ERIA Research Project Report 2012, No. 19

Analysis on Energy Saving Potential in East Asia

Edited by
Shigeru Kimura

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June 2013

DISCLAIMER

This report was prepared by the Working Group for Analysis of Energy Saving Potential in East Asia under the Economic Research Institute for ASEAN and East Asia (ERIA) Energy Project. Members of the Working Group, who represent the participating East Asia Summit (EAS) region countries, discussed and agreed to certain key assumptions and modelling approaches in order to enable harmonisation of the forecasting techniques. These assumptions and modelling approaches may differ from those normally used in each country. Therefore, the projections presented here should not be viewed as official national projections of the participating countries.

FOREWORD

Energy security and climate change are very important issues in the world. At the 2nd East Asia Summit (EAS) in Cebu Island of the Philippines, January 2007, the leaders of the region declared that East Asia could mitigate these problems by strong leadership on several countermeasures. These include: a. promotion of energy conservation, b. utilisation of bio-fuels and cleaner use of coal.

Two groups were designated to assist in implementing the countermeasures mentioned above: the Energy Cooperation Task Force (ECTF) and Economic Research Institute for ASEAN and East Asia (ERIA). ECTF is charged with supporting the efforts of the EAS and its Energy Ministers Meeting (EMM) to promote cooperation on policies to implement these countermeasures. ERIA is in charge of studying the potential impacts of the countermeasures. ERIA is focusing on energy studies in two areas: first, promotion of energy conservation and, second, utilisation of bio-fuels.

This report was prepared by the Working Group for Analysis of Energy Saving Potential in East Asia under the ERIA Energy Project. The report covers all research activities of the Working Group from August 2012 to May 2013, including methodology, estimated impacts of current energy saving goals, and policy recommendations to the ECTF. This report extends and enhances the analysis of the working group undertaken annually from 2007 to 2011.

The structure of this report is still similar to the previous versions in view of the application of similar methodology but it should be noted that one of the important accomplishments of this research study is the development of energy efficiency targets for the countries that did not have targets when this project started in 2007. It could be said that these countries started taking energy efficiency as an important energy policy as a result of this study.

This report hopefully contributes to mitigating problems related to energy security and climate change through increasing understanding of the potential for energy saving of a range of energy efficiency goals, action plans and policies. A number of key insights for policy development are also discussed.

Mr. Shigeru Kimura

Leader of the Working Group

2013

ACKNOWLEDGEMENTS

This analysis has been implemented by a working group under ERIA. It was a joint effort of Working Group members from the EAS Countries and The Institute of Energy Economics, Japan (IEEJ). We would like to acknowledge the support provided by everyone involved. We would especially like to take the opportunity to express our gratitude to the members of the Working Group, ERIA, International Affairs Division of Agency for Natural Resources and Energy (ANRE) / Ministry of Economy, Trade and Industry (METI) of Japan, and IEEJ's Energy Outlook Modelling Team.

Special acknowledgement is also given to Ms. Cecilya L. Malik of Indonesia, Ms. Lilibeth T. Morales of the Philippines and Mr. Brett Jacobs of ERIA for their contributions in the editing of this report.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANRE = Agency for Natural Resources and Energy
APS = Alternative Policy Scenario
ASEAN = Association of Southeast Asian Nations
A/C = Air conditioner
BAU = Business as Usual
BREE = Bureau of Resources and Energy Economics
BOCM = Bilateral Offset Credit Mechanism
CCS = Carbon capture and storage
CCT = Clean Coal Technology
CDM = Clean Development Mechanism
CO_2 = Carbon dioxide
CRT = Cathode ray tube
EAS = East Asia Summit
ECTF = Energy Cooperation Task Force
EEC = Energy efficiency and conservation
EMM = EAS Energy Ministers Meeting
ERIA = Economic Research Institute for ASEAN and East Asia
FiT = Feed-in-Tariff
GCV = Gross calorific value
GDP = Gross domestic product
GHG = Greenhouse gas
GW = Gigawatt
IEEJ = The Institute for Energy Economics, Japan
IPCC = Intergovernmental Panel for Climate Change
JARI = Japan Automobile Research Institute
ktoe = Thousand tonnes of oil equivalent
kWh = kilowatt-hour
LCD = Liquid crystal display
LDV = Light Duty Vehicles
LEAP = Long-range Energy Alternative Planning System
LEDS = Long-Term Energy Demand System
LET = Low emission technologies
LPG = Liquefied petroleum gas
METI = Ministry of Economy, Trade and Industry
Mtoe = Million tonnes of oil equivalent (1 Mtoe = 41.868 PJ)
Mt C = Million tonnes carbon (may be converted to million tonnes of CO_2 by multiplying by 44/12)
MW = Megawatts
MWh = Megawatt-hour
NCV = net calorific value
OECD = Organization for Economic Cooperation and Development
RPS = Renewable Portfolio Standards
SWG = Sub-Working Group
toe = Tonnes of oil equivalent
t C = Tonnes of carbon

TPES = Total Primary Energy Supply
TWh = Terawatt-hour
WG = Working group

EXECUTIVE SUMMARY

Responding to the Cebu Declaration of the leaders of the East Asia Summit (EAS) countries, Japan proposed to undertake a study of the energy savings and CO_2 emission reduction potential in the EAS region. The study provides an insight to national energy ministers for establishing goals and action plans to improve energy efficiency in their respective countries. The first study was undertaken in 2007 by the Working Group (WG) for Analysis of Energy Saving Potential in East Asia and has met several times a year since then to update and incorporate more recent information such as energy saving targets and action plans reported at the EAS Energy Ministers Meetings (EMM).

The study examined two key scenarios up to 2035, a Business-As-Usual (BAU) scenario which reflected each country's current goals and action plans, and an Alternative Policy Scenario (APS), which included additional goals and action plans currently under consideration in each country. The focus of the study is on analysing the additional energy savings that might be achieved through the goals and action plans of individual countries, above and beyond BAU. The additional savings were measured as the difference between the BAU and APS scenarios.

Each scenario was modelled for each country by the members using their national models or by the Institute of Energy Economics, Japan (IEEJ) model that was used in the preparation of IEEJ's Asia/World Energy Outlook. The working group is composed of experts from each EAS country. Some of the members developed their national energy outlook and the remaining members supplied projections of key socio-economic variables, as well as energy saving plans to IEEJ for developing their energy outlook.

Modelling results show that the EAS region's final energy consumption in the BAU case is projected to increase from 2489 Mtoe in 2010 to 5439 Mtoe in 2035, an increase of 3.2 percent per year. This is in the assumption that the EAS region's total GDP will increase by 4.1 percent per year on average along with 0.6 percent annual growth in population. In the APS case, final energy consumption is projected to rise to 4677 Mtoe in 2035, 14.0 percent less than in the BAU case. CO_2 emissions in the BAU case are projected to increase from 3309 Mt-C in 2010 to 6562 Mt-C in 2035, implying an annual growth rate of 2.8 percent. In the APS case, CO_2 emissions are projected to be 4719 Mt-C in 2035, 28.1 percent lower than in the BAU case.

While the emission reductions under the APS are significant, CO_2 emissions in the APS case in 2035 will still be above 2010 levels and far above 1990 levels. Scientific evidence suggests these reductions will not be adequate to prevent severe climate change impacts.

In order to support the analysis on energy saving potential, the following related projects were commissioned during 2012: a) best energy mix in road transport sector in Indonesia b) economic impact by energy efficiency investment in EAS region, and c) biofuel market analysis. In addition, the WG improved the quality of sample data collected through the pilot survey especially on estimation of electric consumption based on power rating.

With reference to the above findings, the following are recommended:

- Energy efficiency and conservation policies are very effective in reducing energy demand and CO_2 emissions. Therefore, energy efficiency action plans should be setup across all energy consuming sectors, especially industry and transport sectors.
- Rationalizing the prices for electricity, oil products and natural gas in the near term including the removal of subsidies, while considering support for low income groups.
- Detailed energy consumption data are indispensable in evaluating the implementation of energy saving action plans. EAS countries should prepare consumption data regularly by conducting large-scale surveys applying the experience and know-how obtained through the ERIA pilot surveys.
- The energy saving goals reported by the 16 EAS countries at EMM6 show large energy saving potential as well as CO_2 emissions reduction. However, CO_2 emission in 2035 will still double the 2010 level. Thus more aggressive energy saving goals and action plans should be implemented and more low or zero carbon energy and technologies should be utilized.
- International and regional collaboration will contribute to transfer of EEC & low carbon emissions technologies from developed countries to developing countries. The bilateral offset credit mechanism is one option to promote the transfer of energy efficient technologies from developed countries to developing countries to contribute to saving energy and mitigating CO_2 emissions.

CHAPTER 1

Main Report

1. Introduction

Responding to the Cebu Declaration on East Asia Energy Security on 15 January 2007 by the leaders of the 16 countries of the East Asia Summit (EAS), the EAS Energy Cooperation Task Force (ECTF) was established and one of the agreed areas for cooperation was the Energy Efficiency and Conservation. Japan proposed to undertake a study of the energy savings and CO_2 emission reduction potential in the EAS region. The study would quantify the total potential savings under the individual energy efficiency goals, action plans and policies of each country above and beyond Business As Usual[1]. The study would provide insights to national energy ministers for establishing goals, action plans and policies to improve energy efficiency in their respective countries. The first study was undertaken in 2007 and was updated annually to incorporate more recent information and on member countries' energy saving potentials and energy efficiency goals, action plans and policies. The 2012 study was again updated to undertake the following:

- Reflect the energy efficiency goals and actions plans submitted by the energy ministers during the 6th EAS Energy Minister's Meeting (EMM) held in Phnom Penh, Cambodia on 12 September 2012 in the latest energy outlook until 2035; and
- Revise the questionnaires collected during the phase 2 of the pilot end-use energy consumption survey in the residential sector in view of the apparent overestimation of electricity consumption of variable-load household appliances.

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

This is the report of that study.

The Cebu Declaration outlined the potential energy challenges the region could face in the future driven by a number of factors including: the limited global reserves of fossil energy, fluctuating world fuel oil prices, worsening energy related environmental and health issues and the urgent need to address climate change[2].

For these reasons, the EAS leaders resolved to enhance regional cooperation in various areas to achieve: improved energy efficiency and environmental performance of fossil fuel use and reduced dependence on conventional fuels through intensified energy efficiency and conservation programs, hydropower, and expansion of renewable energy, biofuels, and civilian nuclear power.

1.1. The East Asia Summit

The East Asia Summit (EAS) is a collection of diverse countries. There are wide variations among them in terms of per capita income, standard of living, population density, energy resource endowments, climate, and energy consumption per capita. It is composed of the 10 member countries of the Association of Southeast Asian Nations (ASEAN), namely: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, and 6 other countries, namely: Australia, China, India, Japan, Republic of Korea and New Zealand.[3]

While some EAS countries have what might be called mature economies, the majority have developing economies. Several countries have a per capita GDP of less than 1000 US$ (in 2000 prices[4]). Countries with mature economies have higher energy consumption per capita, while developing countries generally have lower energy consumption per capita. A large percentage of the people in the latter countries still meet their energy needs mainly with traditional biomass fuels.

These differences partly explain why energy efficiency and conservation goals,

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

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

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

action plans and policies are assigned different priorities across countries. While countries with developed economies may be very keen on reducing energy consumption, developing countries tend to put more emphasis on economic growth and improving standards of living. However, as the economies of these countries grow, it should be expected that energy consumption per capita will grow as well.

Despite the differences among the 16 countries, the EAS leaders agree that the EAS "could play a significant role in community building", which could be an important cornerstone for the development of regional cooperation in the years to come[5].

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

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[5] The Ministry of Foreign Affairs of Japan (2005) *Prime Minister Junichiro Koizumi Attends the EAS, ASEAN+3, and Japan-ASEAN Summit Meetings, (Overview and Preliminary Evaluation*), 2005. Tokyo: http://www.mofa.go.jp/region/asia-paci/eas/summary0512.html (accessed February 28,2008)

Table 1: Geographic, Demographic, and Economic Profiles, 2010

	Land Area (thousand sq.km.)[1]	Population (million)	Population Density (persons/ sq.km.)	GDP (Billion 2000US$)[2]	GDP per Capita (2000US$/ person)
Australia	7,682	22.18	2.89	561.8	25,324
Brunei Darussalam	5.3	0.40	75.70	6.9	17,221
Cambodia	181	14.14	78.11	7.9	558
China	9,327	1,337.83	143.43	3,246.0	2,426
India	2,973	1,170.94	393.83	995.5	850
Indonesia	1,812	237.64	131.18	274.7	1,156
Japan	365	127.23	349.05	5,029.3	39,530
Korea, Rep.	97	49.41	508.86	801.3	16,216
Lao PDR	231	6.20	26.86	3.4	556
Malaysia	329	28.40	86.44	147.3	5,185
Myanmar	653	47.96	73.42	20.3	423
New Zealand	263	4.37	16.59	68.3	15,634
Philippines	298	93.26	312.77	129.0	1,383
Singapore	0.7	5.08	7,251.43	165.7	32,645
Thailand	511	69.12	135.30	145.0	2,098
Vietnam	310	86.90	280.26	62.8	723

Note: [1] Information on the land area data of Cambodia was provided by the Cambodian government.
[2] GDP data of Myanmar at constant 2000 US$ values are calculated by IEEJ.

Source: World Bank (2012) World Databank: http://databank.worldbank.org/ddp/home.do. Washington DC (accessed: November, 2012) and Government of Cambodia.

Table 2: Economic Structure and Energy Consumption, 2010

	GDP (Billion 2000US$)	Share of Industry In GDP, %[1]	Share of Services in GDP, %[1]	Share of Agriculture in GDP, %[1]	Primary Energy Consumption (Mtoe)	Energy Consumption per Capita (toe/person)
Australia	561.8	19.8	77.9	2.3	124.7	5.6
Brunei Darussalam	6.9	74.1	25.3	0.6	3.1	7.9
Cambodia	7.9	23.3	40.7	36.0	1.4	0.1
China	3,246.0	46.7	43.2	10.1	2,212.5	1.7
India	995.5	27.6	54.4	18.0	523.9	0.4
Indonesia	274.7	47.0	37.7	15.3	158.6	0.7
Japan	5,029.3	27.4	71.5	1.2	494.0	3.9
Korea, Rep.	801.3	38.8	58.5	2.6	247.3	5.0
Lao PDR	3.4	31.8	35.5	32.7	0.9	0.1
Malaysia	147.3	41.1	48.5	10.4	69.2	2.4
Myanmar	20.3	48.4	16.2	35.4	6.0	0.1
New Zealand	68.3	24.8	69.5	5.6	18.2	4.2
Philippines	129.0	32.6	55.1	12.3	34.9	0.4
Singapore	165.7	27.9	72.1	0.0	33.1	6.5
Thailand	145.0	44.7	43.0	12.4	112.2	1.6
Vietnam	62.8	41.1	38.3	20.6	40.9	0.5

Note: [1] Sectoral shares to GDP of Myanmar are 2004 values while those of New Zealand are 2006 values.

Sources: World Bank (2012) World Databank: http://databank.worldbank.org/ddp/home.do. Washington DC (accessed November, 2012); International Energy Agency (IEA) (2011) Energy Balances of OECD Countries 2010 and Energy Balances of Non-OECD Countries 2011, Paris.

1.2. Rationale

The rationale of this study is derived from the Cebu Declaration[6], which highlighted a number of goals including the following:

- improving the efficiency and environmental performance of fossil fuel use;
- reducing the dependence on conventional fuels through intensified energy efficiency and conservation programmes, hydropower, expansion of renewable energy systems and biofuel production/utilisation, and for interested parties, civilian nuclear power; and
- mitigating greenhouse gas emissions through effective policies and measures, thus contributing to global climate change abatement.

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

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

The Economic Research Institute for ASEAN and East Asia (ERIA) approved the proposal of the Japanese government to conduct a study on energy saving and CO_2 emission reduction potentials in the East Asia Region. As a result, the Working Group (WG) for the Analysis of Energy Savings Potential was convened. Members from all of the 16 EAS countries are represented in the WG with Mr. Shigeru Kimura of the Institute of Energy Economics, Japan (IEEJ) as the leader of the group.

1.3. Objective

The objective of this study is to analyse the potential impacts of proposed additional energy saving goals, action plans and policies in the East Asia Summit region on energy consumption by fuel and sector and greenhouse gas emissions.

Specifically a BAU scenario was developed for each country outlining future sectoral and economy-wide energy consumption assuming no significant changes to government policies. An APS was also designed to examine the potential impacts if additional energy efficiency goals, action plans or policies were developed that are currently, or likely to be, under consideration. Increased uptake of renewable energy sources and nuclear energy was also considered in the APS. The difference between the BAU and APS represent potential energy savings.

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

1.4. Working Group Activities in 2012

In 2012, the WG continued to assess energy saving potentials in the EAS region using the goals, action plans and policies reported at the 6th EAS Energy Ministers

Meeting (EAS-EMM6). The WG in 2012 enhanced and extended the analysis that was undertaken from 2007 to 2011. The WG conducted three meetings, one in Cambodia in August 2012, another in Indonesia in November 2012 (for Southeast Asian member states only) and another meeting in Kuala Lumpur in April 2013.

During the first meeting, the WG discussed and developed the 2012 research plan and provided updates on revised energy saving goals, action plans and policies that each EAS country reported in 2012 as well as each of the countries' economic development plans. The research plan included the revision of the questionnaires obtained during phase 2 pilot survey in the residential sector. The revision was necessary due to the overestimation of the consumption of variable-load household appliances. It was learned that variable-load appliances do not always operate at its maximum power rating due to temperature controls and variable speed of the motors in these appliances. The updated report on the pilot end-use energy consumption survey in the residential sector is presented in Section 5 of this main report.

During the second meeting, which was a special meeting for the ASEAN countries, the WG provided capacity building on energy modelling as there were several new members in the WG from Brunei Darussalam, Lao PDR, Myanmar, and Singapore. For the more seasoned members, the agenda covered discussions on more reliable energy outlook and review of energy outlook models of their respective countries.

During the third meeting, the WG discussed the preliminary energy outlook of each country and the policy implications that could be derived from the outlook results. The contents of the research report were also discussed and decided during the third meeting along with the responsibilities of each WG members and IEEJ in the writing of the report. The WG also discussed the preliminary report of additional research projects carried out by ERIA in 2012.

1.5. Additional Research Studies

In 2012, research studies related to energy efficiency and emission reduction were commissioned by Japan. These are the following:

- Best Energy Mix in the Transport Sector
- Green Growth in Asia Phase 2
- Asian Potential on Biofuels Market

The report on Best Energy Mix in the Transport Sector in Indonesia is included as part of the Annexes of this report.

Other studies on energy were conducted by ERIA during the year 2012-2013. These are the following:

- Energy Market Integration Study
- Energy Security Indices
- Energy Efficiency Improvement in Urban Transport
- Effective Investment in Power Infrastructure
- Nuclear Safety Management

2. Data and Methodology

2.1. Scenarios Examined

The study continued to examine two scenarios, as in the studies conducted annually from 2007 to 2011, a Business As Usual (BAU) scenario reflecting each country's current goals, action plans and policies, and an Alternative Policy Scenario (APS). The APS included additional goals, action plans and policies reported at the EAS-EMM6 held in September 2012 in Phnom Penh, Cambodia or those that are currently, or likely to be, under consideration.

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

While all of the EAS countries are actively developing and implementing EEC goals, action plans and policies, progress so far varies widely. Some countries are quite advanced in their efforts, while others are just getting started. A few countries already have significant energy savings goals, action plans and policies built into the BAU scenario. Conversely, others 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 Savings Potential and Its Limitations

There are many definitions of energy saving potential, including ‘technical potential’ (what might be possible with current technology) and ‘economic potential’ (what might be economic with current technology). However, the outputs of this study do not match any standard definition.

Perhaps the best way around the difficulties in defining ‘energy saving potential’ is to recognise that a definition is not really necessary. Despite the name given to the Working Group, this study does not really 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 was converted from Gross Calorific Value (GCV) to Net Calorific Value (NCV) to be consistent with IEA energy balances. Estimations of national energy data from Lao PDR were made using the same methodology as IEA. The socio-economic data were obtained from the World Bank’s online World Databank - World Development Indicators (WDI) and Global Development Finance (GDF). Other data such as those relating to transportation, buildings, and industrial production indices were provided by the WG members from each EAS country, where these data are available. Where official data were not available, estimates were obtained from other sources or developed by IEEJ.

2.4. Methodology

In 2007, the primary model used was the IEEJ World Energy Outlook Model which is used by IEEJ in the preparation of their *Asia/World Energy Outlook*[7]. Following capacity building exercises in ASEAN, 8 of the 10 member countries utilised their own energy models with IEEJ support. In addition, Australia and Korea also used their own national models. However, in 2011, the WG decided to use IEEJ's energy outlook on Korea in view of the non-participation of the country to the study in the past 3 years. In 2012, the IEEJ energy outlook on Korea was again used but with the strong involvement of the new member from Korea who started to join the WG just during the third meeting. 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 and the LEAP models were then used to develop energy projections for these countries.

In the next section, brief descriptions of the energy models in this study are provided.

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

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[7] Ito, *et al.* (2007).

ASEAN countries: The LEAP model is an accounting system used to develop projections of energy balance tables based on final energy consumption and energy input/output in the transformation sector. Final energy consumption is forecasted using 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.

2.5. Enhancing the 2011 Study

From 2007 to 2011, 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 2012 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-EMM6 in Phnom Penh, Cambodia. Specifically, the following new information is incorporated in this study:

- revised recent energy saving goals, action plans and policies in each country;
- more conservative GDP growth projections

- projected future oil prices; and
- results of the revision of the questionnaires collected during phase 2 of the pilot end-use energy consumption survey in the residential sector;

3. Socio-economic Indicators and Energy Policies: Assumptions

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

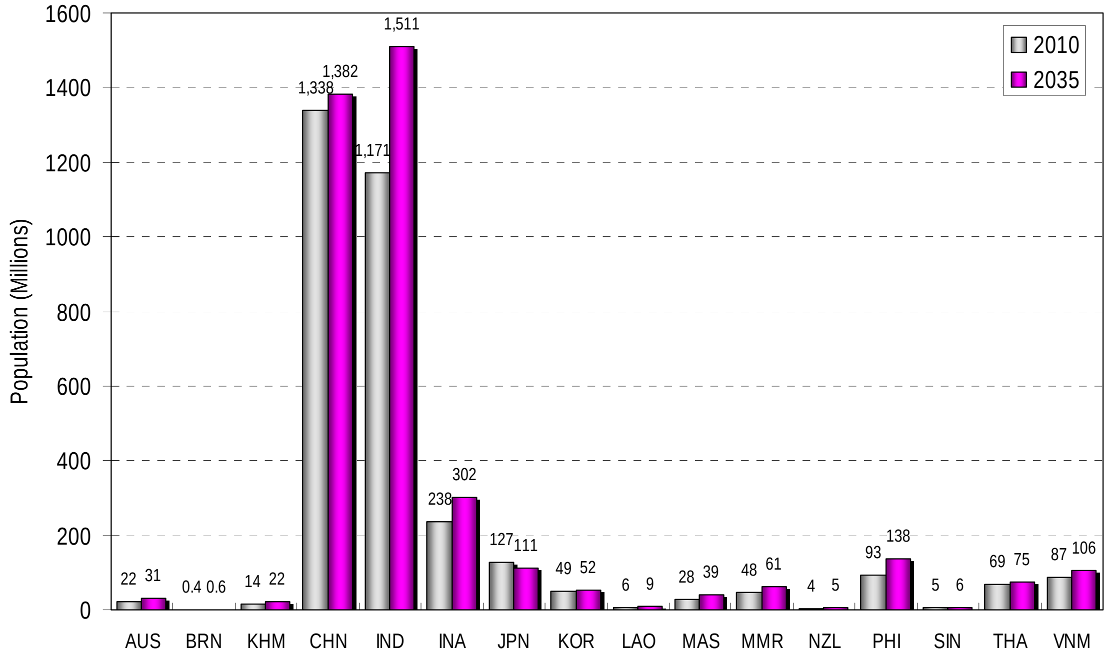
In this section assumptions regarding key socioeconomic indicators and energy policies until 2035 are discussed for the EAS countries.

3.1. Population

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

In 2010, the total population in the EAS region was about 3.3 billion – around 48 per cent of total world population. Based on the forecasts, population in the EAS region is projected to increase at an average annual rate of about 0.6 per cent reaching about 3.85 billion in 2035. Figure 1 shows the 2010 and projected 2035 population by country.

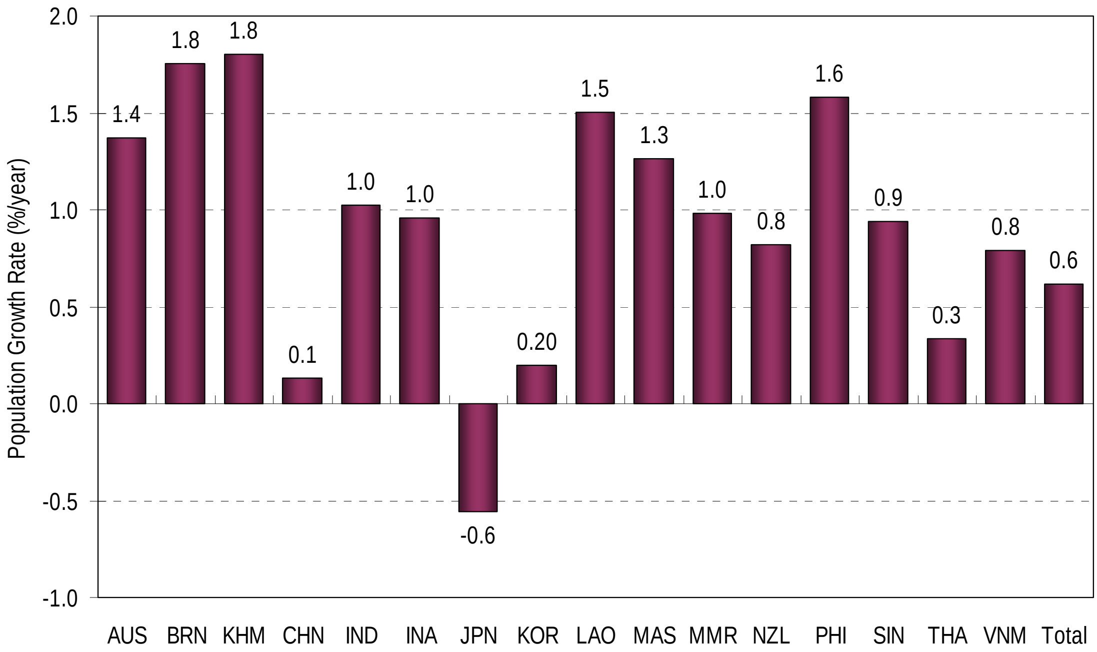
Figure 1: Assumed Population in the EAS Region, 2010 and 2035



As shown in Figure 2, growth in population is generally assumed to be fastest in developing countries. China and Thailand are notable and significant exceptions, as they are expected to have relatively modest population growth. Nevertheless, by 2035, India and China are assumed to account for about 76 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, 2010 to 2035



3.2. Economic Activity

In the models used for this study, assumed changes in economic output to 2035 are set exogenously. GDP data (in 2000 US$) were obtained from the World Bank.[8] Assumed GDP growth rates to 2035 were submitted by all the EAS countries. In general these assumptions took into account the actual GDP growth rates from 2005 to 2011 which are already reflective of the economic recession 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.

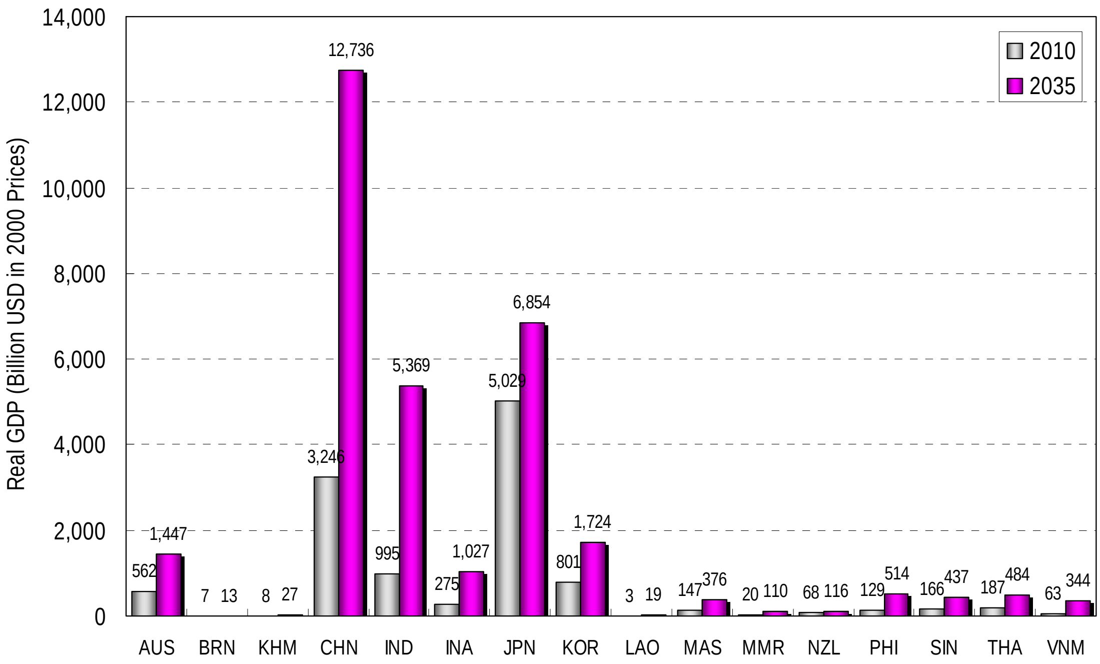
In 2010 total GDP in the EAS region was about 11.7 trillion in 2000 US$ and it accounted for about 28 percent of global GDP. The GDP of the EAS region is assumed to grow at an average annual rate of about 4.1 percent from 2010 to 2035. This implies that by 2035 total GDP in the EAS region will reach about 31.6 trillion in 2000 US$.

In 2010, Japan was the largest economy by far in terms of total economic output: about 5.0 trillion 2000 US$. However, by 2035, China is projected to be the largest economy with an estimated GDP of about 12.7 trillion 2000 US$. Japan and India

[8] World Bank (2012).

are projected to be the next largest economies with projected GDPs of about 6.9 trillion 2000 US$ and 5.4 trillion 2000 US$ respectively in 2035. See Figure 3.

Figure 3: Assumed Economic Activity in the EAS Region, 2010 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, 2010 to 2035

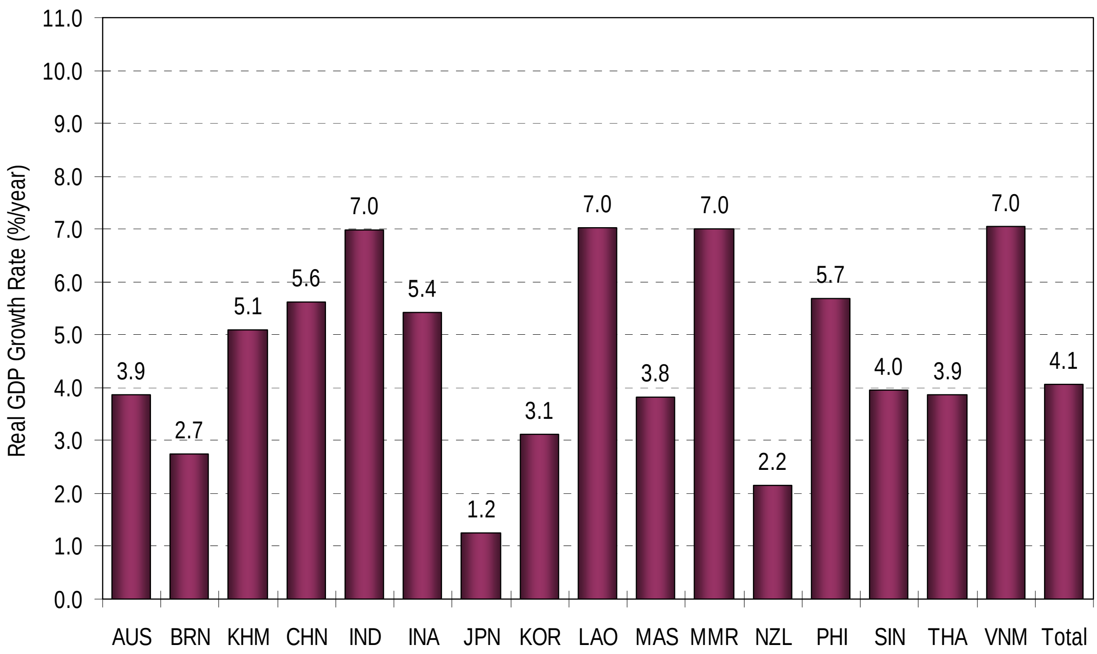
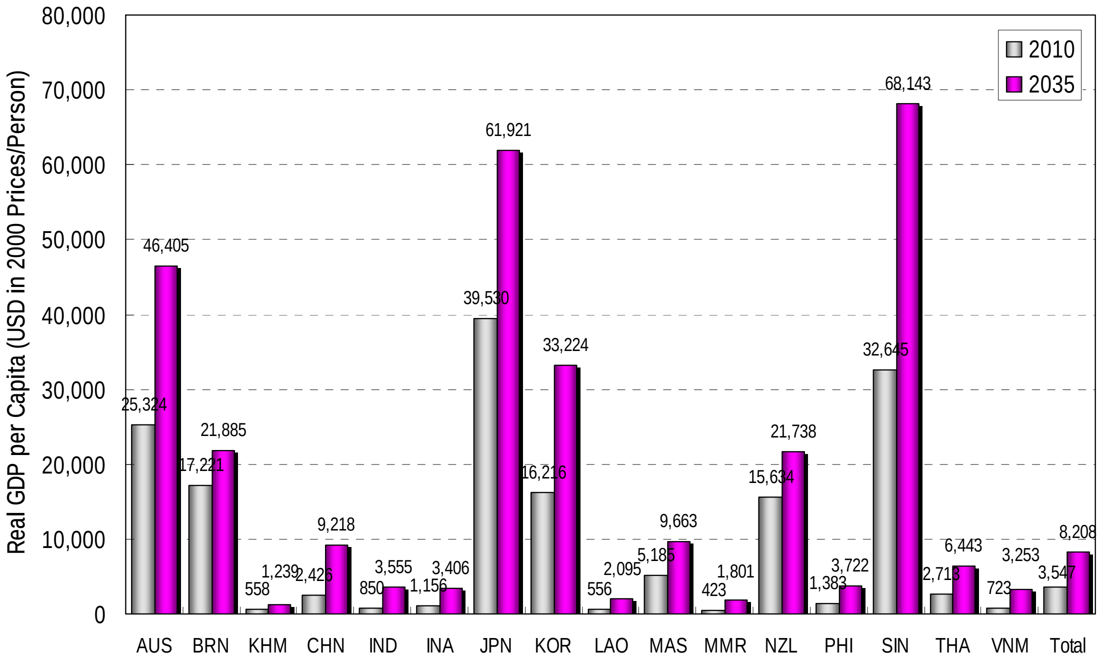


Figure 5: Real GDP per Capita, 2010 and 2035



Average GDP per capita in the EAS region is assumed to increase from about US$3500 in 2010 to about US$8200 in 2035. However, as shown in Figure 5, there is, and will continue to be, significant differences in GDP per capita. In 2010, per capita GDP ranged from just over US$400 in Myanmar to about US$40,000 in Japan. In 2035, per capita GDP is assumed to range from just over US$1200 in Cambodia to about US$68,000 in Singapore.

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, 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 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 2010 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, Philippines, Singapore,

[9] IEA (2011).

