Chapter 3

Socio-economic Indicators and Energy Policies Assumptions

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conversion and end use sectors and fuels comprise 19 primary and secondary fuels with all states and territories represented. Energy demand for each fuel is modelled based on econometrically estimated price and income elasticities.

ASEAN countries: The energy models of ASEAN countries were developed using the 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 forecasted using energy demand equations by energy and sector and future macroeconomic assumptions. For this study, all the ten member countries used the LEAP model, of which two were assisted by IEEJ in their model development.

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

3. Socio-economic Indicators and Energy Policies: Assumptions

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

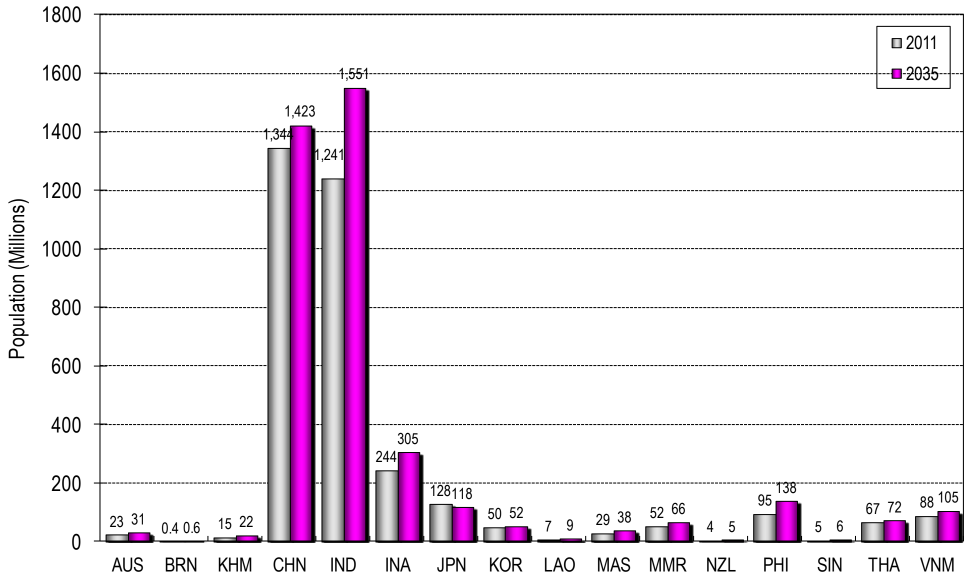
In this section, assumptions regarding key socioeconomic indicators and energy policies until 2035 are discussed for the EAS countries.

3.1. Population

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

In 2011, the total population in the EAS region was about 3.4 billion – around 49 per cent of total world population. Based on the forecasts, population in the EAS region is projected to increase at an average annual rate of about 0.6 percent reaching about 3.94 billion in 2035. Figure 1 shows the 2011 and projected 2035 population by country.

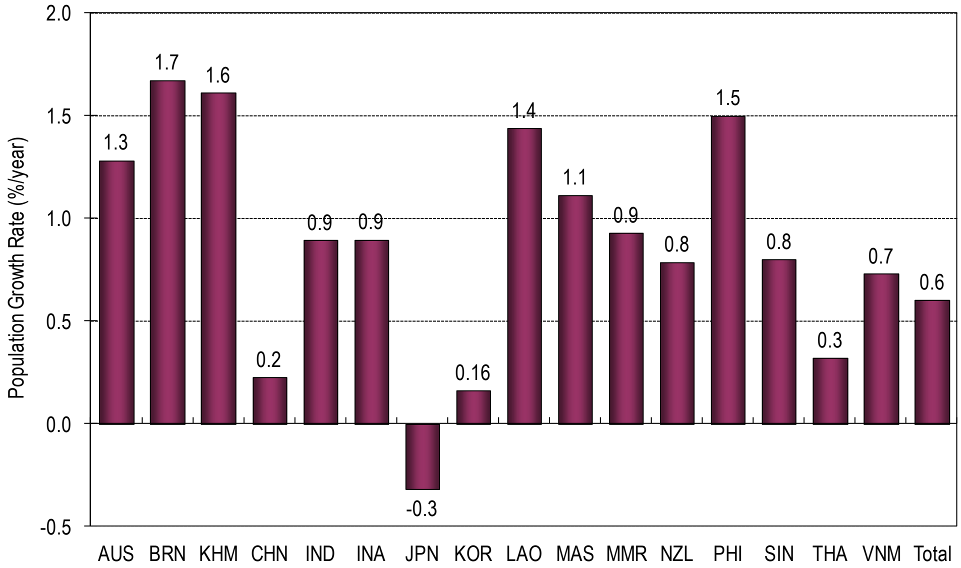
Figure 1: Assumed Population in the EAS Region, 2011 and 2035



