Chapter 1

Main Report on Energy Outlook and Saving Potential in the East Asia Region

Edito Barcelona
The Institute of Energy Economics, Japan

September 2015

This chapter should be cited as
Barcelona, E. (2015), 'Main Report on Energy Outlook and Saving Potential in the East Asia Region, in Kimura, S. and H. Phoumin (eds.), *Energy Outlook and Energy Saving Potential in East Asia*. ERIA Research Project Report 2014-33, Jakarta: ERIA, pp.1-48.

CHAPTER 1

Main Report on Energy Outlook and Saving Potential in the East Asia Region

EDITO BARCELONA
Senior Coordinator
The Energy Data and Modelling Center (EDMC),
The Institute of Energy Economics, Japan (IEEJ)

1. Introduction

Responding to the Cebu Declaration on East Asia Energy Security on 15 January 2007 announced 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 energy efficiency and conservation (EEC). Japan proposed to undertake a study on energy savings and CO_2 emission reduction potential in the EAS region. The study would quantify 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 for national energy ministers to help them establish goals, action plans, and policies for improving energy efficiency in their respective countries. The first study was undertaken in 2007 and was updated annually to incorporate more recent information on member countries' energy saving potentials and energy efficiency goals, action plans, and policies. The 2013 study was updated again to undertake the following:

- Reflect the energy efficiency goals and actions plans submitted by the energy ministers during the 8th EAS Energy Minister's Meeting (EMM) held in Vientiane, Lao PDR on 24 September 2014 in the latest energy outlook until 2035; and
- Determine the impacts of various energy policies aimed at reducing energy demand and CO_2 emissions as follows:
    a. Improving energy efficiency in final energy consumption;
    b. Improving efficiency in thermal electricity generation;
    c. Increasing the utilisation of new and renewable energy in electricity generation and transportation sector; and
    d. Introduction or increasing the utilisation of nuclear power
- Carry out additional studies affecting energy consumption as follows:
    a. Pilot survey on road transport sector
    b. Impact of removal of energy subsidies
    c. Energy demand analyses in road transport and residential sectors using the bottom-up approach
    d. Cost–benefit analysis of clean coal technology (CCT)

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

e. Study on renewable energy in electricity generation using optimisation analysis

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 programmes; increase share of hydropower; and expansion of renewable energy, biofuels, and civilian nuclear power.

1.1. The East Asia Summit

The EAS is a collection of diverse countries, with wide variations amongst them in terms of per capita income, standards 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) – Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam, and six other countries – Australia, China, India, Japan, Republic of Korea (henceforth, South Korea), and New Zealand.[3]

Whereas some EAS countries have what might be called mature economies, the majority have developing economies. Several countries have a per capita gross domestic product (GDP) of less than US$1,000 (in 2005 prices[4]). Countries with mature economies have higher energy consumption per capita, whereas 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. Countries with developed economies may be very keen to reduce 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 would grow as well.

Despite the differences amongst the 16 countries, the EAS leaders agreed 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].

---

[2] ASEAN Secretariat (2007), *Cebu Declaration on East Asian Energy Security 2007*. Jakarta: http://www.aseansec.org/19319.htm (accessed 27 February 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 27 February 2008).
[4] All US$ (US dollars) in this document are stated at constant year 2005 values unless specified.
[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 28 February 2008)

Table 1-1 shows the geographic, demographic, and economic profiles of the 16 EAS countries. Table 1-2 shows their economic structure and energy consumption profiles.

Table 1-1. Geographic, Demographic, and Economic Profiles, 2012

	GDP (Billion 2005US$)	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	845.9	28.2	69.3	2.4	128.3	5.7
Brunei Darussalam	10.3	71.1	28.2	0.7	2.9	7.0
Cambodia	10.0	24.4	40.1	35.6	5.8	0.4
China	4,523.6	45.3	44.6	10.1	2,894.3	2.1
India	1,394.5	31.9	50.0	18.0	788.1	0.6
Indonesia	427.6	46.8	38.7	14.5	219.5	0.9
Japan	4,708.6	25.6	73.2	1.2	452.3	3.5
Korea, Rep. of	1,077.9	38.1	59.5	2.5	263.4	5.3
Lao PDR	4.3	36.0	35.9	28.1	2.6	0.4
Malaysia	198.4	40.8	49.2	10.0	69.0	2.4
Myanmar	23.1	16.2	35.4	48.4	15.6	0.3
New Zealand	148.3	23.8	69.1	7.2	20.1	4.5
Philippines	145.2	31.2	56.9	11.8	42.3	0.4
Singapore	191.8	26.7	73.3	0.0	22.9	4.3
Thailand	226.4	43.6	44.2	12.3	117.7	1.8
Viet Nam	87.5	38.6	41.7	19.7	61.2	0.7

GDP = gross domestic product.

[1] Information on the land area of Cambodia, Indonesia, and Japan were provided by the Energy Saving Potential Working Group members from these countries.

Source: World Bank (2014), Washington, DC: World Bank. http://databank.worldbank.org/ddp/home.do (accessed November 2014); United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014) and Government of Cambodia.

Table 1-2. Economic Structure and Energy Consumption, 2012

	Land Area (thousand sq.km.)[1]	Population (million)	Population Density (persons/ sq.km.)	GDP (Billion 2005US$)	GDP per Capita (2005US$/ person)
Australia	7,682	22.6	2.9	845.9	37,368
Brunei Darussalam	5.3	0.4	78.2	10.3	24,951
Cambodia	181	14.9	82.1	10.0	672
China	9,327	1,350.7	144.8	4,523.6	3,349
India	2,973	1,236.7	415.9	1,394.5	1,128
Indonesia	1,911	246.9	129.2	427.6	1,732
Japan	378	127.8	338.1	4,708.6	36,838
Korea, Rep. of	97	50.0	515.0	1,077.9	21,556
Lao PDR	231	6.5	28.2	4.3	667
Malaysia	329	29.2	89.0	198.4	6,786
Myanmar	653	52.8	80.8	23.1	437
New Zealand	263	4.4	16.8	148.3	33,444
Philippines	298	96.7	324.3	145.2	1,501
Singapore	0.7	5.3	7,588.6	191.8	36,107
Thailand	511	66.8	130.7	226.4	3,390
Viet Nam	310	87.5	282.3	87.5	1,000

GDP = gross domestic product.
Note: [1] Sectoral shares to GDP of Myanmar and New Zealand are 2004 and 2009 values, respectively.
Source: World Bank (2014), World Databank. Washington, DC: World Bank. http://databank.worldbank.org/ddp/home.do (accessed November 2014); International Energy Agency (IEA) (2014), Energy Balances of Organisation for Economic Co-operation and Development (OECD) Countries 2012 and Energy Balances of Non-OECD Countries 2012, Paris; and United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

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, increase share of hydropower, expansion of renewable energy systems and biofuel production/utilisation, and for interested parties, civilian nuclear power; and
- mitigating greenhouse gas emissions through effective policies and measures, thus contributing to global climate change abatement.

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

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 for the Analysis of Energy Savings Potential was convened. Members from all of the 16 EAS countries are represented in the Working Group, 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 Business-as-Usual (BAU) scenario was developed for each country outlining future sectoral and economy-wide energy consumption assuming no significant changes to government policies. An Alternative Policy Scenario (APS) was also designed to examine the potential impacts if additional energy efficiency goals, action plans, or policies were developed that are currently, or likely to be, under consideration. Increased

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

uptake of renewable energy sources – including liquid biofuels – and nuclear energy as well as utilisation of more efficient thermal power plant technologies were also considered in the APS. The difference between the BAU scenario and the APS in both final and primary energy consumption represents potential energy savings. The difference in CO_2 emissions between the two scenarios represents the greenhouse gas emission reduction potential.

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

1.4. Working Group Activities in 2014

In 2014, the Working Group continued to assess energy saving potentials in the EAS region, using the goals, action plans, and policies reported at the 7th EAS Energy Ministers Meeting (EAS–EMM7). The Working Group in 2014 enhanced and extended the analysis that had been undertaken from 2007 to 2013. The Working Group conducted three meetings – one in Chiang Mai on 15–17 October 2014, one in Phnom Penh on 13–15 January 2015, and another one in Jakarta on 26–27 March 2015.

During the first meeting, the Working Group discussed and developed the 2014 research plan and provided updates on revised energy saving goals, action plans, and policies that each EAS country reported in 2014 as well as each of the countries' economic development plans. The research plan included additional studies that were undertaken by Working Group volunteers as follows:

- Impact of removal of energy subsidies;
- Energy demand analyses in road transport in Thailand and residential sectors in Cambodia and Viet Nam using the bottom-up approach;
- Cost–benefit analysis of clean coal technology (CCT); and
- A study on renewable energy in electricity generation using optimisation analysis.

During the second meeting, the agenda mainly covered the review of energy outlook models of each of the 16 EAS countries. The progress of the analyses on the additional studies was also reported.

During the third meeting, the Working Group discussed the preliminary energy outlook of each country and the policy implications that could be derived from the outlook results. The Working Group also discussed the reports of additional studies carried out by volunteer Working Group members in 2014.

2. Data and Methodology

2.1. Scenarios Examined

The study continued to examine two scenarios, as in the studies conducted annually from 2007 to 2013 – a BAU scenario reflecting each country's current goals, action plans, and policies; and an APS. The APS included additional goals, action plans, and policies reported at the EAS–EMM7 held in September 2014 in Vientiane, Lao PDR or those that are currently, or likely to be, under consideration.

One might be tempted to call the APS a 'maximum effort' case, but 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.

In 2014, the APS assumptions were grouped into four – a) more efficient final energy demand (APS1), b) more efficient thermal power generation (APS2), c) higher consumption of new and renewable energy (NRE) and bio-fuels (APS3), and d) introduction or higher utilisation of nuclear energy (APS4). The energy models are able to estimate the individual impacts of these assumptions on both primary energy demand and CO_2 emissions. The combination of these assumptions constitutes the assumptions of the APS.

The assumptions in APS1 are the reduction targets in sectoral final energy demand assuming that more efficient technologies are utilised and energy saving practices are implemented in the industrial, transport, residential, commercial, and even the agricultural sectors for some countries. This scenario resulted in less primary energy and CO_2 emission in proportion to the reduction in final energy demand.

In APS2, the utilisation of more efficient thermal power plant technologies in the power sector is assumed. This assumption resulted in lower primary energy consumption and CO_2 emission in proportion to the efficiency improvement in the thermal power generation. The most efficient coal and natural gas combined-cycle technologies are assumed to be utilised for new power plant construction in this scenario.

In APS3, higher contributions of NRE for electricity generation and utilisation of liquid biofuels in the transport sector are assumed. This resulted in lower CO_2 emission as NRE is considered carbon-neutral or would not emit additional CO_2 in the atmosphere. However, primary energy consumption may not decrease as NRE, like biomass and geothermal energy, are assumed to have lower efficiencies compared with fossil fuels-fired generation when converting electricity generated from these NRE sources into its primary energy equivalent.

APS4 assumes introduction of nuclear energy or a higher contribution of nuclear energy in countries that are already using this energy source. It is expected that this scenario would produce less CO_2 emission as nuclear energy has minimal CO_2 emission. However, as the assumption of thermal efficiency when converting nuclear energy output to primary energy is only 33 percent, primary energy consumption is not expected to be lower than the BAU in this scenario.

All of the EAS countries are actively developing and implementing EEC goals, action plans, and policies, but progress so far has varied widely. Some countries are quite advanced in their efforts, whereas others are just getting started. A few countries already have significant energy savings goals, action plans, and policies built into the BAU scenario, whereas others have only just started 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 updating 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 Saving 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 focus 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 Organisation of Economic Co-operation and Development (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 used by the IEA. The socio-economic data for 15 countries were obtained from the World Bank’s online World Databank – World Development Indicators (WDI) and Global Development Finance (GDF) – and the data of Myanmar were obtained from the United Nations Statistics Division (UNSD) Statistical Databases. Other data, such as those relating to transportation, buildings, and industrial production indices, were provided by the Working Group members from each EAS country where such 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] In 2014, all of the 10 ASEAN member countries utilised their own energy models. Australia used its own national model as well. 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 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,[8] 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 sectors, and fuels comprise 19

[7] Ito et al. (2014).

[8] E4cast is a partial equilibrium model of the Australian energy sector used by ABARE to project Australia's long term energy consumption, production and trade.

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 energy models of ASEAN countries were developed using the Long-range Energy Alternative Planning System (LEAP) software, an accounting system used to develop projections of energy balance tables based on final energy consumption and energy input/output in the transformation sector. Final energy consumption is forecast using energy demand equations by energy and sector and future macroeconomic assumptions. For this study, all the ten member countries used the LEAP model.

Other countries: Other countries used the IEEJ model, which has a macro-economic module that calculates coefficients for various explanatory variables based on exogenously specified GDP growth rates. The macro-economic module also projects prices for natural gas and coal based on exogenously specified oil price assumptions. Demand equations are econometrically calculated in another module using the historical data and 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 Working Group 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 2013 Study

From 2007 to 2013, 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 2013 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–EMM8 in Vientiane, Lao PDR. Specifically, the following new information is incorporated in this study:

- revised recent energy saving goals, action plans, and policies of each country;
- revised GDP growth projections;
- projected future oil prices; and
- results of the additional studies.

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 for 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.

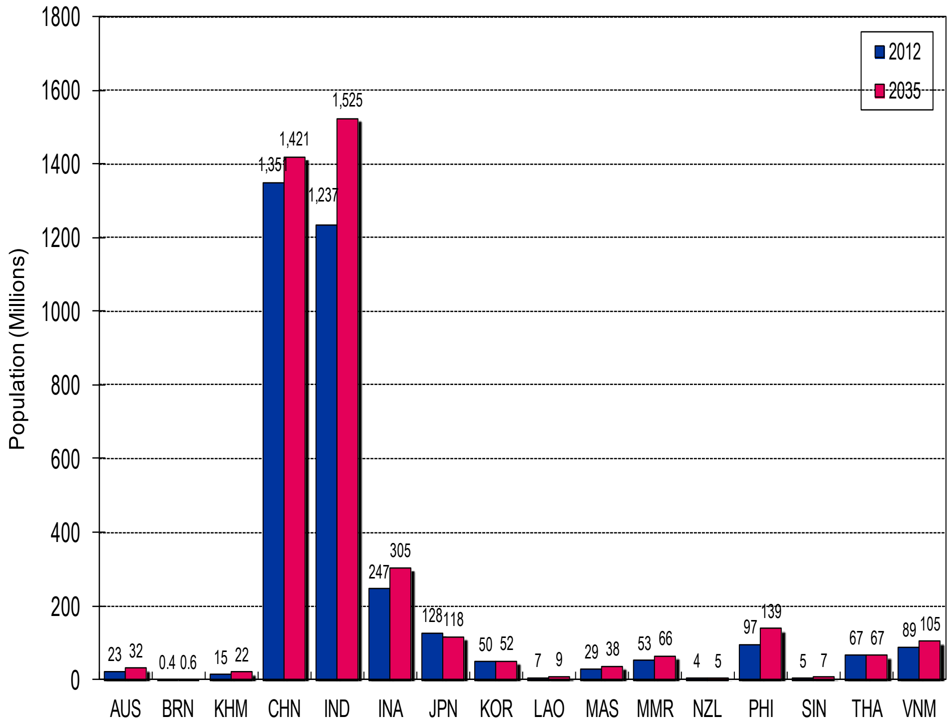
In this section, assumptions regarding key socioeconomic indicators and energy policies until 2035 are discussed for the EAS countries.

