lower utilisation of nuclear power, so that its relative share in the electricity generation mix is lower. The low nuclear scenario (the BAU case) assumes that 1311 TWh will be generated using nuclear power in 2035 (6 percent of total generation) and the nuclear 0 scenario 0 TWh (0 percent of total generation). These are outlined in Table 6.

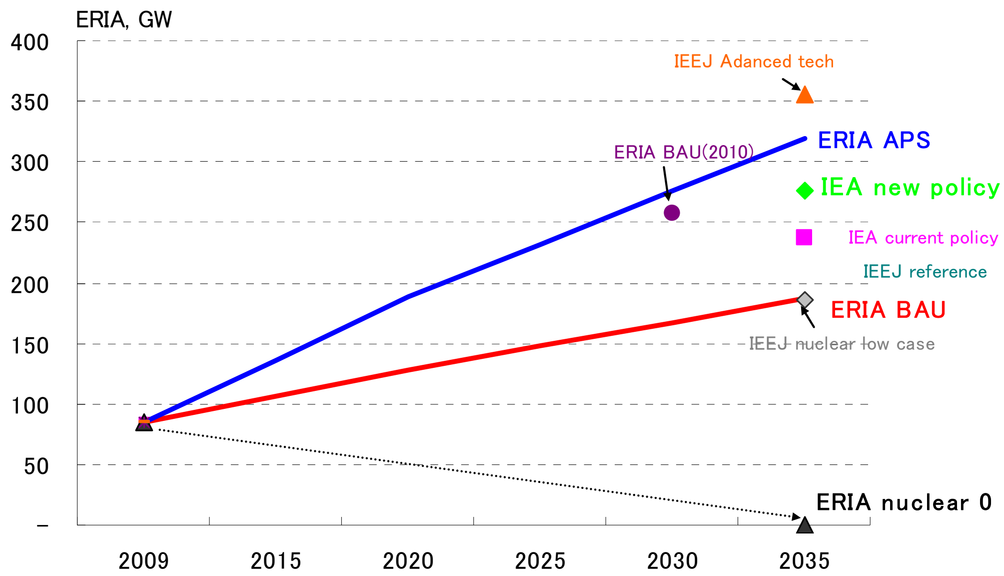
[12] Natural gas can be delivered by pipeline and LNG.

Table 6: Scenarios for Nuclear Abolition Analysis

	Nuclear power generation and share of total power generation in 2035	Scenario
Nuclear Reference APS scenario	2243 TWh, 13%	Nuclear power generation in the EAS region except for Japan expand toward 2035.
Low Nuclear BAU scenario	1311 TWh, 6%	Japan's all nuclear power reactors to be retired after 40 years of service and by 2035, all reactors are retired.
Nuclear 0	0TWh, 0%	All nuclear reactors in EAS are retired by 2035.

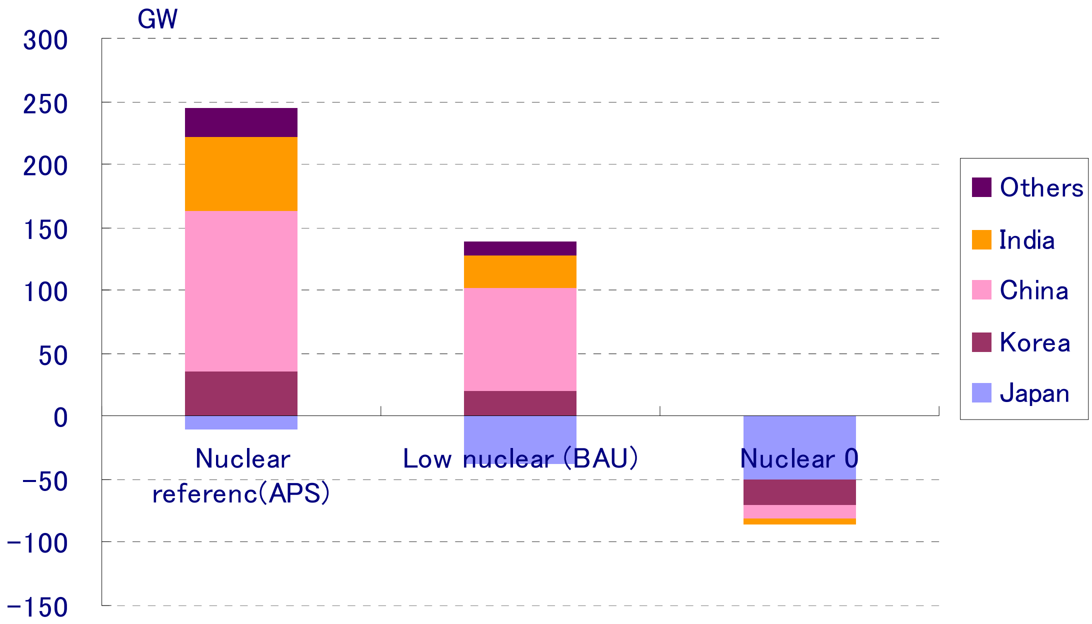
Figure 21 shows projected nuclear capacity by each scenario. In the nuclear reference which is the APS case, nuclear capacity is assumed to be 320 GW in 2035. This is lower than the advanced technology scenario estimated by the Institute of Energy Economics Japan considering nuclear expansion and is larger than the IEA new policy scenario. On the other hand, the capacity under the low nuclear scenario which is the BAU case is assumed to be 187 GW in 2035. This is almost equal to the low nuclear scenario by the Institute of Energy Economics, Japan.

Figure 21: Nuclear Capacity in Each Scenario



As shown in Figure 22, nuclear capacity in the EAS countries except for Japan is assumed to increase toward 2035 in the low nuclear scenario. In the nuclear 0 scenario, nuclear capacity of all countries is assumed to decrease to 0 GW by 2035.

Figure 22: Projected Nuclear Capacity (Increase from 2009 to 2035)



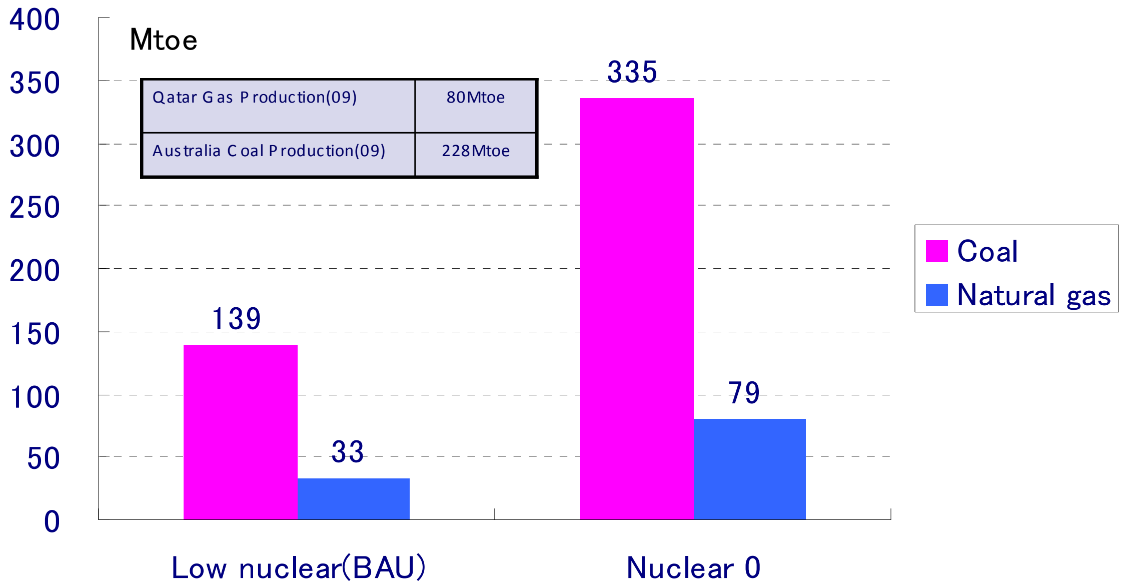
5.3. Results

Increase in fossil fuel use for power generation

Figure 23 illustrates the increase in fossil fuel inputs for power generation under each scenario. In this analysis it was assumed that the efficiency of gas-fired generation was 49 percent and coal-fired generation was 42 percent. Under the low nuclear scenario, the increase in natural gas and coal consumption in electricity generation is estimated to be 33 Mtoe and 139 Mtoe, respectively. In the nuclear 0 scenario, gas and coal consumption is estimated to increase by 79 Mtoe and 335 Mtoe, respectively.

