Chapter 2

Data and Methodology

September 2014

This chapter should be cited as
ERIA (2014), ‘Data and Methodology’, in Kimura, S. (ed.), *Energy Outlook and Analysis of Energy Saving Potential in East Asia*, ERIA Research Project Report FY2013, No.19.Jakarta: ERIA, pp.5-8.

2. Data and Methodology

2.1. Scenarios Examined

The study continued to examine two scenarios, as in the studies conducted annually from 2007 to 2012, 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 2013 in Bali, Indonesia or those that are currently, or likely to be, under consideration.

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

In 2013, the APS assumptions were grouped into four, namely: a) more efficient final energy demand (APS1), b) more efficient thermal power generation (APS2), c) higher consumption of 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 in 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 with 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 with 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 contribution of new and renewable energy (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, the primary energy consumption may not decrease as NRE technologies using biomass and geothermal energy are assumed to have lower efficiencies compared to fossil fuels-fired generation when converting electricity generated from these NRE sources to primary energy equivalent.

APS4 assumes introduction of nuclear energy or 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 as gas and coal technologies that would be replaced have higher efficiencies.

While all of the EAS countries are actively developing and implementing EEC goals, action plans and policies, progress so far varies widely. Some countries are quite advanced in their efforts, while others are just getting started. A few countries already have significant energy savings goals, action plans and policies built into the BAU scenario. Conversely, others 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 to update this study periodically, as the quality and scope of the national goals, action plans and policies are likely to improve considerably over time allowing for valuable collaboration across countries.

2.2. The Definition of Energy 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 OECD and non-OECD countries except for Australia and Lao PDR. Australian national energy data were converted from Gross Calorific Value (GCV) to Net Calorific Value (NCV) to be consistent with IEA energy balances. Estimations of national energy data from Lao PDR were made using the same methodology as IEA. The socio-economic data for 15 countries were obtained from the World Bank's online World Databank - World Development Indicators (WDI) and Global Development Finance (GDF) while 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 WG members from each EAS country where these data are available. Where official data were not available, estimates were obtained from other sources or developed by IEEJ.

2.4. Methodology

In 2007, the primary model used was the IEEJ World Energy Outlook Model which is used by IEEJ in the preparation of their *Asia/World Energy Outlook*[6]. In 2013, eight of the 10 ASEAN member countries utilised their own energy models. Australia used its own national model as well. IEEJ also assisted Brunei Darussalam and Cambodia in making their projections using the assumptions provided by their respective WG members during the first meeting. 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[7], 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

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

[7] 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.

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