As shown in Figure 2, growth in population is generally assumed to be fastest in developing countries. China and Thailand are notable and significant exceptions, as they are expected to have relatively modest population growth. Nevertheless, by 2035, India and China are assumed to account for 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. Australia, New Zealand, and Singapore are assumed to have low, but still significant, population growth. The Republic of Korea's population is assumed to be roughly stable. Japan's population is assumed to decline slowly throughout the projection period as the population continues to age.

Figure 2: Assumed Average Annual Growth in Population, 2011 to 2035



3.2. Economic Activity

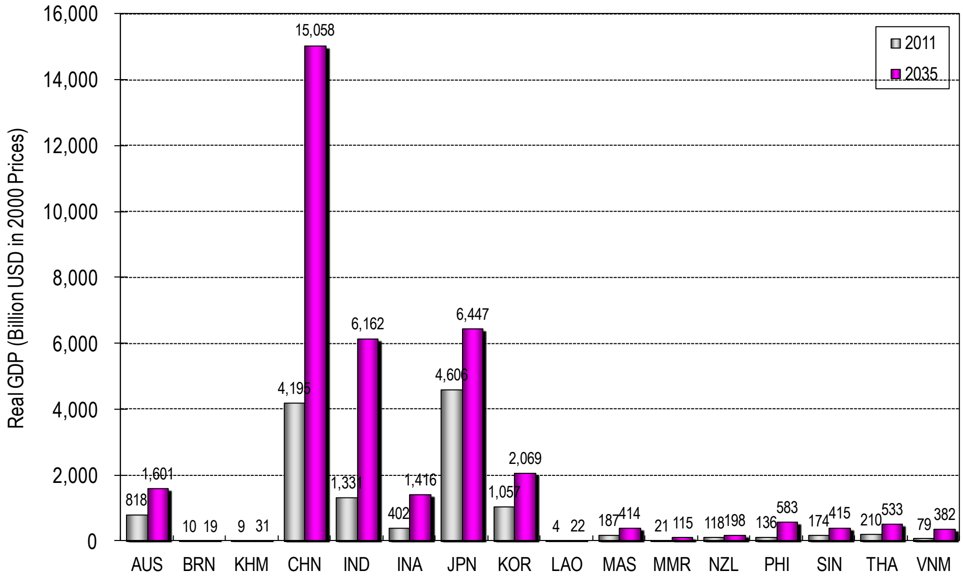
In the models used for this study, assumed changes in economic output to 2035 are set exogenously. GDP data (in 2005 US$) were obtained from the World Bank.[8] Assumed GDP growth rates to 2035 were submitted by all the EAS countries. In general, these assumptions took into account the actual GDP growth rates from 2005 to 2011 which are already reflective of the economic recession 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 2011, total GDP in the EAS region was about 13.4 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 4.2 percent from 2011 to 2035. This implies that by 2035, total GDP in the EAS region will reach about 35.5 trillion in 2005 US$.

[8] World Bank 2012. *World Databank - World Development Indicators (WDI) and Global Development Finance (GDF)*. http://databank.worldbank.org/ddp/home.do (accessed: November 2012).