In the low nuclear scenario, increase of gas consumption and coal consumption are equivalent to 41 percent of Qatar gas production in 2009 and 60% of Australia coal production in 2009, respectively. In the nuclear 0 scenario, increase of gas consumption and coal consumption are equivalent to Qatar gas production and 1.5 times of Australia coal production, respectively.

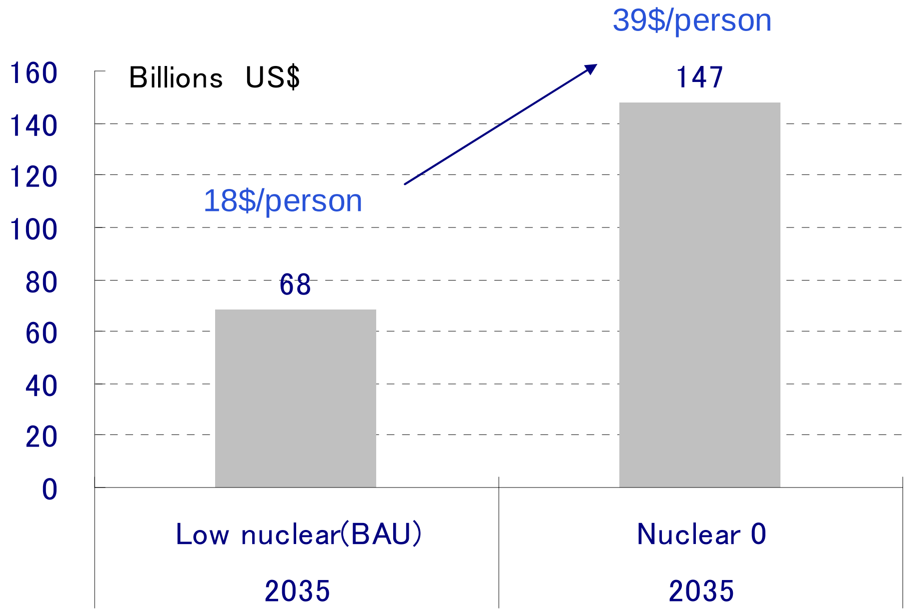
Figure 23: Increase in Fossil Fuel Use for Power Generation in 2035



Note: Natural gas and coal thermal efficiency are assumed to be 49 percent and 42 percent, respectively

Figure 24 illustrates the increase in fossil fuel cost under each scenario. Unit fuel cost by each EAS country is based on "Projected Costs of Generating Electricity 2010 edition" released by the International Energy Agency. In the low nuclear scenario, increase of fossil fuel cost is estimated to be 68 billion US$. Fuel cost in the nuclear 0 scenario is estimated to be 147 billion US$. Those increases are equivalent to 18$ annual increase per person in the low nuclear scenario and 39$ annual increase per person in the nuclear 0 scenario.

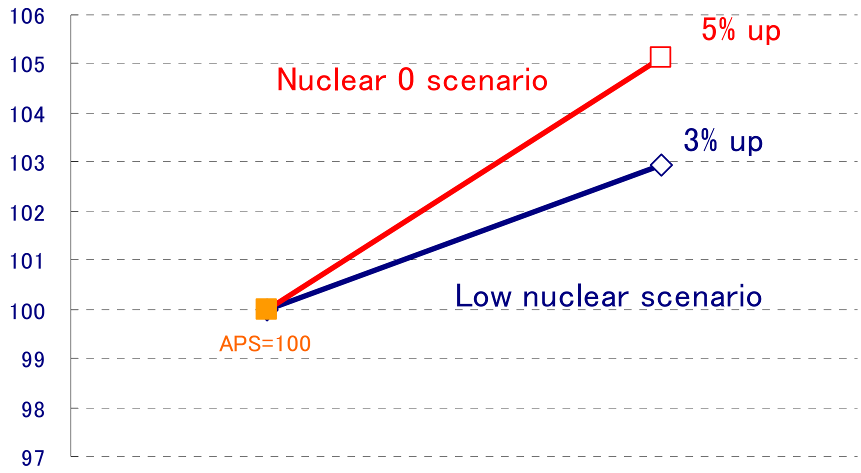
Figure 24: Increase in Fossil Fuel Cost in 2035



Rising power generation costs in 2035

The change in the electricity generation mix caused by the lower utilisation of nuclear power will increase the average cost of power generation as higher cost options are used. The increase in average power generation costs ($/kWh) was calculated by multiplying power generation by source under each scenario by a unit cost estimated by the "National Policy Unit, Japan" and "Projected Cost of Generating Electricity". As illustrated in Figure 25, the cost of power generation in the low nuclear scenario could increase by as much as 3 percent compared with the APS base case in 2035. In the nuclear 0 scenario, the cost could increase 5 percent compared with the APS base case in 2035.

Figure 25: Index of Power Generation Cost in 2035



Note: Japan's assumption for power generation cost by source was obtained from "National Policy Unit". Assumptions for other countries are obtained from "Projected Costs of Generating Electricity 2010 Edition" released by the International Energy Agency.

Increase in CO_2 emissions

Figure 26 shows the estimated increase in CO_2 emissions under each scenario compared with the APS case. The largest increase in emissions is expected under the nuclear 0 scenario. Under this case, the increase in emissions is estimated to be 391 Mt-C, which is equivalent to 10 times of Malaysia's total emissions in 2009. CO_2 emission under the low nuclear scenario is equivalent to 4 times of Malaysia's total emission in 2009.

Figure 26: Increase in CO_2 Emissions Compared with APS Case in 2035.

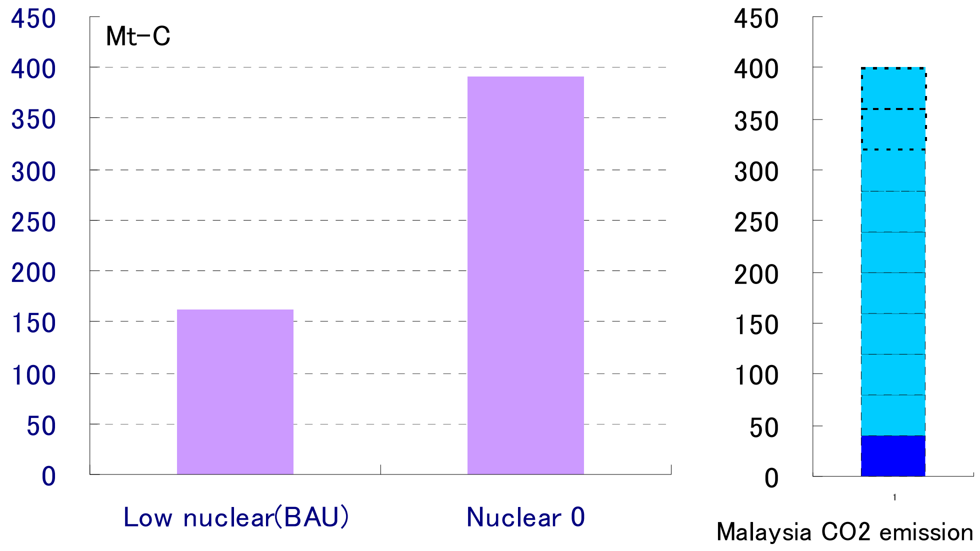
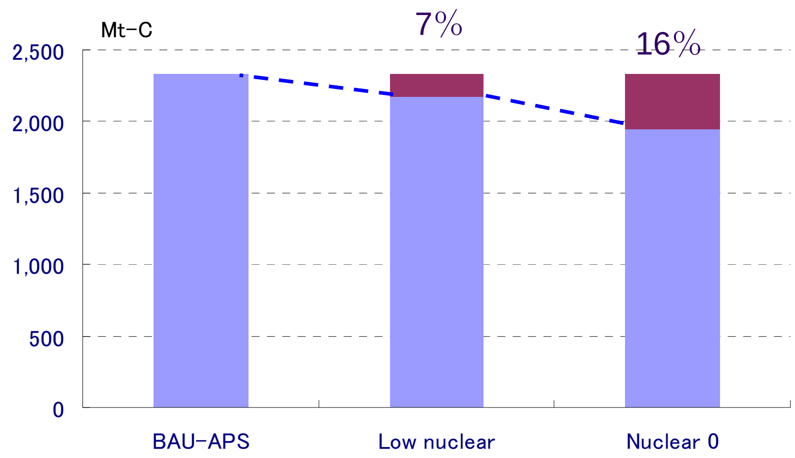


Figure 27 shows potential in CO_2 emissions reduction by each scenario in 2035. The potential which is BAU minus APS is estimated at 2334 Million Carbon tons. The potential by each scenario is estimated to decrease 7 percent in the low nuclear scenario and 16 percent in the nuclear 0 scenario. Increased utilisation of coal in the EAS region will have serious implications to CO_2 abatement goals in the region.