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

Figure 6: Thermal Efficiencies of Gas Electricity Generation

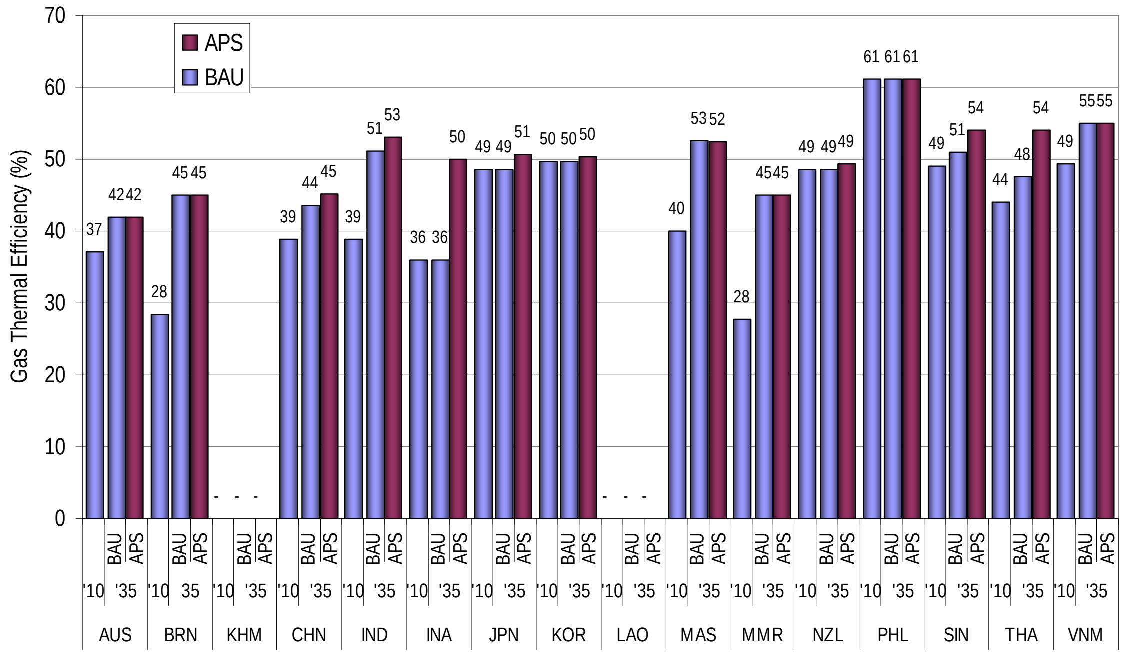
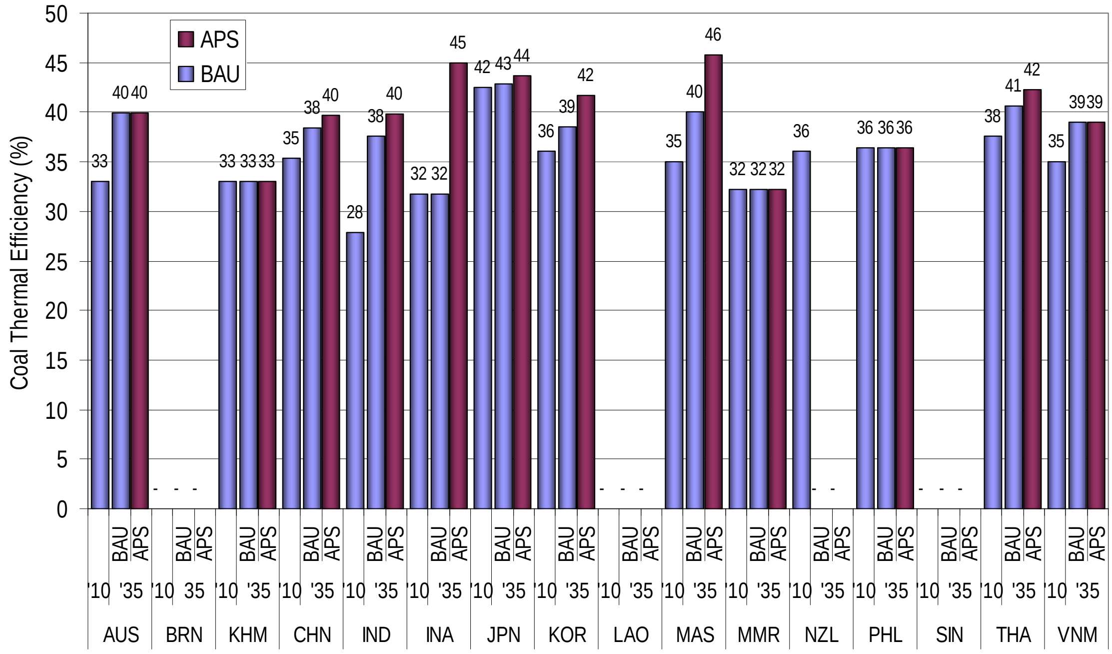


Figure 7: Thermal Efficiencies of Coal Electricity Generation

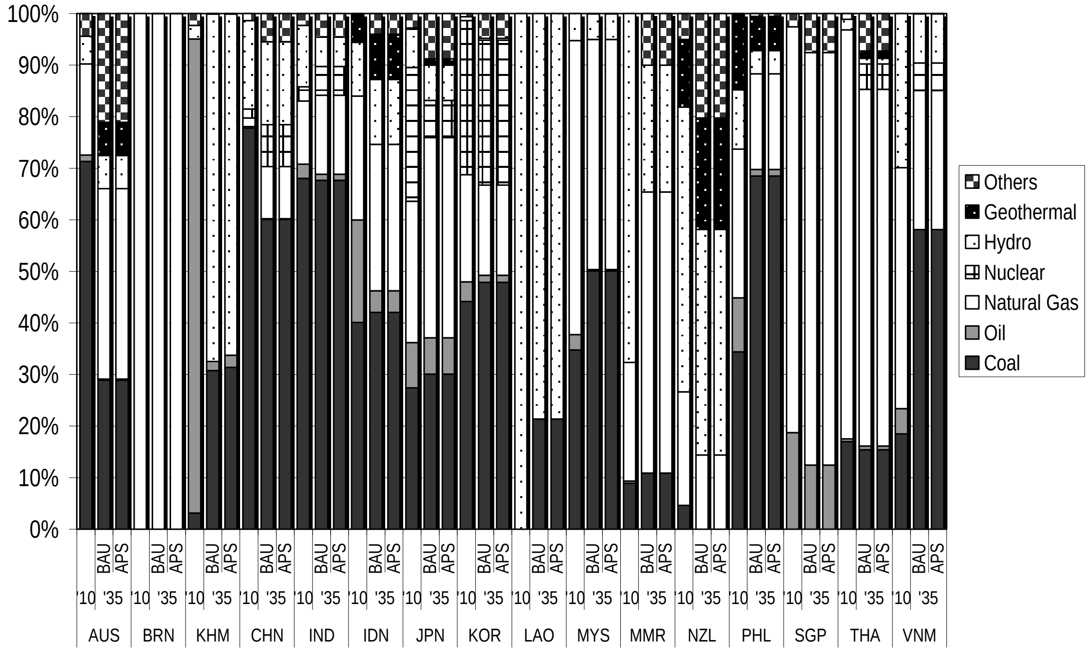


3.4.1 Electricity Generation Fuel Mix

The combination of fuels used in electricity generation differs among countries, reflecting both historical and current conditions, including access to and cost of resources and technology. It was, therefore, an exogenous input to the model. It is an important input, not only because it is a key driver of demand for primary fuels, but also because the fuel mix used can have important implications for greenhouse gas emissions. Only China did not provide electricity generation fuel mix assumptions for the BAU scenario. IEEJ developed their own estimates based on other sources for this country.

Across the EAS countries in the APS, it was initially assumed that hydro and nuclear output would remain the same as in the BAU scenario, and any reduction in electricity demand would be distributed among the other fuels in proportion to their BAU share. These initial APS results were then reviewed by the WG members from each country, who in some cases suggested additional changes. The projected electricity generation mix is shown in Figure 8.

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



Coal is projected to remain the dominant source of electricity generation in the EAS region as a whole in both the BAU and APS. However, the share of coal in electricity generation in the EAS region is projected to decline from about 56.3 percent in the BAU scenario to about 40.8 percent in the APS by 2035 as countries are assumed to implement policies designed to reduce the emissions intensity of electricity generation. In the APS, the share of lower emission fuels such as 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.

3.4.2 Access to Electricity

Currently, many households in developing countries lack access to electricity, and eliminating this situation is a major development goal. At the WG meetings, a number of the developing countries reported on initiatives to significantly expand access to electricity in their countries by 2035. Although this increasing access to electricity is another one of the drivers of increasing energy demand in the EAS region, it was not explicitly represented in the model used for this study.

Nevertheless, the impact of increasing access to electricity on electricity demand should be largely reflected through the increased demand for electricity as a result of the relatively rapid GDP growth that is assumed to be experienced in these same countries.

3.5. Use of Biofuels

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

Table 3: Assumptions on Biofuels – Summary by Country

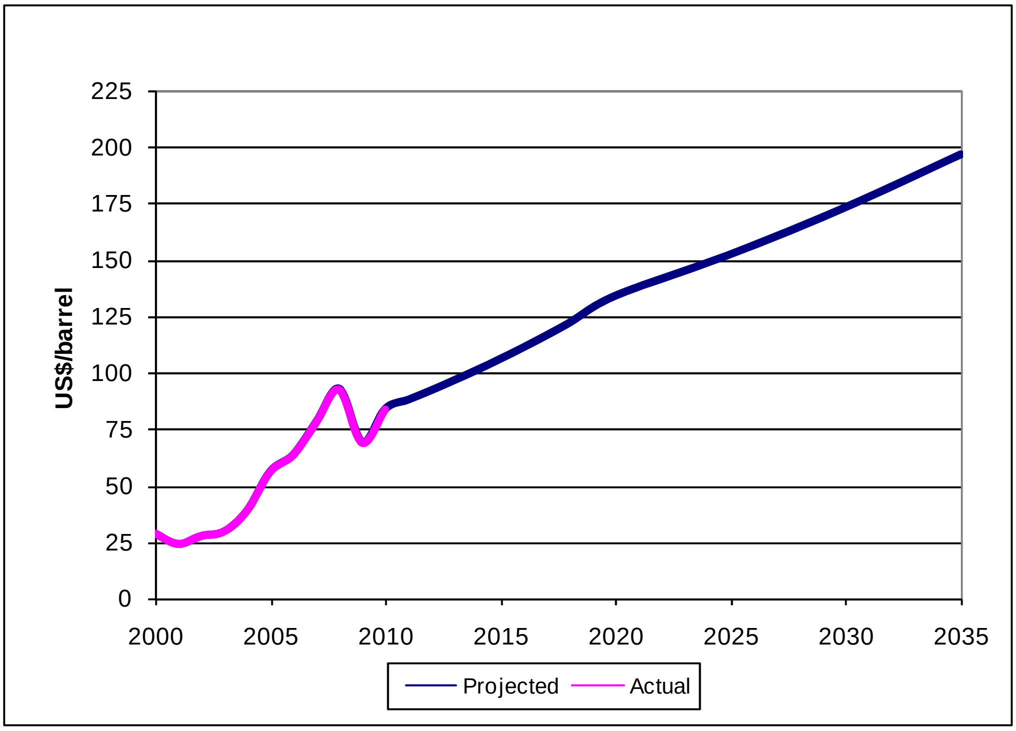
Country	Period	Assumptions
Australia	2010	No targets on biofuels.
Brunei Darussalam		No targets on biofuels.
Cambodia	2030	10% of road transport diesel and 20% of road transport motor gasoline will be displaced by biodiesel and bioethanol, respectively
China	2030	BAU: 20 billion litres, APS 60 billion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

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

3.6. Crude Oil Price

Future changes in crude oil prices remain highly uncertain. In this modelling exercise the crude oil price, as measured by Japan's average import price (current USD), is assumed to increase from about US$79 a barrel in 2010 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 2012 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: Summary of Energy Saving Goals, Action Plans and Policies Collected from each EAS WG Member

<table>
<tr><th></th><th>BAU scenario</th><th>APS</th></tr>
<tr><td>Australia</td><td colspan="2">• 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.</td></tr>
<tr><td>Brunei Darussalam</td><td>Brunei Darussalam aims to contribute to the 25% improvement in regional energy efficiency by 2030 (with 2005 as baseline), as declared by APEC leaders in the Sydney Declaration on Climate Change and Energy.</td><td>Reduce energy intensity by 45% by 2030 in line with the country's commitment to APEC through supply and demand side measures such as:
• Reduce energy consumption of the top 5 government offices by 10%
• Reduce energy consumption in the residential sector by 10%
• Conversion of existing simple-cycle power plants to combined-cycle units
• Expansion of cogeneration plants with heat recovery and steam generator</td></tr>
<tr><td>Cambodia</td><td></td><td>10% reduction of BAU energy consumption by 2015</td></tr>
<tr><td>China</td><td></td><td>• 16% energy intensity reduction from 2011 to 2015
• 40-~45% carbon intensity reduction from 2006 to 2020</td></tr>
<tr><td>India</td><td></td><td>• 20 to 25% improvement in CO_2 Intensity by 2020 relative to 2005 level</td></tr>
<tr><td>Indonesia</td><td></td><td>• 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%</td></tr>
</table>

Table 4 continued

	BAU scenario	APS
Japan		• 30% improvement in energy intensity in 2030 from 2005 level
Republic of Korea		• Reduce final energy intensity by 46% in 2030 from 2009 level
Lao PDR		• Reduce final energy consumption from BAU level by 10% from 2011-2015
Malaysia	Implementation of current policies by the government to promote energy efficiency in the industry, buildings and domestic sectors.	**1.** Residential Sector • Relamping of incandescent bulbs with CFL • Replacing inefficient refrigerators with 5-star refrigerators **2.** Commercial Sector • Raise air-conditioned space temperature • Relamping of T8 with T5 fluorescent tubes in government buildings • Building energy audit **3.** Industrial • Factory energy audit
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 10% of annual final demand relative to BAU through various energy efficiency programs in all sectors of the economy.
Singapore		• Reduce energy intensity by 20% by 2020 and by 35% by 2030 from the 2005 level. • Cap CO_2 emissions by 16% from BAU by 2020.
Thailand		• Reduce total final energy consumption by 20% relative to BAU by 2030
Vietnam		• Reduce energy consumption between 5%-8% by 2015 relative to BAU

3.8. Economic Growth and Climate Change Mitigation

Economic growth in the EAS countries is needed to provide for the region's growing population and improving living standards. Economic growth is assumed to exceed population growth in the 2010 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

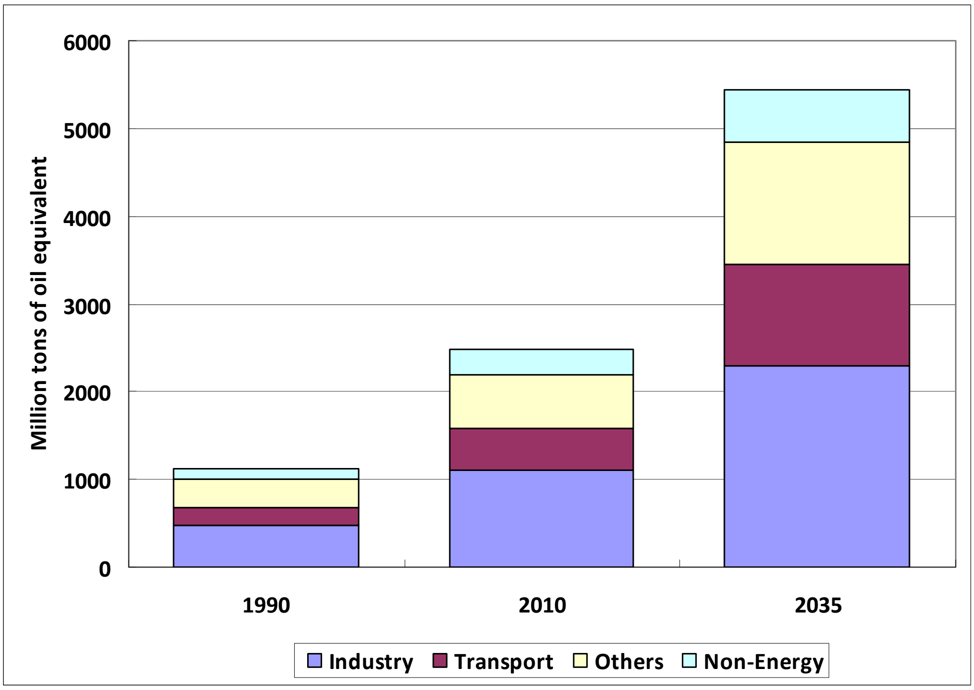
4.1.1.Final Energy Demand

Between 2010 and 2035, the total final energy demand[10] in the 16 EAS countries is projected to grow at an average annual rate of 3.2 percent, reflecting the assumed 4.1 percent annual GDP growth and 0.6 percent population growth. Final energy demand is projected to increase from 2489 Mtoe in 2010 to 5439 Mtoe in 2035. The transport sector demand is projected to grow most rapidly, increasing by 3.6 percent per year, as a result of motorization that is to be driven by increasing disposable income as EAS economies grow. The commercial and residential (Others) sectors'

[10] 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.

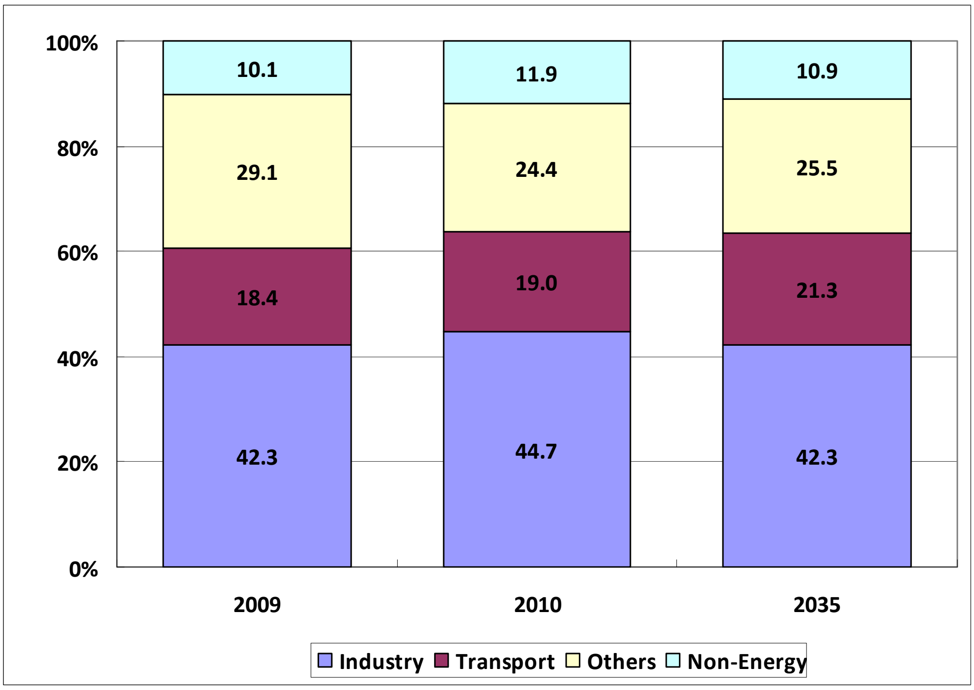
demand will grow at 3.4 percent per year faster than that of the industry sector reflective of EAS countries preference to change the structure of their economies to less energy intensive activities. Energy demand in the industry sector is projected to grow at an average annual rate of 2.9 percent. Figure 10 shows final energy demand by sector under in EAS, in 1990, 2010, and 2035.

Figure 10: Final Energy Demand by Sector (1990, 2010 and 2035)



There will be a slight change in the shares of the sectors in final energy demand from 2010 to 2035 with both the transport and other (largely residential and commercial) sectors having increasing shares while the industry sector will have a decreasing share. The transport sector's share will increase from 19.0 percent in 2010 to 21.3 percent in 2035. The other sectors' share will also increase from 24.4 percent to 25.5 percent during the same period. The share of industry sector, on the other hand, will decrease from 44.7 percent to 42.3 percent from 2010 to 2035. Non-energy demand will also decrease like the industry sector from 11.9 percent to 10.9 percent during the same period. The sectoral shares to final energy demand are shown in Figure 11.

Figure 11: Final Energy Demand Share by Sector (1990, 2010 and 2035)



For the energy sources, natural gas demand in the BAU scenario is projected to exhibit the fastest growth, increasing by 5.3 percent per year, from 180 Mtoe in 2010 to 657 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 2.9 percent per year, reaching 1999 Mtoe in 2035. This is compared with its 3.7 percent per year growth over the last two decades. Its share will decline from 39.0 percent in 2010 to 36.7 percent in 2035. Demand for electricity will grow at a relatively fast rate of 3.8 percent per year. Its share will increase from 22.3 percent in 2010 to 25.9 percent in 2035 surpassing the share of coal. The growth in coal demand will grow at a slower rate of 2.1 percent per year on average. Other fuels, which are mostly solid and liquid biofuels, will have a rapid annual growth rate of 4.1 percent on average. The share will however remain low but will increase from 1.9 percent in 2010 to 2.4 percent in 2035.

Figure 12 and 13 show the final energy demand and shares by energy in the EAS under the BAU, in 1990, 2010, and 2035.

Figure 12: Final Energy Demand by Energy (1990, 2010 and 2035)

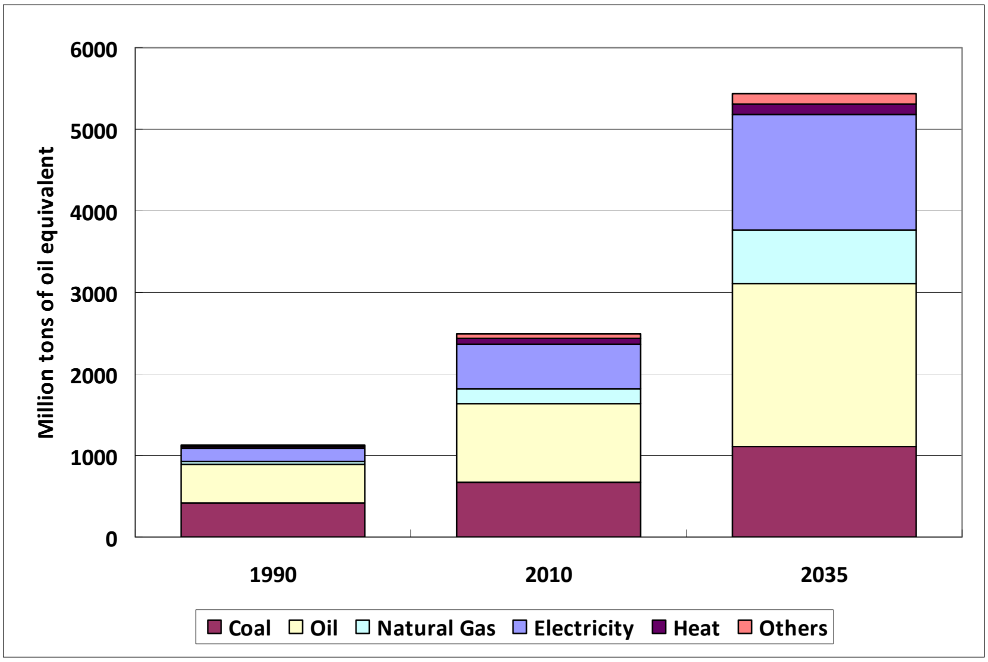
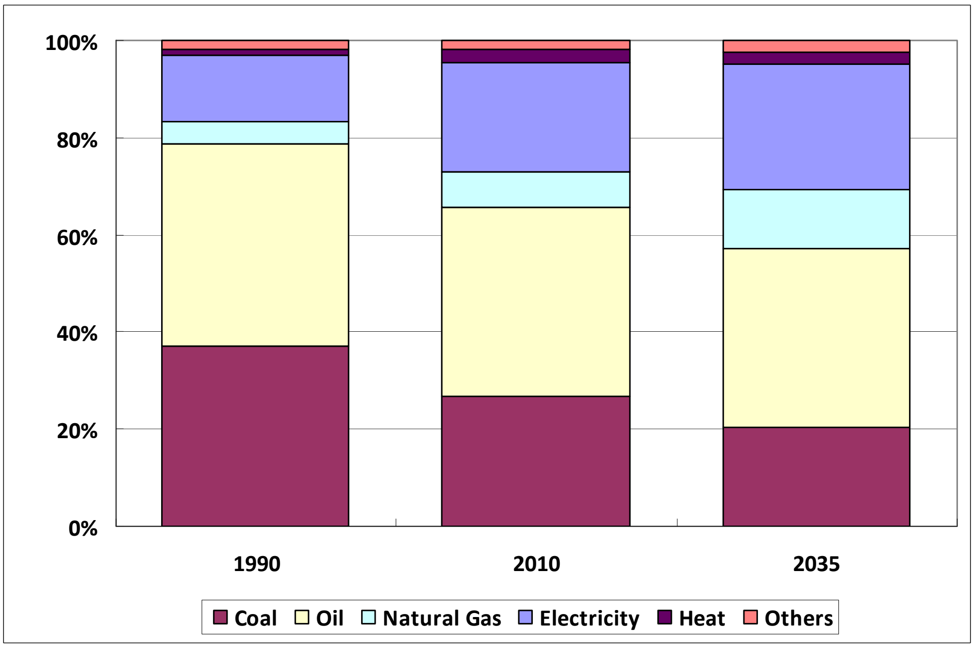


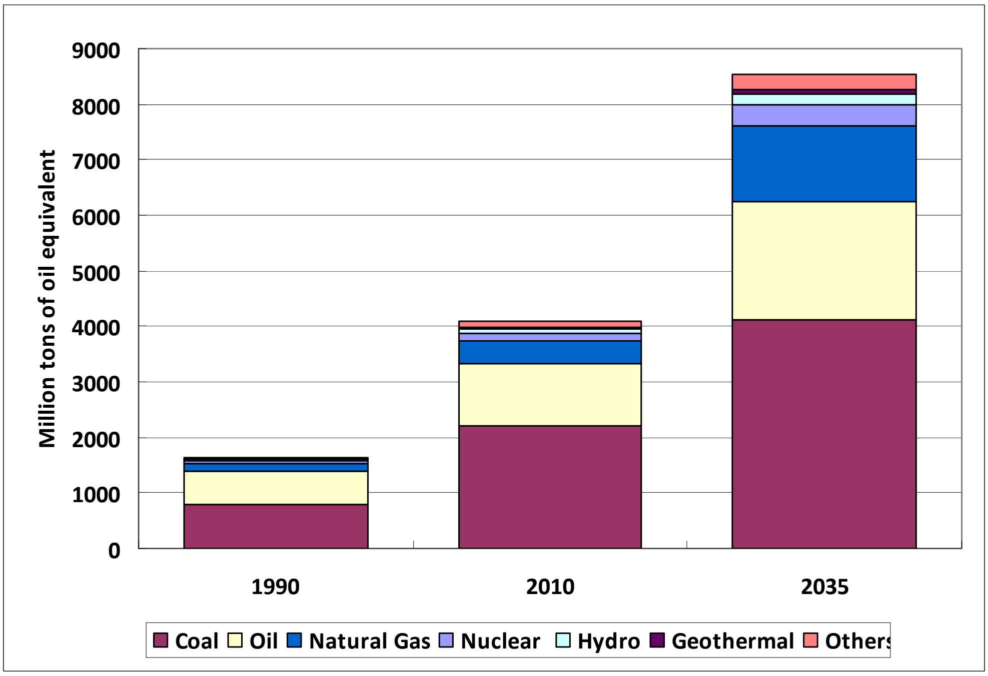
Figure 13: Final Energy Demand Share by Energy (1990, 2010 and 2035)



4.1.2.Primary Energy Demand

Primary energy demand[11] in EAS is projected to grow at a slower pace of 3.0 percent per year on average than the final energy demand of 3.2 percent. It is expected that growth in primary energy demand will be slightly slower than final energy demand because of improved efficiency in the energy transformation sector. The EAS primary energy demand is projected to increase from 4079 Mtoe in 2010 to 8536 Mtoe in 2035. Coal will still constitute the largest share of primary demand, but its growth is expected to be slower, increasing at 2.5 percent per year. Consequently, the share of coal in total primary energy demand will decline from 54.1 percent in 2010 to 48.3 percent in 2035. Figure 14 shows the primary energy demand in 1990, 2010 and 2035.

Figure 14: Primary Energy Demand in EAS (1990, 2010 and 2035)



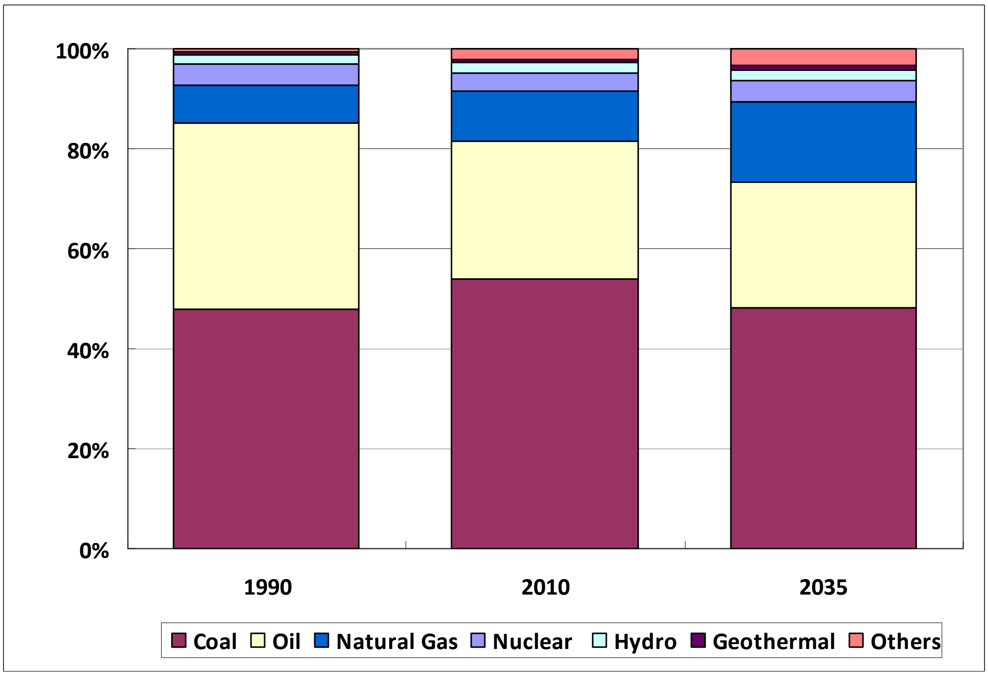
Among conventional sources of energy, natural gas is projected to exhibit the fastest growth between 2010 and 2035, increasing at an annual average rate of 4.9 percent. Its share to the total will subsequently increase from 10.2 percent in 2010 to

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

16.0 percent in 2035. Nuclear energy is also projected to increase at a rapid rate of 4.0 percent per year on average and its share will improve from 3.4 percent in 2010 to 4.4 percent in 2035. This is due to the expansion of power generation capacity in China and India and the introduction of this energy source in Vietnam.

Among the energy sources, "Others" - which constitute solar, wind as well as solid and liquid biofuels - will have the fastest growth rate of 4.7 percent. Consequently, the share of these other sources of energy will increase from 2.1 percent in 2010 to 3.2 percent in 2035. Geothermal energy will also increase at a rapid pace of 4.3 percent per year but its share will remain low at 0.9 percent in 2035, slightly increasing from 0.6 percent in 2010. The growth of hydro will be 3.1 percent per year and its share will remain at 2.2 percent from 2010 to 2035. Figure 15 shows the shares of each energy source to the total primary energy mix in 1990, 2010 and 2035.

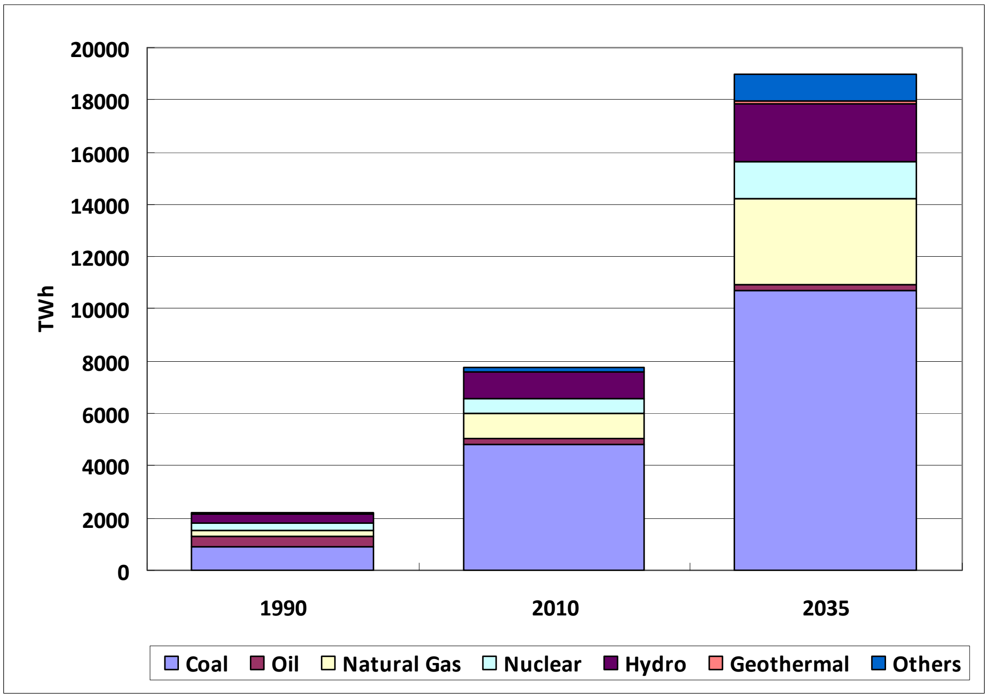
Figure 15: Primary Energy Mix in EAS (1990, 2010 and 2035)



4.1.3.Power Generation

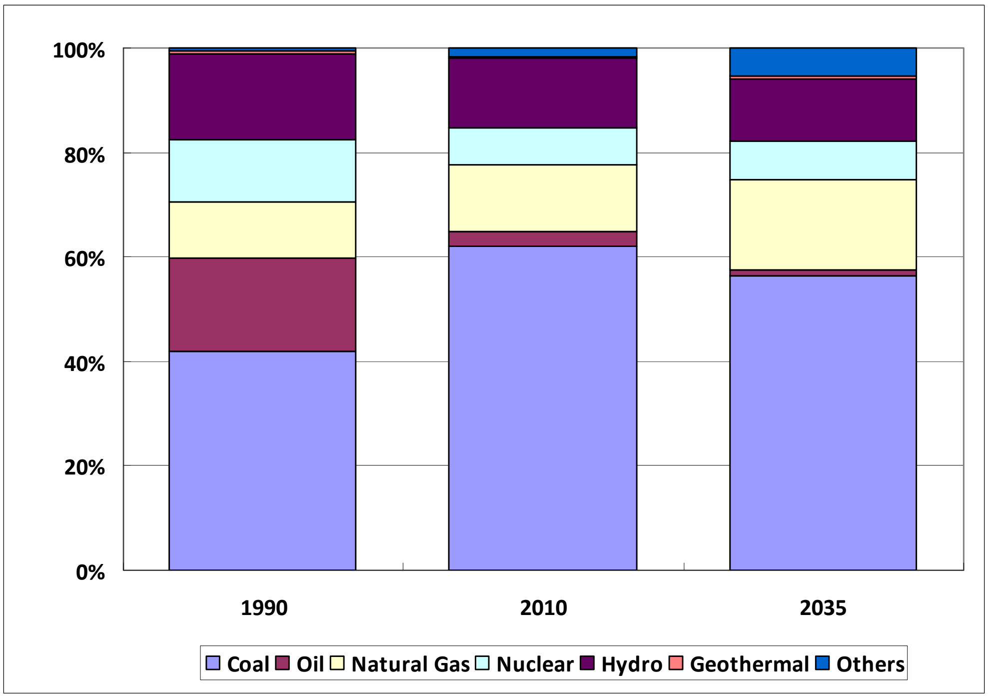
Power generation in EAS is projected to grow at 3.7 percent per year on average from 2010 (7740 TWh) to 2035 (19,012 TWh), slower than the 6.5 percent annual rate of growth from 1990 to 2010 (Figure 16).

Figure 16: Power Generation in EAS (1990, 2010 and 2035)



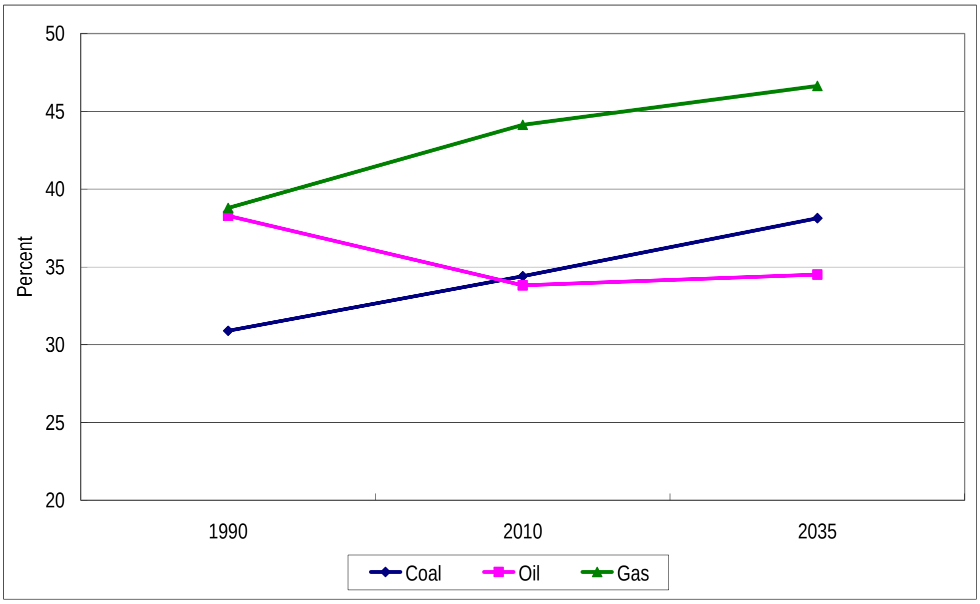
The share of coal–fired generation is projected to continue to be the largest and will remain above 56 percent of the total until 2035. Natural gas share is projected to increase from 12.7 percent in 2010 to 17.3 percent in 2035 along with those of nuclear (6.9 percent in 2010 to 7.5 percent in 2035), geothermal (0.4 percent to 0.7 percent) and others (wind, solar, biomass, etc at 1.7 percent to 5.4 percent). The shares of oil and hydro are projected to decrease slightly from 2.8 percent to 1.1 percent and 13.4 percent to 11.7 percent, respectively, during the same period. Figure 17 shows the shares of each energy source in electricity generation in 1990, 2010 and 2035.