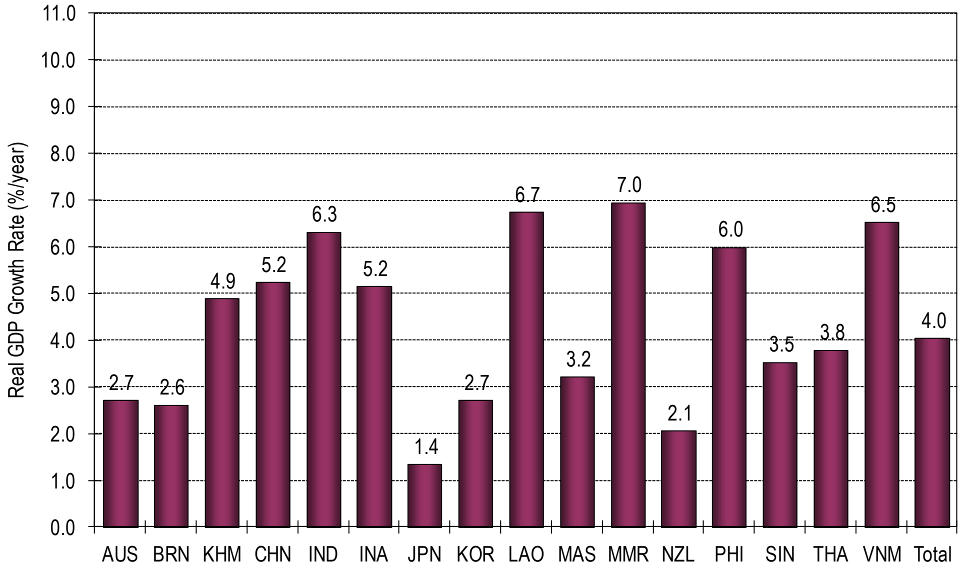
In 2011, Japan was the largest economy by far in terms of total economic output: about 4.6 trillion 2005 US$. However, by 2035, China is projected to be the largest economy with an estimated GDP of about 15.1 trillion 2005 US$. Japan and India are projected to be the next largest economies with projected GDPs of about 6.4 trillion 2005 US$ and 6.2 trillion 2005 US$ respectively in 2035 (see Figure 3).

Figure 3: Assumed Economic Activity in the EAS Region, 2011 and 2035



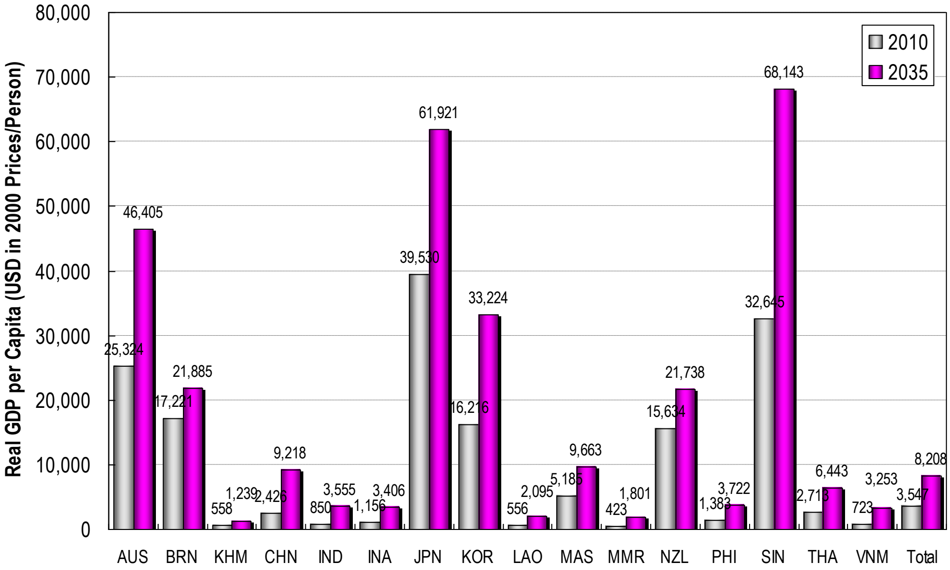
As shown in Figure 4, long term economic growth rates are assumed to be quite high in the developing countries, with the highest growth rates in India, Lao PDR, Myanmar and Viet Nam. Economic growth in other developing countries is also assumed to be relatively rapid. Due to the large size of their economies,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