Figure 27: Potential CO_2 Emissions Reduction in Each Scenario n 2035.



5.4. Implications

The Great East Japan Earthquake and the Fukushima Daiichi nuclear plant incident have raised the global issue of safety regarding nuclear power generation. As a result, various countries in the world reviewed and changed their nuclear energy policies.

At the moment, EAS countries, with the exception of Japan, are still expected to proceed with their nuclear plans over the period to 2035. However, there is the potential for a decrease in nuclear power generation by delay and setbacks in the region. Setbacks in nuclear power generation are expected to increase fossil fuels and CO_2 emissions and cost. Those increases will damage the environment and destabilize energy security. Unstable energy security could adversely affect economic growth. Likewise, those damages are expected to influence not only the EAS countries, but also to the world.

Consequently, it is important to promote safety in nuclear power generation and for technologically developed countries, such as Japan, to make active contributions to the establishment of a global nuclear safety control system.

6. The Pilot Survey on Residential End-use Energy Consumption

6.1. Research Objective

Strong economic growth and urbanization in the EAS region has contributed to rising household energy consumption in recent years. As a result, energy efficiency in the household sector has become a priority for many countries, with energy saving programs in the sector being implemented or planned. The pilot survey on residential end-use energy consumption was carried out to determine how energy is consumed in the residential sector by end-use level to serve as a basis for the formulation of energy saving goals and action plans in the sector and for monitoring performance of energy saving programs. The surveys were conducted by the working group member for participating ASEAN countries. The survey included 106 households in seven countries including Cambodia, Indonesia, Malaysia, Philippines, Lao PDR, Thailand and Viet Nam. The following analysis is based on the response to this survey. The survey created some data series, but most importantly provided an insight into the structure of household energy consumption in these economies.

The questionnaire was designed by the working group members and consists of five parts: electricity, petroleum, natural gas, biomass and coal briquettes.

6.2. Data Collection

The respondents to the survey were selected by the working group members and consist mainly of colleagues and residents in their neighbourhood. From September 2011 to March 2012, 106 respondents from Cambodia, Indonesia, Malaysia, Philippines, Lao PDR, Thailand and Viet Nam participated in the survey. The profile of the respondents is shown in Table 7.

Table 7: Profile of Pilot Survey Respondents

	n	%
Cambodia	20	19
Indonesia	17	16
Malaysia	18	17
Philippines	17	16
Lao PDR	11	10
Thailand	13	12
Viet Nam	10	9
Total	106	100

The majority of the surveyed respondents live in urban areas, accounting for 63 percent of the participants, with the remainder in rural areas (37 percent) (Figure 28). The histogram in Figure 29 shows the number of persons per respondent household is concentrated at around 4 to 5 persons. The majority of the respondents live in relatively large houses (Figure 1Figure 30, Figure 31).

Figure 28: Share of Respondents in Urban and Rural Areas

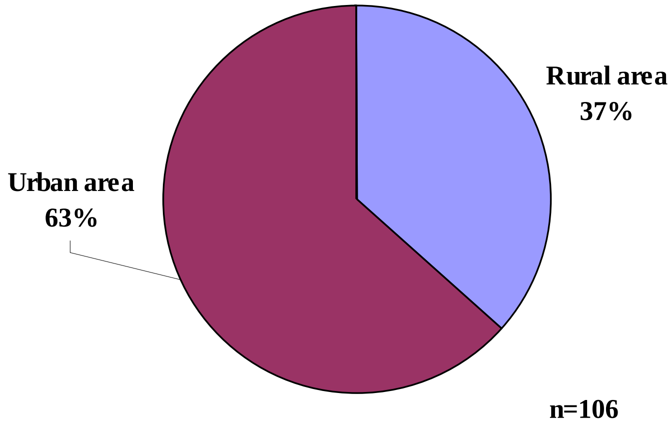


Figure 29: Histogram of Household Size

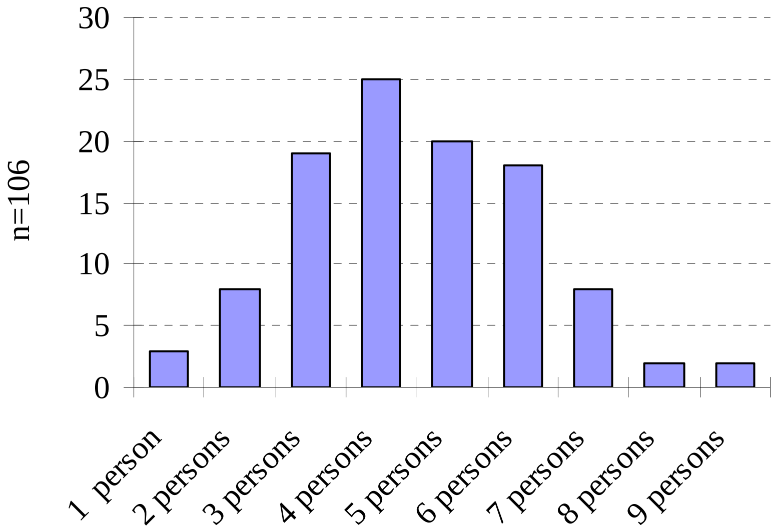


Figure 30: Share of Respondents by Type of Residence

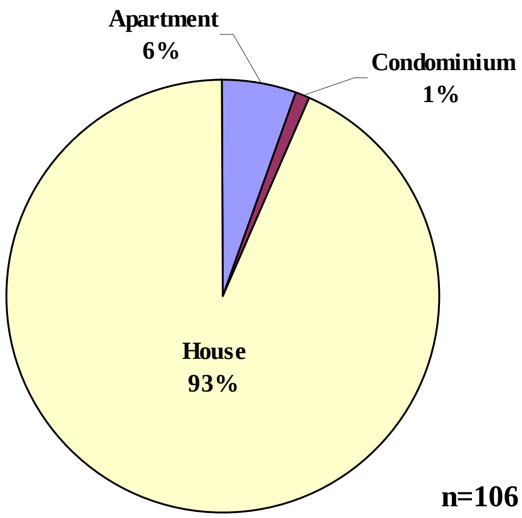
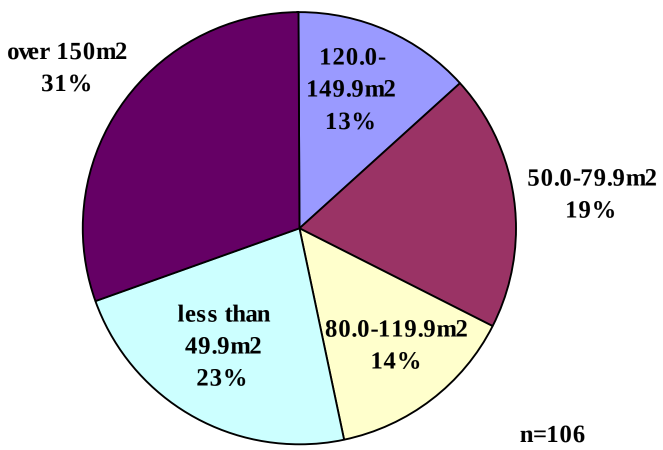


Figure 31: Share of Respondents by Floor Area



6.3. Main Electrical Appliances and Equipment in Households

The ownership of electrical appliances and equipment is much higher in urban areas, with large observed differences in the ownership of air conditioners, refrigerators, rice cookers, personal computers and washing machines. In particular, there is a stark difference in the ownership of air conditioners - the number of air conditioners in urban and rural areas is 1.17 units and 0.3 units per household, respectively. The ownership of electrical appliances in urban areas is almost as high as in developed countries. The ownership of the three “must have” appliances in Japan such as a television, refrigerator and washing machine in participating countries is almost 1 unit per household in urban areas. Similarly, the number of televisions is almost 1 unit per household, in even rural areas.