Figure 17: Power Generation Mix in EAS (1990, 2010 and 2035)



Thermal efficiency is projected to grow in EAS from 2010 to 2035 due to improvement in electricity generation technologies like combined-cycle gas turbines and advanced coal power plant technologies. From 34.4 percent in 2010, the efficiency of coal thermal power plants, which is a mix of old and new power plants, will increase to 38.1 percent in 2035. Efficiency of natural gas power plants will also increase from 44.1 percent in 2010 to 46.6 percent in 2035. Even oil power plants, which will not be used significantly in the future, will have improved efficiency from 33.8 percent in 2010 to 34.5 percent in 2035. Figure 18 shows the thermal efficiency of coal-, oil- and natural gas-fired power generation.

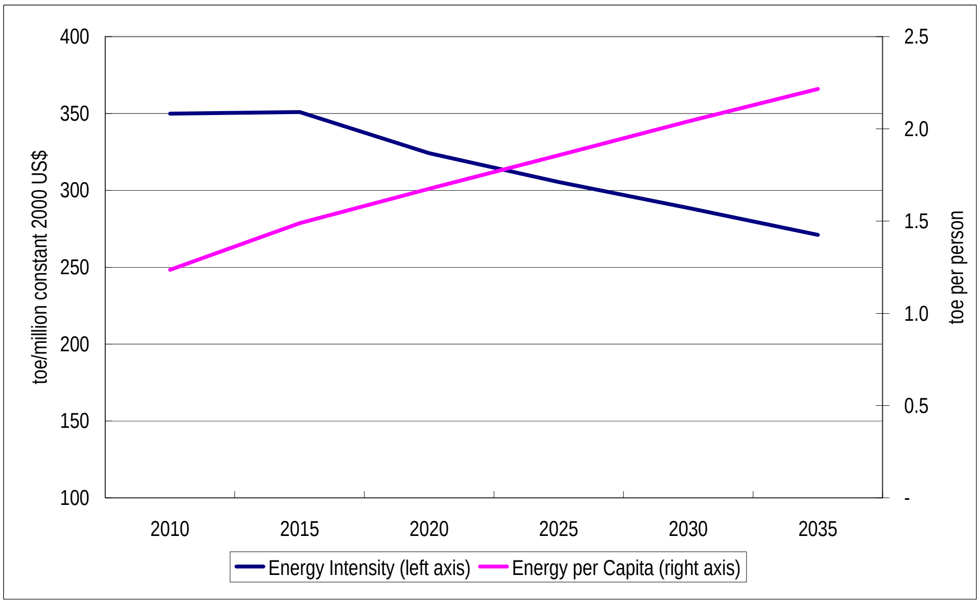
Figure 18: Thermal Efficiency by Fuel. BAU (1990, 2010 and 2035)



4.1.4.Energy Intensity and per Capita Energy Demand

Even in the BAU, energy intensity in EAS is projected to decline from 348 toe/million US$ (constant 2000) in 2010 to 270 toe/million US$ in 2035. In contrast, energy demand per capita is projected to continue to increase from 1.24 toe per person in 2010 to 2.22 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 19 shows the energy intensity and energy per capita in 1990, 2010 and 2035.

Figure 19: Energy Intensity and per Capita Energy Demand in EAS

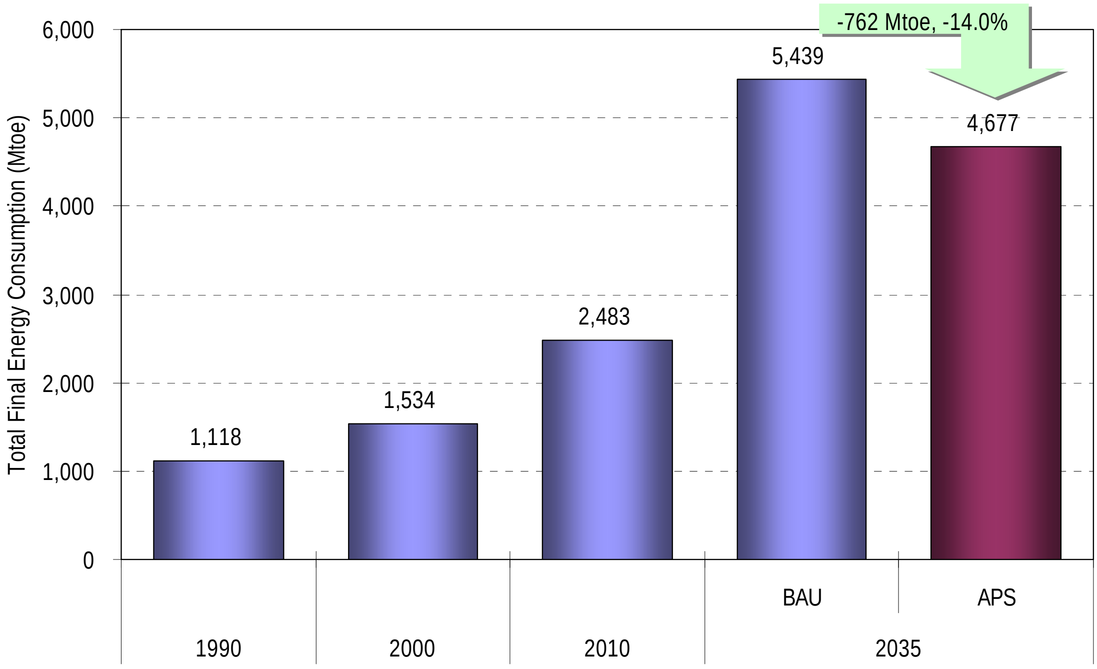


4.2. Alternative Policy Scenario (APS)

4.2.1.Total Final Energy Demand

In the APS case, final energy demand is projected to rise to 4677 Mtoe, 762 Mtoe or 14.0 percent lower than in the BAU case in 2035. This is due to the various energy efficiency plans and programs, presented in Section 3 above, in both the supply and demand sides that are to be implemented by EAS countries. Figure 21 shows the evolution of final energy demand from 1990 to 2035 in both the BAU and APS scenarios.

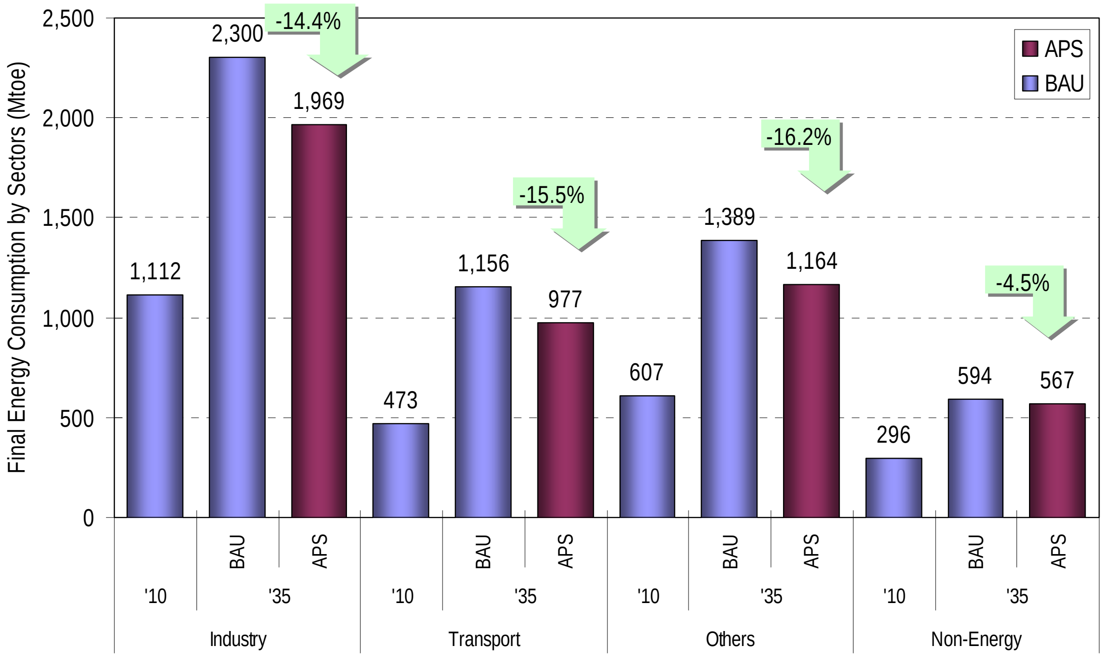
Figure 20: Total Final Energy Demand, BAU and APS



4.2.2. Final Energy Demand by Sector

Figure 21 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 other sectors at 16.2 percent, followed by the transport sector at 15.5 percent and the industry at 14.4 percent. Non-energy demand will also be lower in the APS by 4.5 percent as compared to the BAU.

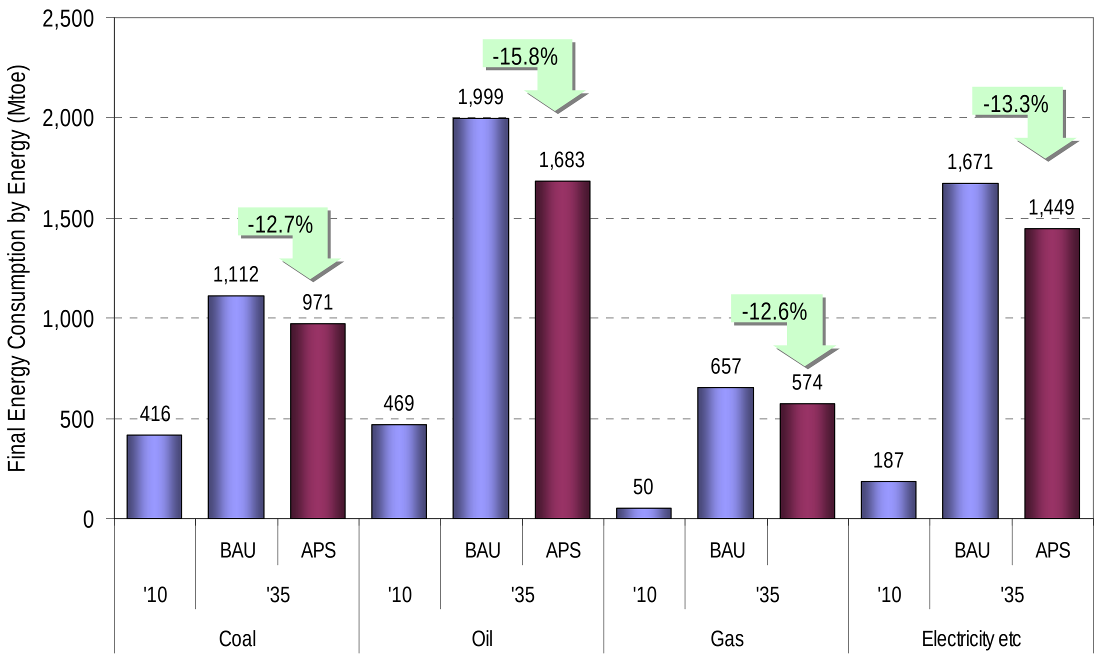
Figure 21: Final Energy Demand by Sector, BAU and APS



4.2.3.Final Energy Demand by Fuel

Figure 22 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 2.6 percent per year on average is lower than the BAU's 3.2 percent. The largest reduction will be in oil demand at 316 Mtoe or 15.8 percent from the BAU's 1999 Mtoe to 1683 Mtoe in the APS. This potential saving in oil is equivalent to 86 percent of China's final oil demand in 2010. The saving potential in other fuels which includes electricity and heat is second largest at 223 Mtoe, equivalent to a reduction of 13.3 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 141 Mtoe and this will come mostly from energy efficiency in the industrial sector. The saving potential for natural gas is around 83 Mtoe or 12.6 percent from the BAU demand.

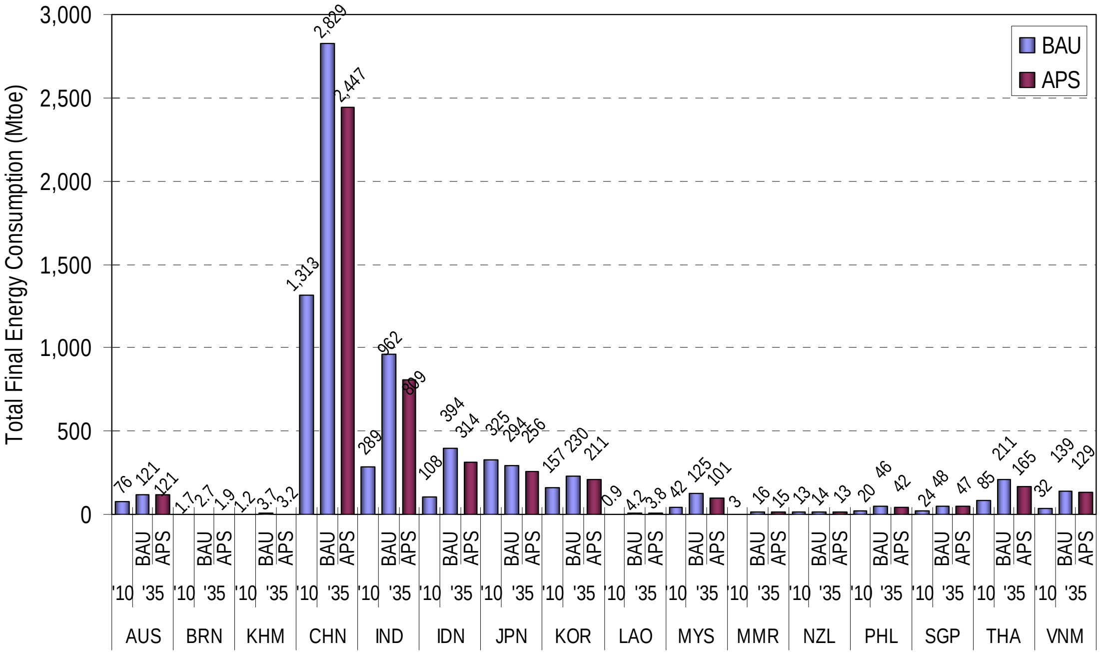
Figure 22: Final Energy Demand by Fuel, BAU and APS



4.2.4.Final Energy Demand by Country

Figure 23 shows final energy demand by country. The most striking result is that China is projected to continue to dominate EAS region final energy demand until 2035. China is projected to account for about 52.3 percent of EAS region final energy demand in 2035, down from about 52.8 percent in 2010. Just five countries—China, India, Indonesia, Japan, and Republic of Korea—are projected to account for 86.6 percent of EAS region final energy demand in 2035, with the growth in final energy demand concentrated in just three countries: China, India, and Indonesia. In fact, these "big three" countries are projected to account for 83.7 percent of the growth in energy demand for the entire EAS region between 2010 and 2035. In the APS case, growth in most countries, including the "big three", is significantly lower relative to the BAU scenario. However, the "big three" are still projected to account for 84.8 percent of the growth in energy demand in the EAS region between 2010 and 2035.

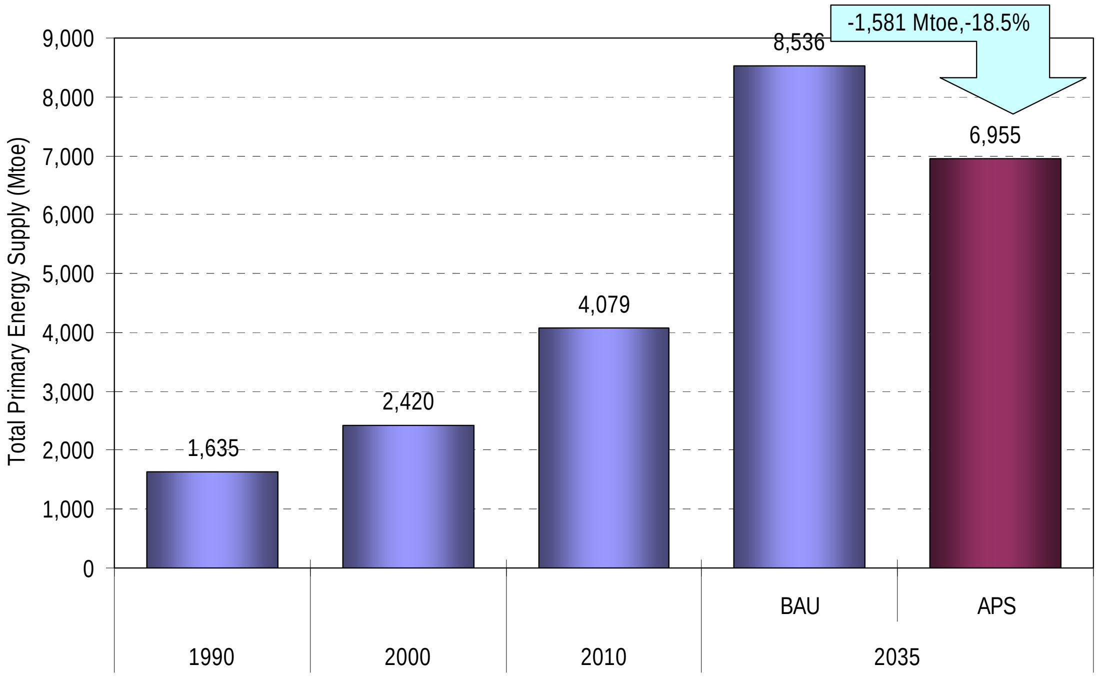
Figure 23: Total Final Energy Demand by Country, BAU and APS



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 24 shows that total primary energy demand is projected to increase from 4079 Mtoe in 2010 to 8536 Mtoe in 2035 in the BAU case, an increase on average of 3.0 percent per year. In the APS case, demand is projected to grow to 6955 Mtoe by 2035, 18.5 percent lower than in the BAU case. The reduction in 2035 primary energy demand in the APS case compared with the BAU case of 1,581 Mtoe is roughly equivalent to 71% of China's demand in 2010.

Figure 24: Total Primary Energy Demand, BAU and APS

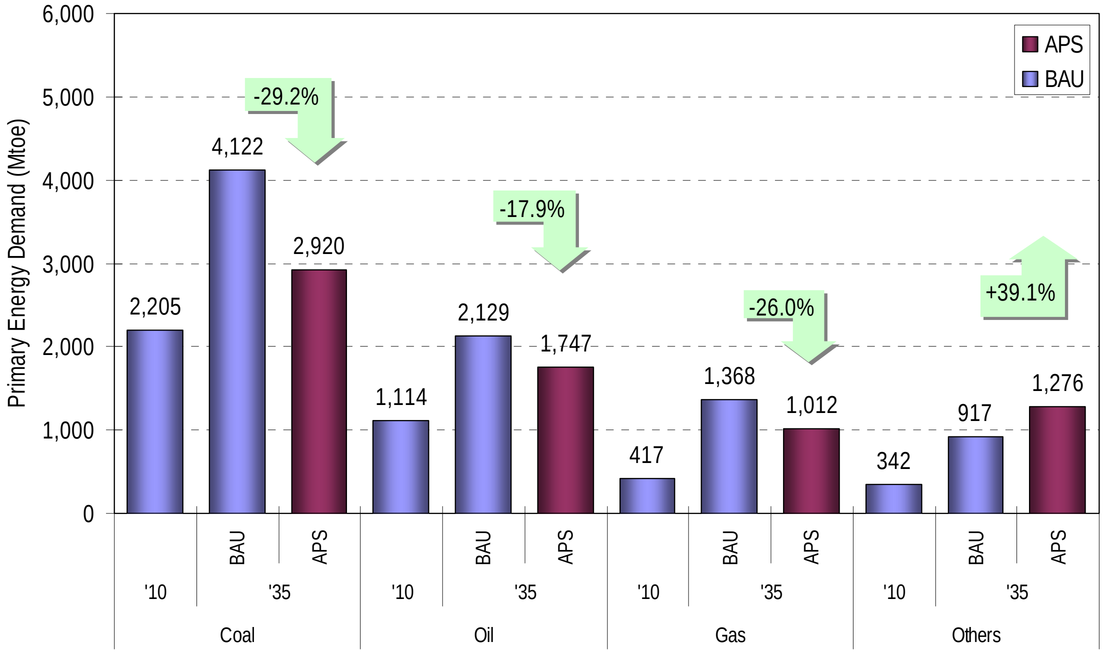


4.2.6.Primary Energy Demand by Source

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 29.2 percent lower in the APS or equivalent to 1202 Mtoe, more than half of EAS coal demand of 2206 Mtoe in 2010. 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 382 Mtoe or 17.9 percent. This is due to the combined effect or more efficient vehicles and the utilization of alternative fuels in the transport sector such as natural gas, electricity and biofuels. The demand of natural gas will also be lower in the APS at 26.0 percent of the BAU, equivalent to 356 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 higher by 39.1 percent in the APS as compared to BAU.

Figure 25 shows primary energy demand by energy source in both scenarios.

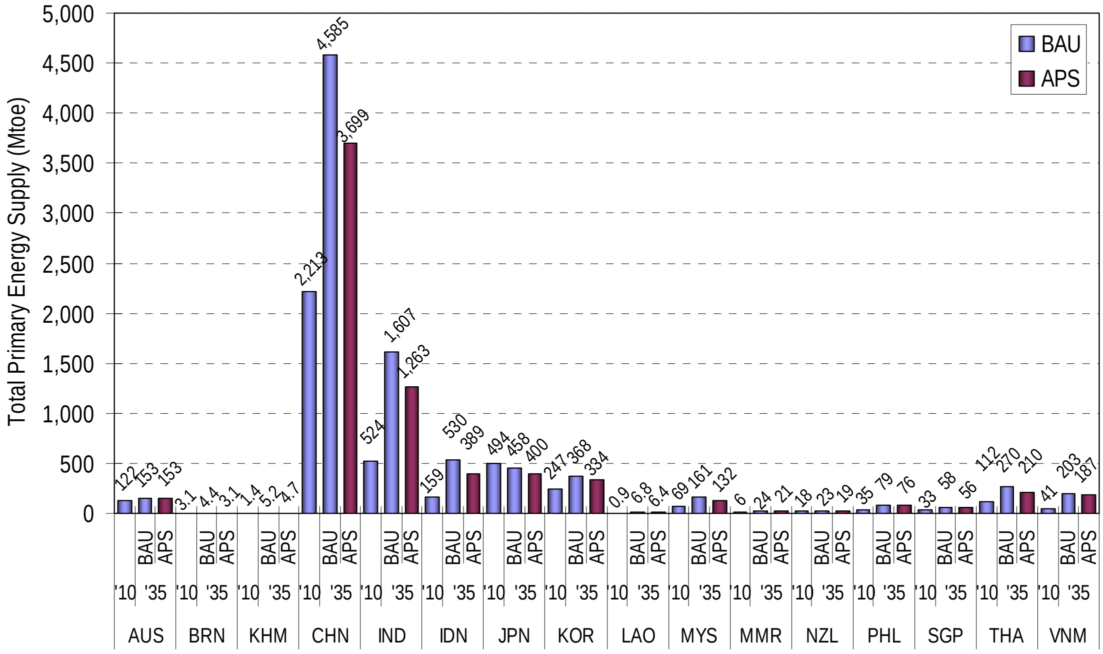
Figure 25: Primary Energy Demand by Source, BAU and APS



4.2.7.Primary Energy Demand by Country

Figure 26 shows primary energy demand by country, which is similar to the pattern for final energy demand by country shown in Figure 23. Five countries - China, India, Indonesia, Japan, and Republic of Korea - are projected to account for 88.5 percent of EAS region primary energy in 2035. The 'big three' - China, India, and Indonesia - will dominate the growth in EAS region primary energy, accounting for 86.0 percent of the growth between 2010 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 26: Primary Energy Demand by Country, BAU and APS



4.2.8.Primary Energy Intensity by Country

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

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

	2010	2035		Variance		
		BAU	APS	APS/BAU	2010/2035 BAU	2010/2035 APS
	(toe/million US$)	(toe/million US$)	(toe/million US$)	%	%	%
Australia	218	106	106	0.0	-51.4	-51.4
Brunei Darussalam	456	324	233	-28.3	-28.9	-49.0
Cambodia	175	140	123	-12.1	-19.9	-29.6
China	682	360	290	-19.3	-47.2	-57.4
India	526	299	235	-21.4	-43.1	-55.3
Indonesia	577	516	379	-26.7	-10.6	-34.4
Japan	98	67	58	-12.7	-31.9	-40.6
Korea	309	213	194	-9.1	-30.9	-37.2
Lao PDR	260	362	339	-6.2	39.4	30.8
Malaysia	470	427	350	-18.0	-9.1	-25.5
Myanmar	297	217	193	-10.8	-27.1	-35.0
New Zealand	266	198	165	-16.5	-25.7	-38.0
Philippines	270	153	149	-2.8	-43.3	-44.9
Singapore	200	133	129	-3.1	-33.2	-35.3
Thailand	598	557	435	-22.0	-6.9	-27.4
Viet Nam	651	589	542	-8.0	-9.5	-16.7
Total	348	270	220	-18.5	-22.5	-36.8

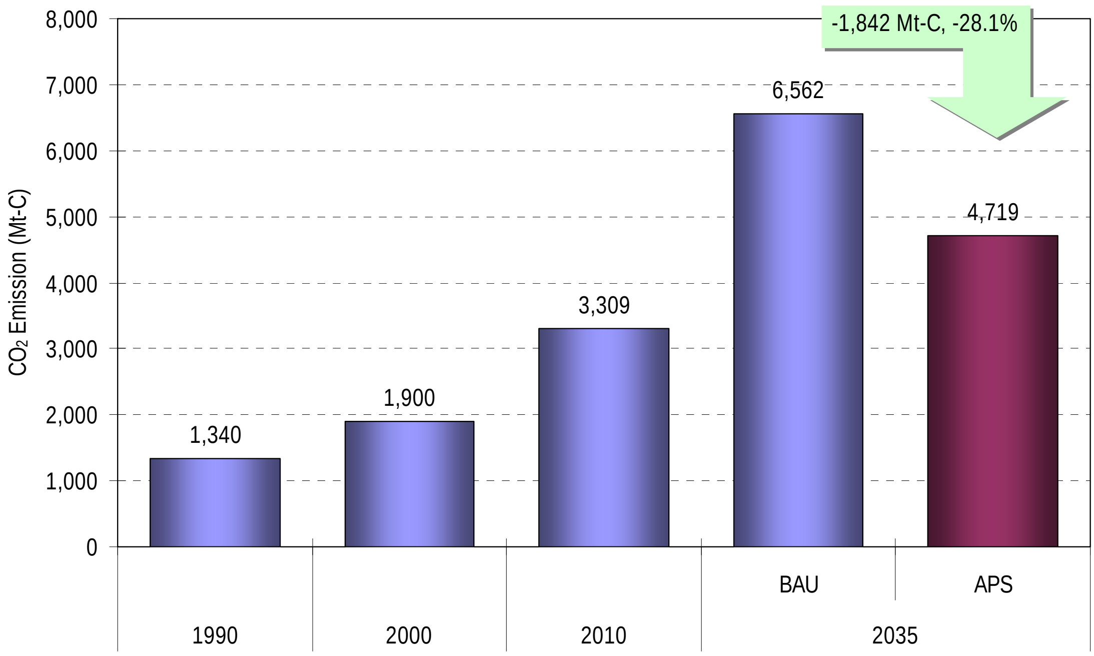
4.3. Carbon Dioxide (CO_2) Emissions from Energy Consumption

4.3.1. CO_2 Emissions

As shown in Figure 27, CO_2 emissions from energy consumption in the BAU case are projected to increase from 3309 million tonnes of Carbon (Mt-C) in 2010 to 6561 Mt-C in 2035, implying an average annual growth rate of 2.8 percent. This is slightly lower than the growth in total primary energy demand of 3.0 percent per year. In the APS case, CO_2 emissions are projected to be 4718 Mt-C in 2035, 28.1 percent lower than under the BAU case.

While the emission reductions under the APS are significant, CO_2 emissions from energy demand under the APS case in 2035 will still be above 2010 levels and far above 1990 levels. Scientific evidence suggests that these reductions will not be adequate to prevent severe climate change impacts. Analysis by the Intergovernmental Panel on Climate Change (IPCC) (reference) suggests that to keep the increase in global mean temperature to not much more than 2°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 year 2000 levels (that is, a reduction of between 85 and 50 percent) by 2050. To keep temperature rises in the 3°C range, CO_2 emissions would need to peak between 2010 and 2030 and be 70 to 105 percent of year 2000 levels by 2050.[12]

Figure 27: Total CO_2 Emissions, BAU and APS



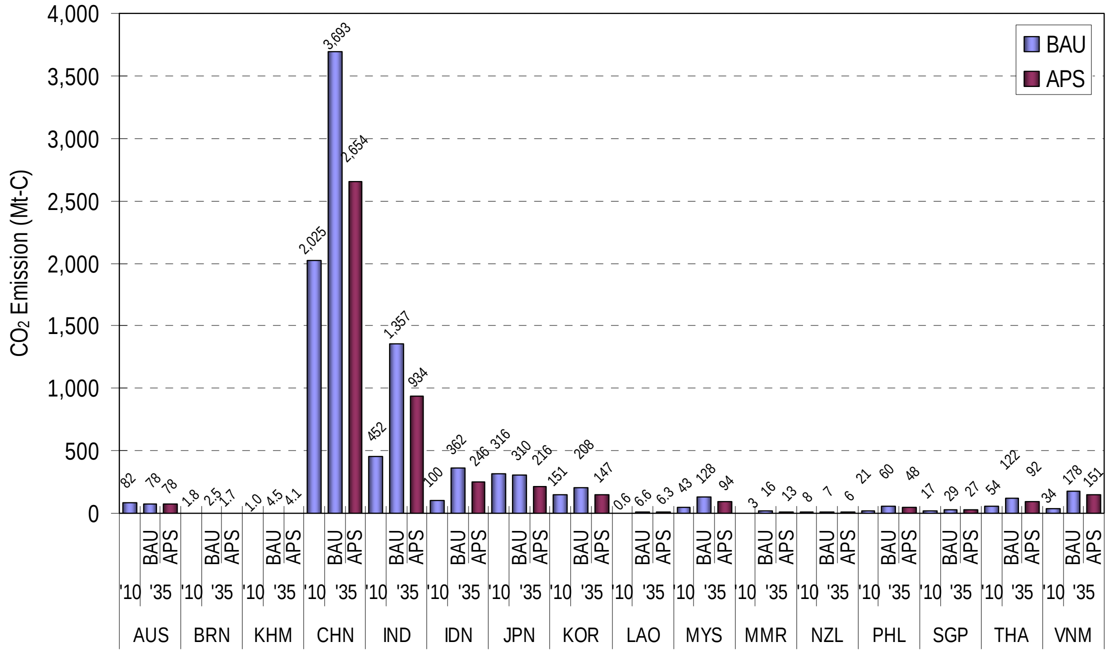
Although much depends on the mitigation achieved in other regions, it would appear unlikely that global emissions could meet either of these profiles given the contribution of the EAS region to global total emissions under the APS results. Yet the consequences of insufficient reductions in emissions could be severe. For example at 2°C above pre-industrial levels, up to 30 percent of species become at increasing risk of extinction, most corals become bleached, and droughts and water availability become an increasing problem worldwide. At 3°C, millions of people

[12] 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.

could experience coastal flooding each year.[13]

As shown in Figure 28, emissions and emission growth in the EAS region is projected to be dominated by China and India. In fact, China and India will account for 1668 Mt-C and 905 Mt-C, respectively, of the projected 3251 Mt-C increase in EAS region emissions from 2010 to 2035 under the BAU case, or 79.1 percent of the total growth in the EAS region. Adding Indonesia's growth of 263 Mt-C, these three countries account for 2835 Mt-C or 87.2 percent of the total growth in EAS region. No other country will account for growth of more than 150 Mt-C. Australia, Japan and New Zealand are the only countries 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 28: CO_2 Emissions by Country, BAU and APS



Under the APS case, China and India are still dominant, accounting for 629 and 482 Mt-C, respectively, of the projected 1409 Mt-C growth in emissions in the EAS region between 2010 and 2035, or 79.6 percent. Adding 146 Mt-C from Indonesia,

[13] 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.

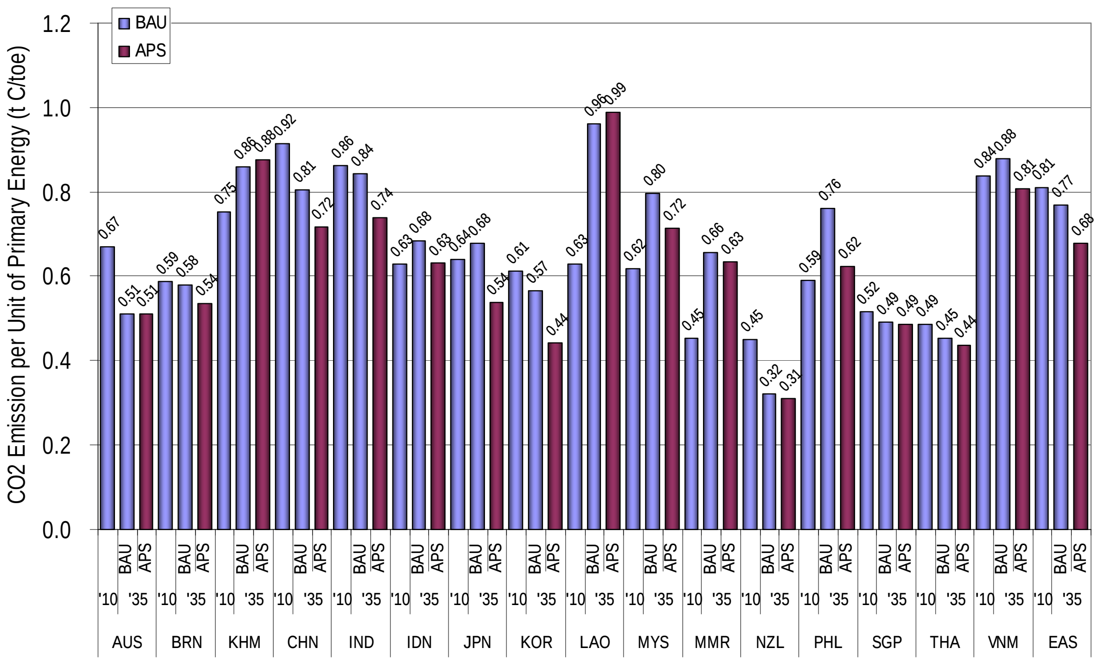
these three countries account for 1258 Mt-C or 89.3 percent of the EAS region total. No other country will account for a growth of more than 117 Mt-C. Emissions from Australia, Brunei Darussalam, Japan, the Republic of Korea and New Zealand are expected to decline under the APS case relative to 2010 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.

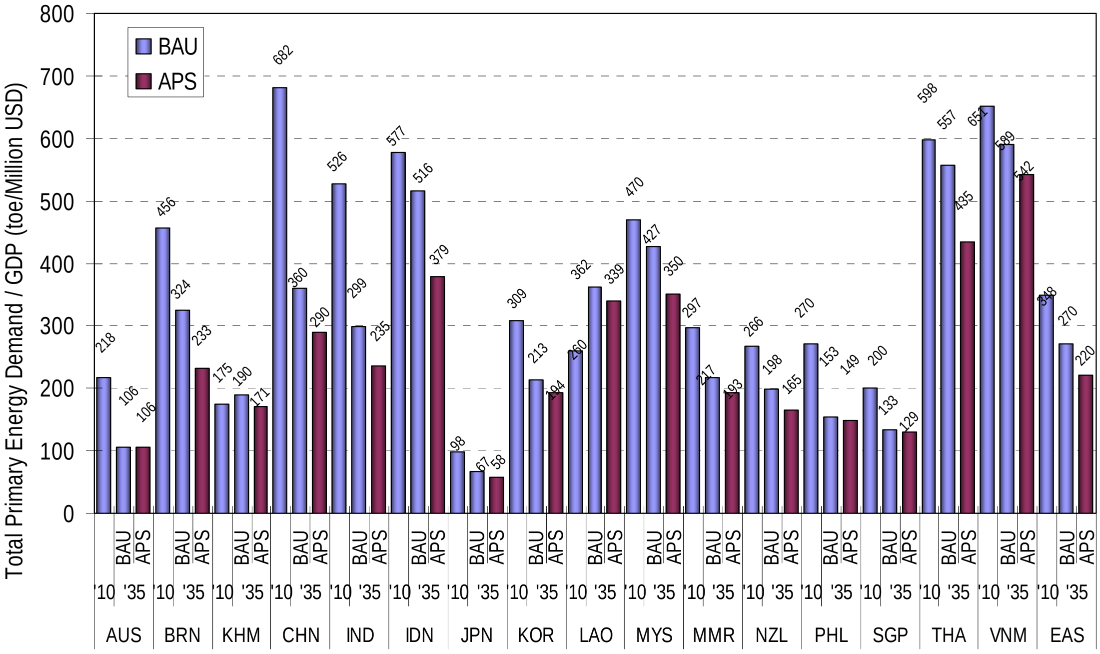
i) Emissions per unit of primary energy are projected to decline to 0.77 t-C/toe in 2035 from 0.81 t-C/toe in 2010 under the BAU case. Under the APS case, this will decline to 0.68 t-C/toe in 2035, equivalent to a decline of 16.3 percent from 2010 (Figure 29). The reduction under the APS case reflects a shift away from coal and oil, the two most emission-intensive fuels.