3.1. Population

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

In 2012, the total population in the EAS region was about 3.4 billion – around 49 percent of total world population. Based on the forecasts, the population in the EAS region is projected to increase at an average annual rate of about 0.6 percent, reaching about 3.91 billion in 2035. Figure-1 shows the 2012 and projected 2035 population by country.

Figure 1-1. Assumed Population in the EAS Region, 2012 and 2035

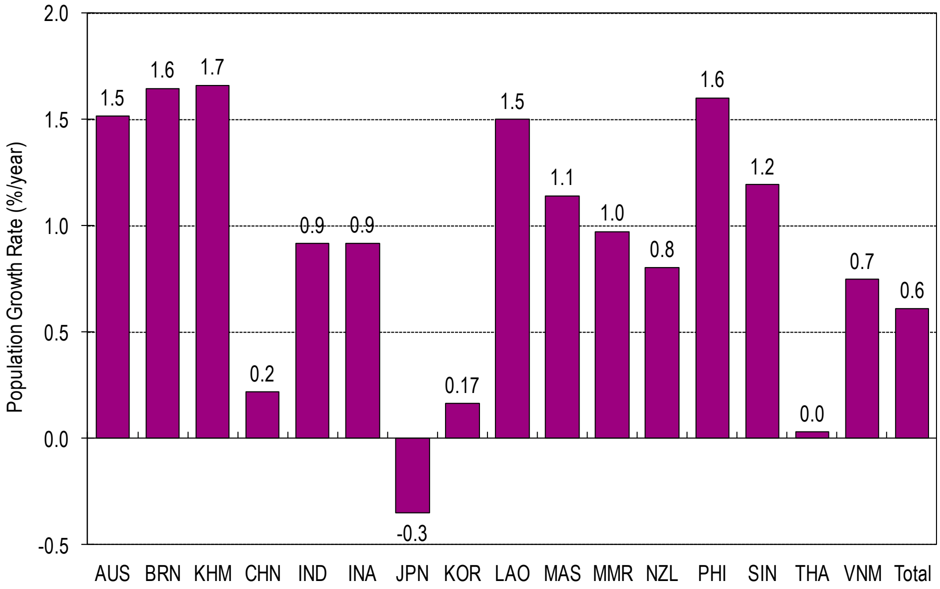


Source: United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

As shown in Figure, population growth 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 over 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. New Zealand and Singapore are assumed to have low, but still significant, population growth. South 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 1-2. Assumed Average Annual Growth in Population, 2012 to 2035



Source: United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

3.2. Economic Activity

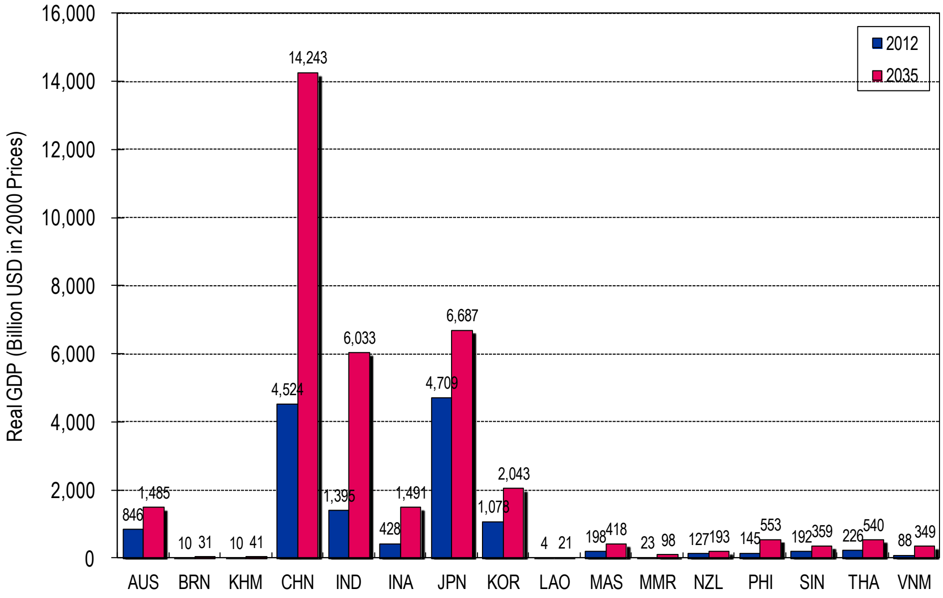
In the models used for this study, assumed changes in economic output to 2035 are set exogenously. GDP data (in 2005 US$) were obtained from the World Bank.[9] Assumed GDP growth rates to 2035 were submitted by all the EAS countries. In general, these assumptions took into account actual GDP growth rates from 2005 to 2012, which already reflect the economic recession and recovery in the United States and other countries in the world. No difference in growth rates was assumed between the BAU and APS scenarios.

In 2012, total GDP in the EAS region was about 14.0 trillion in 2005 US$ and it accounted for about 25 percent of global GDP. The GDP of the EAS region is assumed to grow at an average annual rate of about 4.0 percent from 2012 to 2035. This implies that by 2035 total GDP in the EAS region will reach about 34.6 trillion in 2005 US$.

In 2012, Japan was the largest economy by far in terms of total economic output: about 4.7 trillion 2005 US$. However, by 2035, China is projected to be the largest economy with an estimated GDP of about 14.2 trillion 2005 US$. Japan and India are projected to be the next largest economies with projected GDPs of about 6.7 trillion 2005 US$ and 6.0 trillion 2005 US$, respectively in 2035 (Figure 1-3Figure).

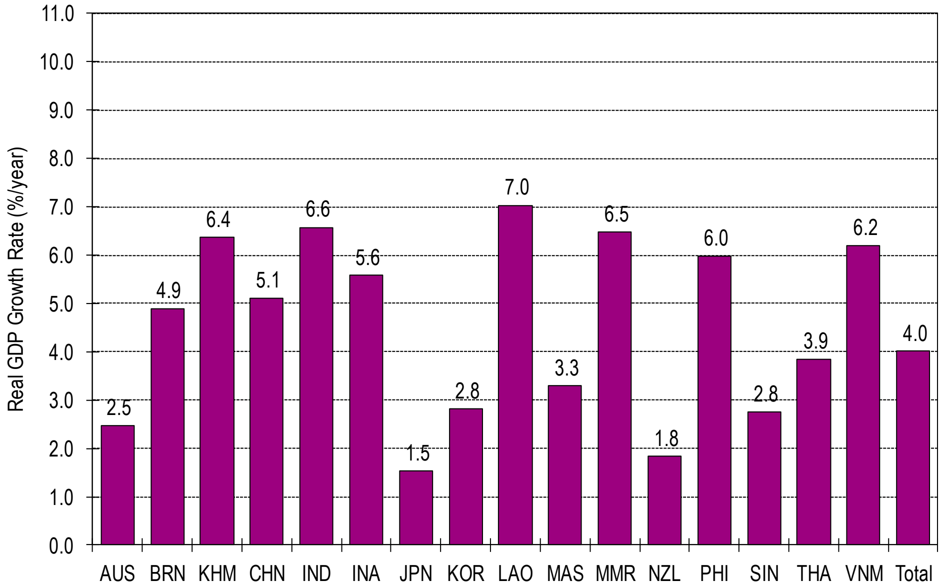
[9] World Bank (2014).

Figure 1-3. Assumed Economic Activity in the EAS Region 2012 and 2035



EAS = East Asian Summit Countries.
Source: United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

Figure 1-4. Assumed Average Annual Growth in GDP, 2012 to 2035

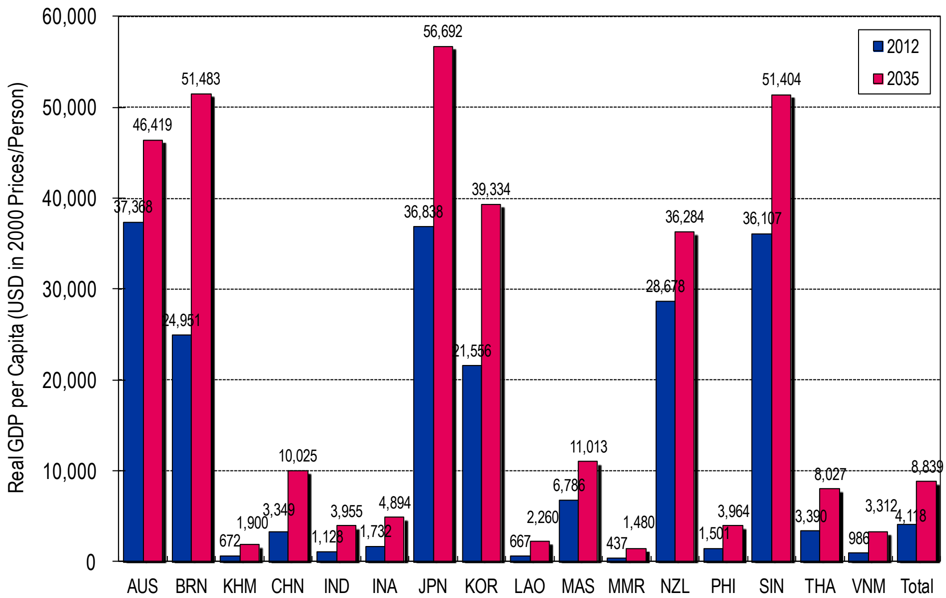


GDP = gross domestic product.
Source: United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

As shown in Figure 1-4, long-term economic growth rates are assumed to be quite high in the developing countries, with the highest growth rates in Cambodia, India, 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, South Korea, and New Zealand – are assumed to experience slower, but still significant, economic growth.

Average GDP per capita in the EAS region is assumed to increase from about US$4,100 in 2012 to about US$8,800 in 2035. However, as shown in Figure 1-5, there are, and will continue to be, significant differences in GDP per capita. In 2012, per capita GDP ranged from about US$450 in Myanmar to over US$36,000 in Australia, Japan, and Singapore. In 2035, per capita GDP is assumed to range from about US$1,500 in Myanmar to over US$56,000 in Japan.

Figure 1-5. Real GDP per Capita, 2012 and 2035



GDP = gross domestic product.

Source: United Nations Statistics Division (2014), United Nations Statistics Division (UNSD) Statistical Databases. New York: UN. https://unstats.un.org/unsd/databases.htm (accessed November 2014).

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 14 countries with the exception of Lao PDR and Viet Nam. 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 312 million and 139 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.

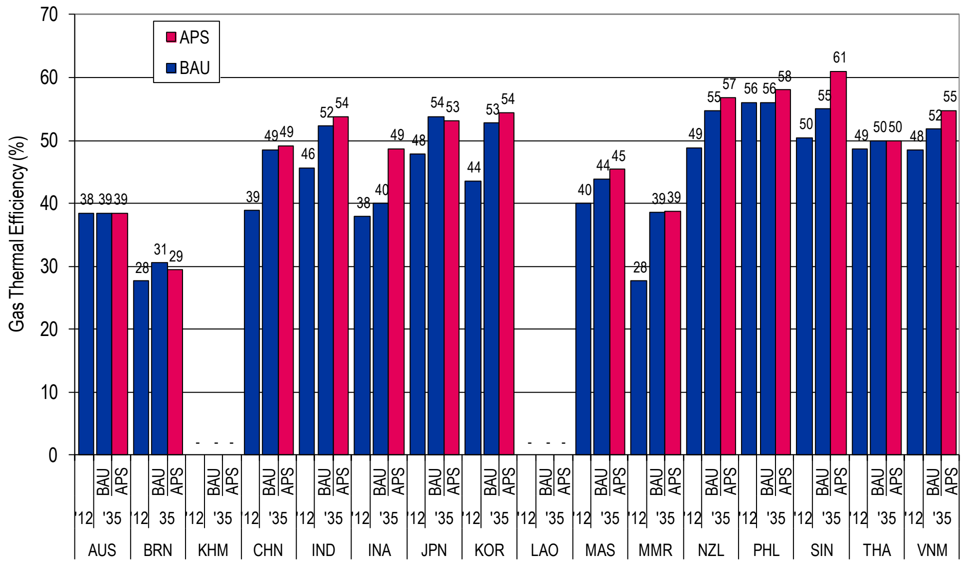
Per capita vehicle ownership is projected to increase in the EAS region. However, vehicle ownership on a per capita basis is projected to vary significantly amongst countries.

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 2012 thermal efficiencies by fuel type (coal, gas, and oil) were derived from International Energy Agency data.[10] Thermal efficiencies by fuel (coal, gas, and oil) were projected by the following countries: Australia, Brunei Darussalam, Indonesia, Japan, Malaysia, Philippines, Singapore, Thailand, and Viet Nam, 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 the IEEJ *Asia/World Energy Outlook 2014.*

Figure 1-6. Thermal Efficiencies of Gas Electricity Generation

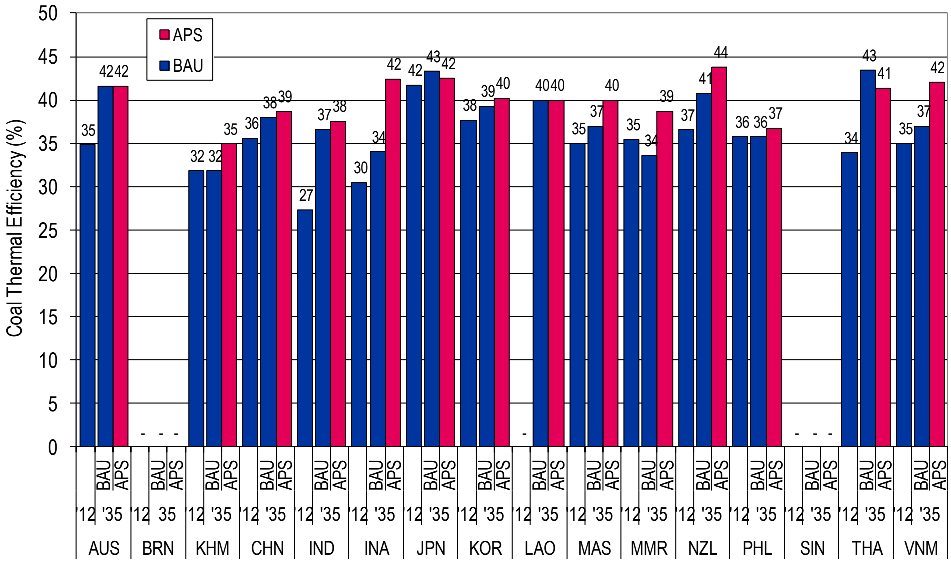


Source: Long-range Energy Alternatives Planning System (LEAP)'s database

Thermal efficiencies may differ significantly between countries due to differences in technological availability, age, 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-fired power plants become available. In many countries, there are also assumed to be additional improvements in the APS (Figures 1-6 and 1-7).

[10] IEA (2011).