Table 8: Main Appliances in Households

	Urban	Rural
Air conditioner	1.23	0.30
Fan	2.64	1.70
Refrigerator	1.00	0.61
Electric stove	0.22	0.08
Microwave	0.58	0.13
Rice cooker	0.95	0.47
Television (CRT)	0.84	0.79
Television (LCD)	0.55	0.21
Desktop computer	0.47	0.08
Laptop computer	0.86	0.24
Washing machine	0.86	0.39

The number of electrical appliances in Malaysia, which has the highest income among the seven participating countries, is relatively higher. The number of air conditioners in the Philippines is relatively low compared with the other countries. This reflects the high electricity price in the Philippines which is about 23 US cents per kWh, the second highest in the ERIA region, following Japan at 28 US cents per kWh. As a result, awareness of energy savings in the Philippines is expected to be higher than other countries.

Table 9: Main Appliances in Households by country

	Cambodia*	Lao PDR*	Vietnam	Indonesia	Philippines	Thailand*	Malaysia	Total
Air conditioner	0.40	0.82	0.40	0.35	0.07	0.92	0.67	0.48
Fan	0.90	1.00	0.90	0.65	1.00	1.00	1.00	0.91
Refrigerator	0.45	0.91	0.90	0.71	0.86	1.33	1.07	0.85
Electric stove	0.00	0.00	0.00	0.00	0.07	0.67	0.40	0.17
Microwave	0.15	0.64	0.20	0.12	0.14	0.92	0.80	0.41
Rice cooker	0.40	1.00	1.00	0.71	0.36	1.08	1.13	0.77
Television (CRT)	1.10	0.64	0.90	0.82	0.93	0.50	0.73	0.82
Television (LCD)	0.10	0.64	0.10	0.47	0.29	1.17	0.40	0.42
Desktop computer	0.25	0.27	0.50	0.35	0.29	0.33	0.33	0.32
Laptop computer	0.45	0.82	0.00	0.53	0.29	0.92	1.33	0.63
Washing machine	0.40	0.82	0.30	0.47	0.71	1.08	1.07	0.69

Notes: (*) Most respondents of Lao PDR, Cambodia and Thailand live in urban areas.

6.4. Hours of Usage of Cooling and Ventilation

The ASEAN region has a moderate climate with an average temperature of 29^{o}C and a maximum temperature of around 40^{o}C.[13] Therefore, the use of air-conditioning is much higher than in countries with cooler climates. As shown Table 10, each day, on average, air conditioners are used for 2.0 hours and fans for 4.6 hours.

One exception is the Philippines, where there is a low penetration of air conditioners and the average operation is only 2 hours per day as a result of high electricity prices. In Lao PDR and Viet Nam, air conditioners and electric fans were used for only 1 to 2 hours per day because of the relatively cooler climate.

Table 10: Hours Used per Day for Cooling

	Air Conditioner	Fan	Temperature(℃)
Cambodia*	1.0	7.5	27.0
Lao PDR*	0.6	1.7	25.3
Vietnam	1.2	1.9	21.3
Indonesia	6.8	6.6	26.5
Philippines	1.8	7.6	27.0
Thailand*	4.0	5.0	27.7
Malaysia	1.1	5.2	27.7
Total	2.0	4.6	26.1

6.5. Residential Energy Consumption

13 Retireasia.com (undated) *Geography, Climate, Weather in Southeast Asia.* Accessed 03 June 2011. http://www.retire-asia.com/asia-weather.shtml

6.5.1. Monthly Energy Consumption by Energy Use

The average energy consumption between September 2011 and February 2012 including non commercial energy of biomass in rural and urban areas was 2255 Mcal and 2130 Mcal per household, respectively. In general, energy consumption per household in both urban and rural areas increases with higher incomes with the exception of the Philippines. Energy consumption in Malaysia, which has the highest income, is much higher than the lower income countries. In addition, it was observed that the electricity price also affected energy usage. For example, despite being in the middle income range of the surveyed countries, energy consumption in the Philippines is relatively low because of its high electricity price. The high electricity price has encouraged consumers in the Philippines to be more aware of their energy use as illustrated by the relatively lower use of air conditioners.

Table 11: Energy Usage by Country

(Mcal/household)

		Electricity	LPG	Kerosene	Biomass	Total	n	Number of household	Floor space
Rural area									
	Cambodia	122.0	134.7	3.1	1,741.7	2,001.5	10.0	6.2	49.0
	Vietnam	581.2	198.8	0.0	2,226.7	3,006.6	5.0	3.6	84.0
	Indonesia	159.6	0.0	1,189.8	1,141.7	2,491.1	4.0	4.4	61.4
	Philippines	412.6	572.1	0.0	728.9	1,713.7	5.0	4.6	125.7
	Thailand	1,565.9	728.2	0.0	0.0	2,294.0	7.0	3.8	116.3
	Malaysia	1,490.7	917.5	0.0	0.0	2,408.2	7.0	6.0	140.0
	Total	575.0	364.4	220.0	1,095.9	2,255.2	38.0	4.8	96.1
Urban area									
	Cambodia	1,151.3	512.1	0.0	186.3	1,849.7	10.0	6.4	90.5
	Lao PDR	1,602.0	347.5	0.0	786.4	2,736.0	10.0	4.9	129.1
	Vietnam	1,108.0	388.1	0.0	0.0	1,496.1	8.0	3.6	92.0
	Indonesia	1,604.3	910.2	0.0	0.0	2,514.5	5.0	3.8	102.5
	Philippines	598.0	246.8	0.0	16.0	860.8	10.0	3.5	56.5
	Thailand	1,713.9	21.2	0.0	0.0	1,735.1	10.0	2.9	113.3
	Malaysia	2,549.9	713.6	0.0	0.0	3,263.5	11.0	4.3	137.5
	Total	1,498.6	465.0	0.0	166.8	2,130.4	64.0	4.2	103.1
Share(%)									
Rural area									
	Cambodia	6.1	6.7	0.2	87.0	100.0			
	Vietnam	19.3	6.6	0.0	74.1	100.0			
	Indonesia	6.4	0.0	47.8	45.8	100.0			
	Philippines	24.1	33.4	0.0	42.5	100.0			
	Thailand	68.3	31.7	0.0	0.0	100.0			
	Malaysia	61.9	38.1	0.0	0.0	100.0			
	Total	25.5	16.2	9.8	48.6	100.0			
Urban area									
	Cambodia	62.2	27.7	0.0	10.1	100.0			
	Lao PDR	58.6	12.7	0.0	28.7	100.0			
	Vietnam	74.1	25.9	0.0	0.0	100.0			
	Indonesia	63.8	36.2	0.0	0.0	100.0			
	Philippines	69.5	28.7	0.0	1.9	100.0			
	Thailand	98.8	1.2	0.0	0.0	100.0			
	Malaysia	78.1	21.9	0.0	0.0	100.0			
	Total	70.3	21.8	0.0	7.8	100.0			