Figure 29: Emissions per Unit of Primary Energy, BAU and APS



ii) Primary energy per unit of GDP is projected to decline from 348 toe/million US$ in 2010 to 270 toe/million US$ in 2035 under the BAU case, or by 22.5 percent (Figure 30). Under the APS case, this will decline to 220 toe/million US$ in 2035, or by 36.8 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 283 t-C/million US$ in 2010 to 208 t-C/million US$ in 2035 under the BAU case, or by 26.6 percent. Under the APS, this will decline to 149 t-C/million US$ in 2035, 47.2 percent lower than 2010.

Figure 30: Primary Energy Demand per Unit of GDP, BAU and APS



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 3500 US$/person in 2010 to 8200 US$/person in 2035, an increase of 131.5 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 1.0 t-C/person in 2010 to 1.7 t-C/person in 2035 under the BAU case, or by 70.0 percent. Under the APS, emissions rise to only 1.2 t-C/person in 2035, or

22.2 percent higher than 2010. However, the rising emissions per capita are associated with increase in GDP/person and improvement in living standards.

iv) Finally, population in the EAS Region is expected to grow from 3301 million in 2010 to 3850 million in 2035, or by 16.6 percent. Combined, all these drivers lead to growth in emissions from 3309 Mt-C in 2010 to 6561 Mt C in 2035 under the BAU case, or 98.3 percent. Under the APS, emissions grow to 4718 Mt-C in 2035, or 42.6 percent.

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

5.1. Research Objective

With the continuous high rate of economic growth and urbanization in the EAS region, household energy consumption has been increasing in recent years. Energy efficiency in the household sector has become a big concern in many countries. Energy saving programs in the sector are being implemented in many countries or are being planned in some countries. This research was carried out from 2010 to determine how energy is consumed in the residential sector in end-use level to serve as basis for formulation of energy saving goals and action plans in the sector and for monitoring performance of energy saving programs.

The survey was carried out again in 2011 to incorporate various lessons learned in the first trial survey. However, in view of the apparent mistake in estimating end-use consumption of appliances that are used at variable loads, an energy efficiency consultant was requested to study how the actual consumption of such kinds of household appliances should be calculated in 2012. The consultant carried out an experiment to determine how to correctly determine the actual consumption of such household appliances. The consultant's report is presented as Annex 1 of this report.

Working group members conducted the survey again to the same respondents using the same methodology from last year to collect more reliable data and reflect more realistic energy consumption structure. As a result, energy consumptions were revised by most respondents, as well as hours of usage and power ratings of electric appliances. The revised samples and result are shown in the following section.

5.2. Data Collection

The respondents to the survey were selected by the working group members and consist mainly of colleagues and residents in their neighbourhood. A total of 112 respondents from Cambodia, Indonesia, Malaysia, Philippines, Lao PDR, Singapore, Thailand and Viet Nam participated in the survey. Seven of eight countries, except Singapore, asked the same respondents from last year to revise data such as number of appliances, hours of usage and power ratings. Singapore submitted new samples for this project. Respondents increased by 6 from last years' 106 respondents. The profile of the respondents is shown in Table 6.

Table 6: Profile of Pilot Survey Respondents

	n	%
Cambodia	20	18
Lao PDR	11	10
Viet Nam	10	9
Indonesia	17	15
Philippines	17	15
Thailand	12	11
Malaysia	15	13
Singapore	10	9
Total	112	100

The majority of the surveyed respondents live in urban areas, accounting for 66 percent of the participants, with the remainder in rural areas (34 percent) (Figure 31). The histogram in Figure 32 shows that the number of persons per respondent household is concentrated at around 4 to 5 persons. The majority of the respondents live in relatively large houses (Figures 33 and 34).

Figure 31: Share of Respondents in Urban and Rural Areas

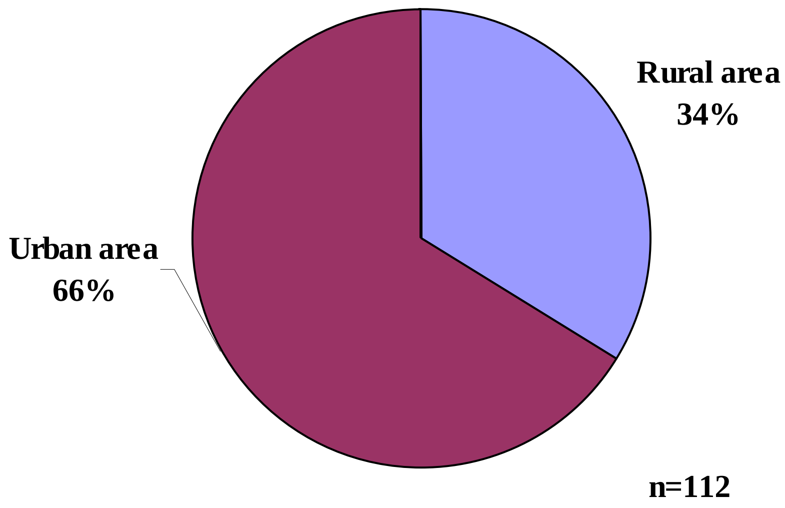


Figure 32: Histogram of Household Size

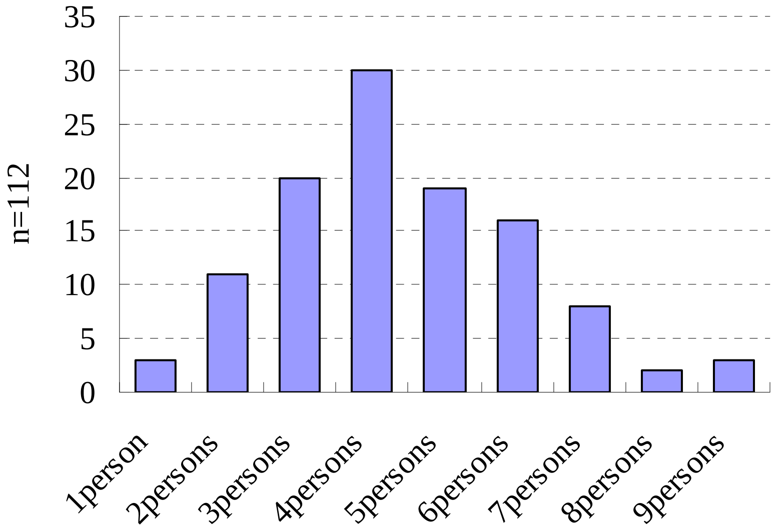


Figure 33: Share of Respondents by Type of Residence

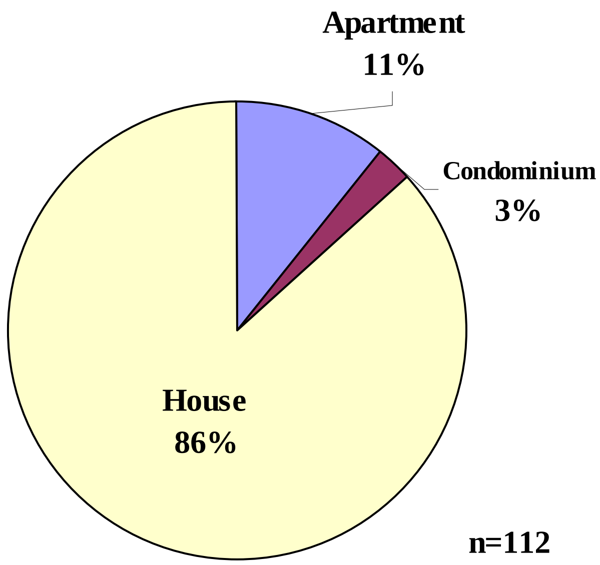
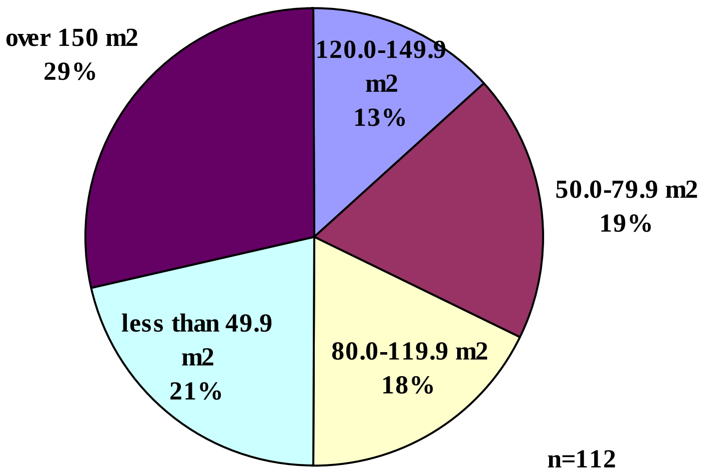


Figure 34: Share of Respondents by Floor Area



5.3. Main Electrical Appliances and Equipment in Households

The ownership of electrical appliances and equipment is much higher in urban areas, with large observed differences in the ownership of air conditioners, refrigerators, rice cookers, personal computers and washing machines. In particular, there is a stark difference in the ownership of air conditioners - the number of air conditioners in urban and rural areas is 1.28 units and 0.32 units per household, respectively. The ownership of electrical appliances in urban areas is almost as high as in developed countries. The ownership of the three “must have” appliances in Japan such as a television, refrigerator and washing machine in participating countries is almost 1 unit per household in urban areas. Similarly, the number of televisions is almost 1 unit per household, in even rural areas.

Table 7: Main Appliances in Households

	Urban	Rural
A/C	1.28	0.32
Fan	2.64	1.66
Refrigerator	1.03	0.92
Electric stove	0.31	0.27
Microwave	0.79	0.36
Rice cooker	1.05	0.82
CRT	1.09	0.83
LCD	0.98	0.57
Desktop	0.79	0.25
Laptop	1.43	0.75
Washing machine	0.97	0.68

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

Table 8: Main Appliances in Households by country

	Cambodia *	Lao PDR*	Vietnam	Indonesia	Philippines	Thailand*	Malaysia	Singapore	Total
A/C	0.70	1.45	0.40	0.47	0.06	1.75	1.80	1.60	0.96
Fan	1.95	2.27	1.90	1.35	2.35	2.58	3.67	2.60	2.30
Refrigerator	1.00	0.91	1.00	0.71	1.00	1.33	1.07	1.10	1.00
Electric stove	-	0.00	-	0.00	-	0.67	1.20	0.71	0.30
Microwave	1.00	0.64	1.00	0.12	1.00	1.00	1.00	0.83	0.70
Rice cooker	1.00	1.00	1.00	0.71	1.00	1.18	1.13	1.00	0.99
CRT	1.10	0.64	1.00	0.82	1.07	1.00	1.22	1.17	0.99
LCD	1.00	0.64	1.00	0.47	1.00	1.56	1.00	1.17	0.88
Desktop	1.00	0.27	1.00	0.35	1.25	0.67	1.00	1.17	0.68
Laptop	1.13	0.82	-	0.53	1.20	1.83	2.00	2.63	1.31
Washing machine	1.00	0.82	1.00	0.47	1.00	1.08	1.07	1.00	0.90

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

5.4. Hours of Usage of Cooling and Ventilation

The ASEAN region has a moderate climate with an average temperature of 29^{o}C and a maximum temperature of around 40^{o}C.[14] Therefore, the use of air-conditioning is much higher than in countries with cooler climates. As shown in Table 9, each day, on average, air conditioners are used for 2.0 hours and fans for 4.6 hours.

One exception is the Philippines, where there is a low penetration of air conditioners and the average operation is close to 0 hours per day as a result of high electricity prices. In Lao PDR, air conditioners and electric fans were used for only 2 hours per day because of the relatively cooler climate. In Singapore, which has higher income level, the average operation is 7.8 hours per day.

[14] Retireasia.com (n.d.)

Table 9: Hours Used per Day for Cooling

	A/C		Fan	
	Days per month	Hours usage per day	Days per month	Hours usage per day
Cambodia*	9.6	3.0	14.2	9.1
Lao PDR*	5.5	2.2	11.3	2.7
Vietnam	0.0	0.0	6.5	5.2
Indonesia	10.2	2.5	17.4	2.6
Philippines	0.0	0.0	29.8	6.1
Thailand*	16.8	4.8	22.8	3.8
Malaysia	14.7	2.2	29.5	5.2
Singapore	24.0	7.8	29.6	8.4

5.5. Residential Energy Consumption

5.5.1. Monthly Energy Consumption by Energy Use

The average energy consumption between September 2011 and February 2012 including non-commercial energy or biomass in rural and urban areas was 2195 Megacalories (Mcal) and 2069 Mcal per household, respectively. In general, energy consumption per household in both urban and rural areas increases with higher incomes with the exception of the Philippines. Energy consumption in Malaysia, which has a high per capita income, is much higher than the lower income countries. In addition, it was observed that the electricity price also affected energy usage. For example, despite being in the middle income range of the surveyed countries, energy consumption in the Philippines is relatively low because of its high electricity price. The high electricity price has encouraged consumers in the Philippines to be more aware of their energy use as illustrated by the relatively lower use of air conditioners.

Table 10: Energy Usage by Country

(Mcal/household)

		Electricity	LPG	Kerosene	Biomass	Total	n	Number of household	Floor space
Rural area									
	Cambodia	122.0	43.0	3.1	1,741.7	1,909.7	10.0	6.2	45.0
	Vietnam	536.3	198.8	0.0	2,226.7	2,961.7	5.0	3.6	86.0
	Indonesia	159.6	0.0	1,189.8	1,141.7	2,491.1	4.0	4.4	59.3
	Philippines	548.5	610.3	0.0	728.9	1,887.7	5.0	4.6	125.7
	Thailand	1,099.5	728.2	0.0	0.0	1,827.7	7.0	3.8	116.3
	Malaysia	1,391.8	917.5	0.0	0.0	2,309.3	7.0	5.8	120.0
	Total	532.0	347.2	220.0	1,095.9	2,195.1	38.0	4.7	92.0
Urban area									
	Cambodia	1,151.3	502.4	0.0	186.3	1,840.0	10.0	6.4	90.0
	Lao PDR	1,602.0	347.5	0.0	786.4	2,736.0	10.0	4.9	131.4
	Vietnam	1,077.8	388.1	0.0	0.0	1,465.9	8.0	3.6	95.0
	Indonesia	1,604.3	910.2	0.0	0.0	2,514.5	5.0	3.8	106.0
	Philippines	535.5	253.4	0.0	16.0	804.9	10.0	3.5	53.5
	Thailand	1,339.8	21.2	0.0	0.0	1,361.1	10.0	2.8	109.4
	Malaysia	2,451.4	662.6	0.0	0.0	3,114.0	11.0	4.0	142.0
	Singapore	1,339.8	21.2	0.0	0.0	1,361.1	10.0	3.8	105.0
	Total	1,476.4	435.2	0.0	157.4	2,069.0	64.0	4.1	104.0
Share(%)									
Rural area									
	Cambodia	6.4	2.2	0.2	91.2	100.0			
	Vietnam	18.1	6.7	0.0	75.2	100.0			
	Indonesia	6.4	0.0	47.8	45.8	100.0			
	Philippines	29.1	32.3	0.0	38.6	100.0			
	Thailand	60.2	39.8	0.0	0.0	100.0			
	Malaysia	60.3	39.7	0.0	0.0	100.0			
	Total	24.2	15.8	10.0	49.9	100.0			
Urban area									
	Cambodia	62.6	27.3	0.0	10.1	100.0			
	Lao PDR	58.6	12.7	0.0	28.7	100.0			
	Vietnam	73.5	26.5	0.0	0.0	100.0			
	Indonesia	63.8	36.2	0.0	0.0	100.0			
	Philippines	66.5	31.5	0.0	2.0	100.0			
	Thailand	98.4	1.6	0.0	0.0	100.0			
	Malaysia	78.7	21.3	0.0	0.0	100.0			
	Singapore	98.4	1.6	0.0	0.0	100.0			
	Total	71.4	21.0	0.0	7.6	100.0			

5.5.2. Energy Consumption by End Use

Table 11 shows the average household residential energy consumption, disaggregated by end-use, between September 2011 and February 2012. In urban areas, 13 percent of energy consumption was used for cooling, 24 percent for cooking and other kitchen use and 17.6 percent for refrigeration. The remaining energy use was attributed to water heating (12 percent), lighting (13 percent) and other appliances (21 percent). In rural areas, 59 percent was used for cooking and 18 percent was used for water heating. The major energy source used for cooking and water heating is biomass such as wood, wood waste and rice husks. The remaining energy use in rural areas, which include refrigerators, lighting and other appliances, is less than 10 percent of total consumption. This is because the ownership of electrical appliances in rural areas is quite low in the eight countries.

Table 11: Energy Consumption by End Use

(Mcal/household)

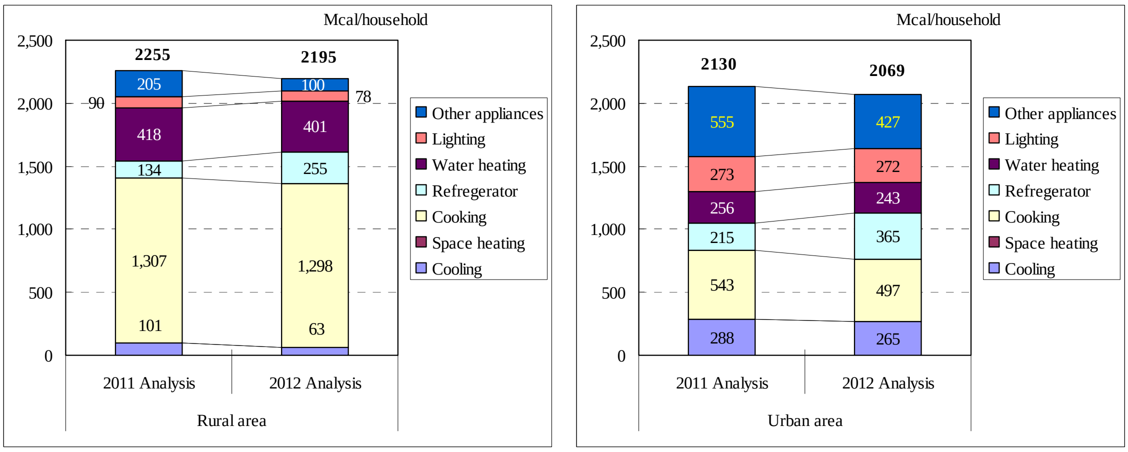
	Cooling	Space heating	Cooking	Refregerator	Water heating	Lighting	Other appliances	Total	n	Number of household	Floor space
Rural area											
Cambodia	1.8	0.0	1,653.4	0.0	134.2	60.0	60.3	1,909.7	10.0	6.2	45.0
Vietnam	11.1	0.0	1,923.2	225.3	530.7	41.0	230.4	2,961.7	5.0	3.6	86.0
Indonesia	14.8	0.0	1,768.8	110.4	570.9	11.3	15.0	2,491.1	4.0	4.4	59.3
Philippines	109.3	0.0	676.1	266.9	667.6	25.0	142.9	1,887.7	5.0	4.6	125.7
Thailand	88.9	0.0	668.2	578.7	144.0	127.6	220.3	1,827.7	7.0	3.8	116.3
Malaysia	222.6	0.0	678.1	721.1	396.2	279.0	12.2	2,309.3	7.0	5.8	120.0
Total	63.4	0.0	1,298.1	254.9	400.6	78.0	100.1	2,195.1	38.0	4.7	92.0
Urban area											
Cambodia	205.4	2.1	547.0	255.9	173.0	202.1	454.5	1,840.0	10.0	6.4	90.0
Lao PDR	147.2	0.0	979.2	390.5	456.5	592.6	170.0	2,736.0	10.0	4.9	131.4
Vietnam	14.2	0.0	376.3	332.8	52.1	52.3	638.2	1,465.9	8.0	3.6	95.0
Indonesia	367.7	0.0	579.2	348.3	373.7	124.6	721.1	2,514.5	5.0	3.8	106.0
Philippines	126.0	0.0	238.1	287.5	55.4	23.4	74.6	804.9	10.0	3.5	53.5
Thailand	499.2	0.0	100.7	508.6	10.6	195.8	46.3	1,361.1	10.0	2.8	109.4
Malaysia	358.0	0.0	555.3	497.7	382.9	599.4	720.6	3,114.0	11.0	4.0	142.0
Singapore	335.9	2.1	410.7	308.8	273.7	229.3	645.1	2,205.6	10.0	3.8	105.0
Total	265.0	0.6	496.8	365.0	242.6	272.1	426.9	2,069.0	74.0	4.1	104.0

Share(%)								
Rural area								
Cambodia	0.1	0.0	86.6	0.0	7.0	3.1	3.2	100.0
Vietnam	0.4	0.0	64.9	7.6	17.9	1.4	7.8	100.0
Indonesia	0.6	0.0	71.0	4.4	22.9	0.5	0.6	100.0
Philippines	5.8	0.0	35.8	14.1	35.4	1.3	7.6	100.0
Thailand	4.9	0.0	36.6	31.7	7.9	7.0	12.1	100.0
Malaysia	9.6	0.0	29.4	31.2	17.2	12.1	0.5	100.0
Total	2.9	0.0	59.1	11.6	18.2	3.6	4.6	100.0
Urban area								
Cambodia	11.2	0.1	29.7	13.9	9.4	11.0	24.7	100.0
Lao PDR	5.4	0.0	35.8	14.3	16.7	21.7	6.2	100.0
Vietnam	1.0	0.0	25.7	22.7	3.6	3.6	43.5	100.0
Indonesia	14.6	0.0	23.0	13.9	14.9	5.0	28.7	100.0
Philippines	15.7	0.0	29.6	35.7	6.9	2.9	9.3	100.0
Thailand	36.7	0.0	7.4	37.4	0.8	14.4	3.4	100.0
Malaysia	11.5	0.0	17.8	16.0	12.3	19.2	23.1	100.0
Singapore	15.2	0.1	18.6	14.0	12.4	10.4	29.2	100.0
Total	12.8	0.0	24.0	17.6	11.7	13.2	20.6	100.0

5.6. Comparison of result from previous project

In this project, power ratings for air conditioner, fan, lighting, electric stove and microwave oven were revised from rated power to operating power (Operating power = rated power*0.5-0.6). Working group members attempted to estimate end use energy consumption with reference to revised power rating information. As the result, energy consumptions for cooling, cooking and lighting were revised downward (Figure 35).

Figure 35: Comparison of End-use Energy Consumption between Estimates in 2011 and 2012



5.7. Lessons from the Survey

The survey was able to assist in disaggregating household energy consumption by end-use. The information contained in this survey was able to help determine the most energy consuming end-use applications, which can assist policy makers in the formulation of energy efficiency programs.

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 the projected changes in socio-economic factors, energy consumption, and carbon dioxide emissions in the BAU scenario and the APS, the working group members identified a number of key findings. These are outlined below:

1. Sustained population and economic growth in the EAS region will lead to significant increases in energy demand. TPES in 2035 will increase 2.6 times from 2010. 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 2010 to 2030, is projected to improve to 0.73 (3.0/4.1) as compared to 1.34 (4.7/3.5) from 1990 to 2010.

2. The continued reliance on fossil fuels to meet increased 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 2010 to 2035, will be 0.68, lower than the energy elasticity. There are two reasons for this. The first is diversification among fossil energy from coal to gas. Coal share of the total primary energy mix will decline from 54.1 percent in 2010 to 48.3 percent in

2035. On the other hand, gas share will increase to 16.0 percent from 10.2 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 NRE. The share of carbon neutral energy in 2010 was 8.1 percent but it will increase to 10.7 percent in 2035.

3. The EAS energy mix in the BAU will change from 2010 to 2035. Coal and oil will decrease their share from 81.6 percent to 73.2 percent. The diversification of the regional energy mix, which increases the share of low and carbon neutral energy, will contribute to improvements in carbon intensity.

4. 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. In this regard, appropriate energy efficiency and conservation programs and low emission technologies are needed in these sectors.

5. 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:

    - 18.5 percent in primary energy demand
    - 18.5 percent in energy intensity
    - 28.1 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, rationalize energy pricing mechanisms, and the 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 remain largest energy consuming sector by 2035. There are several EEC action plans to be implemented, which include replacement to more efficient facilities and equipment. In addition, the working group suggested the following points:

- Lengthening the life span of manufacturing facilities and equipment - Lengthening the replacement cycle of industrial facilities will reduce the demand for energy intensive goods such as cement and steel. In addition, producing manufactured durable goods with longer life span will also reduce the need for frequent replacement of and consequently, the need for more energy.
- Changing the industrial structure from heavy to light industries - Shifting of industries from 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:

- Improvement of fuel economy
- Shift from personal to mass transportation mode
- Shift to more efficient and clean alternative fuels

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

- Application of demand management systems such as household energy management systems (HEMS) and building energy management systems (BEMS)
- Improving the 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 to energy technology development such as smart grids
  - Planning of best energy mix in both power generation and primary energy supply
- 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 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 the academe should be carried out in order to determine the economic potential of NRE and the safe use of nuclear energy.

d. ***Rationalizing Energy Pricing Mechanism***

The WG group members recognized that distorted energy price is a barrier to the effective implementation of energy efficiency policies. It was therefore suggested that energy prices should be rationalized to reflect the real cost of energy while ensuring that the most vulnerable sectors of the society are still able to use energy. Rationalizing energy prices is considered as 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 WG also recognized 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 in the formulation and assessment of the effectiveness of energy saving policies and monitoring of actual energy savings. In this regard, the WG conducted the pilot surveys in 2010 and 2011 to enhance the developing countries' capability in collecting end-use energy consumption data in the residential sector. However, it was observed that actual electricity consumption is quite different from estimated electricity consumption based on power ratings in the name plate or in the catalogues. The WG requested an expert to improve the estimation methodology and the expert suggested to apply a "diversity factor" for each appliance. The sample data collected by the pilot survey were revised using the "diversity factor". Through the analysis of the revised sample data, the WG noted the improvement on end-use energy consumption patterns. The WG hopes that end-use energy statistics become available in all energy consuming sectors in order to be able to conduct assessment of targets in each subsectors.

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 important action plans in the industry sector. On the other hand, improvement of fuel economy and shift from personal to mass transport mode are essential in road transport sector. Rationalizing the current pricing mechanism is a key policy to advance energy efficiency and conservation activities, expand the use of renewable energy, provide consumers the best energy mix and reduce the burden on the national government budgets. However, in parallel, assistance to low income households is required to help them cope up with higher prices.

A lack of reliable end-use energy statistics will impose barriers in monitoring and evaluating the energy saving targets and action plans of EAS countries. The pilot survey on end-use energy consumption in the residential sector, which covered both urban and rural areas, has contributed to improving the 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 enough to mitigate all of the challenges posed by climate change. Therefore, more aggressive saving goals, advanced technologies to reduce CO_2 emissions directly, such as clean coal technologies 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, transfer and policy implementation within the EAS and between the EAS and the rest of the world. It was also noted that financial scheme 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.

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CHAPTER 2

Australia Country Report

ARIF SYED

Bureau of Resources and Energy, Canberra, Australia

1. Executive Summary

This report provides the basis for informed decision making in the Australian energy sector. Australian energy projections were derived using the *E4cast* model, a dynamic partial equilibrium model of the Australian energy sector. The BREE *E4cast* modelling framework incorporates domestic as well as international trade in energy sources. It provides a complete treatment of the Australian energy sector, representing energy production, trade and consumption at a detailed level. As a result, the model can be used to produce a full range of results, including Australian energy balance tables.

Key results in the latest Australian energy projections worth highlighting and reported in this paper are in terms of energy supply and demand. Electricity generation is projected to grow by 49 percent over the period (1.1 percent a year) to total 377 terawatt hours in 2049-50. Coal's share (including with carbon capture and storage) of this production is projected to fall to 13 percent in 2049-50, while gas (including with and without carbon capture and storage, and integrated solar-gas technologies) rises to 36 percent. About half of Australia's electricity is projected to be generated by renewable sources in 2049-50.

Primary energy consumption is projected to grow by 21 percent (0.5 percent a year) to 7389 petajoules in 2049-50. This moderate growth projection is a result of a projected long-term fall in energy intensity, and the greater role of renewable technologies. Overall, the results suggest that Australia's energy future will be markedly different to its current structure. Changes in energy use by fuel and by sector will alter consumption patterns, while a substitution away from carbon-intensive fuels to renewable energy sources will support a cleaner energy future.

- The projections include existing government policies, including the Renewable Energy Target and carbon pricing. They also incorporate the latest estimates of electricity generation technology costs from the Australian Energy Technology Assessment (BREE 2012).

2. Introduction

2.1. Historical Australian energy context

2.1.1. Energy resources

Australia is endowed with abundant, high quality and diverse energy resources. Australia has around 34 percent of the world's uranium resources, 14 percent of the world's black coal resources, and almost 2 percent of world conventional gas resources. Australia has only a small proportion of world resources of crude oil. Australia also has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy and bioenergy resources.

The development of these resources has contributed to the competitiveness of energy-intensive industries and provided considerable export income. Australia is one of the few OECD economies that are significant net exporter of energy commodities, with the major exports being coal, liquefied natural gas (LNG), uranium and petroleum.

Uranium is not consumed domestically; therefore, it is not included in the energy balance projections presented in the following sections.

Australia is the world's ninth largest energy producer, accounting for around 2.4 percent of the world's energy production (IEA 2012). Energy production in Australia has fallen over the past two years, to be 16 140 petajoules in 2010-11, mainly as a result of weather related supply disruptions (BREE 2012).

The main fuels produced in Australia are coal, uranium and gas. While Australia produces uranium, it is not consumed domestically and all output is exported. Coal accounted for around 60 percent of total energy production in energy content terms in 2010-11, followed by uranium (20 percent) and gas (13 percent). Crude oil, condensate and naturally occurring LPG represented 6 percent of total energy production in that year, and renewable energy the remaining 2 percent.

2.1.2. Australian energy consumption

Australia is the world's twentieth largest primary energy consumer, and ranks eighteenth on a per person energy use basis (IEA 2012b). Since 2000-01, growth in energy consumption in Australia has averaged 2.0 percent a year (BREE 2012b).

Although Australia's energy consumption is growing, the rate of growth has been declining over the past 50 years. Following annual growth of more than 5 percent during the 1960s, growth in energy consumption fell during the 1970s to an average of around 4 percent a year, largely as a result of the two major oil price shocks. During the 1980s and 1990s, the growth rate averaged around 2.3 percent a year. The growth rate has constantly been declining ever since.

Australian primary energy consumption consists mainly of coal, oil and gas. In 2010-11, black and brown coal accounted for around one-third of the primary energy mix, its lowest contribution since the early 1970s, as a result of substitution away from coal toward other fuels in electricity generation. Oil accounted for a little under 40 percent of primary energy consumption, followed by gas (about 25 percent) and renewable energy sources (4 percent).

The main users of energy in Australia are the electricity generation, transport and manufacturing sectors. Together, these sectors accounted for more than 88 percent of energy consumed in 2010-11.

2.1.3. Australia's energy exports

Australia is a net energy exporter, with domestic energy consumption representing only one-third of total energy production, including uranium. Australia's energy exports were 13 312 petajoules in 2010–11 in energy content terms. In value terms, energy exports accounted for 32 percent of the total value of Australia's commodity exports in 2010–11. Australia's largest energy export earners are coal, crude oil and LNG. In 2010–11 exports were $43.7 billion for coal, $12.2 billion for crude oil and condensate and $10.4 billion for LNG.

Australia is a net importer of liquid hydrocarbons, including crude oil and most petroleum products.

2.2. Energy policy

2.2.1. Energy White Paper 2012

The Energy White Paper 2012, laying out Australia's energy policy, was released by the Australian Government in November 2012 (Australian Government 2012). It sets out a strategic policy framework to address the challenges in Australia’s energy sector and position Australia for a long term transformation in the way it produces and uses energy.

The Energy White Paper identifies four priority action areas to support Australia’s energy transformation:

1. delivering better energy market outcomes for consumers;
2. accelerating our clean energy transformation;
3. developing Australia’s critical energy resources, particularly gas resources; and
4. strengthening the resilience of Australia’s energy policy framework.

2.2.2. Clean Energy Future Plan

In Australia, a carbon price was introduced on 1 July 2012, making large emitters of carbon financially liable for their carbon emissions. It is fixed for the first three years before transitioning to an emissions trading scheme. During the fixed price period, an unlimited number of permits will be available at a fixed price, and these must be purchased and surrendered for each tonne of reported emissions. The price in 2012-13 is $23 a tonne of carbon dioxide equivalent (CO_2-e), increasing by 2.5 percent in real terms until 30 June 2015. From 1 July 2015, the carbon price will transition to an emissions trading scheme where the number of available permits will be capped and the permit price will be determined in the marketplace (Australian Government, 2011).

2.2.3. *Renewable Energy Target*

The Renewable Energy Target complements the carbon price by providing additional support for renewable energy investment and industry development in the transition period to more mature carbon prices and technology costs. The RET scheme is designed to deliver on the Australian Government's commitment that the equivalent of at least 20 percent of Australia's electricity comes from renewable sources by 2020.

2.2.4. *Energy Efficiency*

The National Strategy on Energy Efficiency (NSEE) is the main mechanism by which all governments in Australia coordinate national action on energy efficiency. The Ministerial Council on Energy is responsible for the delivery of several important measures in the NSEE.

3. Key Assumptions

There are a number of economic drivers that will shape the Australian energy sector over the next two decades. These assumptions underlie the modelling, and include:

- Population growth;
- Economic growth;
- Energy prices;
- Electricity generation technologies;
- End use energy technologies; and
- Government policies.

The assumptions relating to these key drivers are presented in the *Australian Energy Projections* (Syed, 2012). In brief, Australian population is assumed to grow from 23.35 million in 2012-13 to 36.26 in 2049-50. Over the projection period, Australia's real GDP is expected to grow at an average annual growth rate of

2.5 percent. Carbon prices included in the modelling from 2012-13 to 2049-50 are provided by the Australian Treasury (2011). Electricity generation technology costs, as mentioned earlier, are based on the recent BREE report, *Australian Energy Technology Assessment* (BREE, 2012b). This report provided the best available and most up-to-date cost estimates for 40 electricity generation technologies under Australian conditions, taking into consideration the impact of carbon pricing. These technologies encompass a diverse range of energy sources including renewable energy (such as wind, solar, geothermal, biomass and wave power), fossil fuels (such as coal and gas), and nuclear power.

4. Energy Projection Results

Australian energy projections from 2012-13 to 2049-50 on energy consumption, electricity generation, and production are provided in Tables 1 to 5 below.

4.1. Energy Consumption

- Total primary energy consumption is projected to grow by around 21 percent (0.5 percent a year) over the period 2012-13 to 2049-50, to reach 7369 petajoules. This moderate growth reflects a long-term decline in the energy intensity of the Australian economy, which has been accelerated by a number of policy drivers such as carbon pricing. Importantly, it also reflects the greater role of renewable technologies, which use less energy inputs to generate electricity than fossil fuels (Table 1 and 2).
- Large-scale changes are expected in Australia's energy mix over the coming decades. The share of coal in total primary energy consumption is projected to fall sharply from 31 percent in 2012-13 to just 6 percent by 2049-50. Oil will remain an important energy source in Australia, while gas will be the

fastest growing non-renewable energy source, with its share increasing to 34 percent by 2049-50.

- Renewable energy use is projected to nearly quadruple in volume terms over the period to 2049-50 (at 3.6 percent a year). The share of renewables is projected to increase from 5 percent of total primary energy consumption in 2012-13 to 14 percent in 2049-50. The fastest growing energy sources are expected to be solar and wind.
- The share of the electricity sector in Australia’s energy demand will fall substantially from 38 percent in 2012-13 to 26 percent in 2049-50, although it will still be the second largest user of primary energy in Australia. The key drivers of this change are the greater use of more efficient renewable technologies and the impact of higher energy prices.
- The transport sector will become the largest user of primary energy in Australia, increasing its share slightly to one-third of primary energy consumption by 2049-50. The fastest growing consumer of primary energy will be the mining sector, with an average growth of 3.5 percent a year expected over the projection period.
- The projected outlook for energy consumption in this report differs substantially from previous BREE long term energy projections. This is because of the use of more up to date and lower projected costs for many renewable technologies. This is projected to result in a greater penetration of renewable energy in terms of the total energy mix. These renewable technologies use less energy in conversion to electricity than traditional fossil fuels and this is projected to lower the growth in demand for primary energy.

Table 2-1: Primary energy consumption, by energy type

	Level			Share		Average annual growth 2012-13 to 2049-50
	2012-13	**2034–35**	**2049-50**	**2012-13**	**2049–50**	**2049-50**
Energy type	**PJ**	**PJ**	**PJ**	**%**	**%**	**%**
Non-renewables	5793	5980	6337	95	86	0.2
Coal	1882	1036	478	31	6	-3.6
black coal	1212	962	478	20	6	-2.5
brown coal	670	74	0	11	0	-21.7
Oil	2359	2888	3391	39	46	1.0
Gas	1552	2056	2469	26	34	1.3
Renewables	276	755	1032	5	14	3.6
Hydro	62	62	62	1	1	0.0
Wind	51	231	282	1	4	4.7
Bioenergy	149	299	346	2	5	2.3
Solar	14	104	236	<1	3	7.8
Geothermal	0	59	106	0	1	
Total [a]	**6069**	**6735**	**7369**	**100**	**100**	**0.5**

[a] numbers in the table may not add up to their totals due to rounding

4.2. Primary energy consumption, by sector

Electricity generation, transportation and manufacturing are estimated to account for 88 percent of Australia's total primary energy consumption in 2012–13. These sectors combined are projected to account for 77 percent of projected primary energy consumption in 2049–50 (Table 2).