Figure 1-7. Thermal Efficiencies of Coal Electricity Generation

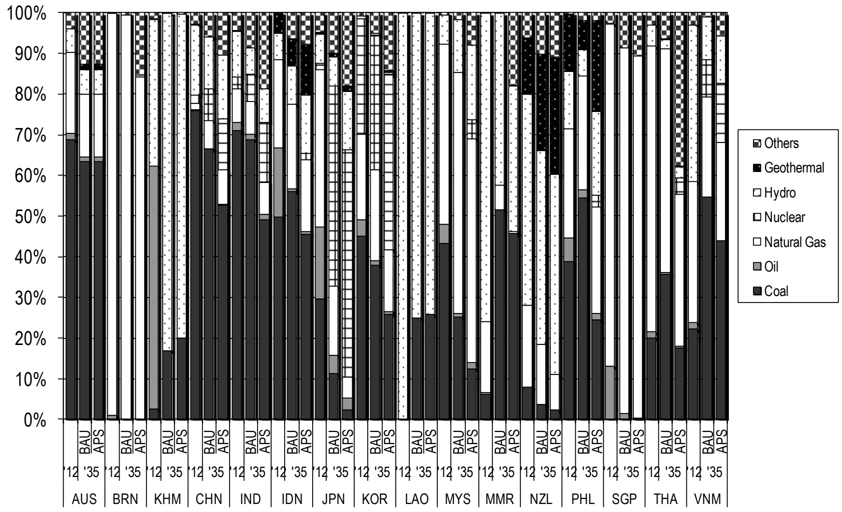


BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Long-range Energy Alternatives Planning System (LEAP)'s database.

3.4.2. Electricity Generation Fuel Mix

The combination of fuels used in electricity generation differs amongst 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. The projected electricity generation mix is shown in Figure 1-8.

Figure 1-8. Share of Fuel Type in the Electricity Generation Mix in the EAS Region



EAS = East Asian Summit.
Source: Country Energy Saving Potential Report_ sub report of this main report, 2015.

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 60.0 percent in the BAU scenario to about 45.0 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 hydro, nuclear, and non-hydro renewable energy are expected to be higher than in the BAU scenario on average in the EAS region. The use of oil in electricity generation is assumed to decline to almost negligible levels across the EAS region as a whole.

3.4.3 Access to Electricity

Currently, many households in developing countries lack access to electricity, and eliminating this situation is a major development goal. At the Working Group 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 Working Group 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 2014.* Table 1-3 summarises the assumptions regarding use of biofuels.

Table 1-3. Assumptions on Biofuels – Summary by Country

Country	Period	Assumptions
Australia		No targets on biofuels.
Brunei Darussalam		No targets on biofuels.
Cambodia		No targets on biofuels.
China	2030	BAU: 20 billion litres, APS 60 billion litres
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	Utilise bio-fuels equivalent to 10% of road transport fuels
Malaysia	2030	Replace 5% of diesel in road transport with biodiesel
Myanmar	2020	Replace 8% of transport diesel with biodiesel.
New Zealand	2012–2030	Mandatory biofuels sales obligation of 3.4% by 2012.
Philippines	2025–2035	BAU: The Biofuels Law requires 10% bio-ethanol/gasoline blend and 2% biodiesel/diesel blend 2 years from enactment of the law (roughly 2009). APS: Displace 20% of diesel and gasoline with biofuels by 2025
Thailand		Biofuels to displace 12.2% of transport energy demand
Viet Nam	2020	10% ethanol blend in gasoline for road transport

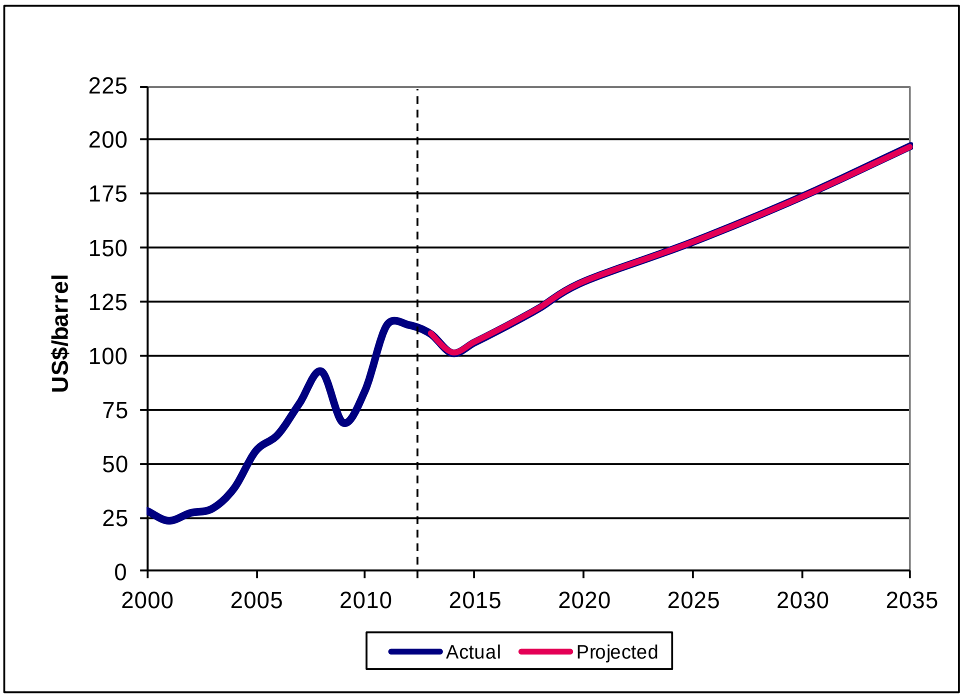
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Country Energy Saving Potential Report_ sub report of this main report, 2015.

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 US$), is assumed to increase from about US$88 a barrel in 2011 to US$197 a barrel in 2035 (Figure 1-). This projection is similar to the trend of the oil price assumption in Asia/World Energy Outlook 2014 of the Institute of Energy Economics, Japan.

Figure 1-9. Nominal Oil Price Assumptions to 2035



Source's Author's calculation in line with IEEJ's assumption of oil price assumptions.

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 Working Group members from the 16 EAS countries. Each Working Group 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 shows the summary of energy saving goals, action plans, and policies collected from each EAS Working Group member in 2014.

Table 1-4. Summary of Energy Saving Goals, Action Plans, and Policies Collected from Each EAS Working Group Member

	Indicator	Goal
Australia	Carbon Pollution	5% reduction below 2000 level by 2020
Brunei Darussalam	Energy Intensity	45% improvement by 2035 from 2005 level
Cambodia	Final Energy Demand	10% reduction of BAU by 2030
China	Energy Intensity	16% improvement during the 12th 5-year plan (2011–2015)
India	Not submitted	•
Indonesia	Energy Intensity	Reduce by 1% /year until 2025
Japan	Energy Intensity	30% improvement in energy intensity in 2030 from 2003 level
Korea, Rep. of	Energy Intensity	46.7% reduction by 2030 from 2006 level
Lao PDR	Final Energy Demand	10% reduction from BAU by 2030
Malaysia	Final Energy Demand	8.6% reduction from BAU by 2020
Myanmar	TPES	• 5% reduction from BAU by 2020 • 10% reduction from BAU by 2030 (Final energy consumption: 5% by 2020 and 8% by 2030).
New Zealand	Energy Intensity	1.3% per year improvement from 2011 to 2016
Philippines	Final Energy Demand	10% savings from BAU by 2030
Singapore	Energy Intensity	• 20% reduction by 2020 from 2005 level • 35% reduction by 2030 from 2005 level
Thailand	Energy Intensity	• 15% reduction by 2020 from 2005 level • 25% reduction by 2030 from 2005 level
Viet Nam	Final Energy Consumption	• 3%–5% saving from BAU until 2015 • 5%–8% saving from BAU after 2015

EAS = East Asian Summit; BAU = Business-as-Usual.
Source: Ito, K. et al (2014).

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 2012 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 4.3, 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

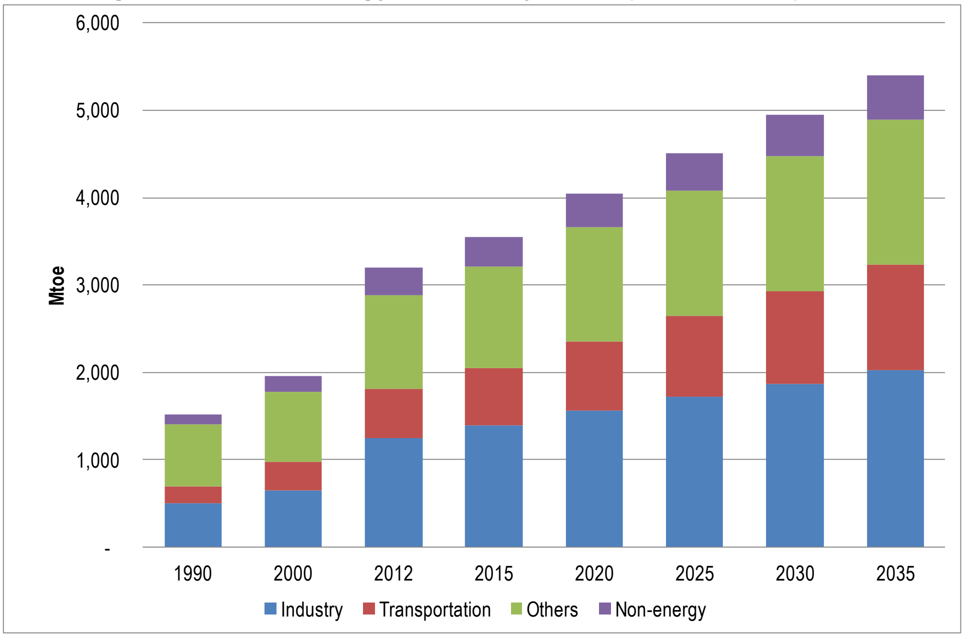
4.1. Business-as-Usual (BAU) Scenario

4.1.1. Final Energy Demand

Between 2012 and 2035, total final energy demand[11] in the 16 EAS countries is projected to grow at an average annual rate of 2.3 percent, reflecting the assumed 4.0 percent annual GDP growth and 0.6 percent population growth. Final energy demand is projected to increase from 3196 Mtoe in 2011 to 5405 Mtoe in 2035. Transport sector demand is projected to grow most rapidly, increasing by 3.4 percent per year, as a result of motorisation driven by increasing disposable income as EAS economies grow. The commercial and residential ('Others') sectors' demand will grow 1.9 percent per year slower than that of the industry sector. Energy demand in the industry sector is projected to grow at an average annual rate of 2.1 percent. Figure 1-10 shows final energy demand by sector under BAU in EAS, from 1990 to 2035.

[11] Refers to energy in the form in which it is actually consumed, that is, including electricity, but not including the fuels and/or energy sources used to generate electricity.

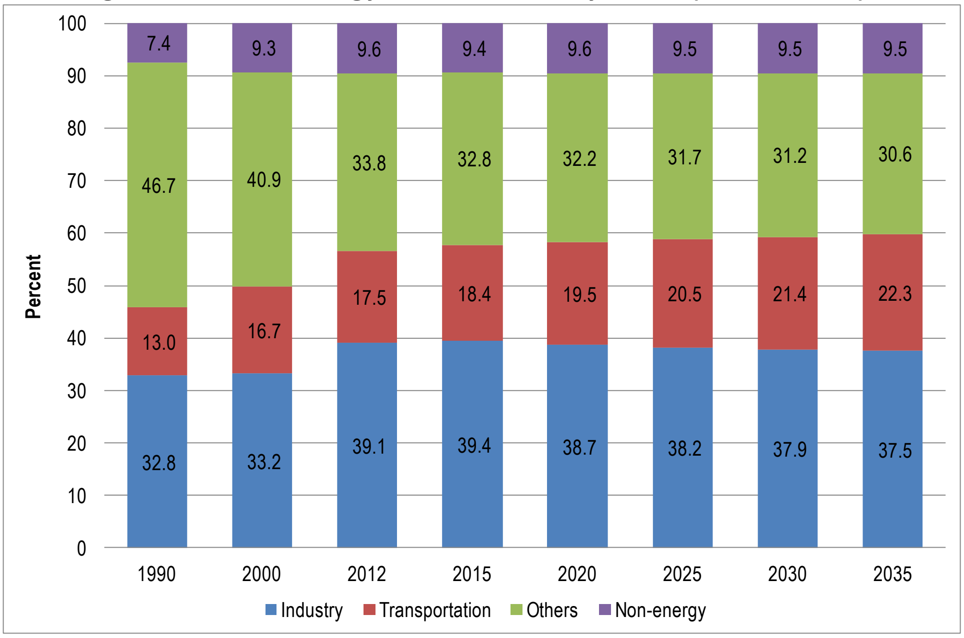
Figure 1-10. Final Energy Demand by Sector (1990 to 2035), BAU



BAU = Business-as-Usual.
Source: Author's calculation.

There will be a slight change in the shares of the sectors in final energy demand from 2012 to 2035, with the transport sector projected to have an increasing share and the industrial and other (largely residential and commercial) sectors decreasing shares. The industrial sector's share will decrease slightly, from 39.1 percent in 2012 to 37.5 percent in 2035. The other sectors' share will significantly decrease, from 33.8 percent to 30.6 percent during the same period. The share of transport sector, on the other hand, will increase from 17.5 percent to 22.3 percent from 2012 to 2035. The share of non-energy demand will remain at around 9.5 percent during the same period. The sectoral shares in final energy demand are shown in Figure 1-11.

Figure 1-11. Final Energy Demand Share by Sector (1990 to 2035)

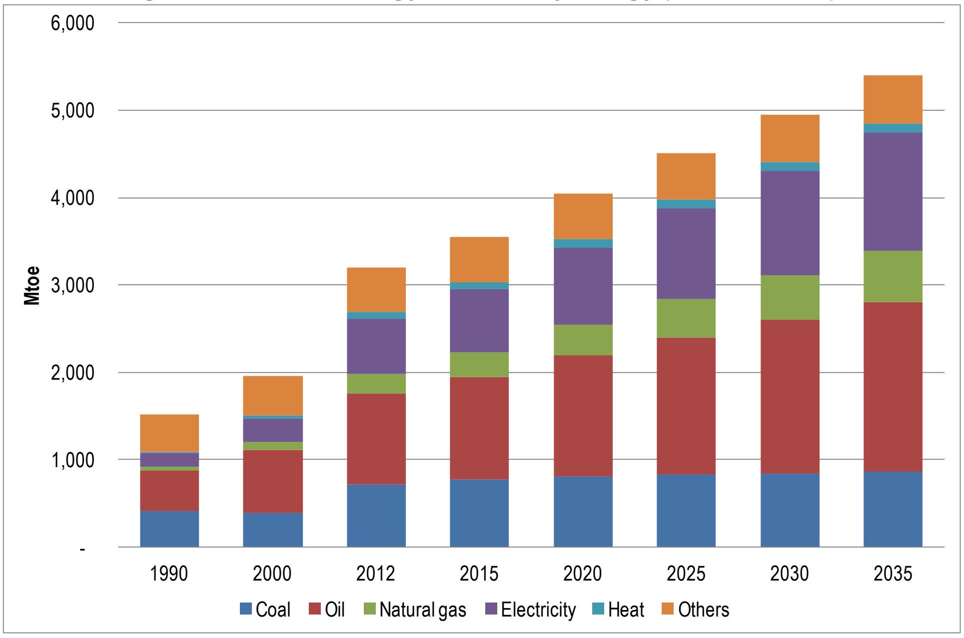


Source: Author's calculation.