Figure 32: Energy Consumption by Source in Rural Areas

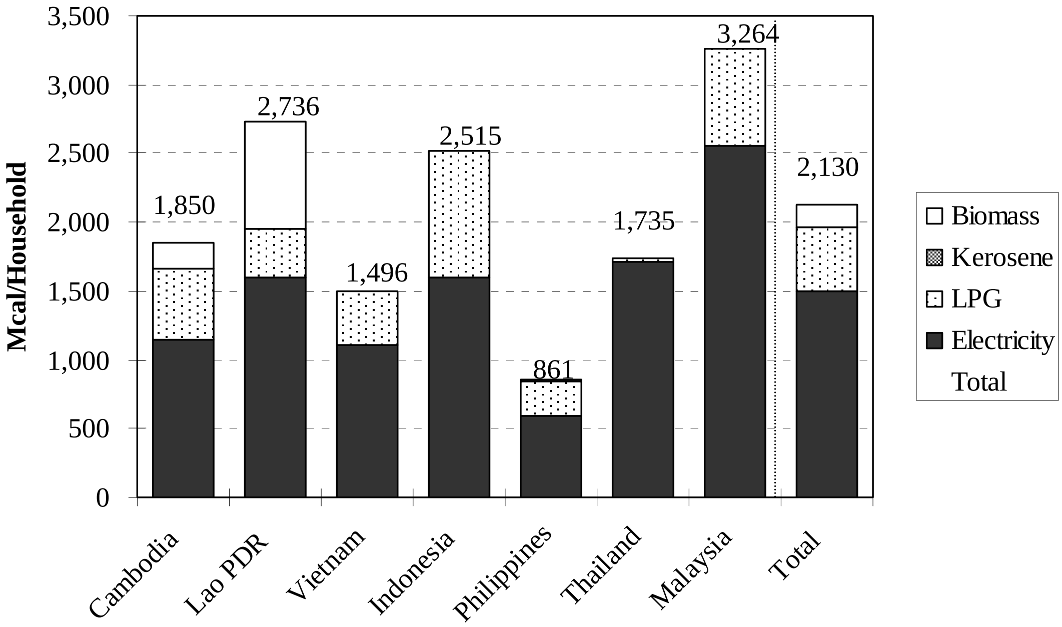
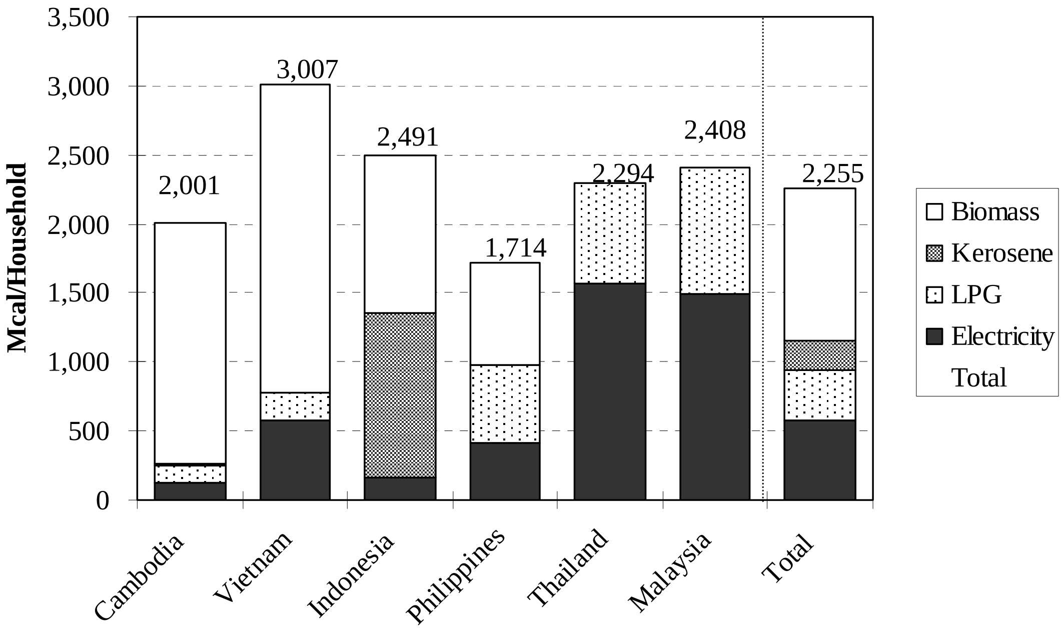


Figure 33: Energy Consumption by Source in Urban Areas



6.5.2. Energy Consumption by End Use

Table 12 shows average household residential energy consumption, disaggregated by end-use, between September 2011 and February 2012. In urban areas, 14 percent of energy consumption was used for cooling, 25 percent for cooking and other kitchen use and 10 percent for refrigeration. The remaining energy use was attributed to water heating (12 percent), lighting (13 percent) and other appliances (26 percent). In rural areas, 58 percent was used for cooking and 18 percent was used for water heating. The major energy source used for cooking and water heating is biomass such as wood, wood waste and rice husks. The remaining energy use in rural areas, which include refrigerators, lighting and other appliances, is less than 10 percent of total consumption. This is because the ownership of electrical appliances in rural areas is quite low in the seven countries.

Table 12: Energy Consumption by End Use

(Mcal/household)

		Cooling	Space heating	Cooking	Refrigerator	Water heating	Lighting	Other appliances	Total	n	Number of household	Floor space
Rural area												
	Cambodia	2.5	0.0	1,662.6	0.0	216.8	60.0	59.5	2,001.5	10.0	6.2	49.0
	Vietnam	3.6	0.0	1,923.2	169.0	600.8	102.6	207.4	3,006.6	5.0	3.6	84.0
	Indonesia	14.8	0.0	1,768.8	82.7	570.9	11.3	42.7	2,491.1	4.0	4.4	61.4
	Philippines	132.4	0.0	720.1	54.6	583.7	69.7	153.1	1,713.7	5.0	4.6	125.7
	Thailand	342.2	0.0	645.7	211.7	190.0	184.7	719.6	2,294.0	7.0	3.8	116.3
	Malaysia	222.7	0.0	678.1	485.7	376.7	230.3	414.6	2,408.2	7.0	6.0	140.0
	Total	100.8	0.0	1,307.1	133.7	418.1	90.2	205.2	2,255.2	38.0	4.8	96.1
Urban area												
	Cambodia	224.4	2.1	555.7	191.7	175.0	202.1	498.8	1,849.7	10.0	6.4	90.5
	Lao PDR	146.6	0.0	979.1	149.4	455.5	766.3	239.1	2,736.0	10.0	4.9	129.1
	Vietnam	70.7	0.0	376.3	249.6	133.3	129.2	537.0	1,496.1	8.0	3.6	92.0
	Indonesia	322.8	0.0	579.2	260.9	373.7	105.3	872.7	2,514.5	5.0	3.8	102.5
	Philippines	180.0	0.0	290.4	149.5	53.3	63.2	124.5	860.8	10.0	3.5	56.5
	Thailand	488.2	0.0	243.5	142.8	151.0	196.6	513.1	1,735.1	10.0	2.9	113.3
	Malaysia	364.9	0.0	586.2	369.0	348.3	301.0	1,294.2	3,263.5	11.0	4.3	137.5
	Total	288.4	0.3	542.9	214.7	255.8	273.3	554.9	2,130.4	64.0	4.2	103.1
Share(%)												
Rural area												
	Cambodia	0.1	0.0	83.1	0.0	10.8	3.0	3.0	100.0			
	Vietnam	0.1	0.0	64.0	5.6	20.0	3.4	6.9	100.0			
	Indonesia	0.6	0.0	71.0	3.3	22.9	0.5	1.7	100.0			
	Philippines	7.7	0.0	42.0	3.2	34.1	4.1	8.9	100.0			
	Thailand	14.9	0.0	28.1	9.2	8.3	8.1	31.4	100.0			
	Malaysia	9.2	0.0	28.2	20.2	15.6	9.6	17.2	100.0			
	Total	4.5	0.0	58.0	5.9	18.5	4.0	9.1	100.0			
Urban area												
	Cambodia	12.1	0.1	30.0	10.4	9.5	10.9	27.0	100.0			
	Lao PDR	5.4	0.0	35.8	5.5	16.6	28.0	8.7	100.0			
	Vietnam	4.7	0.0	25.2	16.7	8.9	8.6	35.9	100.0			
	Indonesia	12.8	0.0	23.0	10.4	14.9	4.2	34.7	100.0			
	Philippines	20.9	0.0	33.7	17.4	6.2	7.3	14.5	100.0			
	Thailand	28.1	0.0	14.0	8.2	8.7	11.3	29.6	100.0			
	Malaysia	11.2	0.0	18.0	11.3	10.7	9.2	39.7	100.0			
	Total	13.5	0.0	25.5	10.1	12.0	12.8	26.0	100.0			