The electricity generation sector accounts for the largest share (38 percent) of primary energy consumption in 2012–13. Total primary energy consumption in electricity generation is projected to decline from 2293 petajoules in 2012–13 to 1927 petajoules in 2049–50. The combined effect of the RET, carbon pricing, and importantly the growth in renewables electricity generation are expected to encourage a change in the energy mix, with a significant shift away from coal to renewable energy.

Table 2-2: Primary Energy Consumption, by Sector

	Level			**Share**		**Average annual growth 2012-13 to**
	2012-13	**2034-35**	**2049-50**	**2012-13**	**2049-50**	**2049-50**
Sector	**PJ**	**PJ**	**PJ**	**%**	**%**	**%**
Electricity	2293	1996	1927	38	26	-0.5
Agriculture	105	145	171	2	2	1.3
Mining	310	899	1089	5	15	3.5
Manufacturing	1268	1256	1332	21	18	0.1
Transport	1760	2 095	2 467	29	33	0.9
Commercial & residential	333	344	385	5	5	0.4
Australia [a]	**6069**	**6735**	**7369**	**100**	**100**	**0.5**

[a] Numbers in the table may not add up to their totals due to rounding.

4.3. Electricity generation

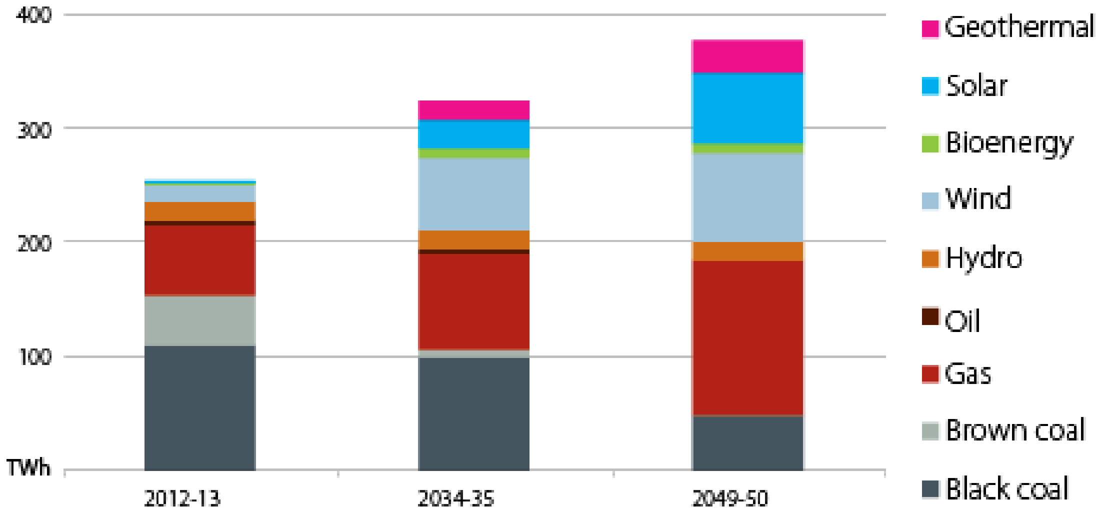
- Gross electricity generation is projected to grow by around 49 percent (1.1 percent a year) to reach 377 terawatt hours in 2049-50. This growth is expected to come from expansion of renewables and gas-fired electricity generation (Table 3).
- The projected rate of growth in electricity generation in this report is slightly less than 1.1 percent a year, which is less than the 1.4 percent reported in the previous BREE report (2011).
- The impact of lower cost renewable generation and carbon pricing is expected to lead to a dramatic decline in coal-fired generation (Figure 1). The share of coal in electricity generation is projected to fall from 60 percent in 2012-13 to 13 percent in 2049-50. The remaining coal fired electricity generation capacity is projected to include carbon capture and storage technology.
- Gas fired electricity generation is projected to double over the projection period, to account for 36 percent of total generation in 2049-50. This also includes carbon capture and storage technologies, including integrated gas-solar technologies.
- About half of Australia’s electricity is expected to be generated by renewables by 2049-50. The use of renewable energy resources in electricity generation is projected to rise by 4.8 percent a year, from 13 percent of total generation in 2012-13 to 51 percent in 2049-50. Wind is expected to be the largest source of renewable electricity generation (21 percent by 2049-50). Solar is projected to be the second largest contributor (16 percent by 2049-50), and is the fastest growing of all sources over the projection period.
- The strong growth in renewable electricity generation is a result of the increased competitiveness of renewable technologies under carbon pricing, as well as expected advances in technologies and a decline in their capital costs.

Table 2-3: Electricity generation, by energy type (TWh)

	Level			Share		Average annual growth 2012-13 to
	2012-13	**2034-35**	**2049-50**	**2012-13**	**2049-50**	**2049-50**
Energy type				%	%	%
Non-renewables	219	194	183	87	49	-0.5
Coal	153	104	48	60	13	-3.1
black coal	109	100	48	43	13	-2.2
brown coal	44	5	0	17	0	
Gas	62	85	136	25	36	2.1
Oil	4	4	0	2	0	-8.6
Renewables	34	130	194	13	51	4.8
Hydro	17	17	17	7	5	0.0
Wind	14	64	78	6	21	4.7
Bioenergy	2	7	7	1	2	3.9
Solar	1	25	62	<1	16	12.3
Geothermal	0	17	29	0	8	
Total [a]	**253**	**324**	**377**	**100**	**100**	**1.1**

[a] Numbers in the table may not add up to their totals due to rounding.

Figure 2-1: Projected electricity generation mix



4.4. Final Energy Consumption, by Energy Type

Total final energy consumption, the amount of energy used in end-use applications, is projected to increase from 4 207 petajoules in 2012–13 to 5 868 petajoules in 2049–50, a rise of 39 percent over the projection period and an average annual rate of increase of 0.9 percent (Table 4). Electricity (1.1 percent) and renewable energy (1.4 percent) are projected to continue to grow strongly to meet energy demand in end-use sectors over the projection period. This will contribute to the declining relative share of coal and gas in final energy consumption by 2049–50 (from 3 percent to 2 percent, and from 22 percent to 17 percent, respectively). The decline in gas consumption is predominantly because of rising prices to 2049–50. The demand for petroleum products increases from growing mining and residential sectors. The consumption of renewables grows strongly at the rate of 1.4 percent a year.

Table 2-4: Final energy consumption, by energy type

	Level			Share		Average annual growth 2012-13 to
	2012-13	**2034-35**	**2049-50**	**2012-13**	**2049-50**	**2049-50**
Energy	**PJ**	**PJ**	**PJ**	**%**	**%**	**%**
Coal	134	119	124	3	2	-0.2
Petroleum products	2180	2709	3241	52	55	1.1
Gas	908	912	1006	22	17	0.3
Renewables	134	185	224	3	4	1.4
Electricity	851	1091	1272	20	22	1.1
Total [a]	**4207**	**5016**	**5868**	**100**	**100**	**0.9**

[a] numbers in the table may not add up to their totals due to rounding

4.5. Energy Production

- Australian energy production (excluding uranium) is projected to grow by 69 percent (an average annual rate of 1.4 percent) over the projection period, to reach 27 803 petajoules in 2049-50. Coal and gas are projected to account for 96 percent of Australia's energy production in 2049-50 (Table 5).
- Production of black coal, which includes thermal and metallurgical coal, is projected to grow at 1.2 percent a year, to 17 973 petajoules (around 539 million tonnes) in 2049-50.
- An increasing proportion of this production will be exported, with coal exports projected to increase by 1.4 percent a year to 17 496 petajoules in 2049-50. World coal demand, particularly for metallurgical coal, is expected to continue to grow over the next four decades, albeit at a slower rate in the latter half of the projection period.

- Strong growth in domestic and global demand for gas will continue to drive the development of new gas fields and LNG capacity in Australia. Australian gas production, including LNG, is projected to nearly triple (equal to growth of 2.9 percent a year), to reach 8595 petajoules in 2049-50. The western market will remain the largest gas market in Australia, although its growth in output is expected to be slower than that of the eastern and northern markets.
- LNG exports are projected to more than triple, to reach 6127 petajoules (around 113 million tonnes) in 2049-50. This includes new LNG projects in all markets, including projects based on coal seam gas and floating LNG technologies.
- Projections of declining oil production and constraints around petroleum refining suggest Australia's net trade position for crude oil and refined petroleum products will weaken over the projection period, with net imports projected to increase at an average rate of 2.1 percent a year.

With the exception of crude oil and refined petroleum products, Australia will remain a net exporter of energy commodities over the period to 2049-50. Demand for Australia's energy resources is expected to remain robust over the projection period, particularly in China, India and other developing economies. This will be supported by growth in economic activity and industrial production, which is expected to provide a solid platform for growth in their energy consumption. The ratio of Australia's primary energy consumption to non-uranium energy production is projected to decline from 37 percent in 2012-13 to 26 percent in 2049–50.

Table 2-5: Energy production, by source

	Level			Share		Average annual growth 2012-13 to
	2012-13	**2034-35**	**2049-50**	**2012-13**	**2049-50**	**2049-50**
Energy type	**PJ**	**PJ**	**PJ**	**%**	**%**	**%**
Non-renewables	16221	26906	26771	98	96	1.4
Coal	12333	18463	17973	75	65	1.0
black coal	11664	18390	17973	71	65	1.2
brown coal	670	74	0	4	0	-21.7
Oil	775	252	98	5	<1	-5.4
LPG	89	98	104	1	<1	0.4
Gas	3023	8092	8595	18	31	2.9
Renewables	276	755	1032	2	4	3.6
Hydro	62	62	62	<1	<1	0.0
Wind	51	231	282	<1	1	4.7
Bioenergy	149	299	346	1	1	2.3
Solar	14	104	236	0	1	7.8
Geothermal	0	59	106	0	<1	
Total	**16497**	**27660**	**27803**	**100**	**100**	**1.4**

5. Conclusion and Policy Implications

The outlook presented in this report represents a significant structural change in Australia's future energy landscape. The current projections show that Australian energy consumption will continue to grow over the next forty years, albeit at a much lower rate than experienced in the past twenty years. It is expected that the share of fossil fuels will decline from 87 percent in 2012-13 to 49 percent (including CCS fossil fuel technologies) of total electricity generation in 2049-50 (excluding roof-top PV generation). The share of fossil fuels in total primary consumption is projected to decline from 95 percent in 2012-13 to 86 percent in 2049-50. By 2049-50, three-quarter of electricity generation in Australia is projected to come from renewables and carbon capture and storage technologies.

Within the non-renewables category, the share of gas is projected to increase in energy use and production. There is a significant increase in the use of gas (natural gas and coal seam gas), primarily for electricity generation – the largest user of primary energy, and LNG production. Gas-fired electricity generation is based on mature technologies with competitive cost structures relative to many renewable energy technologies. Thus, it has the potential to play a major role as a transitional fuel until lower-emission technologies become more cost effective in the short to medium term.

Renewable energy is projected to have the strongest growth prospects. The highest growth trajectory is expected to apply to the lowest cost renewable energy sources – namely large-scale solar PV and wind energy and, to a lesser extent, geothermal energy.

Transition to a low carbon economy will require long term structural adjustment in the Australian energy sector. While Australia has an abundance of energy resources, this transformation will need to be underpinned by significant investment in energy supply chains to allow for better integration of renewable energy sources and emerging technologies into our energy systems. It will be critical to ensure that the broader energy policy framework continues to support cost-effective investment in Australia's energy future, and timely adjustments to market settings in response to emerging pressures, and market developments.

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CHAPTER 3

Brunei Darussalam Country Report

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1. Background

Brunei Darussalam is an independent sovereign constitutional Sultanate, headed by His Majesty Sultan Haji Hassanal Bolkiah. Brunei Darussalam is situated on the north-east coast of Borneo Island in South-east Asia, occupying 1 percent, 5,765 square kilometres, of the land area on the island of Borneo. It is divided into four administrative districts namely Brunei-Muara, Tutong, Belait and Temburong. The capital city, Bandar Seri Begawan, is located in the Brunei-Muara district and is where the government operations and major business activities take place.

The development policy of Brunei Darussalam is based on the principle of prudent use of natural resources. His Majesty the Sultan of Brunei has placed great emphasis on environmental protection and conservation. This resulted in the conservation of the rainforest which currently makes about 65 percent of the land area.

1.1. Socio-Economic Situation

Brunei is an energy exporting country in Southeast Asia, exporting about 17.4 Mtoe of oil and natural gas in 2007. With a population of just about 400 thousand, Brunei Darussalam enjoys a high standard of living with positive social indicators, like literacy rates and life expectancy. The 2011 per capita GDP PPP for Brunei Darussalam is 45,707[1]. Brunei Darussalam's Real GDP growth was at 2.2 percent in

[1] World Bank, World Development Indicator April 2013.

2011 and the population growth at 2.0 percent[2].

In the long-term development plan called Wawasan 2035[3], Brunei Darussalam has set out to achieve:

- A first class education system to meet the requirements of a changing economy and one that encourages life-long learning.
- Top 10 in the world in living standards as defined by the United Nations Human Development (UNHD) Index.
- A dynamic and sustainable economic growth.

1.2. Energy Supply-Demand Situation

The main energy sources in Brunei Darussalam are natural gas and oil. The primary energy consumption for these two sources of energy in 2010 was 3.1 Mtoe and 2.7 Mtoe for gas. The use of natural gas is mainly for the generation of electricity and town gas. In mid-2010, the production of methanol came on line using natural gas as feedstock. The use of oil is primarily for petroleum products.

In the electricity sector, 3,792 GWh was generated in 2010. The installed generation capacity in 2010 stands at 888 MW, 99.7 percent of it came from natural gas. The efficiencies of power plants commissioned before 2005 are estimated to be around 25.0 percent and the combined cycle power plant around 45.0 percent.

1.3. Energy Policies

1.3.1 Supply

Brunei Darussalam has sufficient reserves of gas and oil. In 2007, Brunei Darussalam produced 20.2 Mtoe of gas and oil, 17.4 Mtoe of which was exported. The potential for the use of alternative energy sources are currently being studied. Likewise, policies pertaining to the use of renewable energy are still being studied. The study covers amongst others: wind, hydro, waste to energy, tidal, bio-energy, and solar. In the meantime, a 1.2 MWp solar photo-voltaic demonstration plant has

[2]Department of Economic Planning and Development, Prime Minister's Office 2011
[3]Department of Economic Planning and Development. Development Board, http://www.depd.gov.bn/productservice.html

been commissioned. The solar PV implementation study is over a period of 3 years. The PV plant has six (6) types of PV modules installed. Other renewable energy demonstration/research plants may come on-line in the near future.

1.3.2. Consumption

Brunei Darussalam has been active in implementing energy conservation initiatives. These energy conservation initiatives are being championed by the Energy Department, Prime Minister Office (EDPMO). EDPMO has been actively promoting energy conservation since 2007, where EDPMO's campaigns had lead to the declaration of 24th May as the National Energy Day.

Early last year, His Majesty the Sultan and Yang Di-Pertuan of Negara Brunei Darussalam has consented for the review of the electricity tariff structure in the residential sector which has taken into effect on the 1st January 2012. The main objective of the introduction of the new electricity tariff is to correct the old tariff, which suits today’s environment. In the old structure, those who consumed less were charged at a higher rate and were paying more on average per kWh compared to those who consumed more. The new tariff structure moves to being progressive from regressive.

Brunei Darussalam is committed in achieving a target of 45.0 percent improvement in energy efficiency by 2035, relative to 2005 levels.

1.3.3. Energy Market Reforms, new energy policies under consideration, etc

The energy market in Brunei Darussalam is state regulated. Energy prices are subsidized. However, it has increased considerably the price of motor gasoline (Premium 97) and diesel for vehicles and vessels not registered in Brunei Darussalam in the wake of increased smuggling of fuels to neighbouring economies. The government is concerned about the increasing cost of maintaining fuel subsidies, and in 2008 began a Subsidy Awareness Campaign.

2. Modelling Assumption

In this study, Brunei's GDP is assumed to grow at an average annual rate of 2.7 percent for the period 2010-2035. Growth is expected to be faster for the period 2010-2020 at 2.9 percent annually. Meanwhile, population is expected to grow at an average rate of 1.8 percent yearly. By end of 2035, it is expected that the country's population will be around 0.6 million.

In the APS, the model is dictated by energy conservation policy, whereby a 25.0 percent reduction from 2005 level is targeted. Also in the APS, efficiencies of natural gas power plants were improved to 40.0 percent while there is no improvement assumed for diesel generators.

3. Outlook Results

3.1. Business-as-Usual Scenario

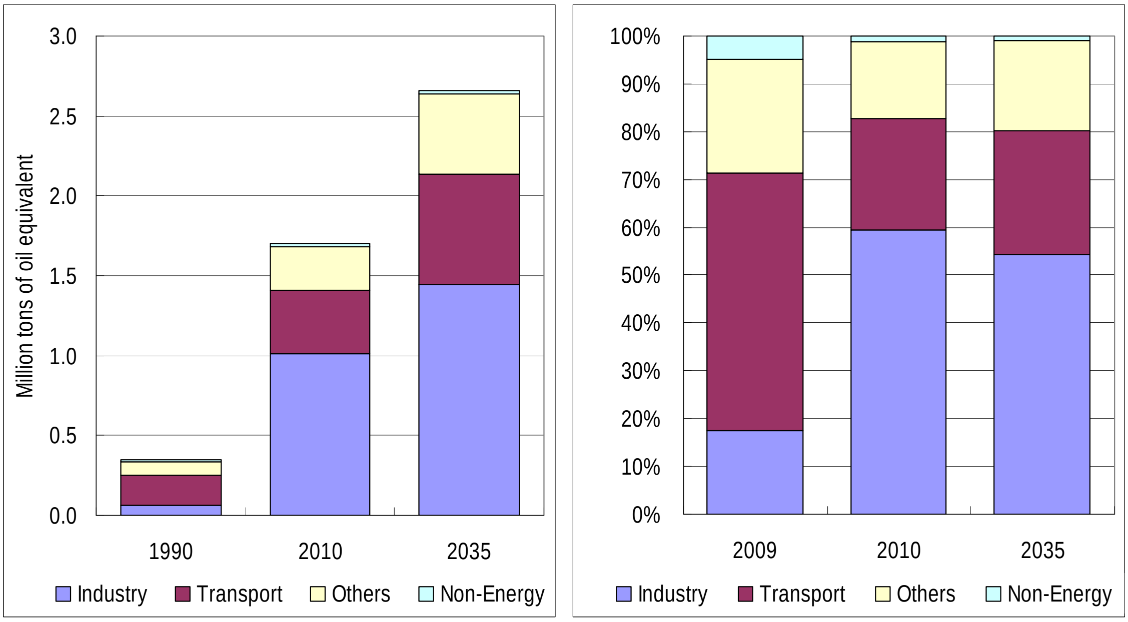
3.1.1 Final Energy Demand

Energy consumption of Brunei Darussalam is increasing over the years. The final energy demand increased from 0.3 Mtoe in 1990 to 1.7 Mtoe in 2010. The projected average annual increase from 2010 to 2035 is 1.8 percent. The projection is linked to GDP growth. The GDP is expected to grow at annual average rate of 2.7 percent over the period 2010 to 2035.

The transportation sector is expected to grow at an average annual growth of 2.3 percent over the period from 2010-2035. The final energy demand in the residential and commercial sectors[4] is foreseen to grow at an average rate of 2.4 percent per year. This is in-line with the population increase of 1.8 percent per year and the increase in economic activities in the commercial sector. Figure 3-1 shows the final energy demand levels and shares by sector in 1990, 2010 and 2035.

[4] Residential and commercial consumption are grouped as "Others"

Figure 3-1: Final Energy Demand by Sector



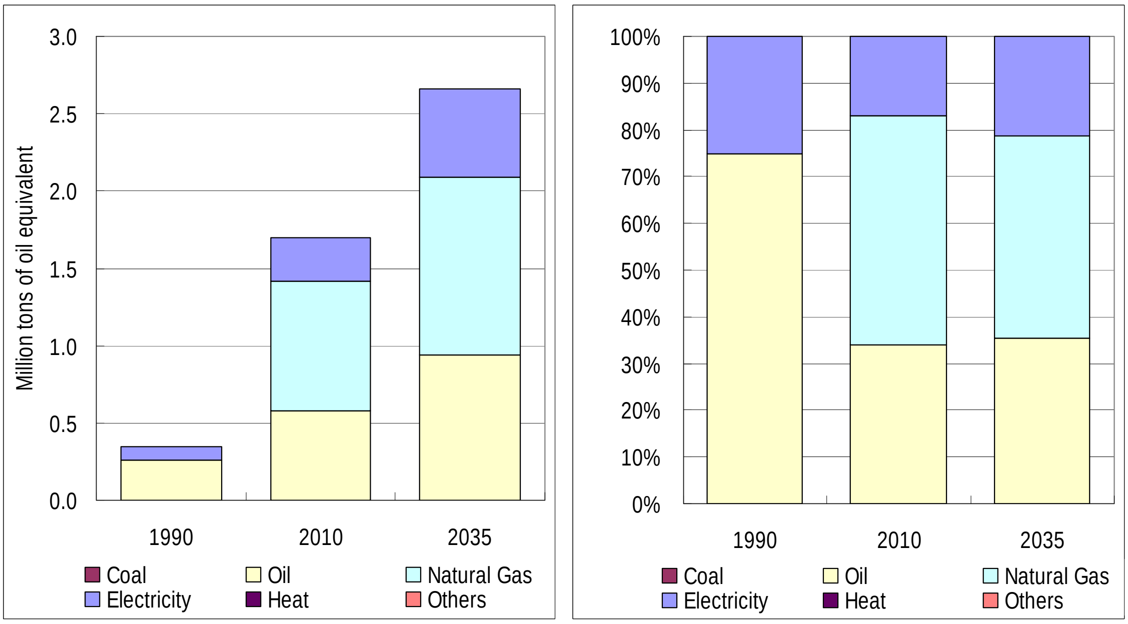
Under the BAU, the industrial sector is foreseen to comprise bulk of the country's energy demand followed by the transportation sector. However, by end of 2035, the industrial sector consumption will decrease to 54.3 percent of the total final energy demand of the country from 59.4 percent in 2010. The transportation sector's share is expected to increase up to 26.0 percent from its 23.2 percent share in 2010.

Similarly, the "others" sector's share in the total final energy demand for the period 2010 to 2035 is expected to decrease to 18.8 percent from its 16.3 percent share in 2010.

By fuel type, electricity demand had the fastest growth over the 1990 to 2010 period, at an average rate of 6.1 percent per year. Oil on the other hand, grew by 4.0 percent over the same period. For the period 2010-2035, electricity will still be the fastest growing fuel of the economy followed by oil and natural gas. Increase in oil consumption is due to the increasing demand in the transport sector.

For 2010, final consumption of natural gas reached 0.8 Mtoe corresponding to around 49.3 percent of the total energy consumed due to the increasing demand in domestic industries. Oil consumption was 0.6 Mtoe in 2010 corresponding to around 33.9 percent of the total fuel consumed. By 2035, final energy demand for oil is expected to be 0.9 Mtoe. The increase in oil consumption is mainly attributed to the increase in the number of road vehicles. Figure 3-2 shows the final energy demand by fuel type and their shares in 1990, 2010 and 2035.

Figure 3-2: Final Energy Demand by Fuel



By fuel type, electricity demand had the fastest growth over the 1990 to 2010 period, at an average rate of 6.1 percent per year. Oil on the other hand, grew by 4.0 percent over the same period. For the period 2010-2035, electricity will still be the fastest growing fuel of the economy followed by oil and natural gas. Increase in oil consumption is due to the increasing demand in the transport sector.

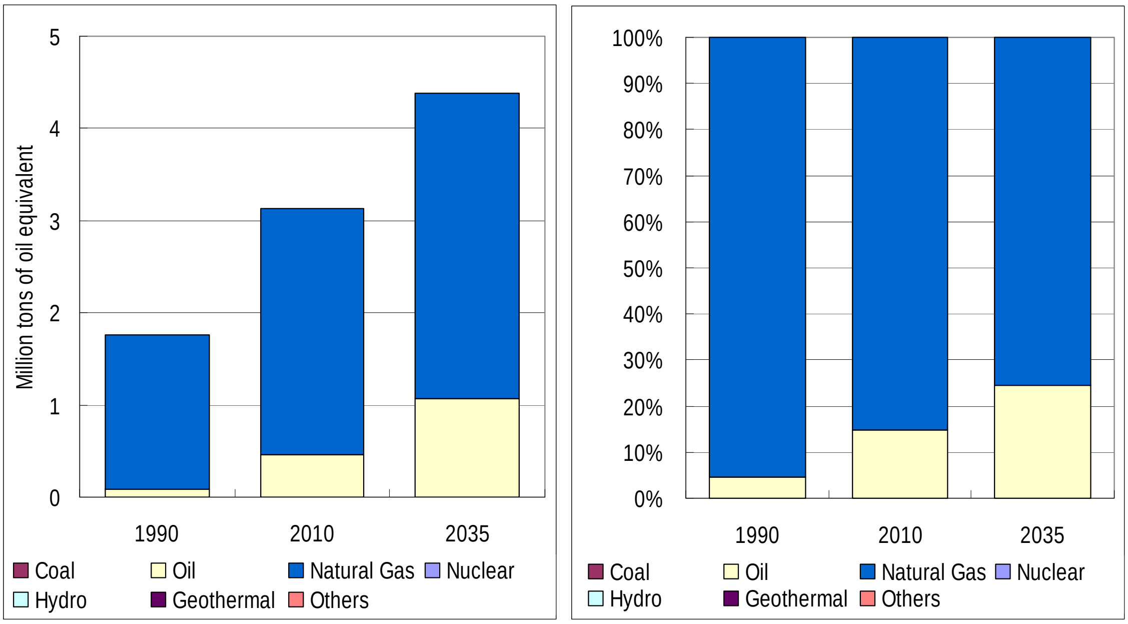
For 2010, final consumption of natural gas reached 0.8 Mtoe corresponding to around 49.3 percent of the total energy consumed due to the increasing demand in domestic industries. Oil consumption was 0.6 Mtoe in 2010 corresponding to around 33.9 percent of the total fuel consumed. By 2035, final energy demand for oil is expected to be 0.9 Mtoe. The increase in oil consumption is mainly attributed to the increase in the number of road vehicles.

3.1.2. Total Primary Energy Supply

Primary energy consumption in Brunei grew slowly than final energy demand at about 2.9 percent per year from 1.8 Mtoe in 1990 to 3.1 Mtoe in 2010. The country relies on two major fuels namely, natural gas and oil. Natural gas comprised more than 95.0 percent of the country energy resource in 1990 and more than 85.0 percent by year 2010. The decreasing share of natural gas is due to the increasing demand for oil which comprised around 14.7 percent of the country's energy supply in 2010.

In the BAU, oil is expected to grow at an average annual rate of 3.4 percent over the study period (2010-235). By 2035 oil is expected to reach 1.1 Mtoe from 0.5 MTOE in 2010. Relatedly, natural gas is expected to grow at average annual rate of 0.9 percent reaching 3.3 Mtoe in 2035. Figure 3-3 shows the primary energy consumption and shares by source in 1990, 2010 and 2035.

Figure 3-3: Total Primary Energy Supply, BAU

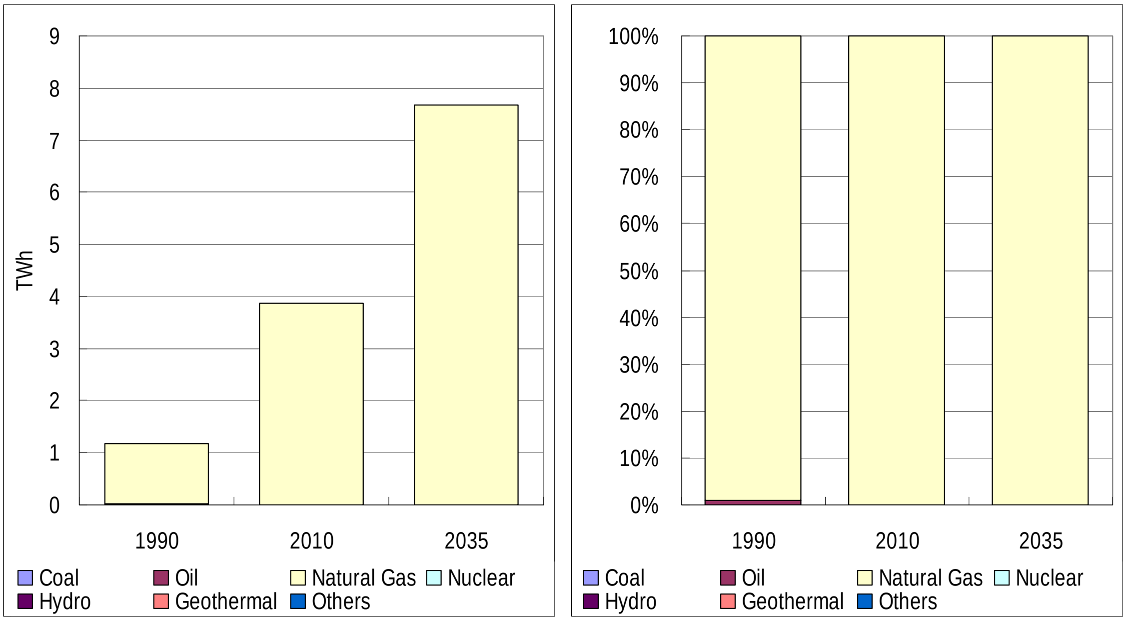


Natural gas constituted the largest share of total primary energy consumption but declining from 95.3 percent in 1990 to 85.3 percent in 2010. By end of 2035, around 75.0 percent of the country's total primary energy supply will still come from natural gas while around 24.5 percent will be sourced from oil.

3.1.3. Power Generation

Power generation output increased at an average rate of 6.2 percent per year over the past two decades, from 1.2 TWh in 1990 to almost 3.9 TWh in 2010. By 2035, 7.7 TWh of electricity will be needed. This corresponds to an average annual increase of 2.8 percent for the period 2010-2035. Figure 3-4 shows the power generation mix in 1990, 2010 and 2035.

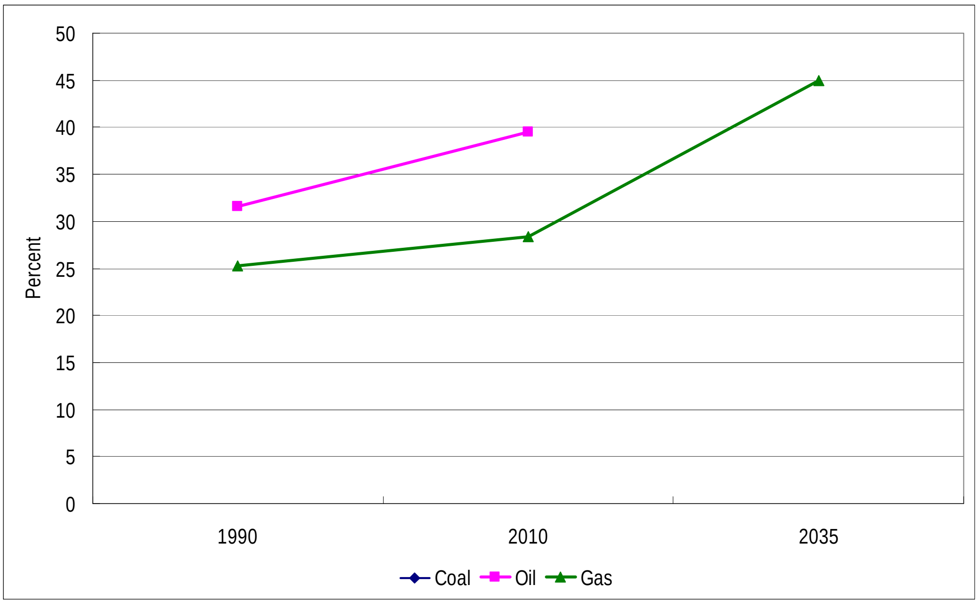
Figure 3-4: Power Generation by Type of Fuel (TWh)



In Brunei Darussalam, power generation is dominated by natural gas; only a negligible percentage is contributed by diesel.

Relatedly, for this study, the model assumes an improvement in thermal efficiency of electricity generation. The efficiency is set to improve from at 28.4 percent in 2010 to 45.0 percent in 2035. Figure 3-5 shows the thermal efficiency of electricity generation in 1990, 2010 and 2035.

Figure 3-5: Thermal Efficiency, BAU



3.1.4. Energy Indicators

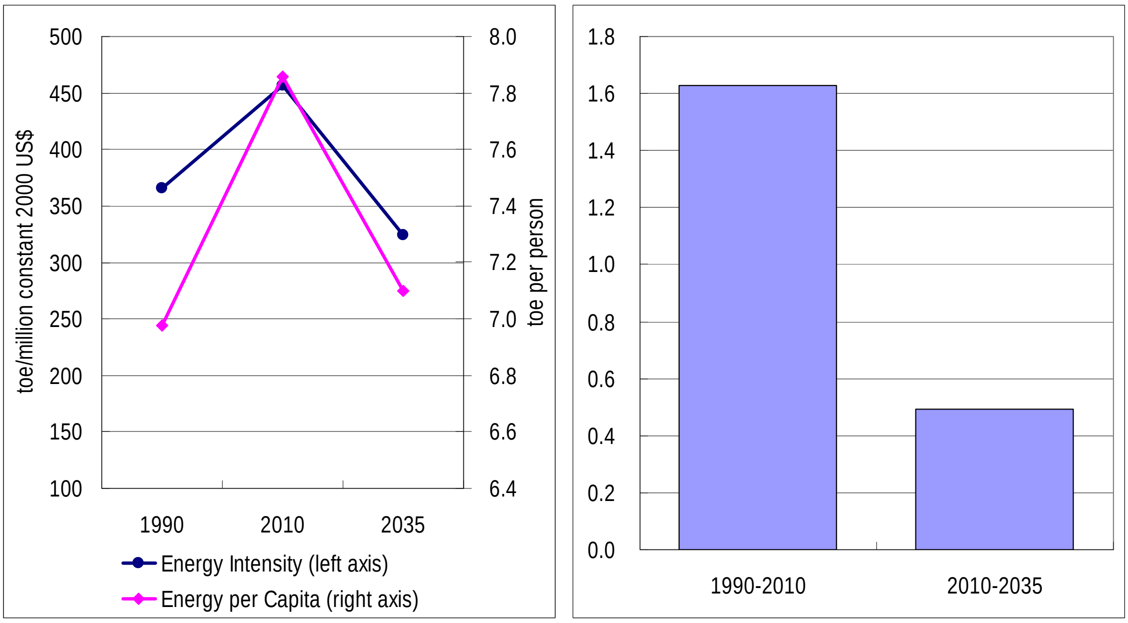
Brunei's primary energy intensity (TPES/GDP) been increased abruptly in 2010 when the methanol plant started operation. This increase in energy intensity does not mean that Brunei energy efficiency worsened. The increase in energy intensity is due to the accounting of natural gas used as feedstock in methanol production as part of total energy consumption.

By end of 2035, energy intensity is expected to decline at an average annual growth rate of 0.4 percent from 456 toe/million 2000 USD to around 324 toe/million 2000 USD by 2035. Thus, the energy intensity ratio is expected to improve by almost 29.0 percent in 2035 as compared to 2010. This is an indication that energy stakeholders had started to effectively use energy through the implemetation of energy conservation measures and greater utilization of more efficient energy technologies.

Meanwhile, the per capita energy consumption, which is measured as the ratio of total primary energy consumption to the total population, has been increasing since 1990 from around 7.0 toe/person to 7.9 toe/person in 2010. By end of 2035 energy consumption per capita will decrease down to 7.1 toe/person. The decrease is an indication of a more efficient use of energy, though this level is much higher compared to other developing countries in the East Asia region.

Figure 3-6 shows the energy intensity, per capita energy consumption and energy elasticity in the period 1990 to 2010 and 2010 to 2035.

Figure 3-6: Energy Intensity and Energy per Capita, BAU



Elasticity of final energy consumption over the 1990-2010 was 1.6 indicating that energy consumption increased faster that the GDP. Implementation of the EEC programs and action plans will reduce the elasticity making the country to be more efficient in the utilization of energy.

In the BAU scenario, the elasticity of final energy consumption is expected to continue to reach 0.5 in 2035. Elasticity below 1.0 is an indicator that growth in final energy consumption will be slower than growth in GDP over the period 2010-2035.