For the energy sources, natural gas demand in the BAU scenario is projected to show the fastest growth, increasing by 4.3 percent per year, from 223 Mtoe in 2012 to 590 Mtoe in 2035. Although oil will retain the largest share of total final energy demand, it is projected to grow at a much lower rate of 2.7 percent per year, reaching 1942 Mtoe in 2035, compared with average annual growth of 3.8 percent over the last two decades. However, its share will still increase from 32.7 percent in 2012 to 35.9 percent in 2035. Demand for electricity will grow at a relatively fast rate of 3.4 percent per year. Its share will increase from 19.7 percent in 2012 to 25.0 percent in 2035, surpassing the share of coal. The growth in coal demand will grow at a slower rate of 0.8 percent per year on average. Other fuels, which are mostly solid and liquid biofuels, will have a slow annual growth rate of 0.4 percent on average, but consumption of liquid biofuels will grow rapidly. Consequently, the share of other fuels will decline from 15.8 percent in 2012 to 10.2 percent in 2035. This slow growth is due to the gradual shift from non-commercial biomass to conventional fuels like liquefied petroleum gas (LPG and electricity in the residential sector.

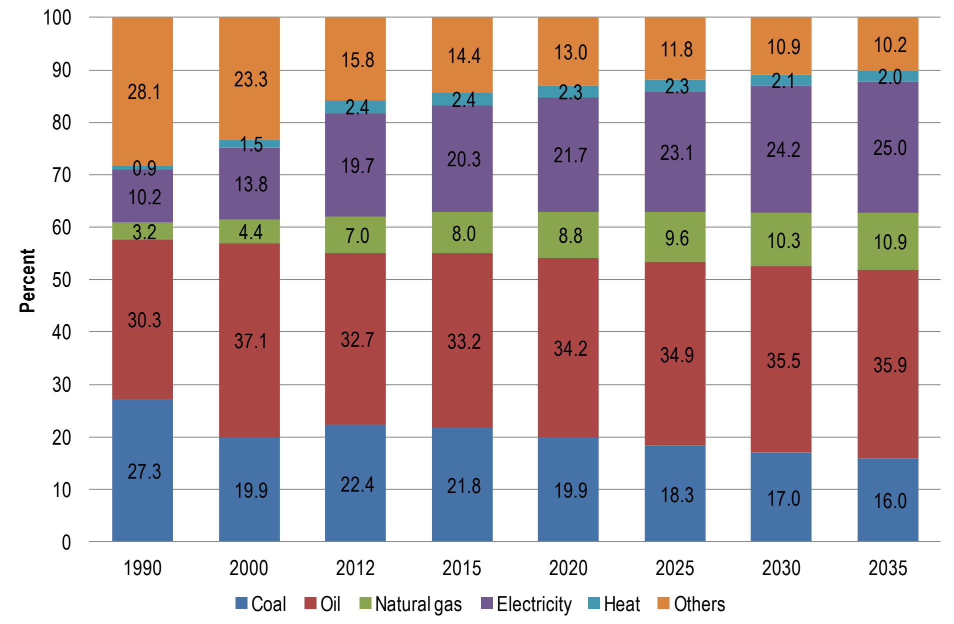
Figures 1-12 and 1-13 show the final energy demand and shares by energy in the EAS under the BAU from 1990 to 2035.

Figure 1-12. Final Energy Demand by Energy (1990 to 2035)



Source: Author’s calculation.

Figure 1-13. Final Energy Demand Share by Energy (1990 to 2035)



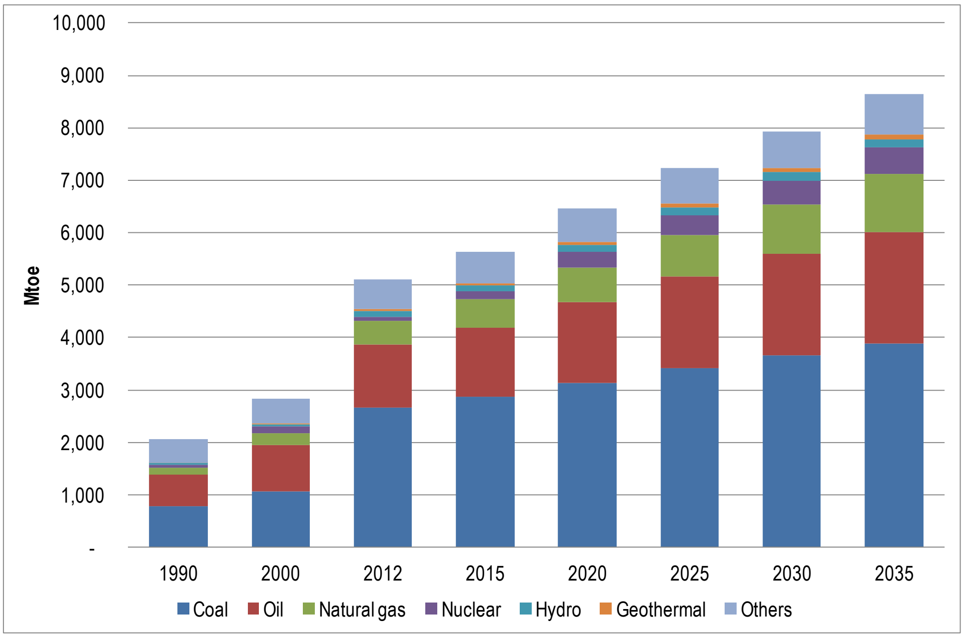
Source: Author's calculation.

4.1.2. Primary Energy Demand

Primary energy demand[12] in EAS is projected to grow at a similar pace, of 2.3 percent per year, as final energy demand. EAS primary energy demand is projected to increase from 5,106 Mtoe in 2012 to 8,635 Mtoe in 2035. Coal will remain the largest share of primary demand, but its growth is expected to be slower, increasing at 1.7 percent per year. Consequently, the share of coal in total primary energy demand is forecast to decline from 52 percent in 2012 to 44.9 percent in 2035. Figure 1-14 shows primary energy demand from 1990 to 2035.

[12] Refers to energy in its raw form, before any transformations, most significantly the generation of electricity.

Figure 1-14. Primary Energy Demand in EAS (1990 to 2035)

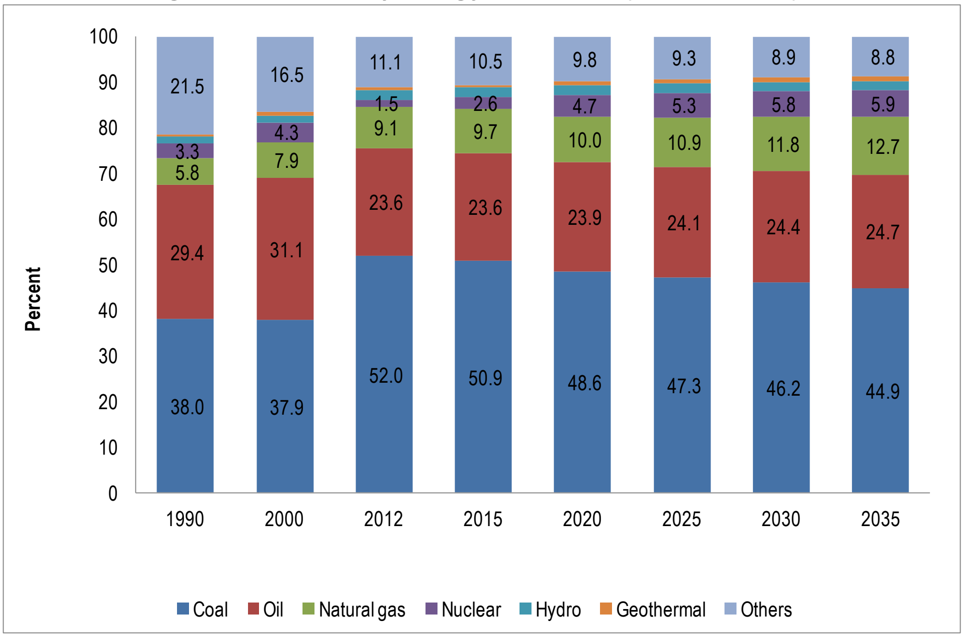


EAS = East Asian Summit.
Source: Author's calculation.

Amongst fossil sources of energy, natural gas is projected to show the fastest growth between 2012 and 2035, increasing at an annual average rate of 3.8 percent. Its share in the total will consequently increase from 9.1 percent in 2012 to 12.7 percent in 2035. Nuclear energy is also projected to increase at a rapid rate of 8.5 percent per year on average and its share will improve from 1.5 percent in 2012 to 5.9 percent in 2035. This is due to the assumed resumption of nuclear power generation in Japan, the expansion of power generation capacity in China and India, and the introduction of this energy source in Viet Nam.

Amongst the energy sources, 'Others' – which is made up of solar, wind, and solid and liquid biofuels – will see the slowest growth rate, of 1.3 percent. Consequently, the share of these other sources of energy will decrease from 11.1 percent in 2012 to 8.8 percent in 2035. Geothermal energy will increase at a rapid pace of 4.2 percent per year, but its share will remain low and will only reach 1.1 percent in 2035, a slight increase from 0.7 percent in 2012. The growth of hydro will be 2.0 percent per year and its share will remain low, at around 2.0 percent from 2012 to 2035. Figure 1-15 shows the shares of each energy source in the total primary energy mix from 1990 to 2035.

Figure 1-15. Primary Energy Mix in EAS (1990 to 2035)

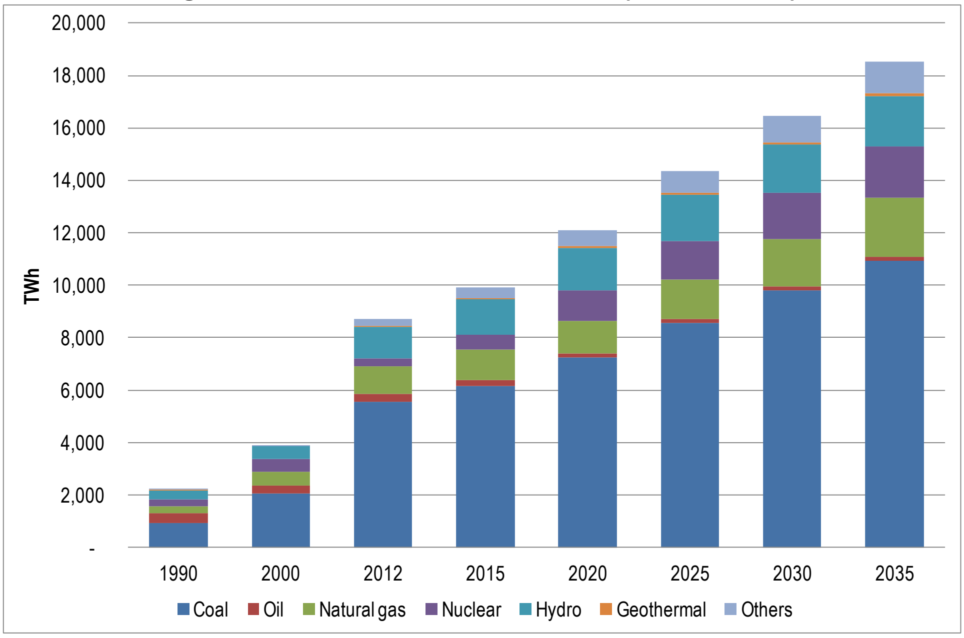


EAS = East Asian Summit.
Source: Author's calculation.

4.1.3. Power Generation

Power generation in EAS is projected to grow at 3.3 percent per year on average from 2012 (8,717 TWh) to 2035 (18,530 TWh), slower than the 6.5 percent annual rate of growth from 1990 to 2012 (Figure 1-16).

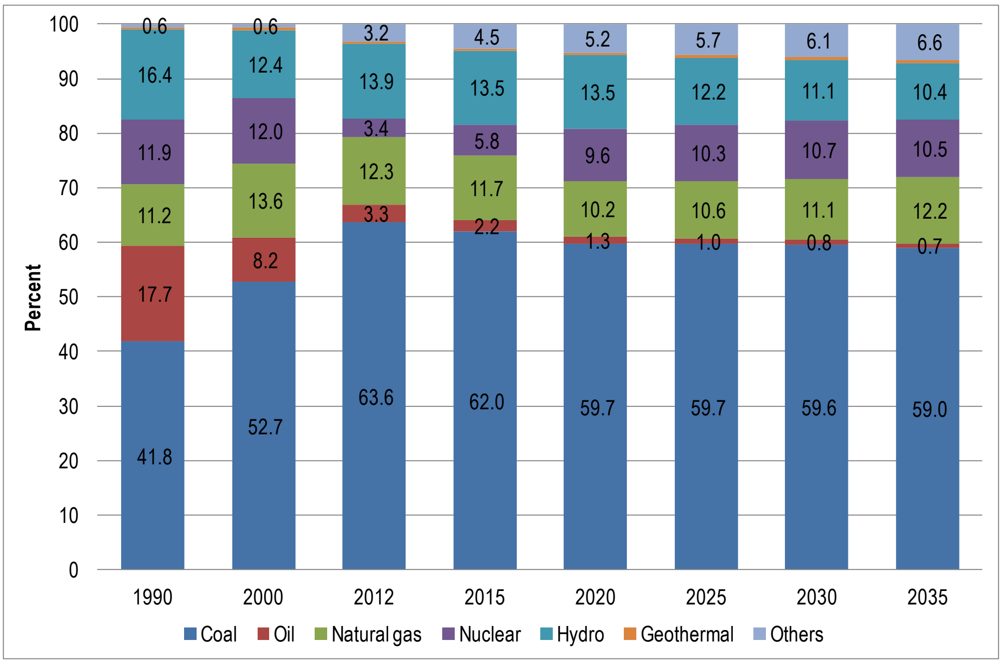
Figure 1-16. Power Generation in EAS (1990 to 2035)



EAS = East Asian Summit.
Source: Author's calculation.

The share of coal–fired generation is projected to continue to be the largest and will remain about 60 percent of the total until 2035. The share of natural gas is projected to be stable at around 12.0 percent from 2012 to 2035. The nuclear share (3.4 percent in 2012) is forecast to increase to 10.5 percent in 2035, in the assumption that nuclear power plants in Japan will resume operation, and due to an increase in generating capacities in China and the introduction of nuclear energy in Viet Nam. Geothermal (0.3 percent in 2012) and other (wind, solar, biomass, etc., at 3.2 percent) shares will also increase, to 0.6 percent and 6.6 percent in 2035, respectively. The shares of oil and hydro are projected to decrease slightly, from 3.3 percent to 0.7 percent, and from 13.9 percent to 10.4 percent, respectively, during the same period. Figure 1-17 shows the shares of each energy source in electricity generation from 1990 to 2035.