Figure 34: Energy Consumption by End Use in Rural Areas

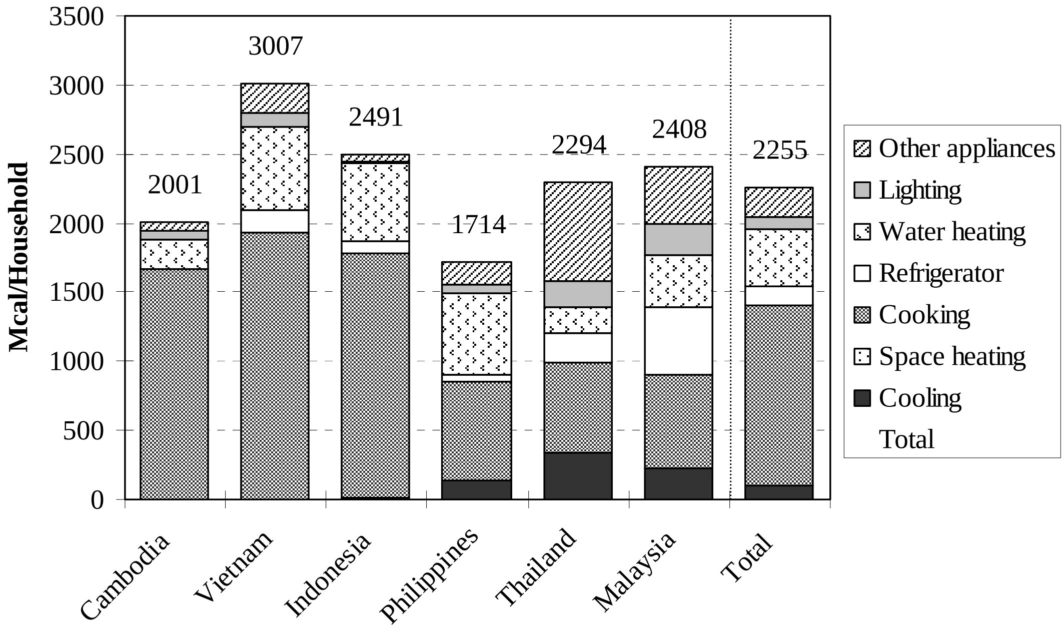
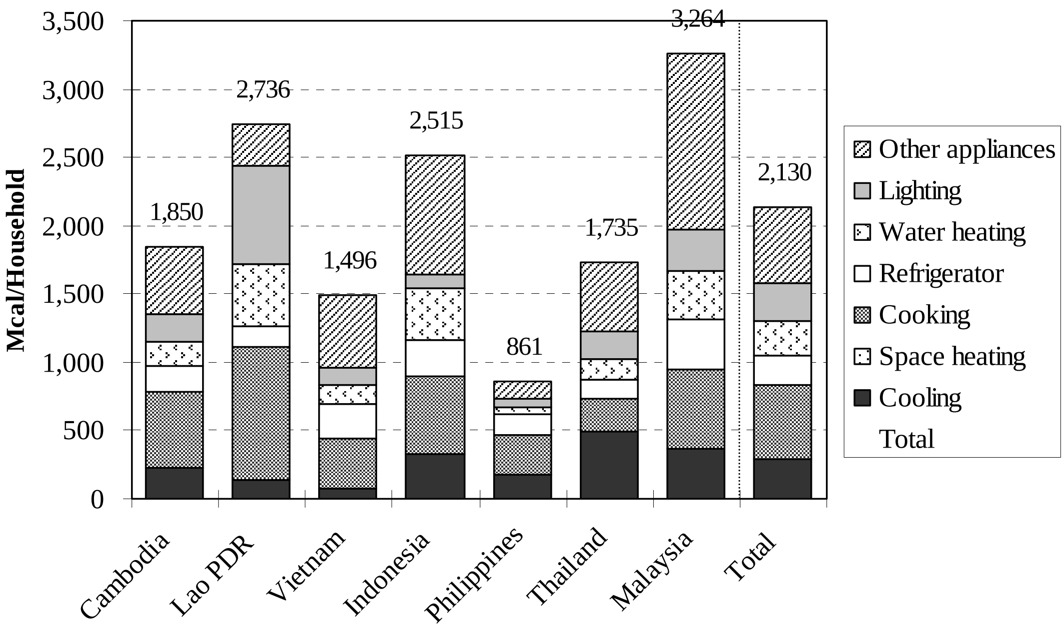


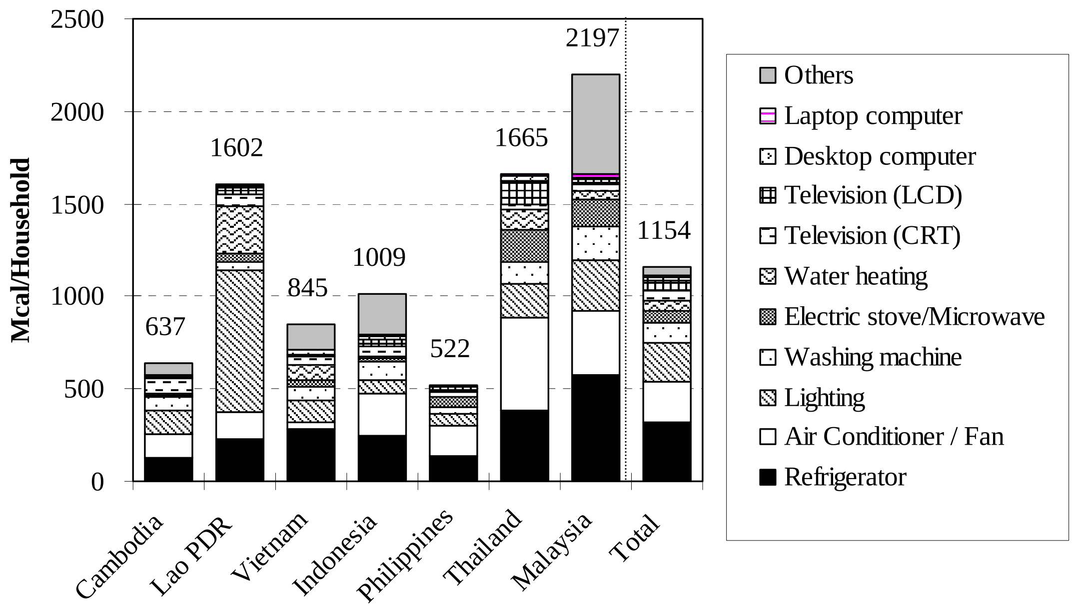
Figure 35: Energy Consumption by End Use in Urban Areas



6.5.3. Energy Consumption by electrical appliance

In this report, electricity consumption by electrical appliance was estimated. Cooling and refrigeration accounted for 47 percent of the total electricity consumption and lighting accounted for 28 percent. Reflecting this, energy policy in the ERIA region could be focused toward these end-uses.

Figure 36: Annual Household Energy Use per Capita in the EAS



6.6. Conclusion

The survey was able to assist in disaggregating household energy consumption by end-use. The information contained in this survey was able to help determine the most energy consuming end-use applications, which can assist policy makers in the formation of energy efficiency programmes. However, the following should be considered when using the results of this survey and for conducting future surveys in this area:

- It is necessary to ask further questions to differentiate between residential and commercial energy usage in dwellings that contain a business such as a shop or restaurant.
- It is difficult to differentiate energy use for heating and cooking when using a

stove. For example, the use of a cooking stove for heating a kettle to use for bathing.

- Further questions are required for water pumping.
- It is necessary to ask further questions about the characteristics of the dwelling, aside from floor area, to further understand energy use. For example, energy usage for lighting outdoor areas.
- Only four types of equipment are listed in the survey, but working group members indicated that households have many more (for example fans only have 4 options).
- Some respondents were unable to fill out the size of their floor area, power ratings for appliances.
- Biomass differentiates between types such as firewood etc, but this was difficult for respondents to understand. They were unable to fill out to this level of detail.

7. Satellite Projects

In order to support and enhance the capacity of the ERIA WG, the following research activities were continued in 2011 with support of METI, Japan. They are:

a. Policy Recommendations for Reducing CO2 Emissions in the Road Transport Sector in the Asian Countries
b. Clean Coal Technologies in EAS Region
c. Promoting Climate Change Finance

Brief descriptions of these projects are given below.