Figure 4: Assumed Average Annual Growth in GDP, 2011 to 2035



Average GDP per capita in the EAS region is assumed to increase from about US$3,900 in 2011 to about US$9,000 in 2035. However, as shown in Figure 5, there is, and will continue to be, significant differences in GDP per capita. In 2011, per capita GDP ranged from about US$450 in Myanmar to over US$36,000 in Australia and Japan. In 2035, per capita GDP is assumed to range from just over US$1,200 in Cambodia to about US$68,000 in Singapore.

Figure 5: Real GDP per Capita, 2011 and 2035



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 Australia, Brunei Darussalam, China, India, Japan, Korea, Lao PDR, Myanmar, New Zealand, the Philippines and Singapore. 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 290 million and 148 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 continue to vary significantly among countries.

3.4. Electricity Generation

3.4.1 Electricity Generation Thermal Efficiency

The thermal efficiency of electricity generation reflects the amount of fuel required to generate a unit of electricity. Thermal efficiency was another exogenous assumption used in this study. Base year 2011 thermal efficiencies by fuel type (coal, gas, and oil) were derived from International Energy Agency data[9]. Thermal efficiencies by fuel (coal, gas, and oil) were projected by the following countries: Australia, Brunei Darussalam, Indonesia, Japan, Malaysia, the 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 IEEJ *Asia/World Energy Outlook 2011.*

Thermal efficiencies may differ significantly between countries due to differences in technological availability, age and cost of technology, temperatures and the cost and availability of fuel inputs. Thermal efficiency in the EAS countries is expected to improve considerably over time in the BAU scenario as more advanced generation technologies such as natural gas combined cycle and supercritical coal plants become available. In many countries, there are also assumed to be additional improvements in the APS. See Figure 6 and Figure 7.