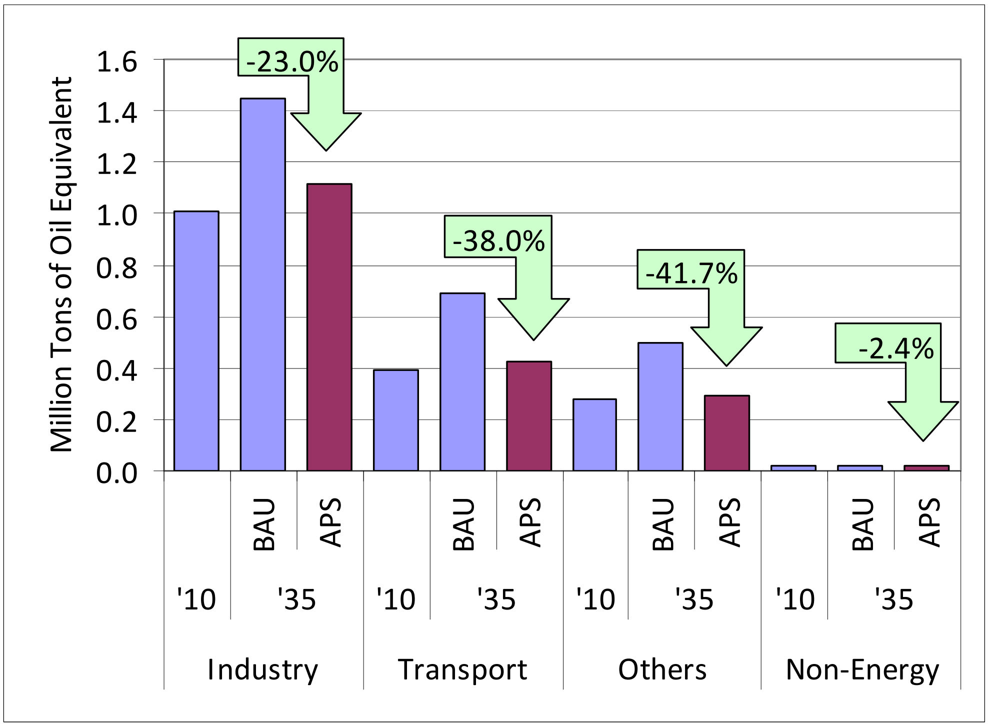
3.2. Energy Savings and CO_2 Reduction Potential

3.2.1. Total Final Energy Demand

In the APS, final energy demand is projected to increase at a slower rate than in the BAU scenario, increasing at an average rate of 0.3 percent per year from 1.7 Mtoe in 2010 to 1.9 Mtoe in 2035. This is equivalent to a reduction of 6.7 percent from the BAU. The APS model is dictated by the energy conservation policy, whereby a 25.0 percent reduction from 2005 level is targeted. However, the model does not show a significant decrease in total FEC since only 2.4 percent decrease is observed between the total FEC in 2035.

The shift in the energy mix may be changed if alternative energy sources are considered in the APS. It is appropriate to assume at this juncture that oil and gas remain as the main sources of energy as there was no strong indication of alternative energy policies to be implemented in the near future. Changes to this scenario maybe realized once an indication of policies on alternative energy are introduced. Figure 3-7 shows the final energy demand by sector in 2010 and 2035 in both the BAU and APS.

Figure 3-7: Final Energy Demand by Sector, BAU and APS



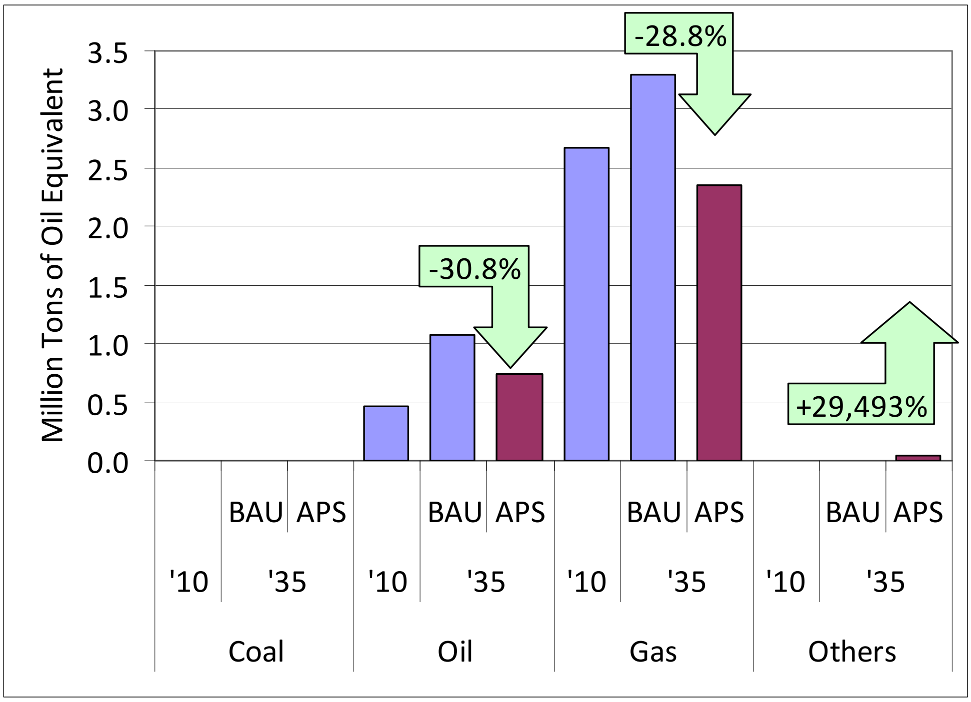
3.2.2. Primary Energy Demand

The primary energy demand (PES) for 2010 is primarily sourced from natural gas at 85.3 percent. PES is expected to increase at an annual average rate of 1.3 percent per year for the period of 2010 to 2035, and in absolute values of 3.1 Mtoe to 4.4 Mtoe.

Under the BAU, PES for oil and natural gas is expected to increase at a rate of 3.4 percent and 0.9 percent, respectively. Brunei Darussalam will continue to be a net exporter of energy.

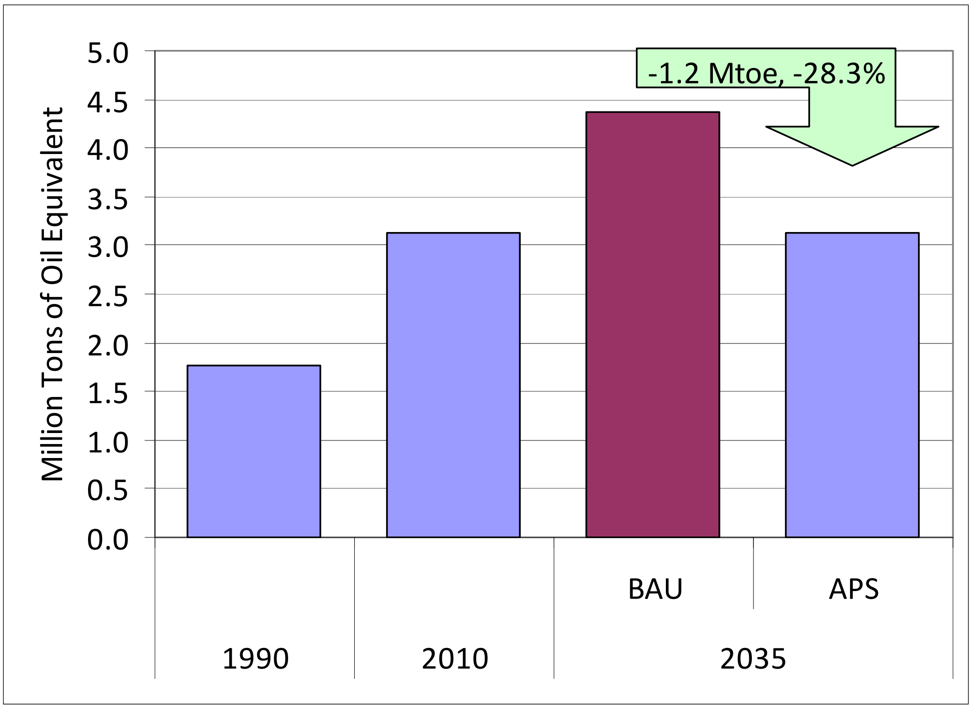
A significant decrease in PES is observed between the BAU and the APS in year 2035. The difference between the two scenarios is 1.2 Mtoe which corresponds to 28.3 percent reduction. In the intermediate year of 2020, the difference between BAU and APS in absolute value is 0.4 Mtoe which corresponds to a decrease of 11.3 percent.

Figure 3-8: Primary Energy Demand, BAU and APS



The energy savings (the difference between primary energy demand in the BAU scenario and the APS) that could be achieved through the energy efficiency and conservation goals and action plans of Brunei is about 1.2 Mtoe, equivalent to 28.3 percent reduction from the BAU in the year 2035 (Figure 3-9).

Figure 3-9: Evolution of Primary Energy Demand, BAU and APS

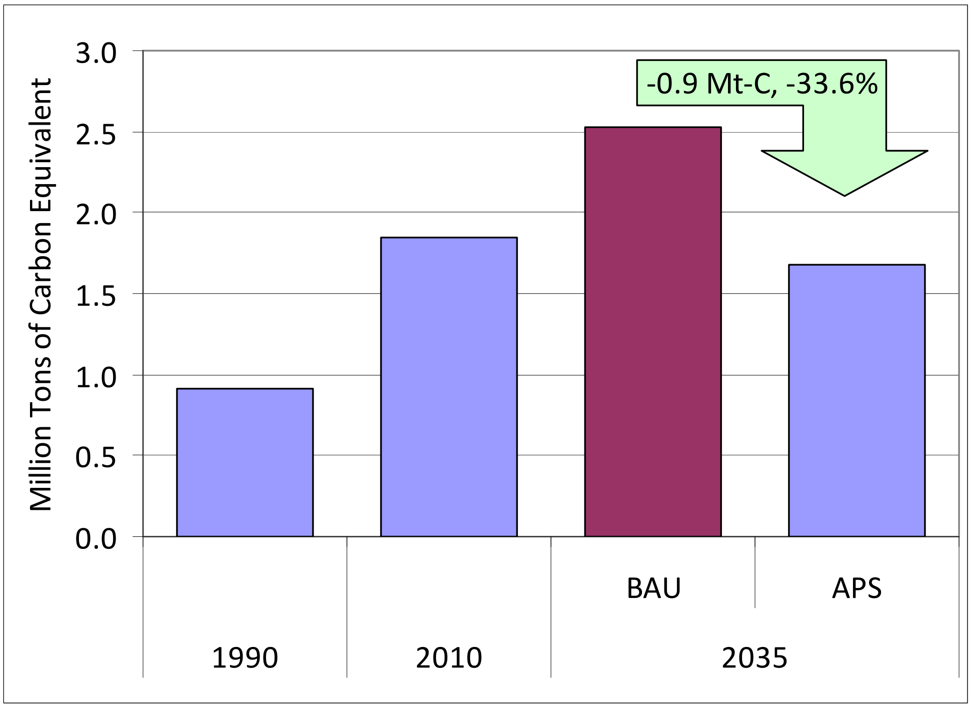


3.2.3. CO_2 Reduction Potential

The percentage increase in carbon dioxide emission correlates strongly to the increase in total primary energy demand (TPES). This is expected because the energy mix for Brunei Darussalam is 99.0 percent dependent on fossil fuel. From the year 2010 level of 1.8 Mt-C, CO_2 emission will at a steady rate of 1.3 percent per year to 2.5 Mt C in year 2035. This growth rate is the same as the growth rate of primary energy demand.

In the APS, carbon dioxide emission is expected to decrease by 33.6 percent in 2035 as compared to BAU (Figure 3-10). The reduction is equivalent to 0.9 Mt-C emissions by 2035. The decrease in carbon dioxide emission is significantly attributed to the improvements in the efficiencies of power generation plants. Carbon dioxide per TPES in BAU and APS will decrease to 0.58 t-C/toe and 0.54 t-C/toe in 2035, respectively. This is due to the introduction of renewable energy in Brunei's energy mix during the period 2010-2035.

Figure 3-10: CO_2 Emission from Energy Demand, BAU and APS



4. Findings and Policy Implications

4.1. Findings

Brunei Darussalam is highly dependent on fossil fuel. The energy profile remains predominantly gas and oil based. The introduction of non-fossil fuel will not be cost effective, and therefore, the most significant way to reduce carbon dioxide emission is to improve on energy efficiency. The model also shows that the improvement in energy efficiency not only reduces carbon dioxide emission but also improves energy intensity, where a decrease from 274.1 toe/Million 2000 US$ in BAU to 179.4 toe/Million 2000 US$ in the APS for the year 2035.

The BAU and the APS only placed emphasis on EEC. The result is significant showing significant reduction in carbon dioxide emission (33.6 percent) and TPES (28.3 percent).

The result of the study also shows that EEC improvement on generation plants have significant impact on TPES and CO_2 emission.

Meanwhile, more emphasis should be given in the reduction of fuel consumption in the transport and others sector (residential and commercial) since these sectors consumed more energy based on the results of the study conducted. Initiatives in these sectors are necessary if significant decrease in TFEC is to be expected. An improved transport network could also play an important role in reducing TFEC and CO_2 emission.

Furthermore, the transport sector which is one of the largest consumers of oil in the country will be crucial in achieving energy savings as well as in reducing CO_2 emissions. Policies to tackle this problem should involve moving away from private to public transport. Currently, there is a proposal to introduce light-rail transit (LRT) to the capital which is still under discussion. Measures to introduce more energy efficient vehicles should also be looked into. Another way to reduce consumption of fuel would be to educate the public and promote techniques for energy saving driving or eco-driving.

4.2. Policy Implications

The projected increase in final energy demand requires urgency for Brunei Darussalam to reduce its final energy demand. The government shall continue to promote and practice energy efficiency and conservation. Various efforts have already been placed in motion such as adopting energy efficiency and conservation (EEC) techniques and technologies within the nation. Having only oil and natural gas for its main sources for energy, it is also imperative for Brunei Darussalam to intensify the EEC initiatives to further strengthen its energy efficiency guidelines and regulations as well as accelerating the adoption of the EEC best practices and advanced technologies.

CHAPTER 4

Cambodia Country Report

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1. Background

The Kingdom of Cambodia is located in the Lower Mekong region of Southeast Asia. It has an 800 km border with Thailand in the west, with Lao PDR in the north, and Viet Nam in the east. The physical landscape is dominated by lowland plains around the Mekong River and the Tonle Sap Lake. Of the country's area of 181,035 km^2, approximately 49 percent remains covered by forest. There are about 2.5 million hectares of arable land and over 0.5 million hectares of pasture land. The country's gross domestic product (GDP) in 2010 was about US$ 7.9 billion at constant 2000 prices with a substantial agriculture share of 34 percent. The population during the same year was 14.1 million.

Cambodia's conventional total primary energy demand in 2010 stood at 1.4 Mtoe. Oil represented the largest share of Cambodia's total primary energy mix at 90.4 percent; coal was third at 0.6 percent, followed by hydro (0.2 percent), and others (8.9 percent). Cambodia's final energy demand stood at 1.2 Mtoe. Cambodia is dependent on imports of petroleum products having no crude oil production or oil refining facilities. Its electricity supply is dominated by oil at 95 percent with hydro accounting for the rest.

Cambodia has 10,000 MW of hydropower potential; however, only 224.57 MW had been installed to date. Commercial quantities of coal have also been discovered in Cambodia but no official figures on recoverable reserves are available currently.

2. Modelling Assumptions

2.1. GDP and Population

In forecasting energy demand to 2035, it is assumed that the GDP of Cambodia will grow at an annual rate of 5.1 percent. Its population on the other hand is projected to grow at 1.8 percent per year resulting to a growth rate of GDP per capita of 3.2 percent per year up to 2035.

2.2. Electricity Generation

With regards to the future electricity supply, coal is expected to dominate Cambodia's fuel mix in 2035 followed by hydro. This is a big change from the current oil-dominated electricity generation. According to the Electricity Supply Development Master Plan from year 2010-2020, Cambodia will have a total additional installed capacity of 3173.2 MW, 900 MW of which will come from coal power plants to be installed from 2010 to 2018. Hydro will make up 1873.2 MW of the total.

From 2020 to 2035, the additional capacity requirements will still be met by coal and hydro. The gross electricity generation also assumes net export of electricity to neighbouring countries of 2600 GWh in 2020 that will gradually increase to 3080 GWh by 2035.

2.3. Energy Efficiency and Conservation Policies

Cambodia's energy efficiency and conservation programs aims to achieve an integrated and sustainable program that will facilitate energy efficiency improvements in the major energy consuming sectors and help prevent increased and wasteful fuel demand. To achieve these aims, the country realizes the need for market transformation towards more efficient energy use, increased access to energy efficiency project financing and the establishment of energy efficiency regulatory frameworks.

As a start, Cambodia is implementing the following pilot projects:

- Improving the efficiency of the overall supply chain for home lighting in rural areas by the provision of decentralized rural energy services through a new generation of rural energy entrepreneurs.
- Assisting in market transformation for home and office electrical appliances through bulk purchase and dissemination of high performance lamps, showcasing of energy efficient products, support to competent organizations for testing and certification of energy efficient products and establishment of "Green Learning Rooms" in selected schools to impart life-long education on the relevance of energy efficiency and conservation.
- Improving energy efficiency in buildings and public facilities.
- Improving energy efficiency in industries in cooperation with UNIDO and MIME to be implemented in the 4 sectors namely, rice mill, brick kiln, rubber refinery, and garment.

Cambodia has also embarked on preparing an action plan for energy efficiency and conservation in cooperation with the Energy Efficiency Design sub-working group created under the WG. Specific actions plans are being drafted for the industrial, transportation and other sectors. The initial estimates of sector demand reduction of existing consumers from these actions plans are 10 percent by 2035. These initial estimates were used in forecasting the energy demand in the APS.

In a close consultation process between Ministry of Industry, Mines and Energy (MIME) and EUEI-PDF that started in July 2011 it was concluded to launch a project support the Royal Government of Cambodia (RGC) in the elaboration of a National Energy Efficiency Policy, Strategy and Action Plan. The project started with an inception phase in August 2012 and will be concluded in April 2013 by a final workshop, where the recommendations and conclusion as elaborated in the document will be presented.

There are five sectors identified as priority areas for the national energy efficiency policy, strategy and action plan.

1- Energy efficiency in industry

2- Energy efficiency of end-user products
3- Energy efficiency in buildings
4- Energy efficiency of rural electricity generation and distribution
5- Efficient use of biomass resources for residential and industrial purposes.

3. Outlook Results

3.1. Business-as-Usual (BAU) Scenario

3.1.1. Total Final Energy Demand

Final Energy Demand by Sector

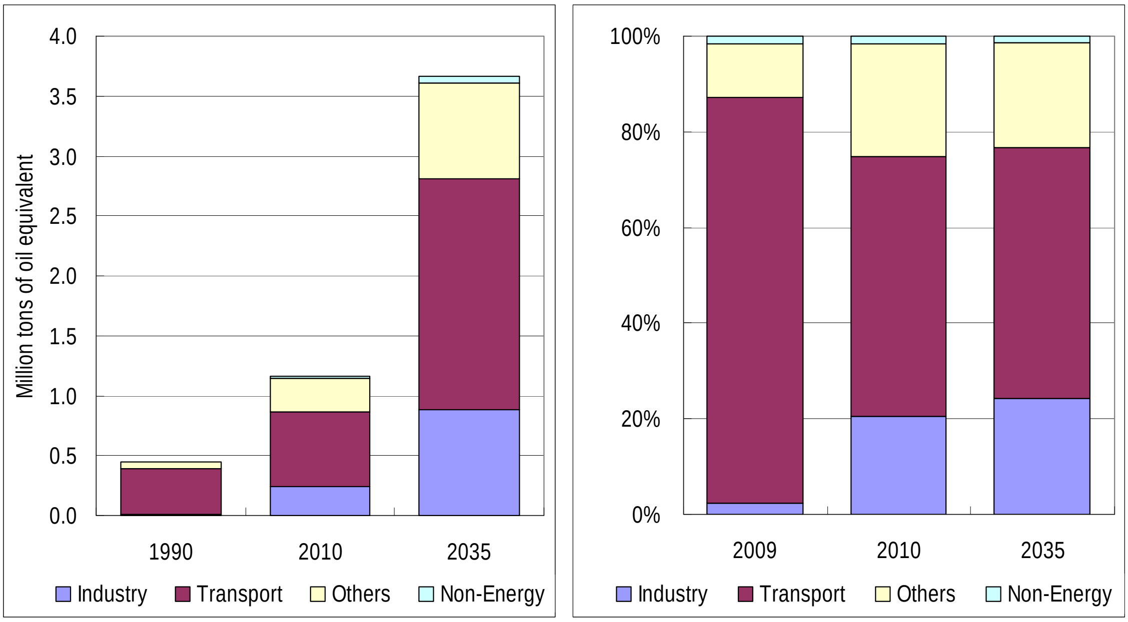
Cambodia's final energy demand (not including biomass) grew at an average annual rate of 6.5 percent per year or 2.57 times from 0.45 Mtoe in 1995 to 1.16 Mtoe in 2010. This growth occurred in the industrial sector which grew at a rapid rate of 23.5 percent per year followed by the residential/commercial (others) sector at 11.9 percent per year, non-energy sector 6.9 percent per year, and the transport sector 3.4 percent per year. Oil is the most consumed product, accounting for 97.8 percent of total final energy demand in 1995, declining to 84.9 percent in 2010. Electricity demand's share also rapidly increased from 2.2 percent in 1995 to 15.1 percent in 2010.

In the BAU scenario, driven by assumed 5.1 percent GDP growth and a rising population, final energy demand is projected to increase at an average rate of 4.7 percent per year or 2.1 times between 2010 and 2035. The strongest growth in demand is projected to occur in the industry sector that will increase by 5.4 percent per year to 2035. This is followed by the transport sector 4.6 percent per year and the residential/commercial (others) sector at 4.4 percent per year. Non-energy demand will increase by 4.1 percent per year.

The transport sector's share to the total final energy demand was the largest share in 2010 at of 54.3 percent. This share is projected to decline to 52.5 percent in 2035 in view of the faster growth of the industrial sector which will grow at 5.4

percent per year on average. The second largest share in demand is in the residential/ commercial (others) sector with the share of 23.6 percent in 2010. This is projected to decline to 21.9 percent due to the faster growth of the industrial sector. The industry sector with had the third largest share of 20.5 percent in 2010 would have a larger share in 2035 at 24.2 percent. Non-energy demand share will remain small from 1.6 percent in 2010 to 1.4 percent in 2035 (Figure 4-1).

Figure 4-1: Final Energy Demand by Sectors, BAU

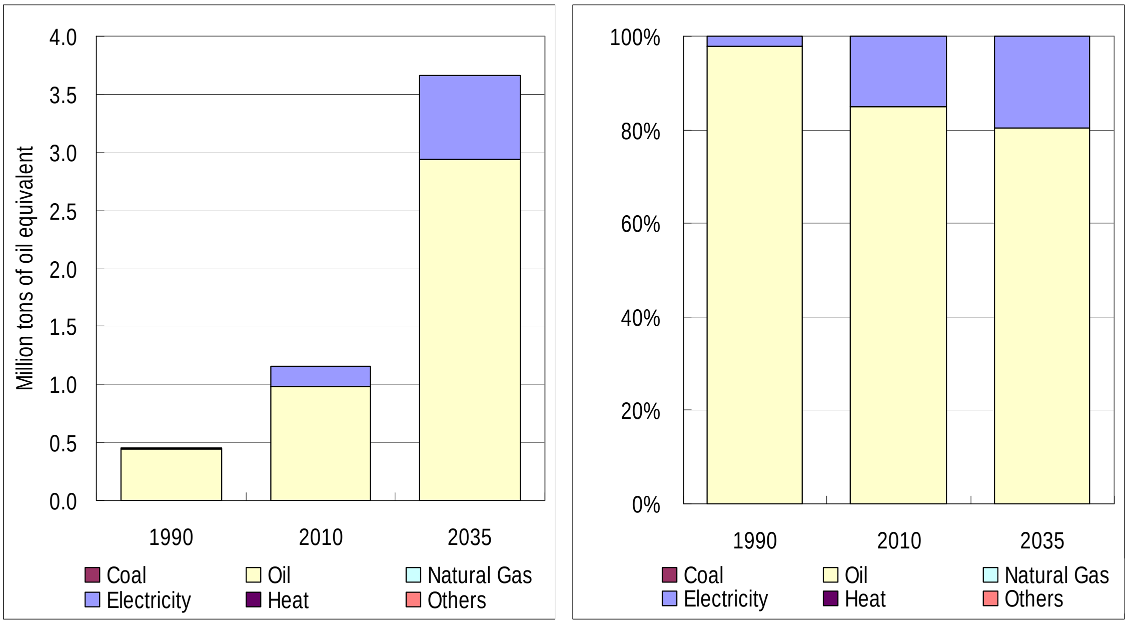


Final Energy Demand by Fuel

By fuel, electricity is projected to exhibit the fastest growth in final energy demand at 5.1 percent per year between 2010 and 2035. From 0.2 Mtoe in 2010, electricity demand is projected to increase to 0.7 Mtoe in 2035. Oil is projected to have a 4.0 percent annual growth rate per year, to increase from 1.0 Mtoe in 2010 to 2.9 Mtoe in 2035. Figure 4-5 shows the final energy demand by fuels in 1990, 2010 and 2035.

Oil products will continue to take the largest share in final energy demand. Its share will remain high from 84.9 percent in 2010 but is projected to decline to 80.4 percent in 2035. In contrast, electricity share will increase from 15.1 percent in 2010 to 19.6 percent in 2035. Figure 4-2 shows the shares of various fuels in Cambodia's final energy demand in 1990, 2010 and 2035.

Figure 4-2: Final Energy Demand by Fuels, BAU

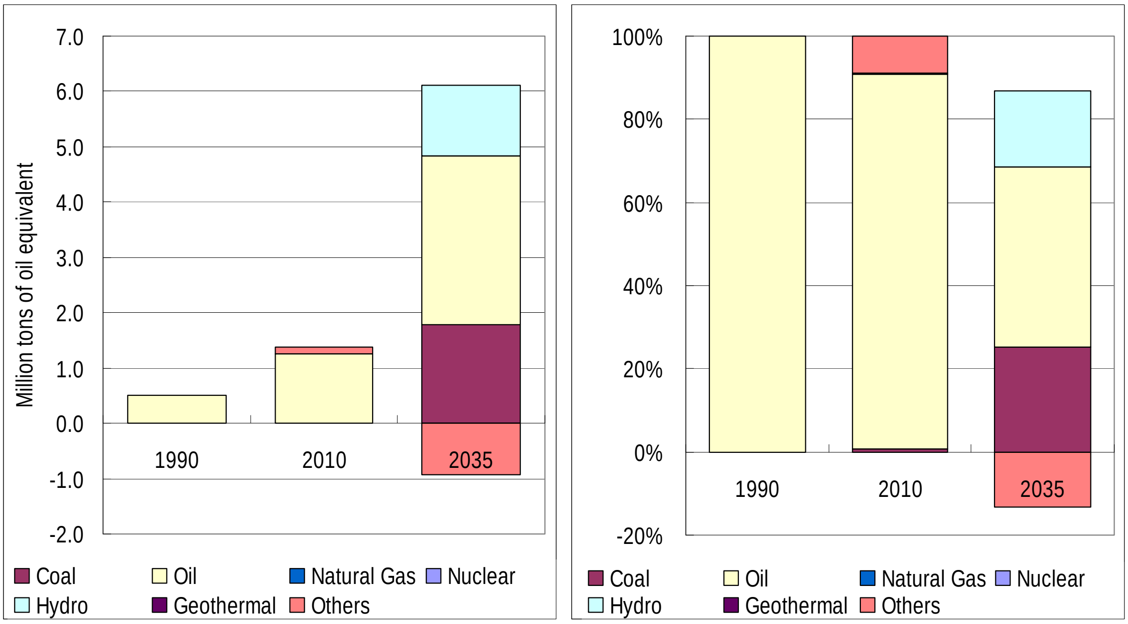


3.1.2. Total Primary Energy Demand

Primary energy demand in Cambodia (not including biomass) grew at 6.8 percent per year on average or 2.7 times from 0.51 Mtoe in 1995 to 1.37 Mtoe in 2010. Among the major energy sources, the fastest growing was oil. Oil demand grew at an average annual rate of 6.1 percent between 1995 and 2010.

In the BAU scenario, Cambodia's primary energy demand is projected to increase at an annual rate of 5.4 percent per year or 2.5 times from 1.37 Mtoe in 2010 to 5.19 Mtoe in 2035. The faster growth would be in hydro, increasing at annual average rate 28.9 percent between 2010 and 2035, followed by coal at 24.1 percent. Oil will have a slower growth rate of 3.6 percent per year on average. Figure 4-3 shows the primary energy demand in Cambodia in 1990, 2010 and 2035.

Figure 4-3: Primary Energy Demand



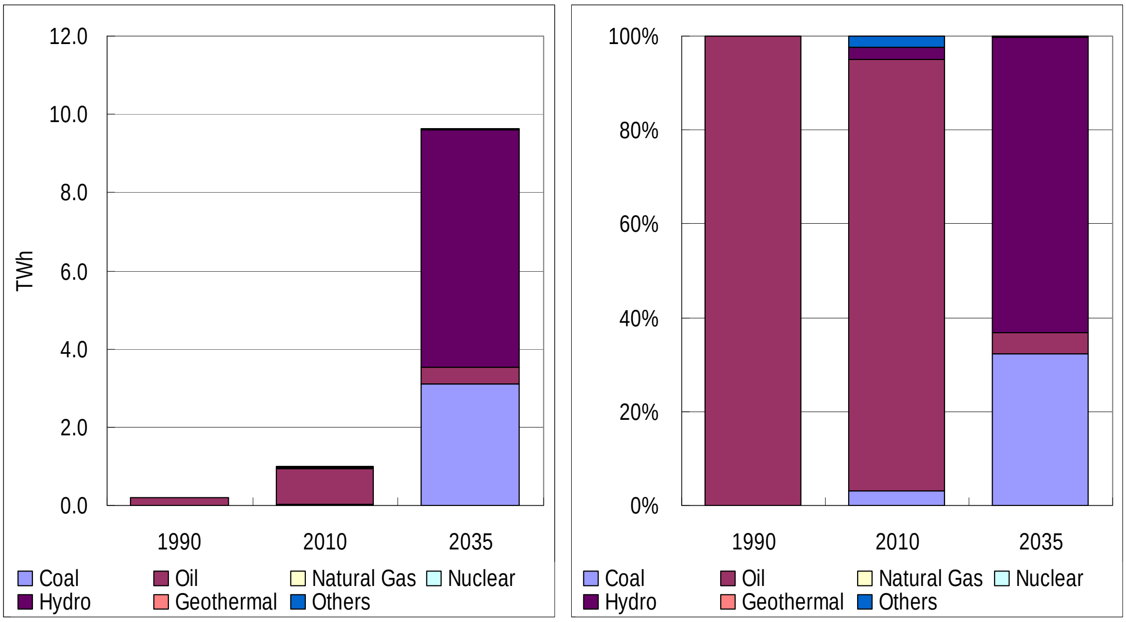
Despite the slower growth in oil demand, oil will remain as the major source of energy in Cambodia. However, its share to the total will decrease from 90.4 percent in 2010 to 58.9 percent in 2035. The share of hydro is projected to increase from 0.2 percent in 2010 to 24.7 percent in 2035. Coal will also increase its share from 0.6 percent to 34.2 percent during the same period.

3.1.3. Power Generation

Power generation increased at 11.4 percent per year or 5 times from 0.2 TWh in 1995 to 1.0 TWh in 2010. Oil power plants were the main source of electricity in 1995 but in 2010, coal, hydro and other sources of electricity became parts of Cambodia's power generation mix. During the year, these sources had 3.1 percent, 2.6 percent and 2.3 percent contribution to Cambodia's power generation mix.

In BAU scenario, to meet the domestic demand for electricity and the export target of the government, power generation is projected to increase at an average rate of 13.2 percent per year or 22.3 times between 2010 and 2035. The fastest growth will be in hydro power generation (28.9 percent per year) followed by the coal thermal power generation (24.1 percent per year) and others (0.1 percent per year). Figure 4-4 shows the power generation mix in Cambodia in 1990, 2010 and 2035.

Figure 4-4: Power Generation, BAU



Oil had the largest share of 92.0 percent in 2010 but this is projected to decline considerably to 1.7 percent in 2035. Hydro and coal, on the other hand will increase their shares to the power generation mix. The share of hydro will increase to 67.4 percent while that of coal will increase to 30.8 percent in 2035. Other sources, like solar, biomass and wind will also have a decrease in share and will reach a negligible 0.1 percent in 2035 from 2.3 percent in 2010. Figure 8 shows the power generation mix in Cambodia in 1990, 2010 and 2035.

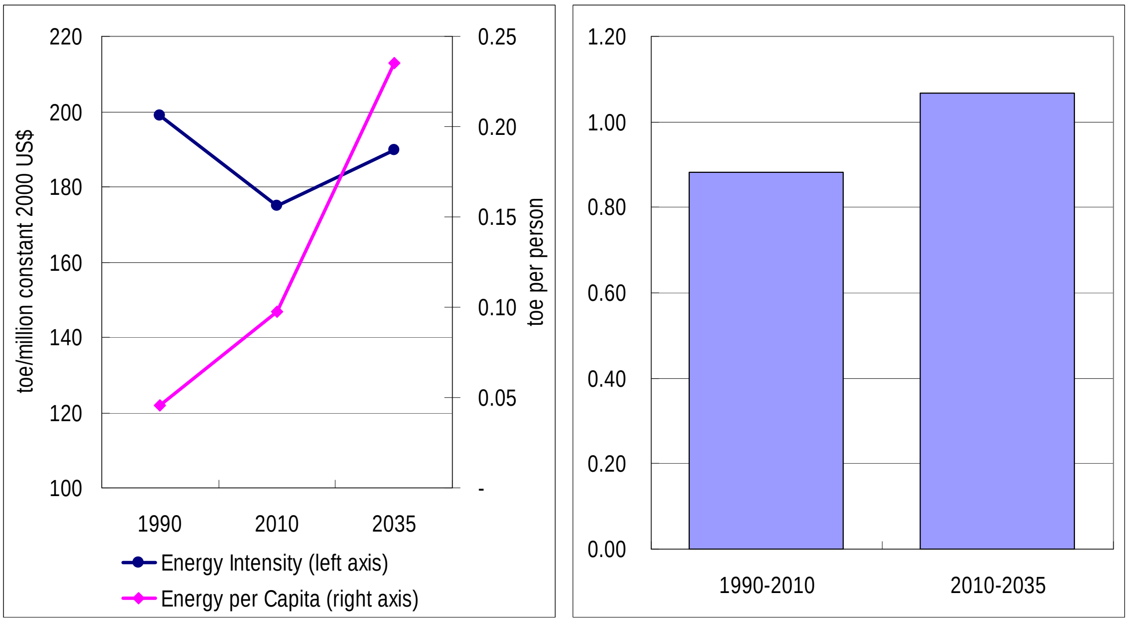
3.1.4. Energy Intensity and Energy Consumption per Capita

Energy intensity had decreased from with 199 toe/million 2000 US dollars in 1995 to 175 toe/million US dollars in 2010. The major reason is that textile and food industry, a non-energy intensive industry, was the most common industry that was developed during that period. In the BAU, the energy intensity will continue to have a decreasing trend and will reach 190 toe/million US dollars in

2035. The reason for the increasing energy intensity is the entry of more coal-fired generation in the power sector. In the past, Cambodia relied on electricity imports to meet a big part of its electricity demand.

In contrast with energy intensity, energy consumption per capita increased from 0.05 toe/person in 1995 to 0.10 toe/person in 2010. In the BAU, energy per capita will continue to increase and will reach 0.23 toe/person in 2035. Figure 4-5 shows the primary energy intensity and energy consumption per capita in from 1990 to 2035.

Figure 4-5: Energy Intensity and Energy Consumption per capita



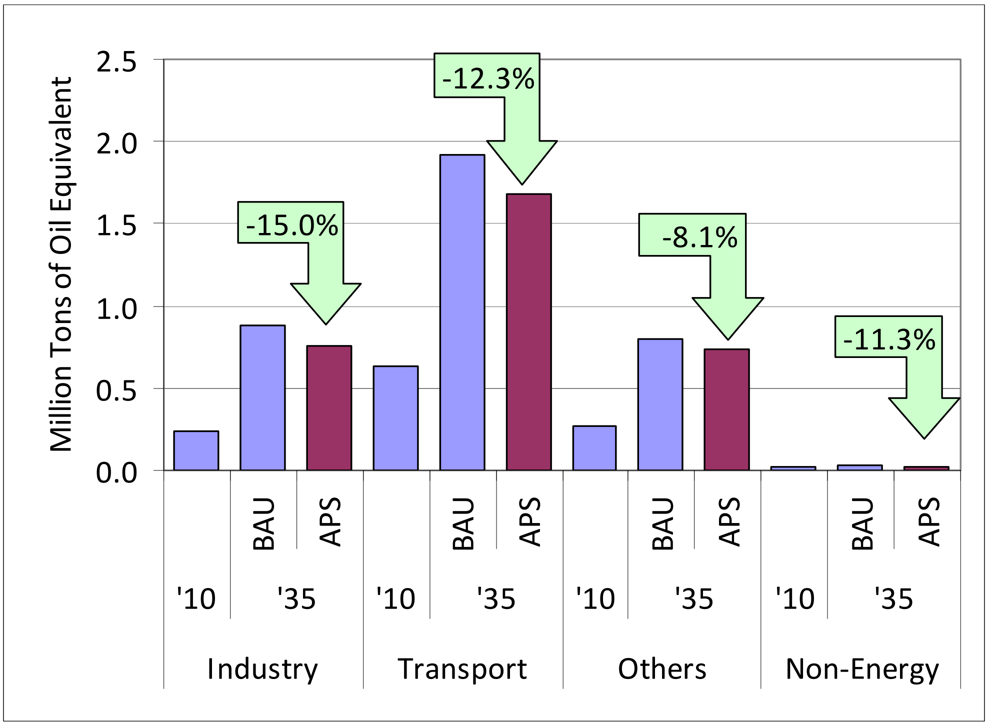
3.2. Energy Saving Potential

3.2.1. Final Energy Demand by Sector

In the Alternative Policy Scenario (APS), final energy demand is projected to increase at a slower rate 4.2 percent per year (compared with 4.7 percent per year in BAU) from 1.2 Mtoe in 2010 to 3.2 Mtoe in 2035, because of energy efficiency and conservation (EE&C) programs. The bulk of the savings are expected to occur in the transport sector (1.7 Mtoe), followed by the industry sector (0.8 Mtoe), and the residential/commercial (others) sector (0.7 Mtoe).