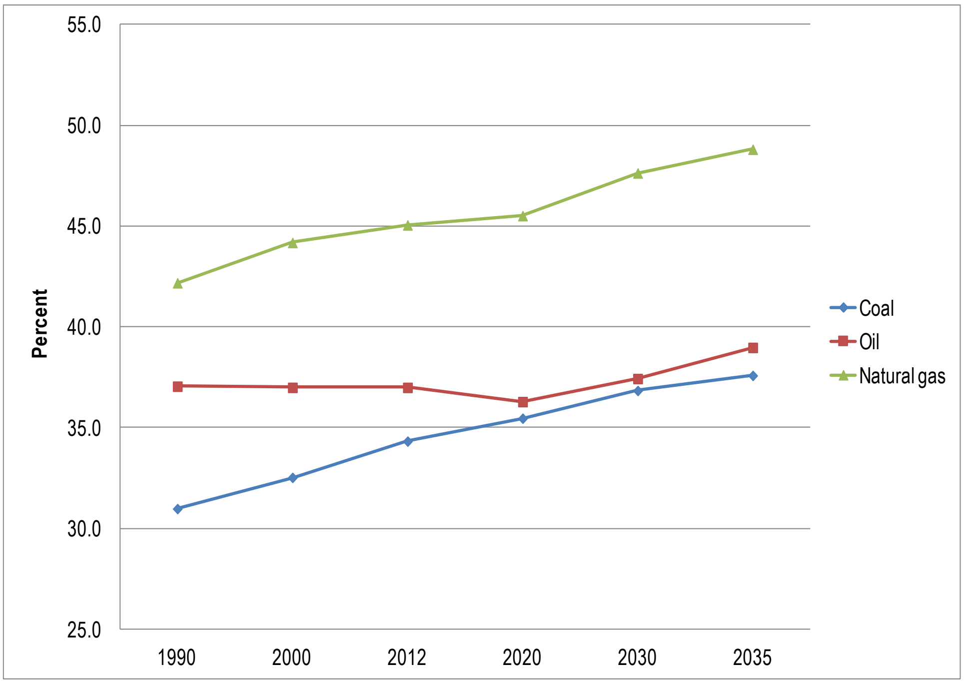
Figure 1-17. Power Generation Mix in EAS (1990 to 2035)



EAS = East Asian Summit.
Source: Author's calculation.

Thermal efficiency is projected to grow in EAS from 2012 to 2035 due to improvement in electricity generation technologies like combined-cycle gas turbines and advanced coal power plant technologies. The efficiency of coal thermal power plants, which is a mix of old and new power plants, will increase from 34.3 percent in 2012 to 37.6 percent in 2035. The efficiency of natural gas power plants will also increase, from 45.1 percent in 2012 to 48.8 percent in 2035. Even oil power plants, which will not be used significantly in the future, will see an improvement in efficiency, from 37.0 percent in 2012 to 39.0 percent in 2035. Figure 1-18 shows the thermal efficiency of coal-, oil-, and natural gas-fired power plants from 1990 to 2035.

Figure 1-18. Thermal Efficiency by Fuel, BAU (1990 to 2035)

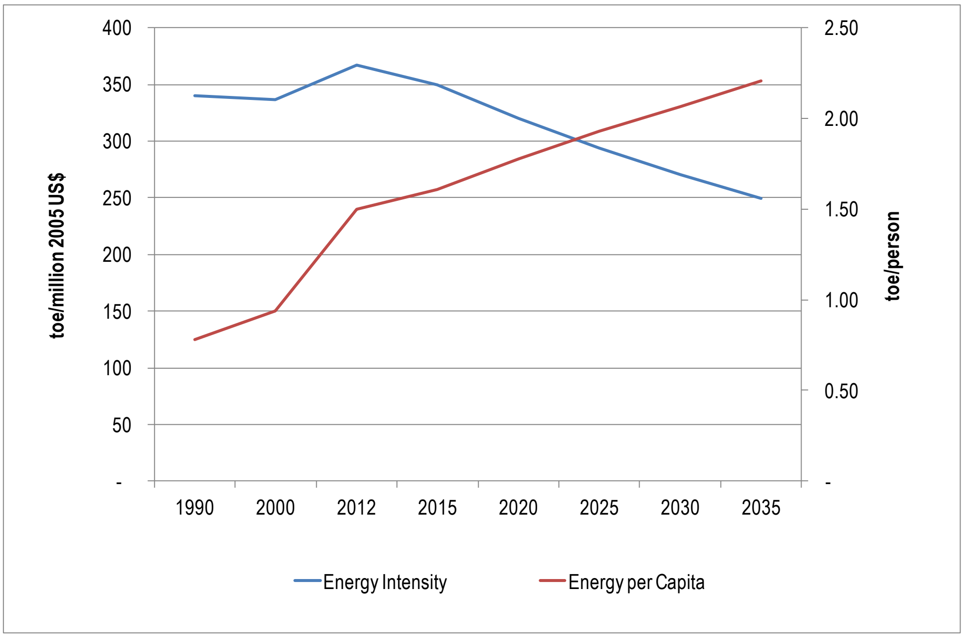


BAU = Business-as-Usual.
Source: Author's calculation.

4.1.4. Primary Energy Intensity and Per Capita Energy Demand

Even in the BAU, energy intensity in EAS is projected to decline, from 365 toe/million US$ (constant 2005) in 2012 to 250 toe/million US$ in 2035. In contrast, energy demand per capita is projected to continue to increase, from 1.5 toe per person in 2012 to 2.2 toe per person in 2035. This could be attributed to the projected continuing economic growth in the region, which will bring about a more energy-intensive lifestyle as people are able to purchase vehicles, household appliances, and other energy consuming devices as disposable income increases. Figure 1-19 shows the energy intensity and energy per capita from 1990 to 2035.

Figure 1-19. Energy Intensity and Per Capita Energy Demand in EAS

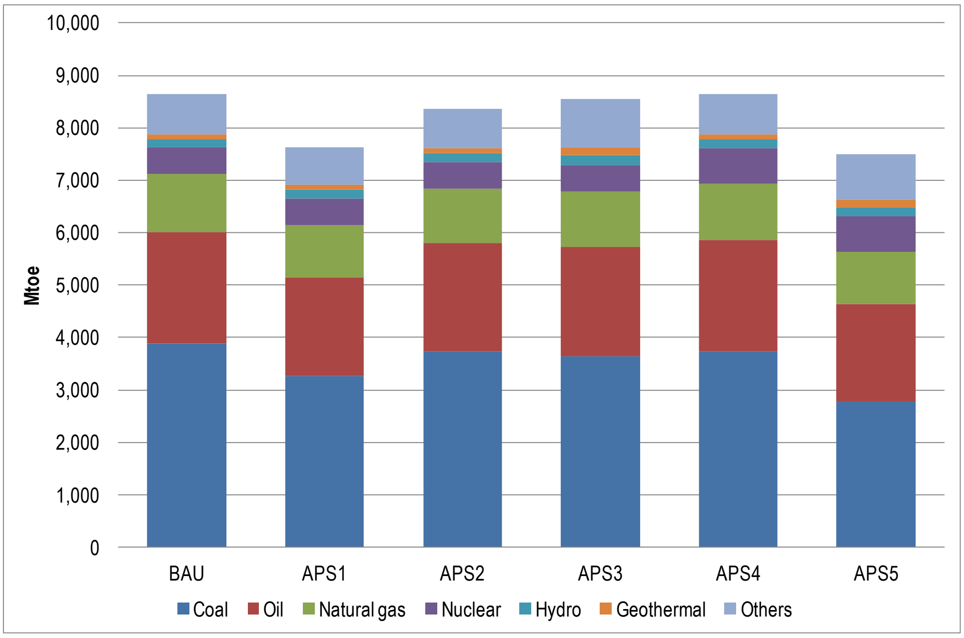


EAS = East Asian Summit.
Source: Author's calculation.

4.2. Alternative Policy Scenario (APS)

As mentioned above, the assumptions in the APS were analysed separately to determine the individual impacts of each assumption in APS1, APS2, APS3, APS4, and the combination of all these assumptions (APS or APS5). Figure 1-20 shows the total primary energy supply in all the scenarios.

Figure 1-20. Total Primary Energy Supply in EAS in 2035 (All Scenarios)



EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

APS1 and APS5 have the largest reduction in total primary energy supply due to the energy efficiency assumptions on the demand-side. Energy efficiency assumptions in APS1 could reduce total primary energy supply in BAU by as much as 973 Mtoe or 11.3 percent. This energy saving is more than two times the consumption of Japan in 2012.

APS2, which assumes higher efficiency in thermal electricity generation, has a lower impact than APS1. This is due to the assumptions that only the newly constructed power plants will have higher efficiency. It is expected that existing power plants will continue to operate until the end of their lifetimes. This is why, only 268 Mtoe or 3.1 percent of the total primary energy supply in the BAU could be saved in this scenario. This energy saving is almost equal to the total primary energy consumption of South Korea in 2012.

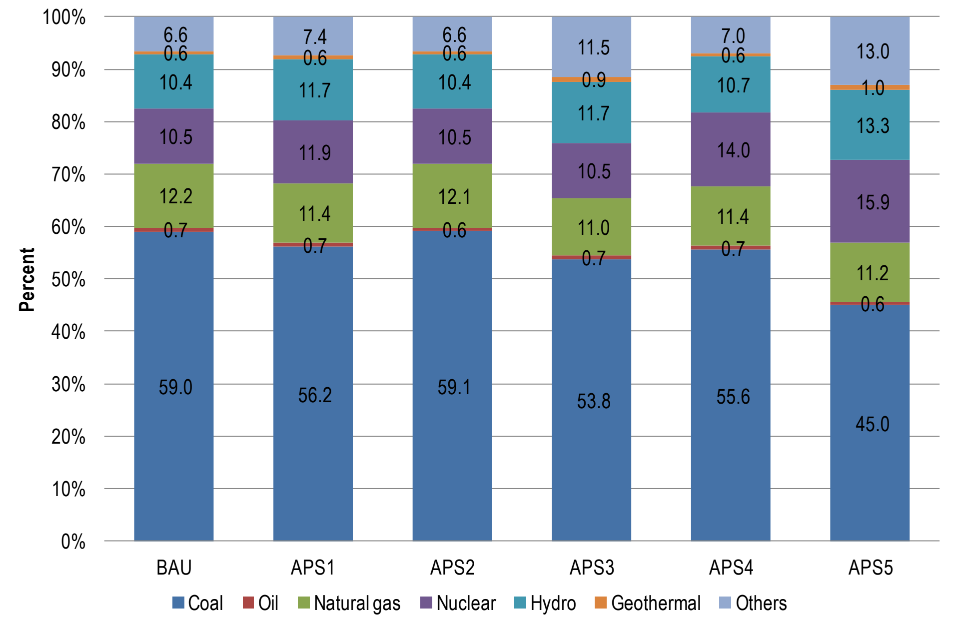
APS3 assumes higher penetration of renewable energy in electricity generation and higher consumption of biofuels in the transportation sector. Like APS2, there is only a small reduction in the BAU value of 255 Mtoe or a 3.0 percent reduction. Although hydro, solar, and wind energy are assumed to have 100 percent thermal efficiency when converted to primary energy, the contributions of these energy sources were dwarfed by the contribution of biomass and geothermal energy, which have lower thermal efficiency than the fossil-fired electricity generation that was replaced in this scenario. However, this 3.0 percent reduction in primary energy consumption can result in a 5.1 percent reduction in BAU CO_2 emission.

APS4 assumes a higher contribution of nuclear energy in power generation. In this scenario, the total primary energy supply is just 6.4 Mtoe or 0.01 percent lower than the total primary energy supply in the BAU. This is due to the relatively lower thermal efficiency of nuclear power generation (33 percent) compared with new coal- and natural gas-fired power plants. However, due to the reduction in fossil fuels that would be replaced by nuclear energy, there could be a 2.9 percent reduction in the BAU CO_2 emission in this scenario.

Figure 1-21 shows the total electricity generation mix in EAS in 2035 in all scenarios. In APS1, due to lower electricity demand, the shares of fossil-fired electricity generation could be lower than in the BAU scenario. In APS2, the shares are almost the same as those of the BAU. In APS3, due to the assumption of more renewable energy, fossil fuel-fired generation could be reduced by 9.1 percent whereas in APS4, nuclear energy could reduce fossil fuel share by 5.9 percent. In APS5, reduction in fossil energy-based generation could be reduced by as much as 30.6 percent.

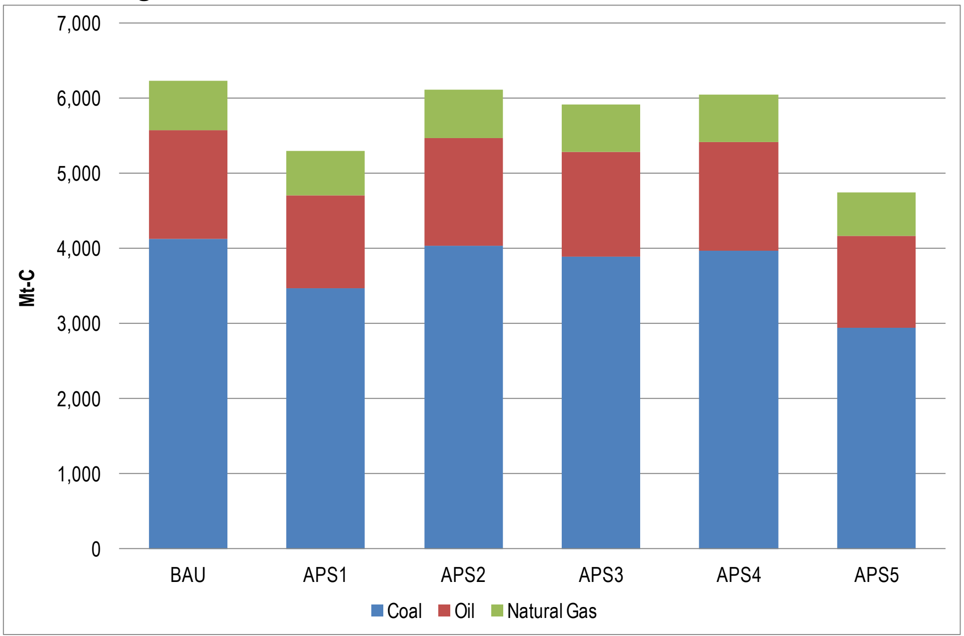
In terms of CO_2 emission reduction, the energy efficiency assumption in APS1 could reduce emissions in the BAU by 15.0 percent in 2035. In APS2, the installation of more efficient new power plants is able to reduce emissions by 1.9 percent. Higher contributions from renewable energy could reduce emissions by 5.1 percent whereas a higher contribution from nuclear energy could result in an emission reduction of 2.9 percent. All these assumptions combined could reduce BAU CO_2 emissions by 23.8 percent in 2035. Figure 1-22 shows the estimated CO_2 emissions in all the analysed scenarios.