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

Figure 6: Thermal Efficiencies of Gas Electricity Generation

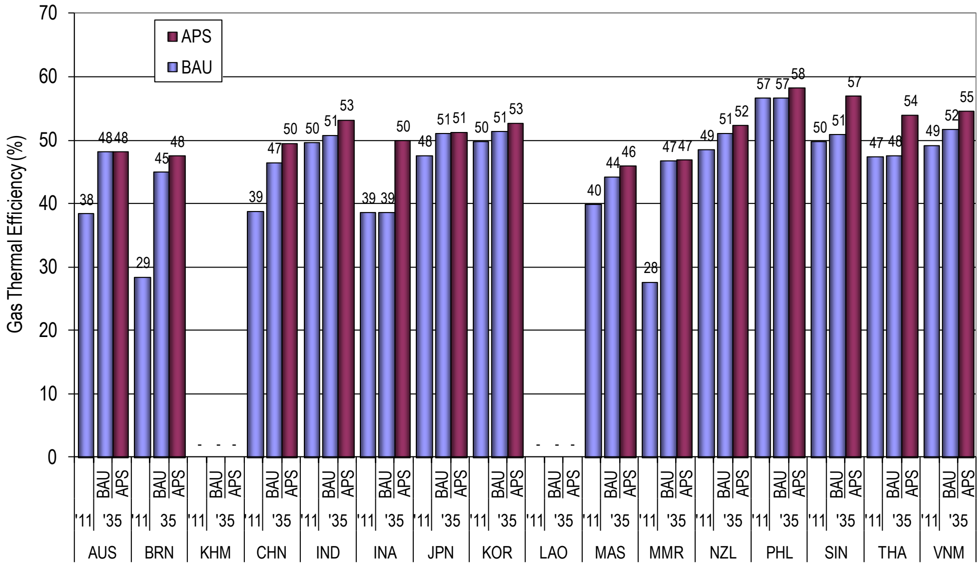
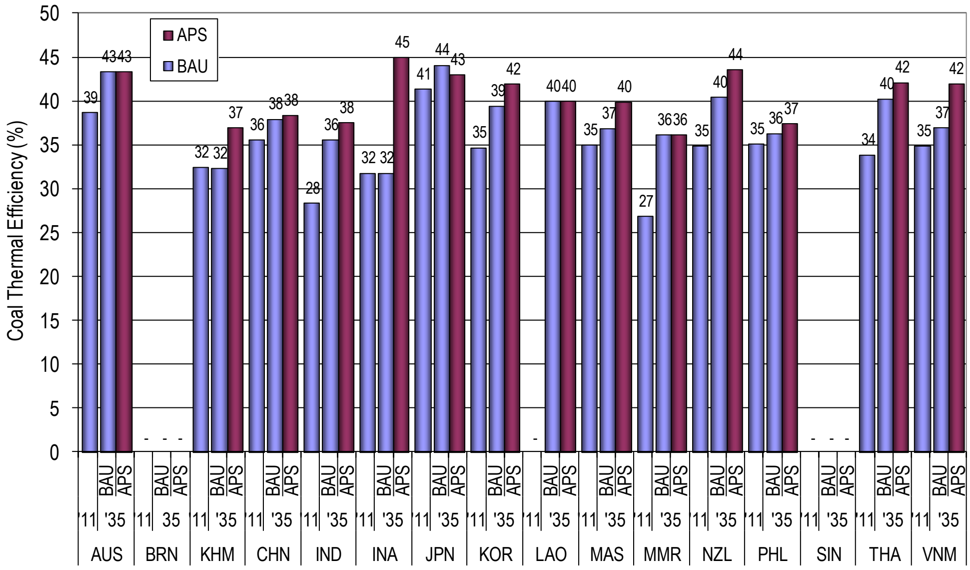


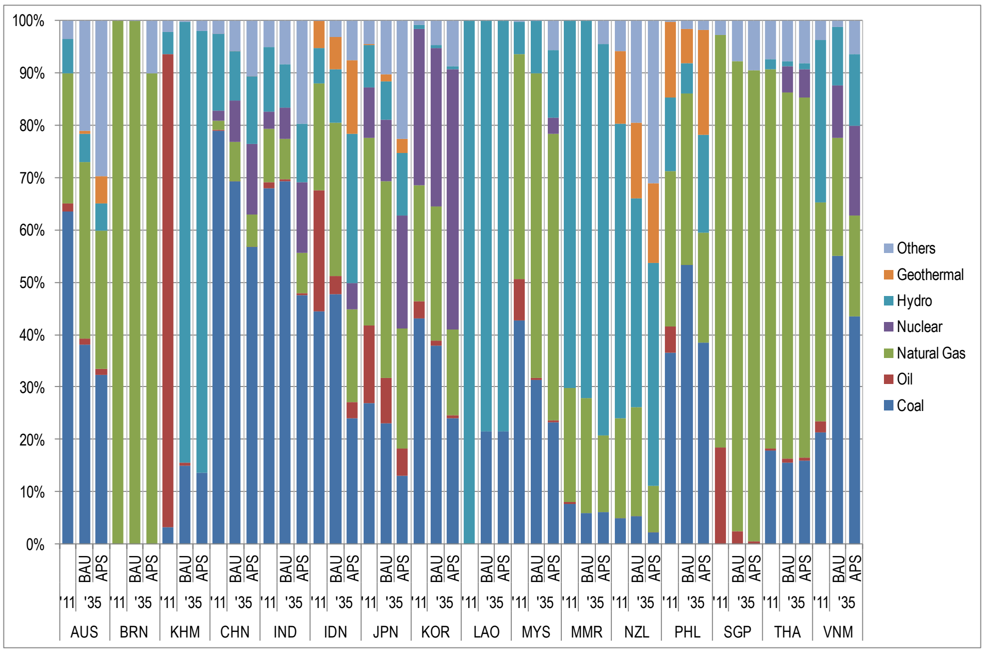
Figure 7: Thermal Efficiencies of Coal Electricity Generation