Improvement in end-use technologies and the introduction of energy management system is expected to contribute to the slower rate of demand growth, particularly in the transport, industry and others (residential and commercial).

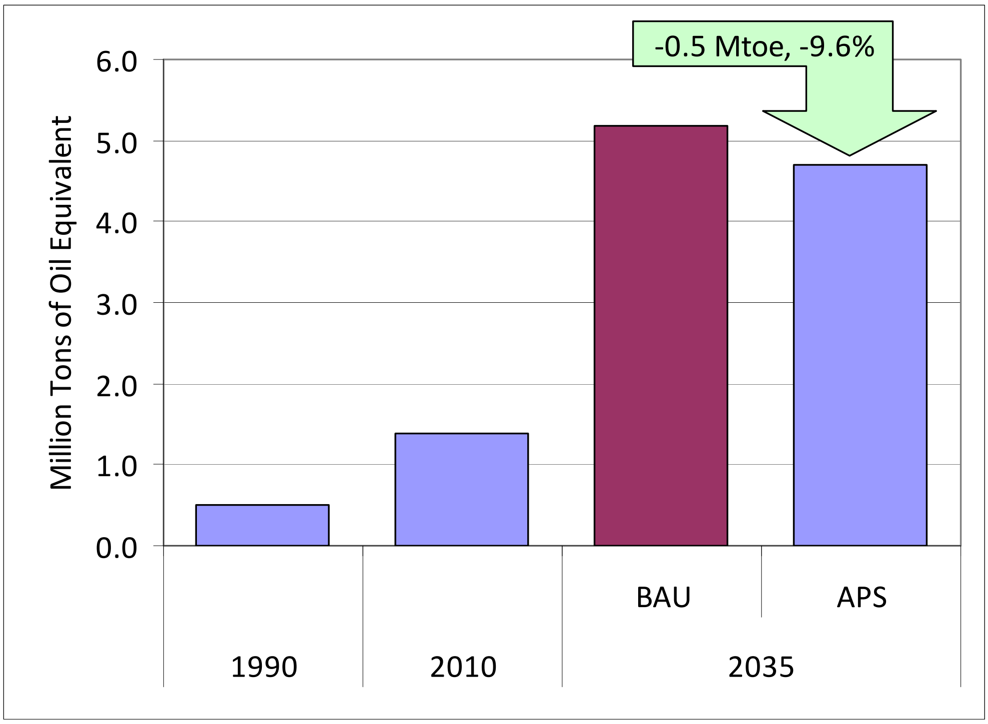
Figure 4-6: Final Energy Demand, BAU vs. APS



3.2.2. Primary Energy Supply

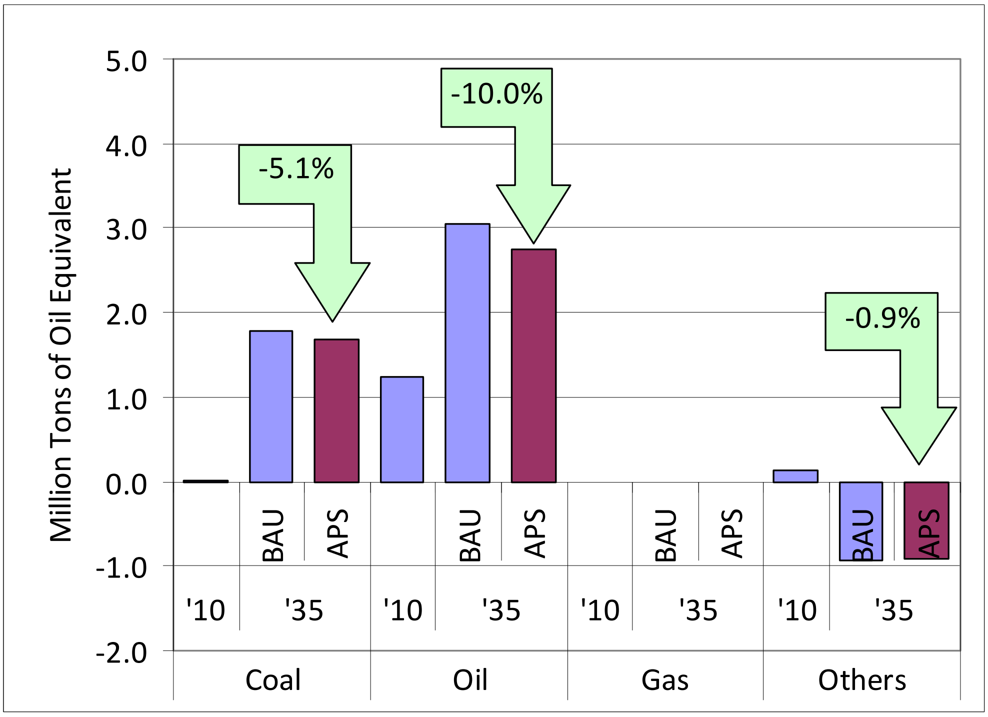
In the APS, primary energy demand is projected to increase at a slower rate of 5.0 percent per year from 1.4 Mtoe in 2010 to 4.7 Mtoe in 2035. The saving that could be derived (the difference between primary energy demand under both scenarios) from the energy saving and conservation goals and action plans of Cambodia is 0.5 Mtoe. This is equivalent to 9.6 percent of total Cambodia's primary energy demand in the BAU in 2035 (Figure 4-7).

Figure 4-7: Evolution of Primary Energy Demand, BAU and APS



In the APS, hydro is projected to grow at an average annual rate of 28.5 percent compared with 28.9 percent in the BAU, followed by coal and oil with 23.8 percent and 3.2 percent (24.1 percent and 3.6 percent in the BAU), respectively over the same period. The slower growth in demand, relative to the BAU scenario, stems from EE&C measures on the demand side and the more aggressive uptake of renewable energy on the supply side. Coal has the highest energy saving potential with 88.5 percent, followed by oil at 4.6 percent. Figure 4-8 shows the primary energy demand by source in 2010 and 2035 in both the BAU and APS.

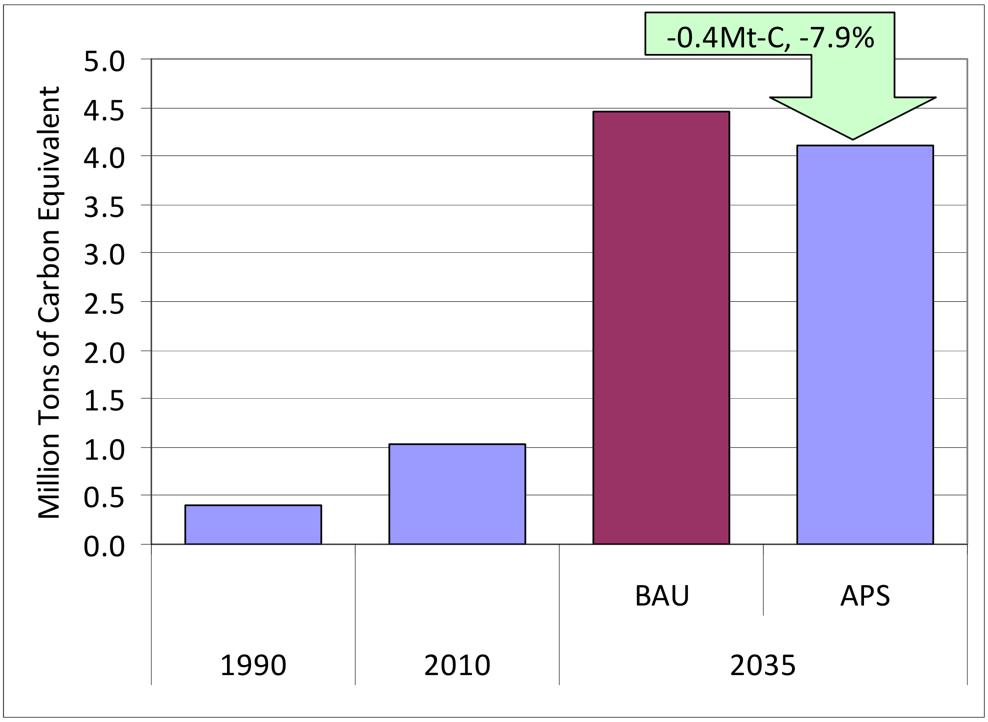
Figure 4-8: Primary Energy Demand, BAU vs. APS



3.2.3. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 6.0 percent per year from 1.0 Mt-C in 2010 to 4.5 Mt-C in 2035 under the BAU scenario. This growth rate is faster than that of the primary energy demand due to the increased contribution of coal to Cambodia's primary energy mix. Under the APS, the annual increase in CO_2 emissions between 2010 and 2035 is projected to be 5.7 percent. CO_2 emissions are 0.4 Mt-C lower (a 7.9 percent decrease) under the APS compared with the BAU scenario in 2035, indicating that the energy saving goals and action plans of Cambodia are effective in reducing CO_2 emissions (Figure 4-9).

Figure 4-9: Evolution of CO_2 Emissions, BAU and APS



3.2.4. Key Findings

From the above analysis on energy saving potential, the following are the key findings:

- Energy demand in Cambodia is expected to continue to grow at a significant rate, driven by robust economic growth, industrialization, urbanization and population growth. Energy efficiency and conservation is an option to meet higher demand in sustainable manner.
- Annual growth of energy of energy demand in industry sector is projected at highest rate of 5.4 percent in BAU and its share is increasing continuously from 20.5 percent in 2010 to 24.2 percent in 2035. This shows that energy efficiency and conservation measures are required in the industrial sector to curb the ever increasing demand.

- Electricity demand is increasing with highest annual growth rate of 5.8 percent in the BAU and is projected to be lower at 5.1 percent in the APS. The difference seems to be modest compared with its potential.
- Hydro power plants will be the major power generation source in Cambodia in coming years. Its share in the total of power generation output will increase from 2.6 percent in 2010 to 67.4 percent in 2035. Coal thermal power plants will be the second major power generation source in Cambodia also in coming years. Its share in the total of power generation output will increase from 3.1 percent in 2010 to 30.8 percent in 2035. This is an area with the largest energy saving as well as GHG mitigation potential in Cambodia.

4. Implications and Policy Recommendations

From the findings above and to be able to implement EE&C activities in Cambodia effectively, the following actions are recommended:

- Establishment of target and roadmap for EE&C implementation in Cambodia is necessary. The target for EE&C in Cambodia should be set up for a short, medium, and long term period and focused on buildings and industries sectors as priority sectors. The long term should be set up based on an assessment of energy saving potential for all energy sectors, including residential and commercial sectors, which have large potential on energy saving up to 2035.
- The growing demand in the residential and commercial sector requires compulsory energy labelling for electrical appliances. The compulsory energy labelling for electrical appliances is an effective energy management measure.
- Hydro and coal thermal power plants will be the major sources of power generation in Cambodia up to 2035. Therefore, advanced clean coal technologies should be used for coal power plants. For hydro, there should

be a careful review of all hydro development projects to ensure that local communities would not be adversely affected but would instead enjoy the economic benefits that the development would bring.

- Renewable energy is a supply side option that will increase energy independence, energy security and GHG abatement in Cambodia. There is a necessity to build up the strategy and mechanisms to support renewable energy development.

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CHAPTER 5

China Country Report

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1. Background

1.1. Natural Condition and History

The People's Republic of China has an area of 9.6 million square kilometres and is situated in eastern Asia on the western shore of the Pacific Ocean. China's continental coastline extends for about 18,000 kilometres, and its vast sea surface is studded with more than 5000 islands. Due to its size, China's climate is very diverse, ranging from an unbearable 48ºC in the northwest during summer to an equally unbearable -40ºC in the far north in winter.

China has more than 5000 years of history and is one of five countries with a great ancient civilization. The People's Republic of China was founded on 1 October 1949. Today, China is implementing reforms and opening up its economy. It has established a socialist market economy, thereby charting the course for socialist modernization with Chinese characteristics.

1.2. Economy and Population

China's GDP in 2010 was around US$3246 billion (in 2000 US$ terms), which translates into a per capita income of around US$2400. China is the world's most populous country and it has a population of about 1354 million (2012). To mitigate population growth, China has implemented a family planning policy since the 1970s. China has been experiencing a fast urbanization process, with a 1 percent annual growth rate since 1978 when China's reform and opening up started. Around 52.6 percent of people lived in urban areas at the end of 2012.

1.3. Energy Situation

China is endowed with coal, oil and gas reserves, and hydropower. China is the world's largest coal producer and has the third largest coal reserves, with recoverable reserves of 114.5 billion tonnes. In 2012, China produced 3.65 billion tonnes of raw coal. China is also a major crude oil producer, with output of 207 million tonnes of crude oil in 2012. However, driven by very fast increases in domestic oil demand, China became a net oil importer in the 1990s. Approximately 60 percent of China's oil consumption is met by imported oil. China is also a large producer and exporter of energy intensive manufactured products. In 2012, it produced 953 million tonnes of finished steel and 2.21 billion tonnes of cement, and exported 56 million tonnes of finished steel.

China's per-capita energy reserve is very low, much lower than the world average. The per-capita average of both coal and hydropower resources is about 50 percent of the world average, while the per-capita average of both oil and natural gas reserves is only about one-fifteenth of the world average. The per-capita average of arable land is less than 30 percent of the world average, which hinders the development of biomass energy.

In 1990, coal accounted for 78.7 percent of net primary energy supply while oil was 17.8 percent, natural gas almost 1.9 percent, and hydro 1.6 percent. In 2010, coal was still a major fuel, but with a lower share of about 72.1 percent. The share of other energy sources increased from 1990 levels to 19.5 percent for oil, 4 percent for gas, and 2.8 percent for hydro.

Net primary energy supply in China increased at an average annual rate of around 6.1 percent from 671.7 Mtoe in 1990 to 2212.5 Mtoe in 2010. Energy intensity (net primary energy supply per unit of GDP) declined from 1510.8 tonnes of oil equivalent per million US$ in 1990 to 681.6 tonnes of oil equivalent per million US$ in 2010.

Final energy demand in China increased at a lower annual average rate of 5.3 percent from 466.2 Mtoe in 1990 to 1312.7 Mtoe in 2010. Coal accounted for 68.6 percent of final energy demand in 1990 but this declined to a share of 39 percent in 2010. In 1990, oil accounted for 18.3 percent of final energy demand but its consumption increased rapidly at 7.6 percent per year between 1990 and 2010. This led to a significant increase in its share to 28.1 percent in 2010. Electricity demand increased very rapidly, with a growth of 10.7 percent per year between 1990 and 2010, higher than any of the other final energy sources. Electricity's share in final energy demand increased from 8.4 percent in 1990 to 22.6 percent in 2010.

Industry is the major energy consuming sector in China followed by the residential/commercial ("Others") sectors and the transport sector. The share of Industry consumption increased from 52.2 percent in 1990 to 54.2 percent in 2010. Conversely, the share of energy consumption by the residential/commercial sectors declined from 31 percent in 1990 to 21.9 percent in 2010 because of the faster growth in the industry and transport sectors.

In China, coal-fired power generation accounted for around 71.3 percent of total electricity generation in 1990. By 2010, this share had increased to 77.8 percent. The share of hydro was around 20 percent in 1990, but has since declined to 17.2 percent in 2010. Gas and oil, collectively, accounted for about 1.9 per cent of total generation in 2010. The share of nuclear power increased to about 1.8 percent in 2010.

The Chinese government is pushing the development of a modern energy industry. The Government takes resource conservation and environmental protection as two basic State policies, giving prominence to building a resource-conserving and environmentally-friendly society in the course of its industrialization and modernization.

2. Modeling Assumptions

2.1. Population and Gross Domestic Product

The outlook results for China have been developed by the Institute of Energy Economics of Japan (IEEJ) and were taken from modelling of a Business As Usual scenario (BAU) and an Alternative Policy Scenario (APS).

China's population increased from 1.135 billion in 1990 to 1.338 billion in 2010, but it is projected that China's population growth will slow as a result of the 'one child' policy. Over the period of 2010-2035, China's population is assumed to increase at average rate of 0.1 percent per year and will reach 1.382 billion people by 2035.

China's economy grew at a rapid average annual rate of 10.5 percent from US$ 445 billion in 1990 to about US$ 3246 billion in 2010. In this study, GDP is assumed to grow at a slower rate of 5.6 percent per year for the period of 2010-2035 to reach US$ 12,736 billion by 2035. Given the GDP and population assumptions, GDP per capita in China is assumed to increase from around US$ 2,426 per person in 2010 to US$ 9,200 per person in 2035.

2.2. Energy and Climate Change Policies

Although China is still a developing country and has a GDP per capita less than one-seventh of that of the United States, the Government has aggressive goals on energy intensity reduction and addressing climate change issues.

According to official communiqué over the last five years, China has achieved significant energy conservation and remarkable progress in environmental protection. Between 2006 and 2011, the country eliminated 80 Gigawatts of small thermal power units, saving more than 60 million tons of raw coal annually. In 2011, coal consumption of thermal power supply per kilowatt hour was 37 grams of standard coal lower than in 2006, a decrease of 10 percent. In 2011, the installed generating capacity of hydropower reached 230 Gigawatts, ranking China first in the world in hydropower capacity. Fifteen nuclear power generating units were put into operation, with a total installed capacity of 12.54 Gigawatts. Another 26 units, still under construction, will have a total installed capacity of 29.24 Gigawatts, ranking China first in the world in nuclear power capacity. The installed generating capacity of wind power connected with the country's power grids reached 47 Gigawatts, ranking China top in the world. Photovoltaic power generation also reported speedy growth, with a total installed capacity of more than 3 Gigawatts in 2011. Solar water heating covered a total area of 200 million square meters. The State also expedites the use of biogas, geothermal energy, tidal energy and other renewable energy resources. Non-fossil energy accounted for 8 percent of the net primary energy supply in 2011, which means an annual reduction of more than 600 million tons of carbon dioxide (CO_2) emission.

China is also quickening the pace of control of coal mining subsidence areas, and has established and improved the compensation mechanism for the exploitation of coal resources and the restoration of the environment. In 2011, the coal washing rate reached 52 percent and the land restoration rate reached 40 percent. Existing power plants have sped up their desulfurization, upgrading coal-fired generating units with flue gas desulfurization facilities accounting for 90 percent of the national total. Coal-fired generating units reported a 100-percent installation of dust-cleaning facilities and a 100-percent discharge of waste water at the national standards.

The State is intensifying efforts for the development and utilization of coal bed methane (CBM), extracting 11.4 billion cubic meters of CBM in 2011. China became the first country to adopt a national standard for CBM emissions.

In China's Outline of the 12th Five-Year Plan (2011-2015) for National Economic and Social Development, it is stipulated that energy consumption per unit of GDP will drop by 16 percent from 2010 to 2015. In order to achieve this goal, the government has already implemented administrative measures, market based measures, and legal measures to promote energy conservation, and it will continue to implement new policies. Energy intensity reduction goals will be assigned to provincial governments and their progress will be announced publicly every year. In addition to conventional intensity targets, controlling total energy consumption is proposed.

The development of renewable energy has also been accelerated. The People's Congress of China passed the Renewable Energy Development Law of China in 2005 to support renewable energy development in the country. The Government also announced the target of increasing the share of non-fossil energy to about 15 percent by 2020 (measured in coal-equivalent). Subsidization policies have also been developed to encourage development of wind power, solar photovoltaic and biomass.

China has announced its goal of reducing CO_2 emissions per unit of GDP (carbon intensity) by 40-45 percent from the 2005 level by 2020. To meet the target, China will implement ambitious energy efficiency and fuel switching policies. Moreover, the Government has also announced its goal of establishing 40 million hectares of forested land to mitigate GHG emissions.

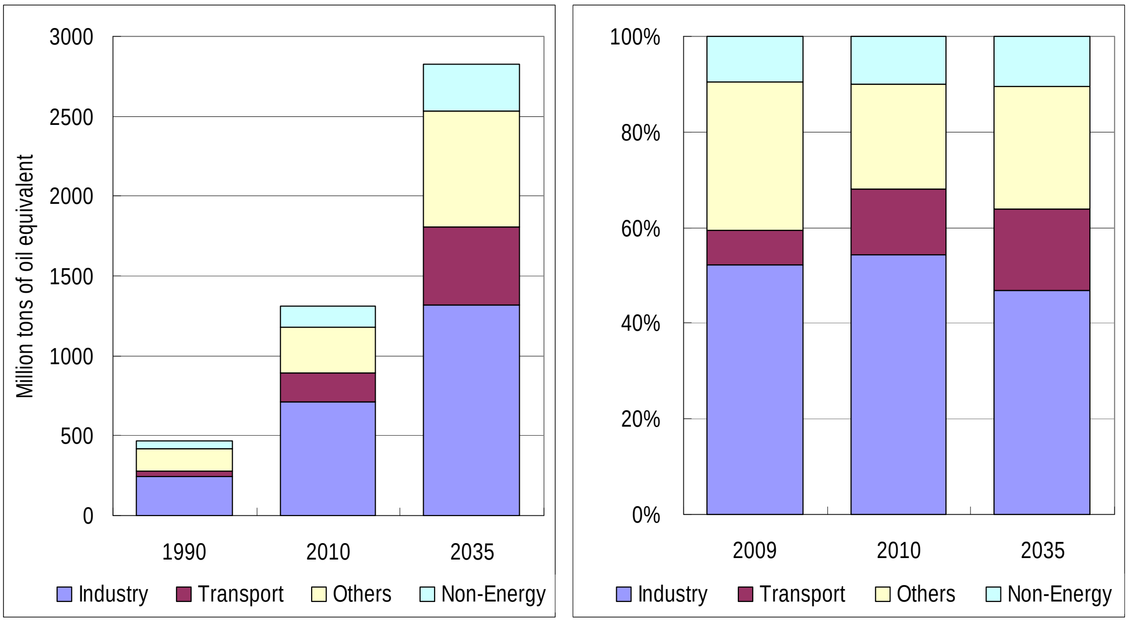
3. Outlook Results

3.1. Business-as-Usual (BAU)

Final Energy Demand

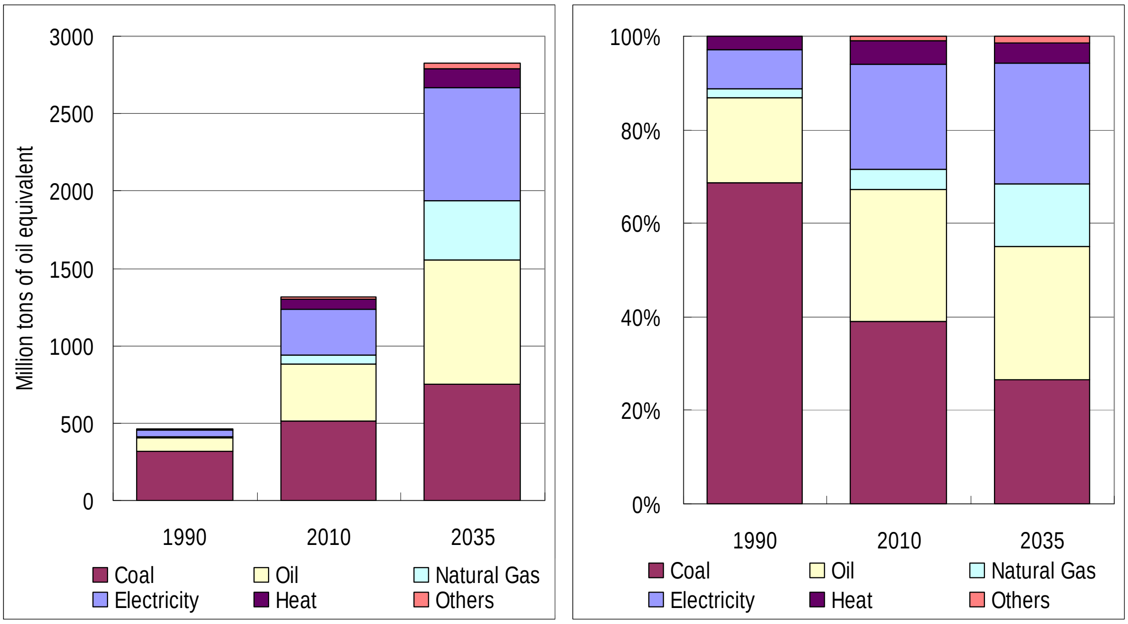
Between 2010 and 2035, the growth in China's final energy demand is projected to slow under the Business As Usual scenario (BAU), reflecting the lower assumed economic and population growth. Final energy demand is projected to increase from 1313 Mtoe in 2010 to 2829 in 2035, an average rate of 3.1 percent per year. The transport sector demand is projected to grow most rapidly, increasing by 4.0 percent per year, followed by the commercial and residential ('Others') sectors at 3.8 percent per year. Energy demand in the industry sector is projected to grow at an average annual rate of 2.5 percent. Figure 5-1 shows China's final energy demand and shares by sector under BAU, in 1990, 2010, and 2035.

Figure 5-1: Final Energy Demand by Sector, BAU



For the energy sources, natural gas demand in the BAU scenario is projected to exhibit the fastest growth, increasing by 7.9 percent per year, from 57 Mtoe in 2010 to 381 Mtoe in 2035. Although coal will retain a large share of total final energy demand, it is projected to grow at a much lower rate of 1.5 percent per year, achieving 749 Mtoe in 2035. This is compared with its 2.4 percent per year growth over last two decades. Demand for electricity and heat are projected to increase at an average annual rate of 3.7 percent and 2.5 percent respectively over 2010-2035, achieving 732 Mtoe and 120 Mtoe in 2035. Oil is projected to grow by 3.2 percent per year to around 805 Mtoe in 2035. Figure 5-2 shows China's final energy demand and shares by energy under the BAU, in 1990, 2010, and 2035.

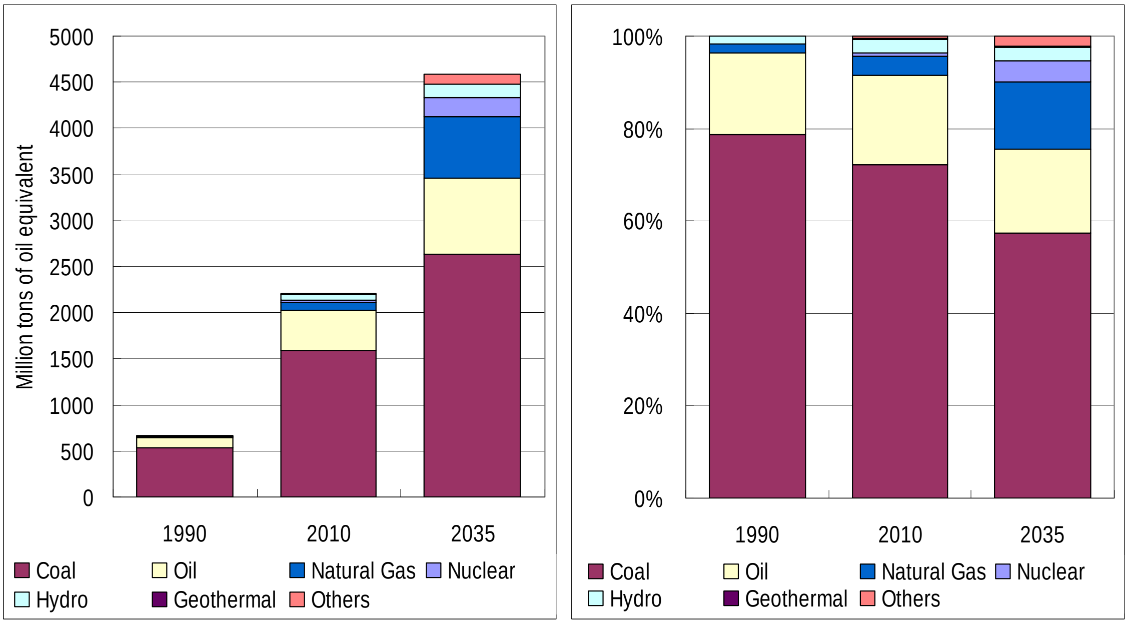
Figure 5-2: Final Energy Demand by Energy, BAU



Primary Energy Demand

It is expected that growth in primary energy demand will be slightly slower than final energy demand because of improved efficiency in the energy transformation sector. China's net primary energy supply is projected to increase at an annual average rate of 3.0 percent per year to 4585 Mtoe in 2035. Coal will still constitute the largest share of primary demand, but its growth is expected to be slower, increasing by just 2.0 percent per year. Consequently, the share of coal in total primary energy requirements is projected to decline from 72.1 percent in 2010 to 57.4 percent in 2035.

Figure 5-3: Primary Energy Demand, BAU



Nuclear energy is projected to exhibit the fastest growth between 2010 and 2035, increasing at an annual average rate of 10.1 percent, followed by natural gas at 8.4 percent. The share of natural gas is projected to increase from 4 percent in 2010 to 14.4 percent in 2035 whereas the share of nuclear will increase from 0.9 percent to 4.6 percent. Oil and hydro are projected to grow at lower rates of 2.7 and 3.3 percent per year, respectively. The share of oil is projected to decline from 19.5 percent in 2010 to 18.1 percent in 2035, while hydro's share is projected to increase from 2.8 percent in 2010 to 3.0 percent in 2035. Figure 5-3 shows China's net primary energy supply and shares by energy under BAU in 1990, 2010, and 2035.

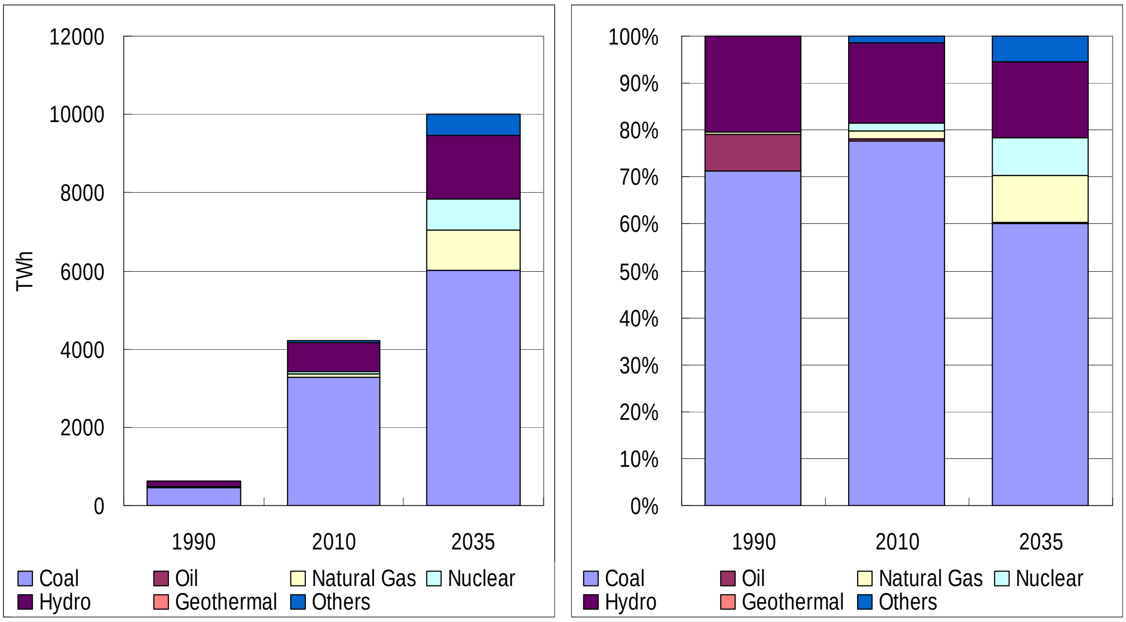
Power Generation

Power generation in China is projected to grow at a slower pace between 2010 and 2035 than in the last two decades. In the BAU scenario, power generation in China is projected to grow at 3.5 percent per year from 4208 TWh in 2010 to 10,009 TWh in 2035 (Figure 5-4).

The share of coal–fired generation under the BAU is projected to decline from 77.8 percent in 2010 to 60.1 percent in 2035. Conversely, the share of natural gas and nuclear generation are projected to grow from 1.6 percent and 1.8 percent in

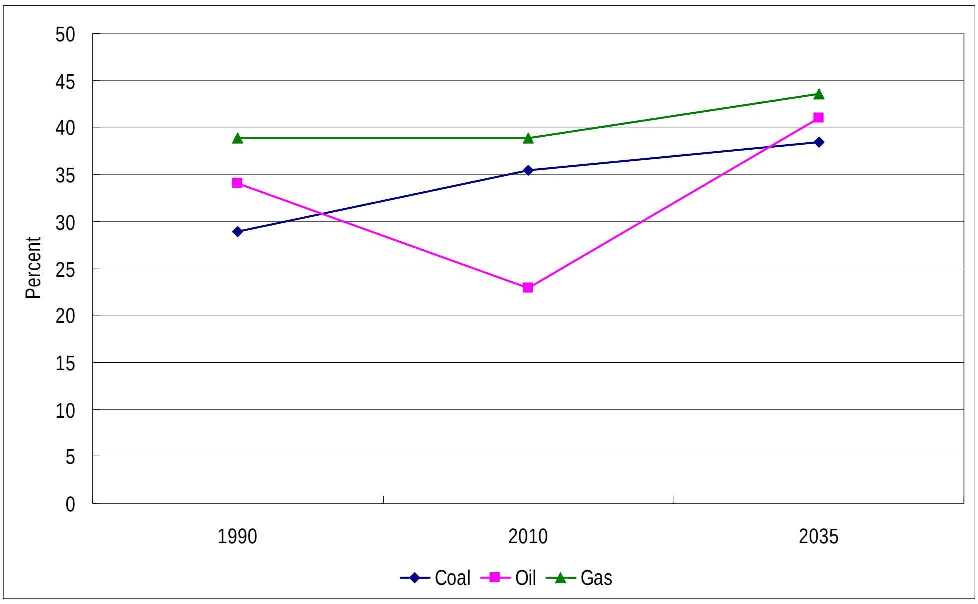
2010 to 10.1 percent and 8.1 percent in 2035 respectively. The shares of oil and hydro are projected to decrease slightly. In addition, other methods of power generation are projected to play an increasing role. The fast development of photovoltaic power generation in China is a typical example reflecting China's growing clean power generation focus.

Figure 5-4: Power Generation, BAU



China's thermal efficiency by fuel under BAU is projected to increase between 2010 and 2035 (Figure 5-5).

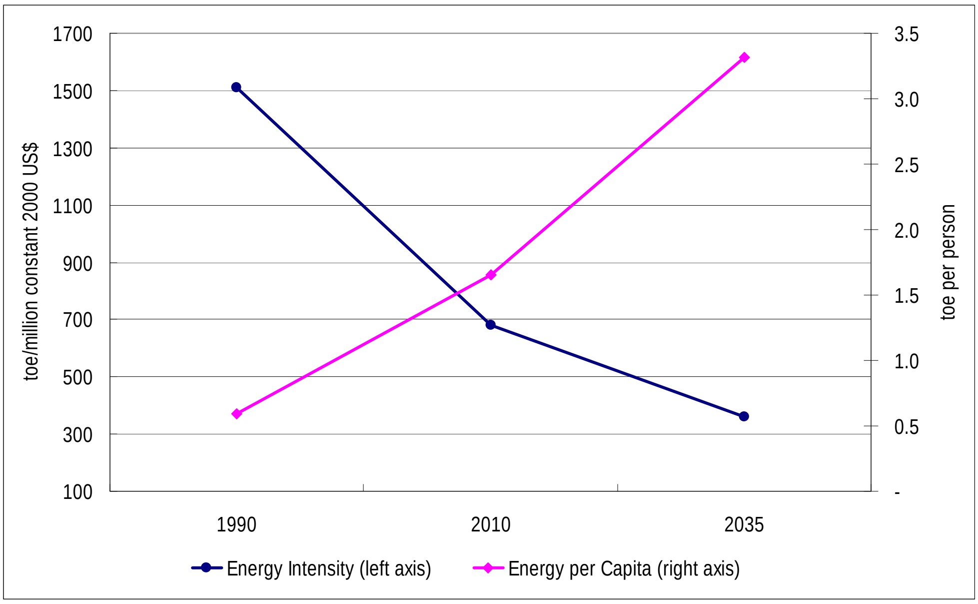
Figure 5-5: Thermal Efficiency by Fuel, BAU



Energy Intensity

Based on the expected economic and population outlook and the projected energy requirements of China, energy intensity defined as TPES/GDP and TPES per capita are illustrated in Figure 5-6. From 1990 to 2010, China's energy intensity experienced a sharp drop through national efforts on energy efficiency and conservation. By 2035, the energy intensity in China is projected to further drop to around 360 TOE per million (in 2000 US$ terms) under the BAU. With the improvement of living standards in China, energy per capita in China is projected to reach 3.32 TOE per person in 2035. Energy elasticity under the BAU, defined as Energy Growth/GDP Growth, is projected to be 0.53 in the future two decades, lower than last two decades 0.59.