Figure 1-21. Electricity Generation in 2035 in EAS in All Scenarios



EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

Figure 1-22. Total EAS CO_2 Emissions in 2035 in All Scenarios



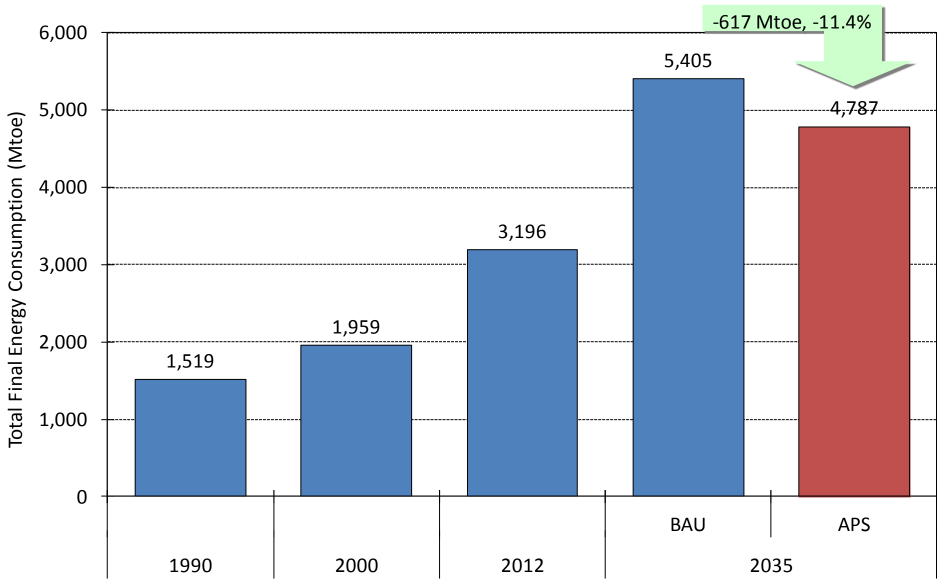
EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

The more detailed analysis of the differences between the BAU and the APS follows below.

4.2.1. Total Final Energy Demand

In the APS case, final energy demand is projected to rise to 4,787 Mtoe, 617 Mtoe or 11.4 percent lower than in the BAU case in 2035. This is due to the various energy efficiency plans and programmes, presented in Section 3 above, in both the supply and demand sides that are to be implemented by EAS countries. Figure 1-23 shows the evolution of final energy demand from 1990 to 2035 in both the BAU and APS scenarios.

Figure 1-23. Total Final Energy Demand, BAU and APS

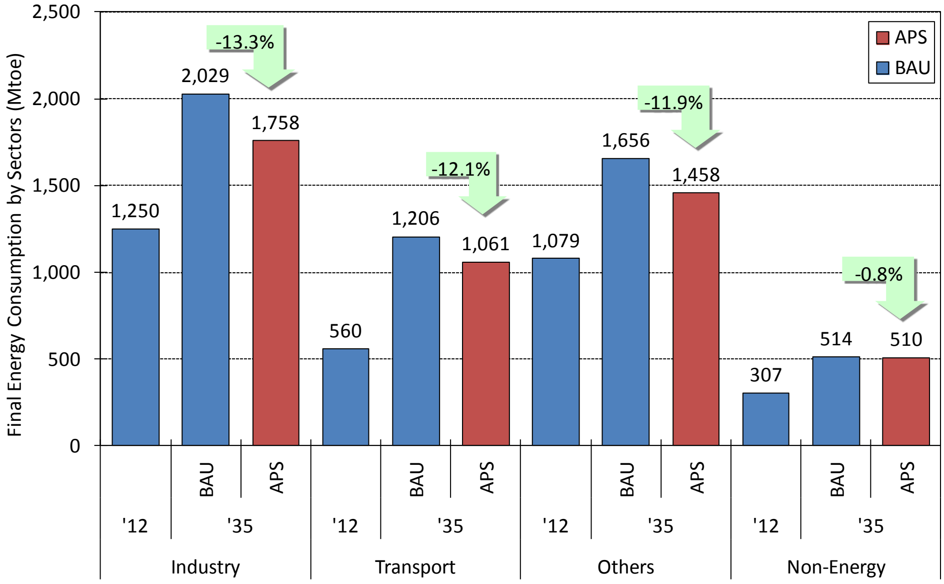


BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.2. Final Energy Demand by Sector

Figure 1-24 shows the composition of final energy demand by sector in both the BAU and APS. Final energy demand in most sectors is significantly reduced in the APS case compared with the BAU case. In percentage terms, the reduction is largest in the industry sector (13.3 percent), followed by the transport sector (12.1 percent), and the others sector (11.9 percent). Non-energy demand will not be significantly different from the BAU.

Figure 1-24. Final Energy Demand by Sector, BAU and APS

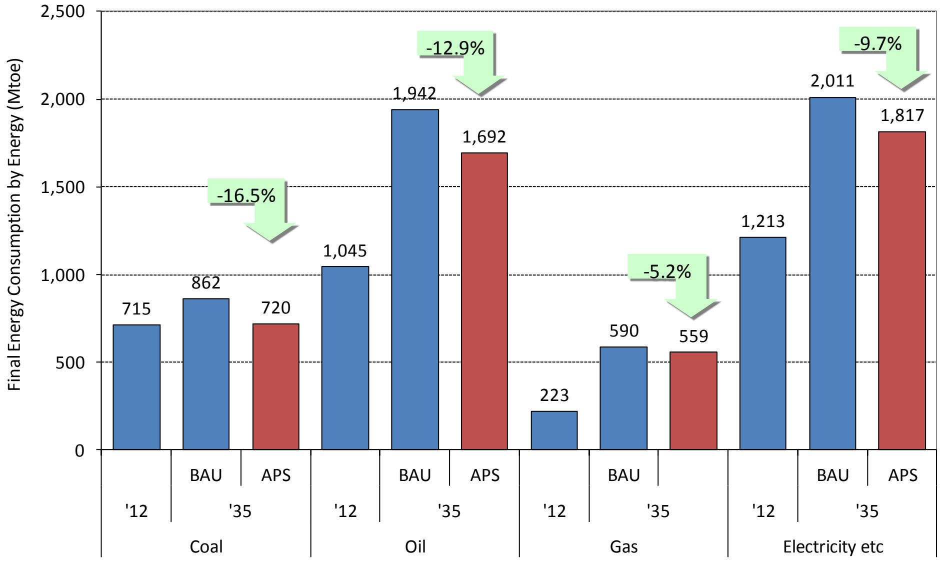


EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.3. Final Energy Demand by Fuel

Figure 1-25 shows final energy demand by type of fuel. In the APS case, growth in final demand for all fuels is lower compared with the BAU case. The growth rate of 1.8 percent per year on average is lower than the BAU's 2.3 percent growth rate. The largest reduction will be in oil demand, at 250 Mtoe or 12.6 percent from the BAU's 1,942 Mtoe to 1,692 Mtoe in the APS. This potential saving in oil is equivalent to 59 percent of China's final oil demand in 2012. The saving potential in other fuels, which includes electricity and heat, is the second largest at 194 Mtoe, equivalent to a reduction of 9.7 percent from BAU. This is to be brought about by improvement in the efficiencies of household appliances and more efficient building designs. The saving potential for coal is 142 Mtoe and this will come mostly from energy efficiency in the industrial sector. The saving potential for natural gas is around 31 Mtoe or 5.2 percent from the BAU demand.

Figure 1-25. Final Energy Demand by Fuel, BAU and APS

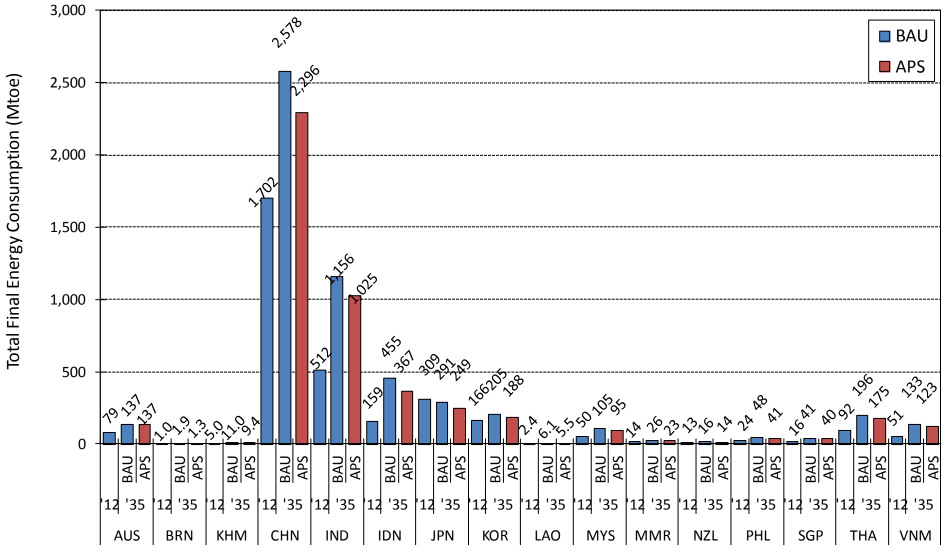


BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.4. Final Energy Demand by Country

Figure 1-26 shows final energy demand by country. The most striking result is that China is projected to continue to dominate the EAS region's final energy demand until 2035. China is projected to account for about 48.0 percent of the EAS region's final energy demand in 2035, down from about 53.3 percent in 2012. Just five countries – China, India, Indonesia, Japan, and South Korea – are projected to account for 86.7 percent of the EAS region's 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 82.2 percent of the growth in energy demand for the entire EAS region between 2012 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 82.6 percent of the growth in energy demand in the EAS region between 2012 and 2035.

Figure 1-26. Total Final Energy Demand by Country, BAU and APS

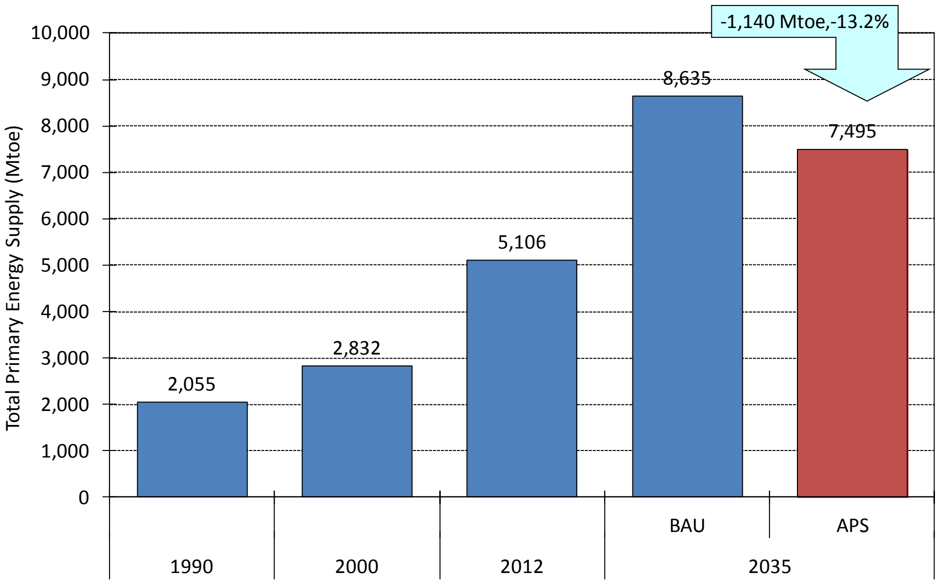


BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.5. Total Primary Energy Demand

The pattern followed by primary energy demand is, as one would expect, similar to final energy demand. Figure 1-27 shows that total primary energy demand is projected to increase from 5,106 Mtoe in 2012 to 8,635 Mtoe in 2035 in the BAU case, an increase on average of 2.3 percent per year. In the APS case, demand is projected to grow to 7,495 Mtoe by 2035, 13.2 percent lower than in the BAU case. The reduction in 2035 primary energy demand in the APS case compared with the BAU case of 1,140 Mtoe is roughly equivalent to 40 percent of China's demand in 2012.

Figure 1-27. Total Primary Energy Demand, BAU and APS



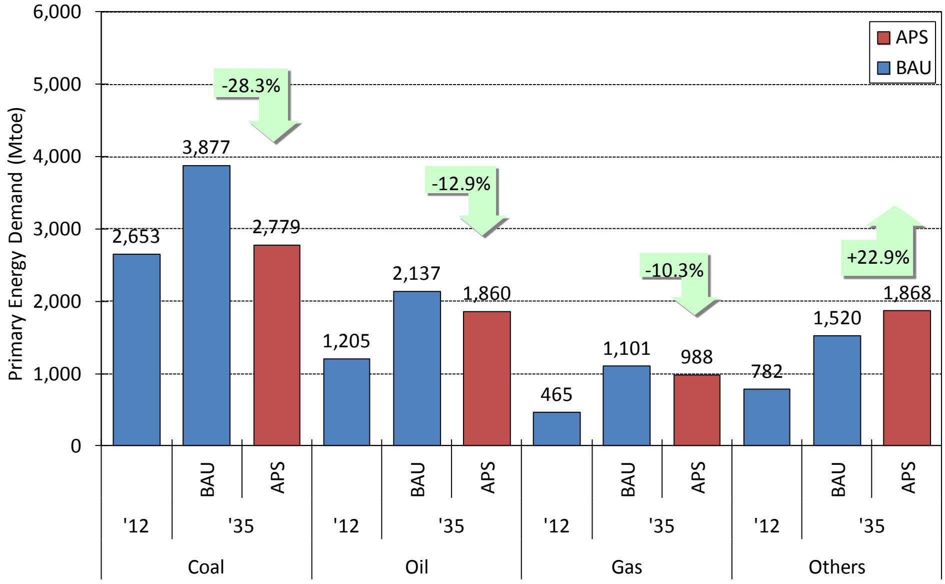
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.6. Primary Energy Demand by Source

In the APS scenario, growth in coal, oil, and natural gas primary demand is projected to be considerably lower than the BAU. Coal demand for example, will be 28.3 percent lower in the APS or equivalent to 1,098 Mtoe, 41.4 percent of EAS coal demand of 2,653 Mtoe in 2012. This reflects a shift from coal-fired electricity generation to nuclear and renewable energy in the APS case. Demand for oil will also be lower in the APS, by 277 Mtoe or 12.9 percent. This is due to the combined effect of more efficient vehicles and the utilisation of alternative fuels in the transport sector, such as natural gas, electricity, and biofuels. The demand for natural gas will also be lower in the APS, at 10.3 percent of the BAU, equivalent to 113 Mtoe. This is mainly due to reduced electricity demand in the APS and the introduction of more efficient power generation technologies and alternative fuels such as nuclear, solar, and wind energy. Other fuels, which include these alternative energy sources, on the other hand, will be 22.9 percent higher in the APS than in BAU.

Figure 1-28 shows primary energy demand by energy source in both scenarios.