3.4.2 Electricity Generation Fuel Mix

The combination of fuels used in electricity generation differs among countries, reflecting both historical and current conditions, including access to and cost of resources and technology. It was, therefore, an exogenous input to the model. It is an important input, not only because it is a key driver of demand for primary fuels, but also because the fuel mix used can have important implications for greenhouse gas emissions. The projected electricity generation mix is shown in Figure 8.

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



Coal is projected to remain the dominant source of electricity generation in the EAS region as a whole in both the BAU scenario and APS. However, the share of coal in electricity generation in the EAS region is projected to decline from about 60.0 percent in the BAU scenario to about 45.9 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 shares 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 WG meetings, a number of the developing countries reported on initiatives to significantly expand access to electricity in their countries by 2035. Although this increasing access to electricity is another one of the drivers of increasing energy demand in the EAS region, it was not explicitly represented in the model used for this study. Nevertheless, the impact of increasing access to electricity on electricity demand should be largely reflected through the increased demand for electricity as a result of the relatively rapid GDP growth that is assumed to be experienced in these same countries.

3.5. Use of Biofuels

The WG members from each country were asked to include information regarding the potential use of biofuels in the BAU scenario and APS. Some, but not all, countries in the EAS region have plans to increase the contribution of biofuels in the transport fuel mix to enhance energy security or meet other policy objectives. For China and Japan, the assumptions on the use of biofuels were based on the IEEJ *Asia/World Energy Outlook 2011*. Table 3 summarizes the assumptions regarding use of biofuels.

Table 3: Assumptions on Biofuels – Summary by Country

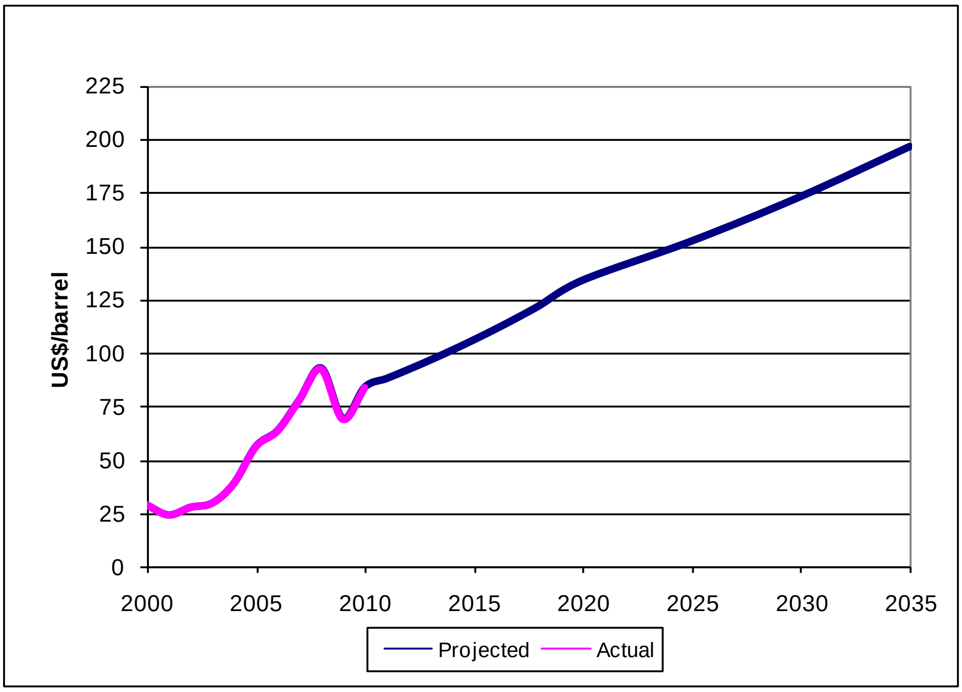
Country	Period	Assumptions
Australia		No targets on biofuels.
Brunei Darussalam		No targets on biofuels.
Cambodia		No targets on biofuels.
China	2030	BAU: 20 billion litres, APS 60 billion litres
India	2017	20% blending of biofuels, both for bio-diesel and bio-ethanol.
Indonesia	2025	Bioethanol: 15% 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