7.1. Policy Recommendations for Reducing CO_2 Emissions in the Road Transport Sector

The study conducted by Japan Automobile Research Institute (JARI) estimated the CO_2 emission reduction in the road transport sector in five EAS countries namely, India, Indonesia, Malaysia, Philippines and Thailand. The study only covered road vehicles such as light duty vehicles (LDV), trucks and motorcycles. In the study, JARI applied the following CO_2 reduction measures:

a. Improving fuel efficiency of new vehicles by introducing fuel efficiency standards

LDV: 1.1% /year and 2.7%/year after 2015

Medium truck: 1.1%/year after 2015

Heavy truck: 0.9%/year after 2015

b. Introducing next generation vehicles (gasoline hybrid LDV)

Sales ratio of gasoline hybrid LDV is 50% in 2050

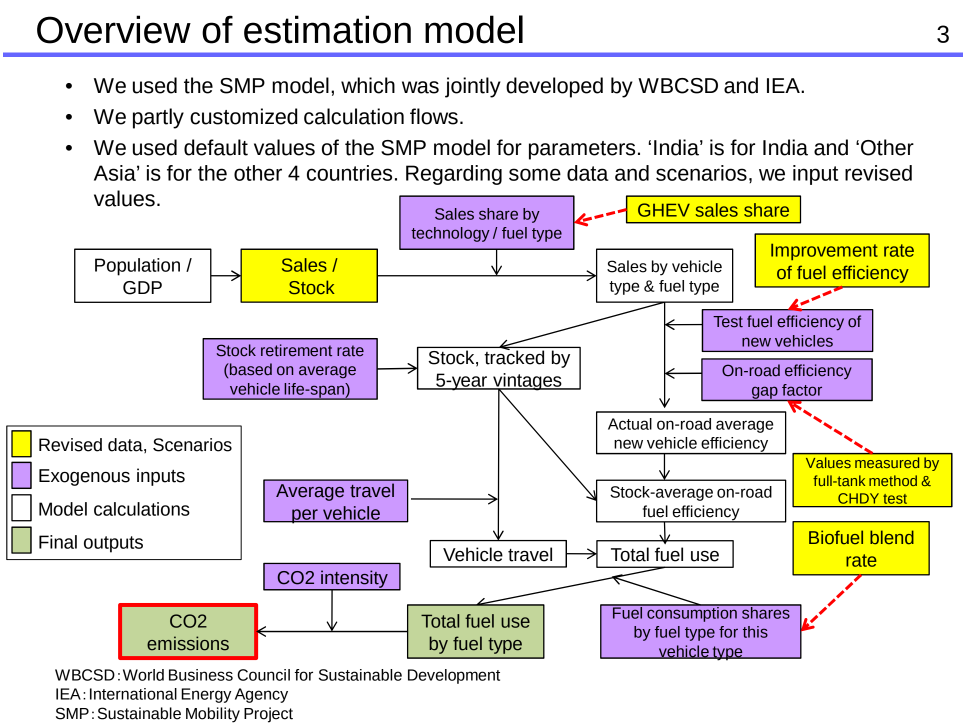
c. Improving traffic flow (increasing average speed)

The fuel efficiency gap factor decreases by 5% because average speed increases by 2km/h

d. Introduction of biofuels

Apply the country targets on ethanol and biodiesel

The estimation model applied by JARI is shown in the diagram below:



The conclusions of the study are:

a. Improving fuel efficiency by introducing fuel efficiency standards is the most effective approach in CO_2 reduction in the road transport sector.
b. The combined CO2 reduction of the 3 other measures amounts to 50 to 60 percent of the reduction of improving fuel efficiency of new vehicles in accordance with fuel efficiency standards.
c. Integrated polices are very important, which include not only improving the fuel efficiency of vehicles themselves but also other policies.
d. In the conduct of the study, it was found out that sufficient and accurate road vehicle data are not available for each country. Improving the transport database is very important in order to increase accuracy in estimation.

7.2. Clean Coal Technologies

The study "Clean Coal Technologies in EAS Region" is one of the studies being continuously conducted under the WG. The study is being carried out by the Institute of Energy Economics, Japan since 2009 in view of the anticipated continuous increase of coal consumption in East Asia for power generation and its consequential adverse impact to the environment. The purpose of the study is to determine the diversity of coal demand, the needs for clean coal technology, the barriers in the promotion of low rank coal utilization as well as high efficiency coal-fired power generation technologies in East Asia.

In 2009, the project was able to collect and organize information on the status of the use of low rank coal and development level of each utilization technologies. Information on the status of coal-fired power generation and the needs for high-efficiency coal-fired generation were also collected from selected East Asian countries.

For 2010, the project collected and organized information on policy targets and barriers related to utilisation of low rank coal and demand for high efficiency coal-fired power generation.

In 2011, the study focused on the technical and economical policy aspects of low rank coal (LRC) utilisation. The study found some issues related LRC utilisation, they are as follows:

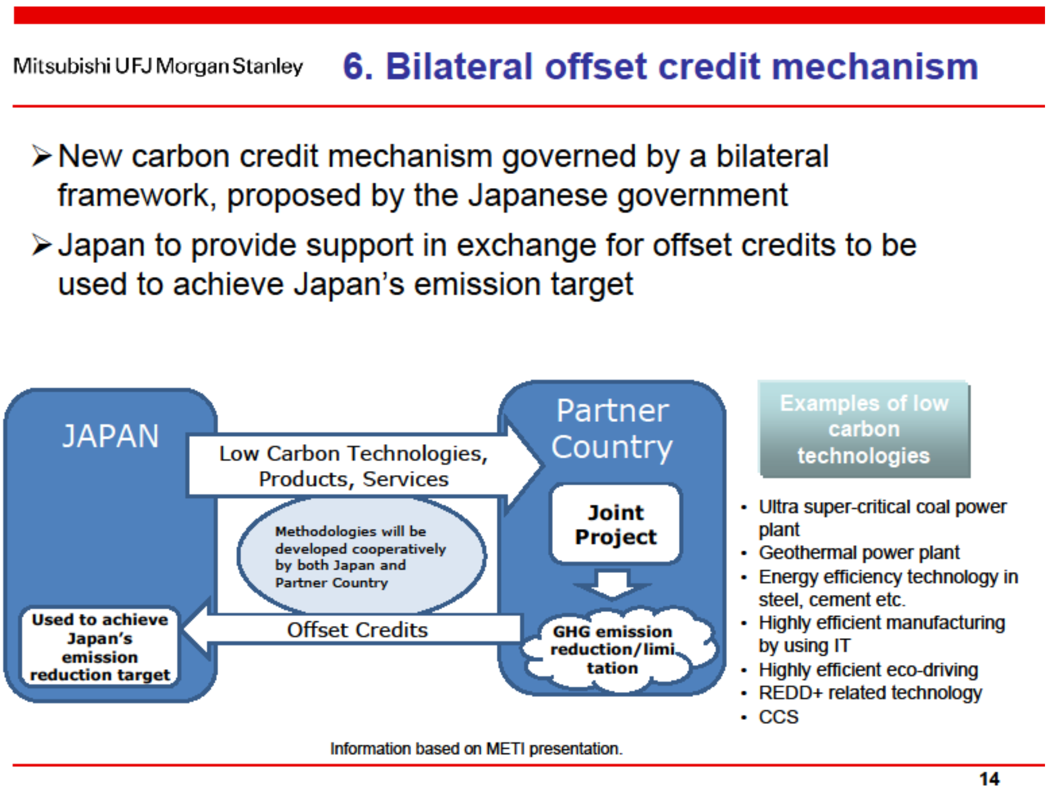
a. LRC utilization technologies are still under development
b. Policy for environment protection comes to be more stringent
c. Effective and economical dewatering/drying technology is important
d. Scientists and engineers are insufficient

In addition, several issues regarding high-efficiency coal-fired plant (CCT) were studied including policy direction, air pollution control, GHG reduction target, electricity price and cost comparison of sub-critical, supercritical and ultra-supercritical coal technologies. Based on the results of the study, lower electricity price with subsidies and financial incentive are the key solution in promoting clean coal technology (CCT).