Figure 1-28. Primary Energy Demand by Source, BAU and APS

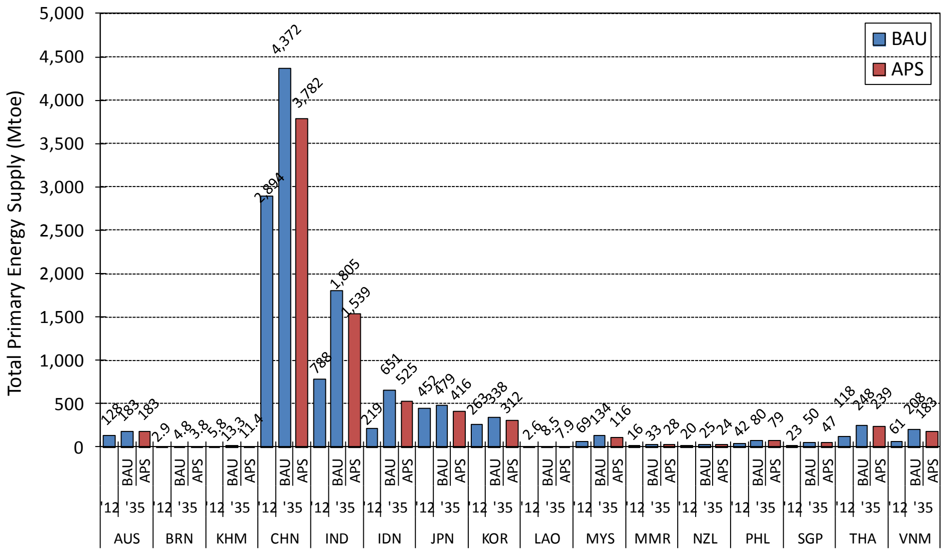


EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.7. Primary Energy Demand by Country

Figure 1-29 shows primary energy demand by country, which is similar to the pattern for final energy demand by country shown in Figure 1-. Five countries – China, India, Indonesia, Japan, and South Korea – are projected to account for 88.6 percent of the EAS region's primary energy in 2035. The 'big three' – China, India, and Indonesia – will dominate the growth in the EAS region's primary energy, accounting for 83.0 percent of growth between 2012 and 2035. In the APS case, growth in primary energy demand in most countries is significantly lower, but the dominance of demand by five countries and the relative importance of the growth in three countries remain unchanged.

Figure 1-29 Primary Energy Demand by Country, BAU and APS



EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.8. Primary Energy Intensity by Country

In Table 1-5, the impacts of the energy saving goals and policies submitted by each Working Group member on energy intensities are summarised. It should be noted that these results are illustrative of the potential energy savings that can be achieved and should not be interpreted as official country projections.

Table 1-5. Quantitative Impact of Energy Saving Goals and Policies: Illustrative Impacts

	2012	2035		Variance		
		BAU	APS	APS/BAU	2012/2035 BAU	2012/2035 APS
	(toe/million 2005 US$)	(toe/million 2005 US$)	(toe/million 2005 US$)	%	%	%
Australia	152	123	123	0.0	-18.8	-18.8
Brunei Darussalam	282	156	123	-21.2	-44.6	-56.3
Cambodia	579	324	277	-14.3	-44.1	-52.1
China	640	307	266	-13.5	-52.0	-58.5
India	565	299	255	-14.8	-47.0	-54.9
Indonesia	513	437	352	-19.4	-14.9	-31.4
Japan	98	72	62	-13.2	-26.8	-36.4
Korea	244	166	153	-7.7	-32.3	-37.5
Lao PDR	605	412	382	-7.4	-31.8	-36.9
Malaysia	348	321	277	-13.8	-7.7	-20.4
Myanmar	676	335	285	-15.0	-50.4	-57.8
New Zealand	158	132	124	-5.9	-16.7	-21.6
Philippines	292	144	142	-1.4	-50.5	-51.2
Singapore	119	138	131	-5.1	15.8	9.9
Thailand	520	460	443	-3.8	-11.5	-14.9
Viet Nam	699	597	524	-12.2	-14.7	-25.1
Total	367	250	217	-13.2	-32.0	-40.9

BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

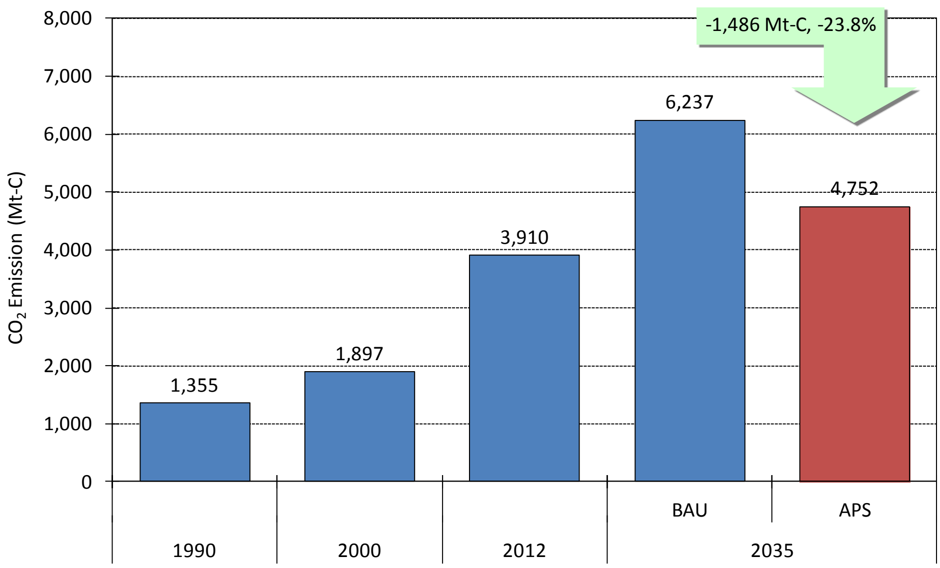
4.3. Carbon Dioxide (CO_2) Emissions from Energy Consumption

4.3.1. CO_2 Emissions

As shown in Figure 1-30, CO_2 emissions from energy consumption in the BAU case are projected to increase from 3,910 million tonnes of Carbon (Mt–C) in 2012 to 6,237 Mt–C in 2035, implying an average annual growth rate of 2.1 percent. This is slightly lower than growth in total primary energy demand of 2.3 percent per year. In the APS case, CO_2 emissions are projected to be 4,752 Mt–C in 2035, 23.8 percent lower than under the BAU scenario.

Although the emission reductions under the APS are significant, CO_2 emissions from energy demand in the APS case in 2035 will still be above 2012 levels and more than three times higher than 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) suggests that to keep the increase in global mean temperature to not more than $2^{o}C$ 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 the levels in 2000 (that is, a reduction of between 50 and 85 percent) by 2050. To keep temperature rises in the $3^{o}C$ range, CO_2 emissions would need to peak between 2010 and 2030 and be at 70 to 105 percent of the levels in 2000 by 2050.[13]

Figure 1-30. Total CO_2 Emissions, BAU and APS



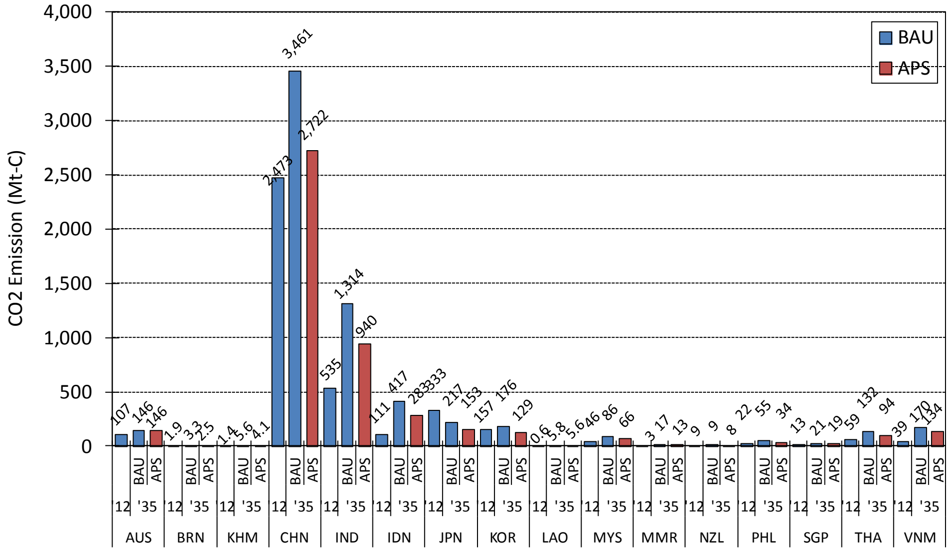
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

[13] 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.

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^{o}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^{o}C, millions of people could experience coastal flooding each year.[14]

As shown in Figure 1-31, emissions and emission growth in the EAS region are projected to be dominated by China and India. In fact, China and India will account for 989 Mt–C and 779 Mt–C, respectively, of the projected 2,328 Mt–C increase in the EAS region's emissions from 2012 to 2035 under the BAU case, or 75.9 percent of total growth in the EAS region. Adding Indonesia's growth of 306 Mt–C, these three countries account for 2,073 Mt–C or 89.1 percent of total growth in the EAS region. No other country will account for growth of more than 132 Mt–C. Japan 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 and increased utilisation of renewable energy.

Figure 1-31. CO_2 Emissions by Country, BAU and APS



EAS = East Asian Summit; BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

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

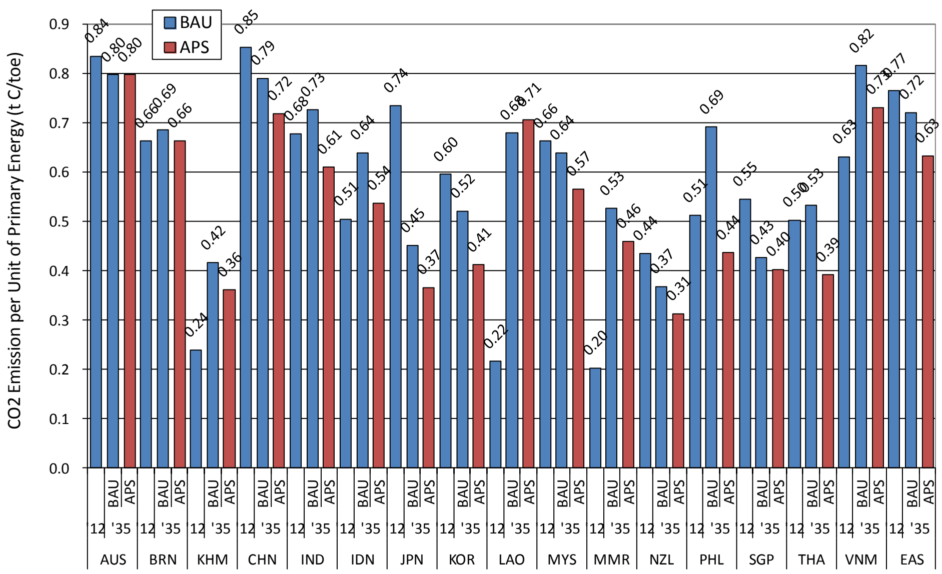
In the APS case, China and India remain dominant, accounting for 249 and 405 Mt–C, respectively, of the projected 842 Mt–C growth in emissions in the EAS region between 2012 and 2035, or 77.8 percent. Adding 171 Mt–C from Indonesia, these three countries account for 826 Mt–C or 98.1 percent of the EAS region total. No other country will account for a growth of more than 96 Mt–C. Emissions from Japan, South Korea, and New Zealand are expected to decline in the APS case relative to 2012 levels, due to effective mitigation policies.

4.3.2. Fundamental Drivers of CO_2 Emissions from Energy Demand

The CO_2 emissions 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 0.72 t–C/toe in 2035 from 0.77 t–C/toe in 2012 under the BAU scenario. In the APS case, this will decline to 0.63 t–C/toe in 2035, equivalent to a decline of 17.2 percent from 2012 (Figure 1-32). The reduction under the APS case reflects a shift away from coal and oil, the two most emission-intensive fuels.

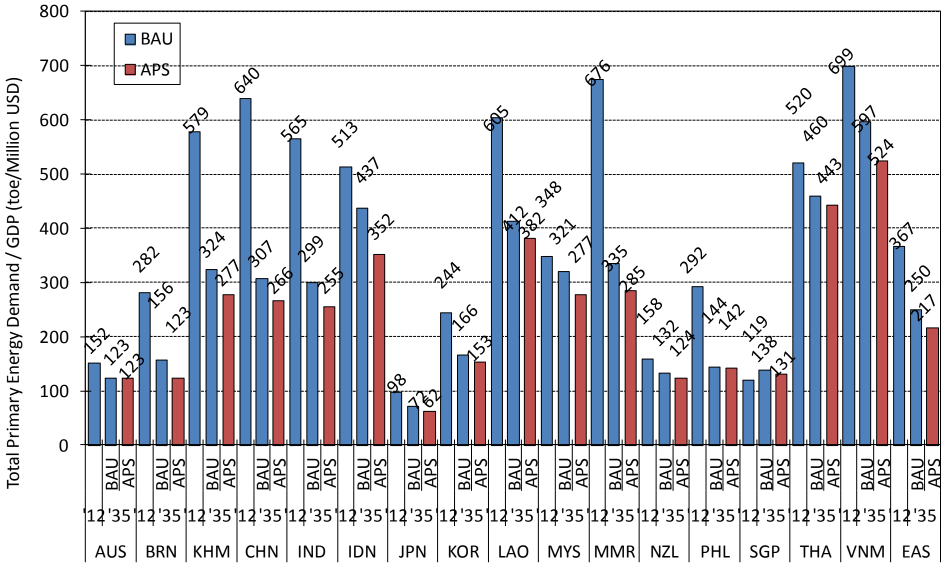
Figure 1-32. Emissions per Unit of Primary Energy, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

ii) Primary energy per unit of GDP is projected to decline from 365 toe/million US$ in 2012 to 250 toe/million US$ in 2035 under the BAU scenario, or by 31.5 percent (Figure 1-33). In the APS case, this will decline to 217 toe/million US$ in 2035, or by 40.6 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 279 t–C/million US$ in 2012 to 180 t–C/million US$ in 2035 under the BAU scenario, or by 35.4 percent. Under the APS, this will decline to 137 t–C/million US$ in 2035, 50.8 percent lower than in 2012.

Figure 1-33. Primary Energy Demand per Unit of GDP, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

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 US$4,100/person in 2012 to 8,800 US$/person in 2035, an increase of 114.7 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 1.1 t–C/person in 2012 to 1.6 t–C/person in 2035 under the BAU scenario, or by 38.7 percent. Under the APS, emissions rise to only 1.2 t–C/person in 2035, or will be 5.6 percent higher than 2012. However, the rising emissions per capita are associated with increases in GDP per capita and improvements in living standards.

iv) Finally, the population in the EAS region is expected to grow from 3,401 million in 2012 to 3,913 million in 2035, or by 15.1 percent. Combined, all these drivers lead to growth in emissions from 3,910 Mt–C in 2012 to 6,237 Mt C in 2035 under the BAU scenario, or a rise of 59.5 percent. Under the APS, emissions grow to 4,752 Mt–C in 2035, or by 21.5 percent.

5. Pilot Survey on Road Transport Sector

5.1. Survey Objective

The objective of the survey was to determine the distance travelled and the fuel economy of each vehicle. From this information, the total fuel consumption can be calculated as follows:

$$FC_i = \Sigma FE_i * ML_i * NV_i$$

Where: FC_i = Fuel consumption of fuel i

FE_i = Fuel economy of vehicle using fuel i (litre/km)

ML_i = distance travelled of vehicle using fuel i (km/vehicle)

NV_i = Number of vehicles using fuel i

i = type of fuel (gasoline, diesel, LPG, CNG, etc.)