The largest increases in consumption of biofuels in the APS are expected in India and China. In all countries, biofuels are expected to meet only a small portion of the transport fuel demand by 2035.

3.6. Crude Oil Price

Future changes in crude oil prices remain highly uncertain. In this modelling exercise, the crude oil price, as measured by Japan's average import price (current USD), is assumed to increase from about US$88 a barrel in 2011 to US$197 a barrel in 2035 (Figure 9). This projection is similar to the trend of the oil price assumption in Asia/World Energy Outlook 2013 of the Institute of Energy Economics, Japan.

Figure 9: Nominal Oil Price Assumptions to 2035



3.7. Energy Saving Goals

Information about the potential energy savings achievable under specific policy initiatives to increase energy efficiency and reduce energy consumption was collected from each of the WG members from the 16 EAS countries. Each WG member specified which policy initiatives were existing policy, and should be applied to the BAU scenario, and which were proposed policies, and should apply only to the APS. Quantitative energy savings were estimated based on the country's own assumptions and modelling results. Table 4 shows the summary of energy saving goals, action plans and policies collected from each EAS WG member in 2013.

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

	BAU scenario	APS
Australia[10]	• End use energy efficiency improvement is assumed to be 0.5% per year over the projection period for most fuels in non energy-intensive end-use sectors • For energy-intensive industries, improvement is assumed to be 0.2% per year • Some individual sectors such as transport are assigned a higher efficiency assumption than 0.5 per cent per year	
Brunei Darussalam[11]		Reduce energy intensity by 45% by 2035 in line with the country's commitment to APEC through supply and demand side measures such as: • Reduce the projected energy consumption in the BAU by 36%, 41%, 10% and 13% in the residential, commercial, industrial and transport sectors, respectively • Increase efficiency in power generation from 23% to more than 45%
Cambodia		10% reduction of BAU energy consumption by 2015 to increase further to 15% by 2035
China		• 16% energy intensity reduction from 2011 to 2015 • 40-~45% carbon intensity reduction from 2006 to 2020
India		• 20 to 25% improvement in CO_2 Intensity by 2020 relative to 2005 level
Japan		• 30% improvement in energy intensity in 2030 from 2005 level
Republic of Korea		• Reduce final energy intensity by 46% in 2030 from 2009 level

Table 4 continued

[10] Syed, Arif. (2012). *Australian Energy Projections*. Canberra. Page 31.
[11] Energy Department, Prime Minister's Office (2013). *Brunei Darussalam Energy White Paper*. Bandar Seri Begawan. Page 26.

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

Lao PDR		• Reduce final energy consumption from BAU level by 10% from 2011-2015

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

New Zealand	The historical energy efficiency improvement of 0.5-1.0% per year is expected to continue in the BAU	By 2030, energy intensity will fall to just over half of that of 1990 level
Philippines		To attain energy savings equivalent to 15% of annual final demand relative to BAU through various energy efficiency programs in all sectors of the economy by 2020.
Singapore		• Reduce energy intensity by 20% by 2020 and by 35% by 2030 from the 2005 level. • Cap CO_2 emissions by 16% from BAU by 2020.
Thailand		• Reduce total final energy consumption by 20% relative to BAU by 2030
Viet Nam		• Reduce energy consumption between 5%-8% by 2015 relative to BAU