7.3. Promoting Climate Change Finance

Mitsubishi UFJ Morgan Stanley Securities studied “Promoting Climate Change Finance” or Leveraging Private Capital through Public-Private Fund Scheme”. Based on the study, developed countries have vast experience and know-how on energy efficiency and conservation technologies but currently, there is no financial scheme on transfer of energy efficiency and conservation technologies and facilities from developed countries to developing countries.

Clean development mechanism (CDM is a useful scheme for promotion of new and renewable energy but it takes a long time that public finance would apply this transfer. It is for this reason that the Japanese Government proposes a new financial scheme, called “Bilateral Offset Credit Mechanism (BOCM)”. This is a new carbon mechanism governed by a bilateral framework through transfer of low carbon technologies such as high-efficient coal-fired plants and energy efficiency technologies in energy intensive industries.



There are several merits on application of BOCM such as, a) host country project owner can enjoy high-end low-carbon / energy efficient technologies and equipments exported from Japan at competitive terms, b) emission reduction achieved through BOCM can be used to achieve Japan's emission target, c) avoid cumbersome and time consuming UN procedures and requirements, d) wider range of technology available that were not fully utilized under CDM, e) predictable BOCM credit revenue may be expected. The report also points out an issue on low energy price including subsidies which is a risk to private finance side.

8. Conclusions and Recommendation

At the 2nd working group meeting, the working group members discussed the key findings and implications of the analysis based on the two energy outlook scenarios, BAU and APS.

8.1. 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. However, the energy intensity of the EAS region is projected to decline, indicating improved energy efficiency in each EAS country.

2. The continued reliance on fossil fuels to meet increased energy demand will also be associated with significant increases in CO_2. The significant increase in electricity demand (which is largely thermal-based) and heavy use of road transport fuel requires the wide deployment of advanced energy efficient and low emission technologies (including clean coal technology and biofuels) for the simultaneous achievement of socioeconomic and environmental development goals and improvement in energy security.

3. While the energy consumption mix of countries within the EAS region is projected to change considerably between 2009 and 2035, the energy mix for the region as a whole is expected to remain largely unchanged. The diversification of the regional energy mix will contribute to improvements in the regional energy security and carbon intensity defined as emissions divided by energy consumption.

4. Attitudes towards nuclear power have changed since the accident at the Fukushima Dai-ichi nuclear power plant. As a result, a number of EAS countries that were considering nuclear power are reassessing their plans. However, most of these countries have not made a final decision on their nuclear policies so for the purposes of this study existing plans have been used. A nuclear impact assessment conducted by the working group showed that delays in the development of nuclear power will result in increased consumption of coal and gas, contributing to higher CO_2 emissions from the region.

5. It is recognized that the industry and transport sectors are major energy consuming sectors in the EAS region and are also challenging sectors in terms of improving energy efficiency and reducing CO_2 emissions. In this regard, appropriate energy efficiency and conservation programs and low emission technologies are needed in these sectors.

6. Throughout the region there is strong potential to increase energy efficiency and reduce growth in energy consumption and CO_2 emissions. The results of this analysis indicate that by 2035 the implementation of currently proposed energy efficiency goals, action plans and policies across the EAS region could lead to the following reductions:

   - 20.5 percent in primary energy demand
   - 31.5 percent in energy intensity
   - 30.0 percent in energy derived CO_2 emissions.

8.2. Policy Implications

Based on the above key findings, the working group members identified a number of policy implications which were aggregated into three major categories. The identified policy recommendations are based on a shared desire to enhance promotion of energy efficiency and conservation policies, increase the utilisation of 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 below. It should be noted 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 Policy and Technology Development***

- There needs to be clearly defined targets and action plans for energy efficiency and conservation. These should be reassessed on a considerable basis.
- The application of energy efficiency and conservation programs and renewable energy should be affordable.
- Public and private investment in technology development and deployment is indispensable. This requires adequate access to financing to ensure this occurs. It is important that the government facilitates this process through public-private partnerships, grants etc.
- An appropriate energy policy framework, such as energy efficiency and conservation acts and renewable energy regulations, assists the technology development as well as their applications.

2. ***Energy Pricing Mechanisms***

- High energy prices provide an incentive to promote energy efficiency and conservation and increase the production of renewable energy.
- Improving the current pricing mechanism for electricity, petroleum products and natural gas by removing subsidies.
- There is a need to pay attention to low income groups to ensure that they can adjust to these changes.

3. ***Enhancing reliable energy statistics for monitoring energy saving goals, action plans and policies***

- The use of benchmarks and best practices are needed to encourage improved performance throughout the region. Therefore, reliable energy statistics, especially end-use data, are required for a robust analysis of energy saving potential.

- There is a need to improve the quality and coverage of energy data in the EAS region. The collection of more detailed end-use data could be achieved through further survey work.

8.3. 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 CO_2 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 which outline in a broad sense how these energy savings will be achieved should also be developed. 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 in establishing energy efficiency and conservation regulations and laws to support technology development, enhancing energy efficiency standards and labelling, promotion of communication campaigns especially in rural areas , implementation of feed-in tariffs (FIT) and renewable energy portfolio standards (RPS),the provision of investment incentives for the private sector through new financing schemes such as a “Bilateral Offset Credit Mechanism” to support technology transfer of energy efficiency facilities and equipment, and explicit emission pricing instruments such as carbon taxes. The choice of policies used in individual countries will depend on a range of country specific factors and other competing policy objectives.

Improvement of the current pricing mechanism, including the removal of subsidies on electricity, petroleum products and natural gas is one policy option to advance energy efficiency and conservation activities and expand the use of renewable energy. But in parallel, assistance to low income households is required to help them adjust to higher prices.

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 are key in achieving potential energy savings. Improvement in the efficiency of thermal electricity generation was also identified as essential in achieving energy savings. International collaboration on technology development and transfer was identified as an opportunity for achieving future gains.

A lack of reliable energy statistics for energy consuming sectors will impose barriers in monitoring and evaluating the energy saving targets and action plans of EAS countries. The pilot survey on end-use energy consumption in the residential sector, which covered both urban and rural areas, has contributed to improving the capacity to collect energy consumption statistics. It is recommended that a national energy consumption survey be conducted in EAS countries, applying the experience and know-how obtained through the pilot survey, where data are insufficient.

The projected level of energy savings and reduction in CO_2 emissions will be significant if all of the energy saving and low emission fuel policies proposed at the 5th Energy Ministers Meeting in September 2011 were implemented in EAS countries. Although enhanced energy efficiency and an increase in the share of low emission and renewable fuels in the energy mix may also have other benefits such as increasing energy supply diversity and enhancing energy security, these measures are not enough to mitigate all of the challenges posed by climate change. Therefore, more aggressive saving goals, advanced technologies to reduce CO_2 emissions directly, such as clean coal technologies, and enhanced uptake of low emission fuels are recommended to further reduce CO_2 emissions.

Concrete action is required to facilitate inter-regional collaboration on technology development and transfer and policy implementation within the EAS and between the EAS 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. Therefore, financial and economic analyses will be included in the scope of this study.

REFERENCES

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

International Energy Agency (2011) *Energy Balances of OECD Countries 2011*. Paris: OECD Publishing.

International Energy Agency (2011) *Energy Balances of Non-OECD Countries 2011*. Paris: OECD Publishing.

IPCC (2007) *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* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Ito, K., Y. Yamashita, K. Koyama, Y. Matsuo, S. Suehiro, *et al.* (2011) *Asia/World Energy outlook 2011*. Tokyo, Japan 26 October 2011. Tokyo: The Institute of Energy Economics, Japan (IEEJ).

Japan Automobile Manufacturer's Association (2010) *World Vehicle Statistics*, 2010, Tokyo: Japan Automobile Manufacturer's Association.

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.

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

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: The Ministry of Foreign Affairs of Japan. http://www.mofa.go.jp/region/asia-paci/eas/summary0512.html (accessed February 28, 2008)

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

World Bank (2011) *World Databank - World Development Indicators (WDI) and Global Development Finance (GDF)*. New York: World Bank. http://databank.worldbank.org/ddp/home.do (accessed August 18, 2011).