5.2. Survey Questionnaire

To obtain the required information, IEEJ designed the questionnaire patterned to the questionnaire used by the Ministry of Land, Infrastructure and Transport of Japan in its monthly survey on road transportation. The questionnaire asks the respondent to record the daily trips of each vehicle and consolidate the total trips in one month. Figure 34 shows the survey questionnaire.

5.3. Survey Methodology

The survey was to be carried out by the members of the ERIA Working Group on the Analysis of Energy Saving Potential in East Asia. The Working Group members were requested to survey colleagues and/or relatives that use personal vehicles. The questionnaires were distributed by the Working Group members to their co-workers and friends.

Figure 1-34. Pilot Survey on Road Transport Questionnaire

Pilot Survey on Road Transport Sector

(This questionnaire should contain the sums of the daily record of trips)

Respondent's Name (optional):	________________________	
Month and Year	________	
Type of Motor Vehicle	☐ Car	☐ Motorcycle
Engine Displacement/Size (cc, liter, etc.)	________	________
Type of Fuel (Gasoline, Diesel, LPG, etc)	________	________
Maker (Toyota, Hyundai, Peugeot, etc.)	________	________
Model	________	________
Odometer Readings:		
Before the first trip of the month	________	________
After the last trip of the month	________	________
Total Distance Travelled (last trip - first trip)	________	________
Amount of fuel Loaded (liters)	________	________
Number of days used:	________	________
Did you use theExpressway?	☐ Yes ☐ No	
Main Purpose of Travel:	☐ going to work ☐ delivering goods ☐ liesure ☐ shopping ☐ Others ________ ________ ________ ________ ________	☐ going to work ☐ delivering good ☐ liesure ☐ shopping ☐ Others ________ ________ ________ ________ ________

Working Group members reported that the respondents complained of the amount of data being collected in the survey. Some respondents do not have data on the odometer readings as the odometers were intentionally disabled for unspecified reasons.

5.4. Results of the Survey

The pilot survey produced some results, as shown in the Table 1-6 below:

Table 1-6. Results of Pilot Road Transport Survey and Similar Data Obtained from National Surveys of Japan and Thailand

Country	Cars			Motorcycles		
	Number of Samples	Average distance travelled (km)	Fuel Economy (km/litre)	Number of Samples	Average distance travelled (km)	Fuel Economy (km/litre)
Brunei Darussalam	28	1,442	11.8	-	-	-
Cambodia	10	948	11.7	10	716	39.8
Indonesia	13	2,660	7.9	25	1,013	27.6
Lao PDR	6	166	8.8	5	141	38.8
Malaysia	6	1,843	13.8	10	1,253	39.7
Myanmar	6	1,461	10.6	10	1,180	27.9
Philippines	12	746	7.5	5	442	27.6
Singapore	5	-	14.5	-	-	-
Viet Nam	10	426	11.5	10	310	43.1
Japan*	-	1,814	11.1	-	-	-
Korea*	-	1,091	9.5	-	-	-
Small	-	967	11.8	-	-	-
Medium	-	1,092	9.2	-	-	-
Large	-	1,293	6.3	-	-	-
Thailand*	-	2,331	13.2	-	-	-

* Based on government survey

Source: Survey conducted by the Working Group of this Energy Outlook and Saving Potential Study (2014).

Nine countries submitted reports on the pilot survey, whereas three countries (Japan, South Korea, and Thailand) provided information obtained from national surveys. It should be noted that the numbers collected in the pilot survey are taken from a biased survey as the selection of the samples is not random. Likewise, the size of the sample is too small relative to the population. In addition, although the engine displacements of vehicles and types of fuel were reported, the analysis did not calculate the fuel economy by size of vehicle or type of fuel.

Nevertheless, based on the results on passenger cars, Singapore showed the highest fuel economy at 14.5 km/litre followed by Malaysia at 13.8 km/litre. The result of the national survey in Thailand of 13.2 km/litre is close to this range. Brunei Darussalam, Cambodia, Myanmar, and Viet Nam had fuel economies ranging from 10.6 km/litre to 11.8 km/litre. This range is very close to the average fuel economy of cars in Japan of 11.1 km/litre and small cars in South Korea at 11.8 m/litre. Indonesia, Lao PDR, and the Philippines had lower fuel economies, ranging from 7.5 km/litre to 8.8 km/litre. For comparison, medium cars in South Korea have fuels economies of 92 km/litre and large cars 6.3 km/litre.

For motorcycles, Viet Nam had the highest fuel economy, of 43.1 km/litre. Cambodia, Lao PDR, and Malaysia had fuel economies ranging from 38.8 km/litre to 39.8 km/litre, whereas Indonesia, Myanmar, and the Philippines registered low fuel economies of 27.6 km/litre to 27.9 km/litre.

As regards distance travelled by cars, Indonesia registered the highest, at 2,660 km/car/month, and Viet Nam the lowest, at 426 km/car/month. Again, these numbers do not represent the national figures due to biased sampling.

5.5. Lessons Learned

Although it was quite challenging, the pilot survey showed that it is possible to carry out a survey on private vehicles using questionnaires. However, the questionnaire should be improved by addressing the complaints of the respondents. In the analysis of the results, it would also be ideal if the income levels of vehicle owners are included in the questionnaire as it is possible that the travelling behaviour of vehicle owners is influenced by their purchasing power.

To collect more useful information, like passenger-kilometres, the questionnaire should also ask for the average number of passengers (including the driver) in the private cars.

In the analysis of the data, it would be better if the fuel economies of vehicles are further classified into types of fuel and size of vehicles (engine displacement) like the national data of South Korea. This may hardly be applicable to a small survey like this pilot survey, but it should be considered when a national survey is carried out.

This survey provided a good example for energy analysts in Southeast Asia. To further enhance the knowledge gained from this survey, it should be repeated next year with an improved questionnaire and, if possible, a bigger sample size.

6. Conclusions and Recommendation

At the third 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.

6.1. Key Findings

Based on projected changes in socio-economic factors, energy consumption, and carbon dioxide emissions in the BAU scenario and the APS, the Working Group members identified several key findings:

1. Sustained population and economic growth in the EAS region will lead to significant increases in energy demand. TFEC in 2035 will increase 1.7 times from 2012 with electricity increasing 2.1 times during the same period. Oil will increase 1.9 times, but will retain its highest fuel share in final consumption at

1,942 Mtoe. Transportation sector consumption – which is dominated by road transport – will increase 2.2 times, to 1,206 Mtoe in 2035.

2. Electricity generation in 2035 will increase 2.1 times, to 18,530 GWh from 2012, with coal increasing 2.0 times. Although nuclear will increase 6.6 times and NRE 2.1 times during the same period, coal will continue to have the largest share at 59 percent in 2035. Electricity generation will be the source of 64.6 percent of the 3,877 Mtoe of primary demand for coal.
3. Total Primary Energy Supply (TPES) in 2035 will increase 1.7 times from 2012. However, even in the BAU, the EAS region's energy elasticity, which is defined as the growth rate of primary energy demand divided by the growth rate of GDP from 2012 to 2030, is projected to improve to 0.58 (2.3/4.0), compared with 1.08 (4.2/3.9) from 1990 to 2011.
4. The continuing reliance on fossil fuels to meet increasing energy demand will also be associated with significant increases in CO_2 emissions. However, even in the BAU, CO_2 elasticity, which is defined as the growth rate of CO_2 emissions divided by the growth rate of GDP from 2012 to 2035, will be 0.51 lower than energy elasticity. There are two reasons for this. The first is diversification amongst fossil energy from coal to gas. Coal's share of the total primary energy mix is forecast to decline from 52.0 percent in 2010 to 44.9 percent in 2035. On the other hand, the share of gas is projected to increase to 9.1 percent from 12.8 percent during the same period. The second reason is the increased use of carbon-neutral energy, such as nuclear power, hydro power, geothermal power, and new and renewable energy (NRE). The share of carbon neutral energy in 2012 was 15.3 percent, but is forecast to increase to 17.6 percent in 2035.
5. The EAS energy mix in the BAU scenario will change from 2012 to 2035. The share of coal and oil will fall from 75.6 percent to 69.6 percent. The diversification of the regional energy mix, which increases the share of low-carbon and carbon-neutral energy, will contribute to improvements in carbon intensity.
6. Industry remains as a major consumer of energy, but the transport sector continues to increase rapidly. These two sectors are challenging sectors in terms of improving energy efficiency and reducing CO_2 emissions. Hence, appropriate energy efficiency and conservation programmes and low emission technologies are needed in these sectors.
7. Throughout the region there is strong potential to increase energy efficiency to 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:
    - 13.2 percent in primary energy demand;
    - 13.2 percent in energy intensity; and
    - 23.8 percent in energy derived CO_2 emissions.

6.2. Policy Implications

Based on the above key findings, the Working Group members identified a number of policy implications, which were aggregated into five major categories. The identified policy implications are based on a shared desire to enhance action plans in specific sectors, prepare appropriate energy efficiency policies, shift from fossil energy to non-fossil energy, rationalise energy pricing mechanisms, and a need for accurate energy consumption statistics. The implications identified by 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.

a. *Energy Efficiency Action Plans in Final Consumption Sectors*

The industry sector would be a major source of energy savings because it will still be the largest energy-consuming sector by 2035. There are several EEC action plans to be implemented, which include replacement of existing facilities and equipment with more efficient ones. In addition, the Working Group had the following recommendations:

- Change the industrial structure from heavy to light industries – a shift of energy intensive industry to less energy intensive industries would surely reduce energy consumption per unit of GDP output.

In the road transport sector, the following are measures that are considered to definitely reduce energy consumption per unit of transport activities:

- Improve fuel economy;
- Shift from personal to mass transportation mode;
- Shift to more efficient technologies such as hybrid vehicles and clean alternative fuels.

In other sectors, the following measures were identified to improve energy efficiency:

- Use demand management systems such as household energy management systems (HEMS) and building energy management systems (BEMS);
- Improve thermal efficiency in the power generation sector by constructing or replacing existing facilities with new and more efficient generation technologies.

b. *Need for Consistent EEC Policies*

To further promote energy efficiency, effective and consistent energy efficiency policies will be needed:

- Demand side
  - Establishment of energy management system
  - Promotion of energy efficiency in small and medium enterprises (SMEs)
- Supply side
  - Strong support for energy technology development such as smart grids
  - Planning of best energy mix in both power generation and primary energy supply
  - Use of more efficient thermal power generation technologies
- Financial side

- Provision of financial incentives on EEC such as soft loans, tax credits, and other incentives that would support energy efficiency and conservation

c. *Shift from Fossil to Non-fossil Fuels to Curb CO_2 Emissions*

To curb the increasing CO_2 emissions, there is a need to shift from fossil to non-fossil fuels. This could be attained by increasing the share of new and renewable energy as well as nuclear energy in the energy mix of each country. Joint research amongst industries, governments, and academics should be carried out to determine the economic potential of NRE and the safe use of nuclear energy.

Various analyses show that the intermittent nature of renewable energy sources poses significant challenges in integrating renewable-energy generation with existing electricity grids. Governments should look into this integration problem, as increasing share of renewable electricity would entail significant costs. Government investment in electricity storage technologies, especially for solar and wind power, might be needed.

Even in the APS, the carbonisation ratio is still projected to increase in view of the inevitable continuing use of fossil fuels to meet increasing demand in both the final consumption and electricity generation sectors. This implies that the development of carbon capture and storage (CCS) technology will be very important in controlling the release of greenhouse gases into the atmosphere.

Likewise, carbon sinks such as forests should also be increased to lessen the impact of emitted CO_2 on the environment.

In most cases, RE technologies are not as competitive as thermal power generation technologies using fossil fuel. Supportive RE policies are needed, therefore, and they can be categorised as energy policies and financial policies. The former mainly include policies such as Feed-in-Tariff (FIT), Renewable Portfolio Standard (RPS), net metering, carbon tax, or carbon cap and trade. Financial policies include public financing, carbon financing, and banking regulations with sustainability requirements. The key to incentivise private investment in renewable energy is to lower the risks related to renewable energy projects and improve the profitability prospects.

d. *Rationalising Energy Pricing Mechanism*

The Working Group members recognised that distorted energy pricing is a barrier to the effective implementation of energy efficiency policies. It was suggested, therefore, that energy prices should be rationalised to reflect the real cost of energy while ensuring that the most vulnerable sectors of society are still able to use energy. Rationalising energy prices is considered to be an important policy that would help to improve more efficient use of energy. Furthermore, government incentives would be necessary for consumers to choose the best energy mix.

e. *End-use Energy Statistics*

The Working Group also recognised the need for end-use energy statistics in all energy-consuming sectors. Currently, only a few countries collect this information and databases containing such information are scarce. End-use energy statistics are important for the formulation and assessment of the effectiveness of energy saving policies and monitoring of actual energy savings.

6.3. Recommendations

The analysis in this report indicates that there is significant potential for countries in the EAS region to reduce growth in energy consumption and 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, especially in industry and road transport sectors. Energy management is one of the important action plans in the industry sector. On the other hand, improvement of fuel economy and a shift from personal to mass transport modes are essential in the road transport sector. Rationalising the current pricing mechanism is a key policy to advance energy efficiency and conservation activities, expand the use of renewable energy, provide consumers with the best energy mix, and reduce the burden on national government budgets. However, assistance for low-income households is required to help them cope with higher prices.

A lack of reliable end-use energy statistics will be barriers to monitoring and evaluating 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 capability to collect energy consumption statistics. It is recommended that a national energy consumption survey be conducted in all sectors in EAS countries, applying the experience and know-how obtained through the pilot survey.

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 6th Energy Ministers Meeting in September 2012 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 sufficient 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 along with carbon capture storage, 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, technology transfer, and technology policy implementation within the EAS and between the EAS and the rest of the world. It was also noted that financial schemes to support the inter-regional collaboration on technology transfer may be associated with implementing more energy efficient technologies and increasing the share of renewable energy sources.

References

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

Energy Department, Prime Minister's Office (2013), *Brunei Darussalam Energy White Paper*. Bandar Seri Begawan.

International Energy Agency (2014), *Energy Balances of OECD Countries 2014.* Paris: OECD Publishing.

International Energy Agency (2014), *Energy Balances of Non-OECD Countries 2014*. 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, UK and New York, NY: Cambridge University Press.

Ito, K. et al. (2014), *Asia/World Energy Outlook 2014*. Tokyo: The Institute of Energy Economics, Japan (IEEJ).

Japan Automobile Manufacturers Association (2014), *World Vehicle Statistics,* 2014. Tokyo: Japan Automobile Manufacturers 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.

Syed, A. (2014), *Australian Energy Projections*. Canberra.

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 27 February 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 28 February 2008)

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

World Bank (2014), *World Databank – World Development Indicators (WDI) and Global Development Finance (GDF)*. Washington, DC: The World Bank. http://databank.worldbank.org/ddp/home.do (accessed November 2014).