Figure 5-6: Energy Intensity and Energy Consumption per capita, BAU

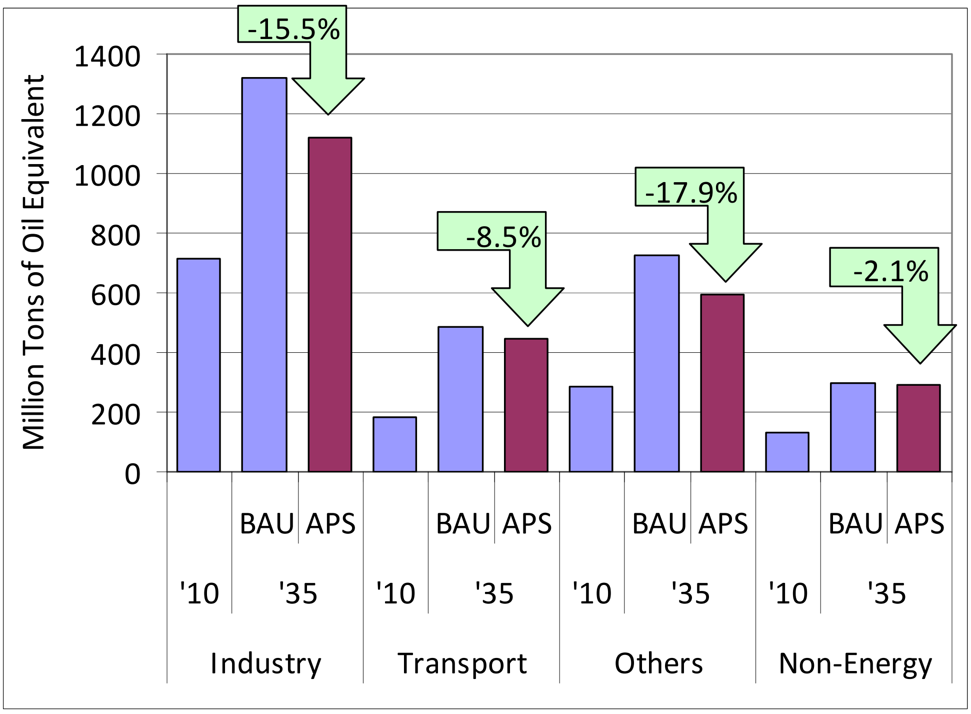


3.2. Energy Saving and CO_2 Reduction Potential

Final Energy Demand

Under the Alternative Policy Scenario (APS), final energy demand is projected to increase at a slower 2.5 percent per year, from 1313 Mtoe in 2010 to 2447 Mtoe in 2035, as a result of China's energy efficiency and conservation programs. An improvement in end-use technologies and the introduction of energy management systems is expected to contribute to slower energy growth in all sectors, particularly in the commercial/ residential and industry sectors. Figure 5-7 shows the difference in final energy demand in China in 2010 and 2035 under the BAU and the APS.

Figure 5-7: Final Energy Demand, BAU and APS



Power Generation

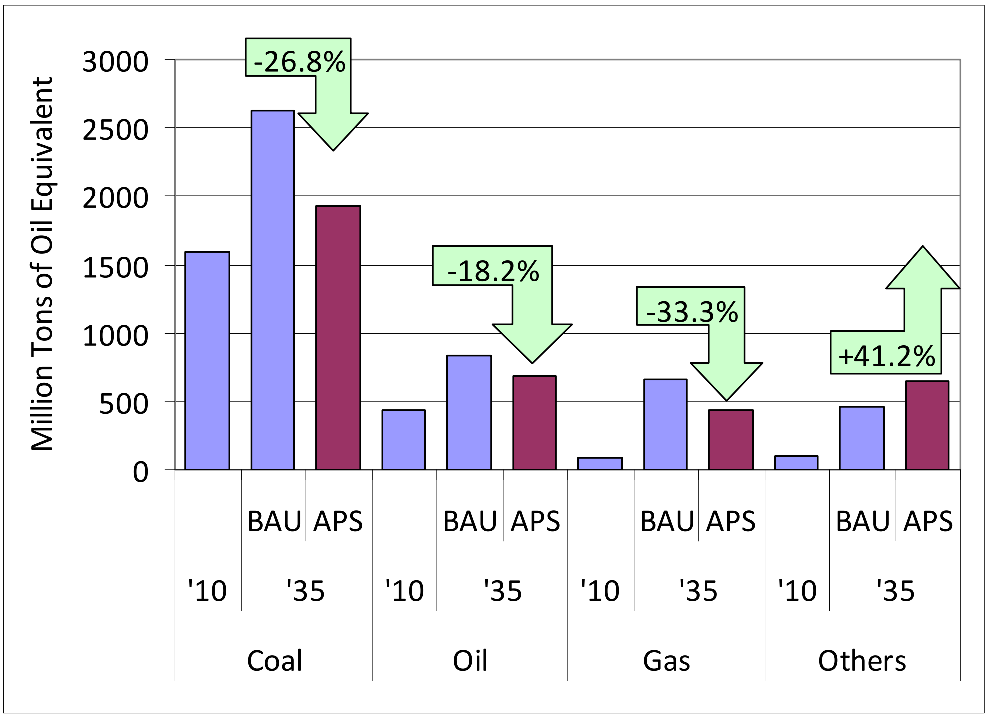
Under the APS, total power generation will increase by 2.6 percent per year between 2010 and 2035, to reach 8031 TWh. While fossil fuel-fired power generation will grow at a slower rate in the APS than in the BAU, the non-fossil fuel power generation will be faster. In 2035, nuclear power, hydro power, geothermal power, and "others" are projected to increase under the APS respectively by 11.7 percent, 4.1 percent, 10.4 percent, 12.2 percent between 2010 and 2035.

Primary Energy Demand

Under the APS, primary energy demand is also projected to increase at a slower 2.1 percent per year between 2010 and 2035, with primary energy demand reaching 3699 Mtoe in 2035. Coal is projected to increase by 0.8 percent per year, oil by 1.8 percent per year and natural gas by 6.6 percent per year.

Reflecting the change in power generation sector inputs, the annual average growth rate for nuclear will be higher than under the BAU, increasing by 11.7 percent per year between 2010 and 2035. The growth rate of hydro in the APS is expected also to be higher than the BAU, increasing by 4.1 percent per year (Figure 5-8).

Figure 5-8: Net Primary Energy Demand by Source, BAU and APS

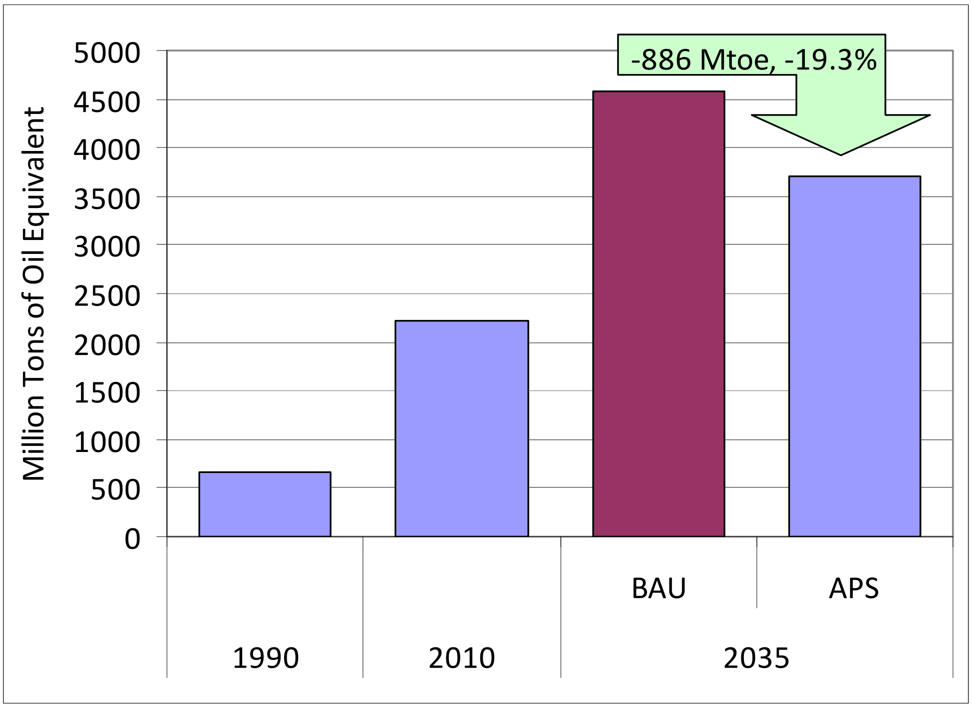


Projected Energy Savings

It is estimated that the implementation of energy efficiency and conservation goals and action plans in China could reduce net primary energy requirements in 2035 by about 886 Mtoe under the APS, relative to the BAU scenario. In the APS, China's primary energy demand is around 19 percent lower than the BAU (Figure 5-9).

In terms of energy savings in the final energy demand sectors in 2035, there are estimated savings of 204 Mtoe in the industry sector, 42 Mtoe in the transport sector, and 130 Mtoe in the residential/commercial sector under the APS, relative to the BAU scenario.

Figure 5-9: Total Net Primary Energy Supply, BAU and APS

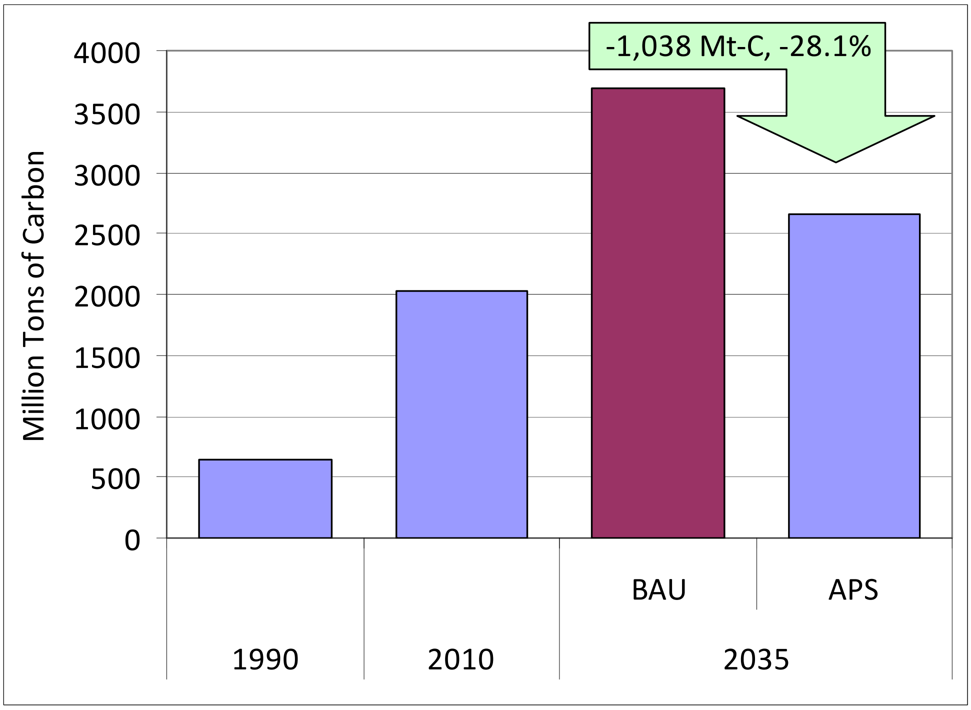


CO_2 Emissions from Energy Consumption

Under the BAU scenario, CO_2 emissions from energy consumption are projected to increase by 2.4 percent per year from 2025 Mt-C in 2010 to 3693 Mt-C in 2035. This growth rate in CO_2 emissions is lower than the growth in primary energy demand (3.1 percent) over the same period, indicating an improvement in the emissions intensity of the Chinese economy.

Under the APS, the annual increase in CO_2 emissions between 2010 and 2035 is projected to be 1.1 percent. This rate is also lower than the average annual growth rate in primary energy demand (2.1 percent) over the same period. The difference between the APS and the BAU CO_2 emissions growth rates indicates that the energy saving goals and action plans of China are effective in reducing CO_2 emissions (Figure 5-10).

Figure 5-10: CO_2 Emissions from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

As the world's largest developing country, it is paramount for China to remove poverty and improve life quality. China is in a fast growth phase and its urbanization rate is relatively low. Consequently, China will maintain its fast GDP growth, and its energy demand and CO_2 emissions will continue their fast growth, albeit at a slower pace compared to the last 20 years. It will be critical that China continue its focus on energy efficiency policy and programs, and that it continues to achieve the successes of the last three decades. While China's energy demand and CO_2 emissions will increase in the future, the energy intensity (energy demand per GDP) and CO_2 emission intensity (CO_2 emission per GDP) will decline with the implementation of sound energy efficiency and non-fossil fuel technology policies. Based on the APS of this analysis, China could reduce its total primary energy requirements by more than one-sixth and its CO_2 emissions by more than one-fourth by 2035.

There is a further great potential for energy saving in China, with around 50 percent of this achievable through structural change of the economy from a focus on heavy to lighter manufacturing industries and to development of China's services industry. It is urgent to lengthen the life cycle of China's buildings and infrastructure: current short life cycles and the need for rapid turnover results in excessive production of energy intensive products such as steel and cement.

The closure of small inefficient power plants, coal mines, and small energy-intensive industries like cement and steel plants has been essential in improving China's industry structure to date. In the longer term, energy efficiency in the residential, commercial and transport sectors will be increasingly important in addressing energy saving given China's booming real estate market and automobile market in recent years. In addition, the market uptake of non-fossil and renewable energy technologies is vital for a future environmental friendly energy market structure.

The Government should formulate and put in place, as soon as possible, market-based measures to motivate enterprises and consumers to take action. This would include energy pricing reform such as removal of the current energy subsidies and the establishment of energy taxes, and the establishment of a carbon tax.

As a more immediate action, China should draw on international experience to develop and implement Minimum Energy Performance Standards (MEPS) and energy efficiency labelling to ensure that industry and consumers are able to invest in high efficiency technologies and appliances.

CHAPTER 6

INDIA COUNTRY REPORT

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1. Background

India is located in South Asia and has a land area of 2973 thousand square kilometers. It had a population of around 850 million in 1990 which grew at an average annual rate of 1.6 percent per year to reach 1171 million in 2010. India's GDP increased at an average annual rate of 6.6 percent from US$275 billion in 1990 to US$996 billion (2000 constant price) in 2010. The services sector and the industry sector are the largest contributors to India's GDP.

1.1. Energy Situation

India's total primary energy consumption was 524 Mtoe in 2010. In 2010, coal represented the largest share of primary energy at 55.0 percent, followed by oil at 31.0 percent. Coal is mainly consumed for power generation and by industry. The remaining shares were: natural gas (10.1 percent), hydro (1.9 percent), nuclear (1.3 percent) and others (0.7 percent). Compared with 1990, the share of coal and oil decreased marginally. Conversely, the share of natural gas increased.

India generated almost 960 TWh of electricity in 2010. The average annual growth in electricity generation between 1990 and 2010 was almost as high as growth in GDP. The share of generation from coal in 2010 amounted to 68.0 percent, natural gas 12.3 percent, hydro 11.9 percent, oil 2.8 percent, nuclear 2.7 percent and others (wind, solar PV and other renewable energy sources) 2.3 percent.

India's final energy demand grew by 4.6 percent per year from 118.2 Mtoe in 1990 to 288.7 Mtoe in 2010. Between 1990 and 2010, the residential and commercial (others) sectors grew by 4.2 percent per year, the industry sector by 4.8 percent a year and the transport sector by 3.6 percent per year. Non-energy use[1] had the fastest growth, increasing by 6.1 percent a year.

Oil was the most consumed product with a share of 44.5 percent of total final energy demand in 1990, and a similar share in 2010. The share of coal declined from 35.4 percent in 1990 to 26.3 percent in 2010. The share of electricity increased from 15.4 percent in 1990 to 21.2 percent in 2010. Similarly, the share of natural gas increased from 4.8 percent in 1990 to 7.9 percent in 2010.

Primary energy consumption in India grew at a higher rate than the final energy demand, increasing by 5.4 percent per year from around 183.3 Mtoe in 1990 to 523.9 Mtoe in 2010. Among the major energy sources, the fastest growing were natural gas and nuclear energy. Natural gas grew at an average annual rate of 8.4 percent while nuclear grew by 7.5 percent per year. Coal, oil and hydro consumption increased but at slower annual average rates of 5.3 percent, 5.0 percent and 2.4 percent, respectively. "Others"[2] increased by 18.5 percent a year, but from a very small base - their collective share in total primary energy consumption was 0.7 percent in 2010.

2. Modelling Assumptions

India's GDP is assumed to grow at an average annual rate of 7.0 percent from 2010 to 2035 while population is assumed to increase by 1.0 percent a year.

With regards to future electricity supply, the share of electricity generation output from natural gas-fired and nuclear power plants are projected to increase to 2035 whereas the shares of coal, oil, hydro, and others are expected to decrease.

India's energy saving goals are expected to be attained through the implementation of energy efficiency programs in power generation and energy end-use sectors. For the industry sector, energy savings are expected from improvements

[1] Non-energy use refer to consumption of energy products for non-energy purposes such as feedstock to the petrochemical industry for the production of ethylene and lubricants in the transportation and industrial sector, etc.

[2] Others constitute wind, solar, solid and liquid biomass and other renewable energy sources as well as electricity imports or exports.

in highly energy-intensive industries and in inefficient small plants. In the residential and commercial sectors, efficient end-use technologies and energy management systems are assumed to induce significant savings. In the transport sector, efficiency improvements will be achieved through improved vehicle fuel economy and more effective traffic management.

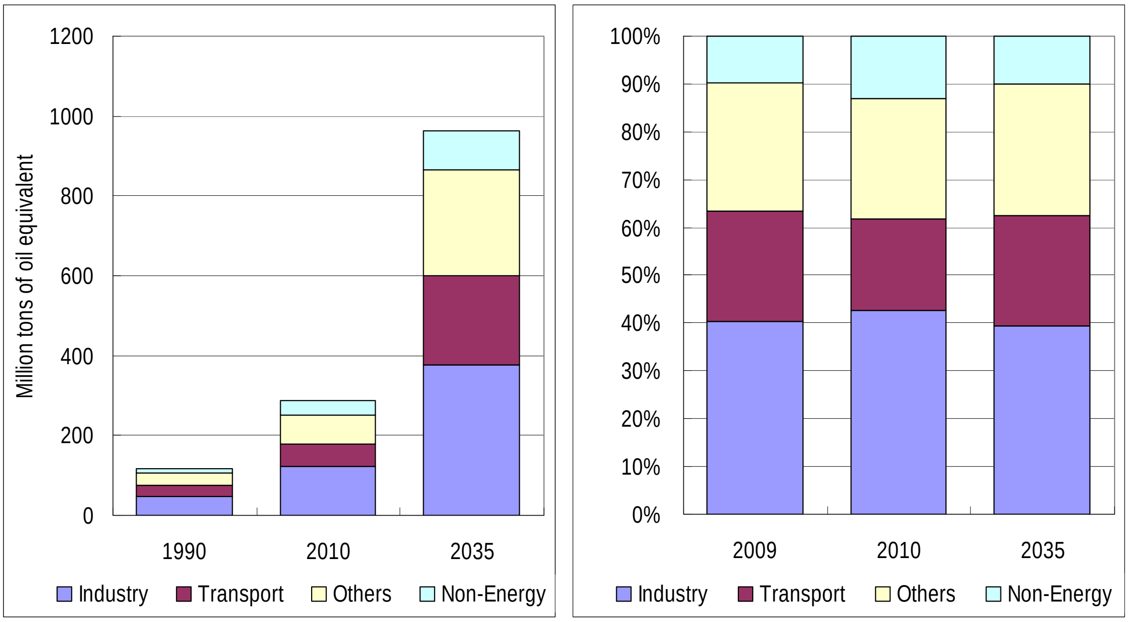
3. Outlook Results

3.1. Business as Usual (BAU) Scenario

Total Final Energy Consumption

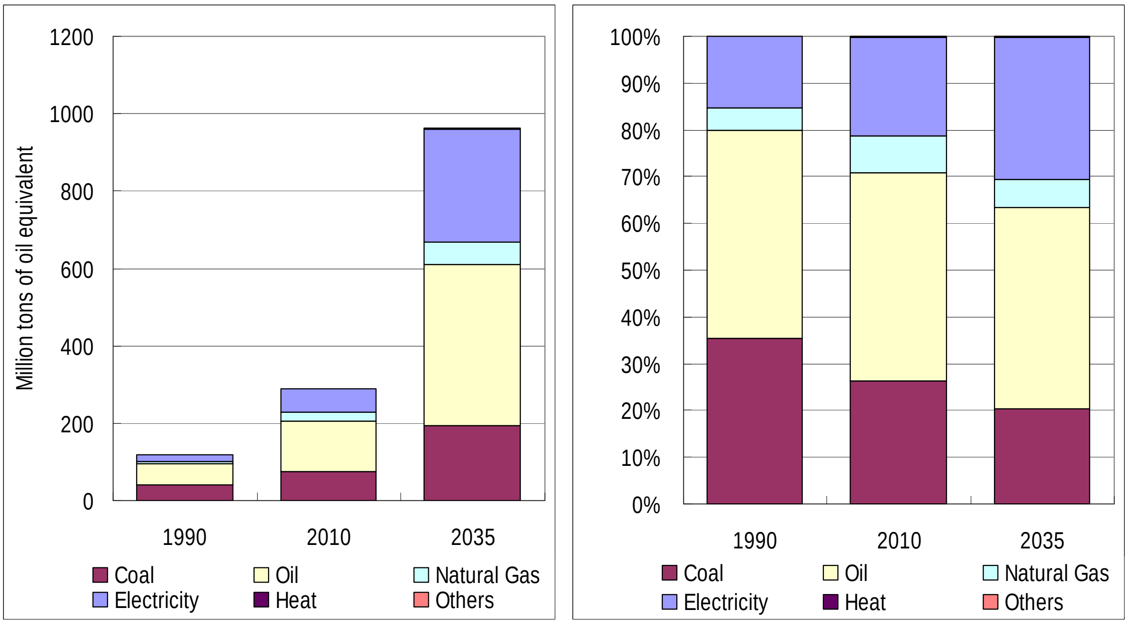
With assumed strong economic growth and a rising population, India's final energy demand is projected to increase at an average rate of 4.9 percent per year from 288.7 Mtoe in 2010 to 961.8 Mtoe in 2035 (Figure 6-1). The strongest growth is projected to occur in the transport sector, increasing at 5.7 percent a year between 2010 and 2035. Strong growth is also expected in the other (5.3 percent a year), industry sector (4.6 percent a year and non-energy consumption (3.8 percent a year).

Figure 6-1: Final Energy Demand and Shares by Sector



Electricity is projected to have the fastest growth, increasing by 6.5 percent per year over the period 2010-2035 (Figure 6-2). Oil is projected to increase at the second highest rate of 4.8 percent per year, followed by coal (3.8 percent a year) and natural gas (3.6 percent a year).

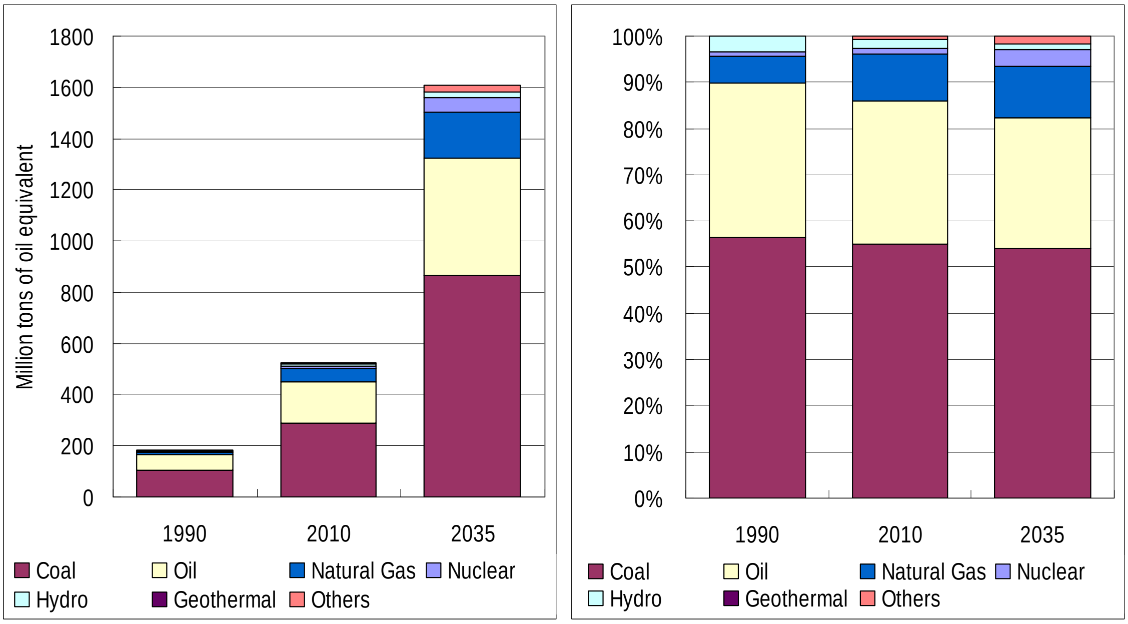
Figure 6-2: Final Energy Demand and Shares by Source



Primary Energy Demand

Under the BAU scenario, India's primary energy demand is projected to increase at an average annual rate of 4.6 percent to 1607.5 Mtoe in 2035. Nuclear energy is expected to grow the fastest at an average annual rate of 9.1 percent. Others, including solar and wind, is projected to increase by 7.9 percent a year through to 2035, but its share will remain small at 1.6 percent. Natural gas consumption is projected to increase by 4.9 percent per year between 2010 and 2035.

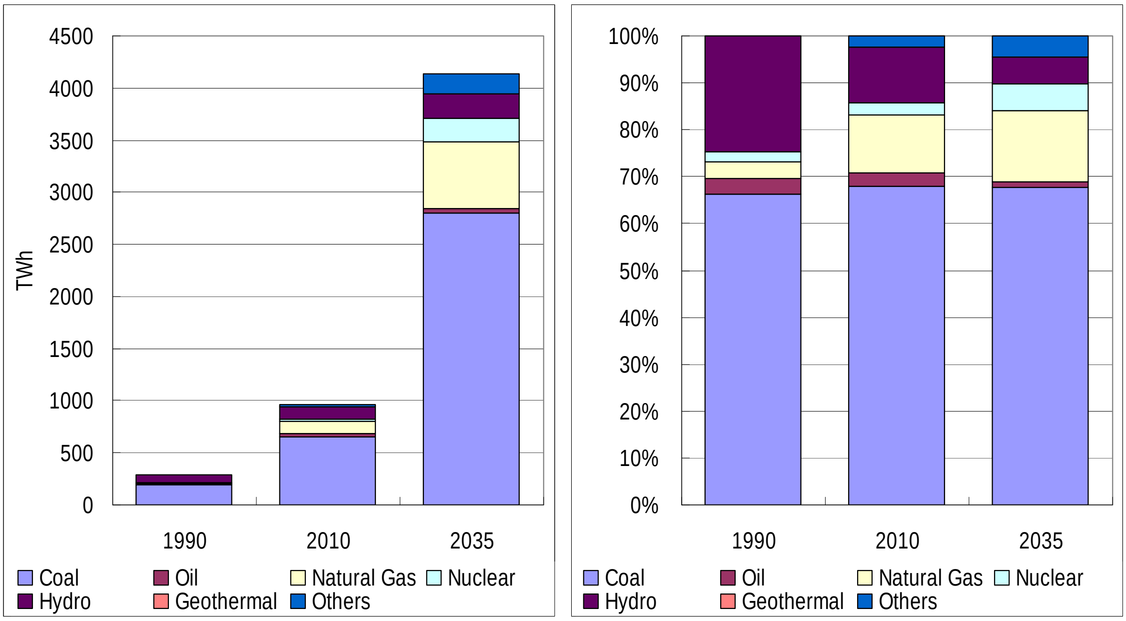
Figure 6-3: Primary Energy Demand by Source and Shares by Source



Power Generation

In 2010, power generation in India was 959.9 TWh. Under the BAU scenario, India's power generation is projected to increase at an annual rate of 6.0 percent per year to 4134.6 TWh in 2035. Coal will continue to dominate India's power mix, maintaining its share at above 65%. Hydro's share in India's power generation mix will decline from 11.9 percent in 2010 to 5.7 percent in 2035, and oil's share will decline from 2.8 percent in 2010 to 1.2 percent in 2035. In contrast, the share of natural gas-fired generation will increase from 12.3 percent to 15.3 percent, nuclear power will increase from 2.7 percent to 5.6 percent, and new energy will increase from 2.3 percent to 4.6 percent.

Figure 6-4: Power Generation, BAU



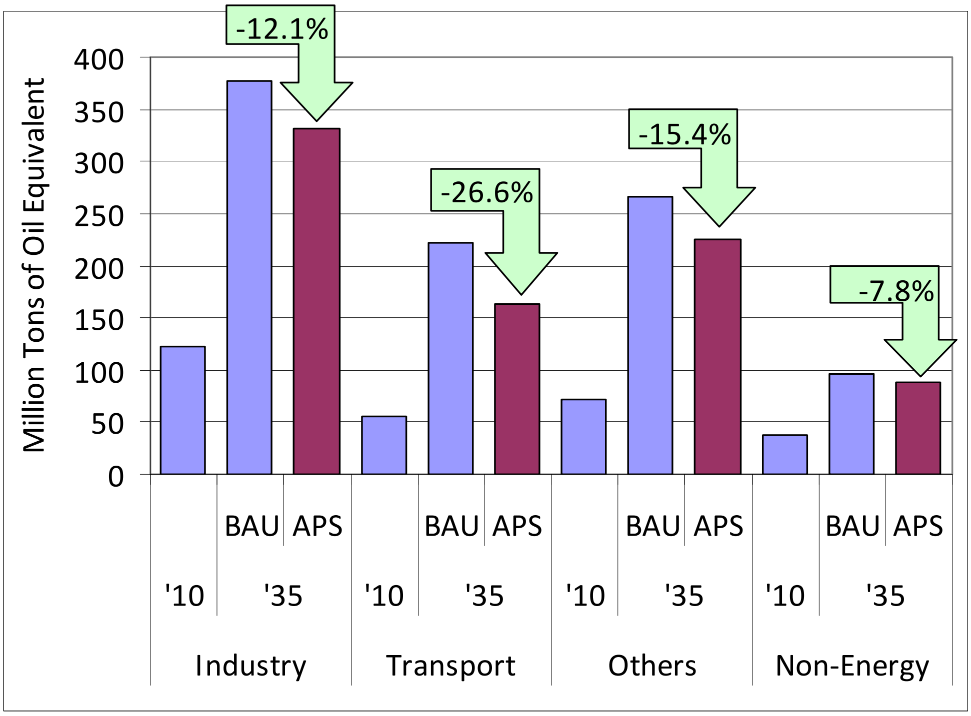
3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Final Energy Demand

Under the Alternative Policy Scenario (APS), final energy demand is projected to increase at a slower rate of 4.2 percent per year from 288.7 Mtoe in 2010 to 808.6 Mtoe in 2035. This is some 153 Mtoe or 15.9 percent lower than that under the BAU. The slower growth in demand is expected to occur across all end-use sectors, especially in the others (residential and commercial sectors) and transport sectors, reflecting improvements in end-use technologies and the introduction of energy management systems.

In 2035 under the APS relative to the BAU scenario, there is an estimated saving of 45.7 Mtoe (12.1 percent) in the industry sector, 59.2 Mtoe (26.6 percent) in the transport sector, and 40.8 Mtoe (15.4 percent) in the others sector.

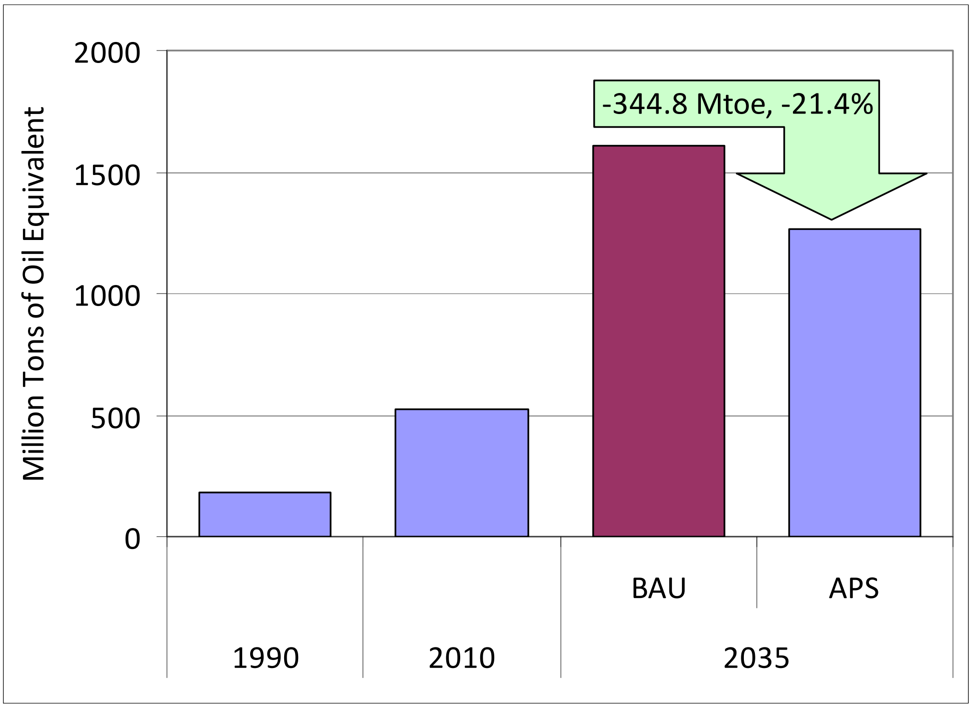
Figure 6-5: Final Energy Demand by Sector, BAU and APS



3.2.2. Primary Energy Demand

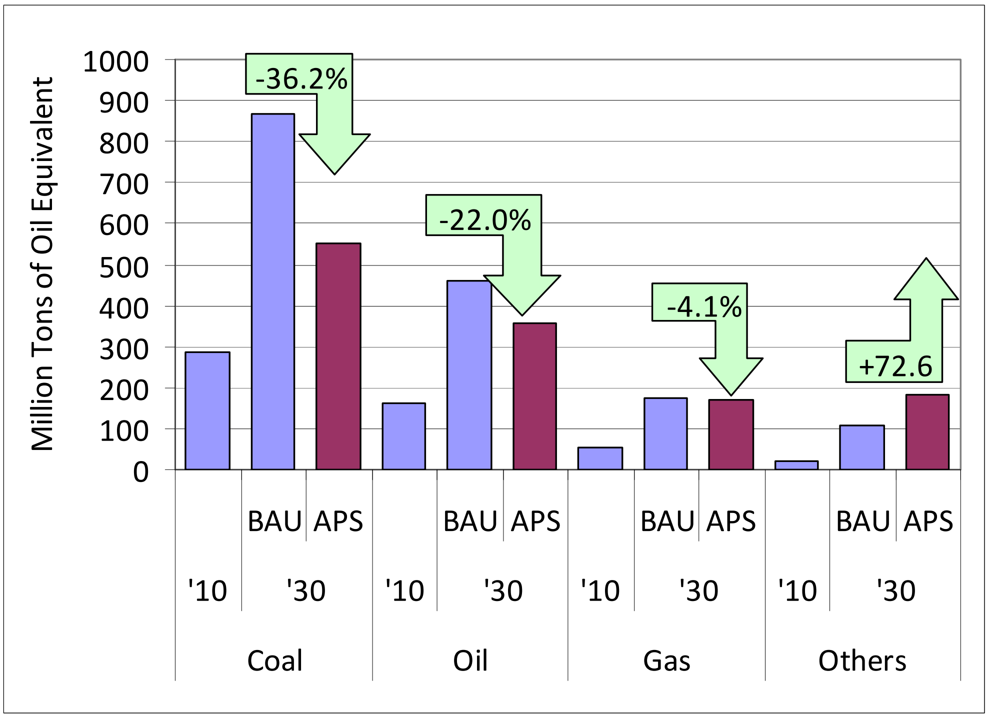
Under the APS relative to the BAU, India's primary energy demand is projected to increase at a slower rate of 3.6 percent per year to 1262.7 Mtoe in 2035. The difference between primary energy demand under the BAU scenario versus the APS in 2035 is 344.8 Mtoe (21.4 percent).

Figure 6-6: Net Primary Energy Supply, BAU and APS



In the APS, nuclear will be the fastest growing energy source, increasing at 12.0 percent per year, followed by natural gas at 4.8 percent per year. Oil, coal and hydro will grow at slower annual rates of 3.2 percent, 2.6 percent and 2.9 percent, respectively. Other energy will also make its mark in the primary energy mix, increasing by 10.6 percent a year. Consequently, its share will increase from 0.7 percent in 2010 to 3.8 percent in 2035.

Figure 6-7: Primary Energy Demand by Source, BAU and APS

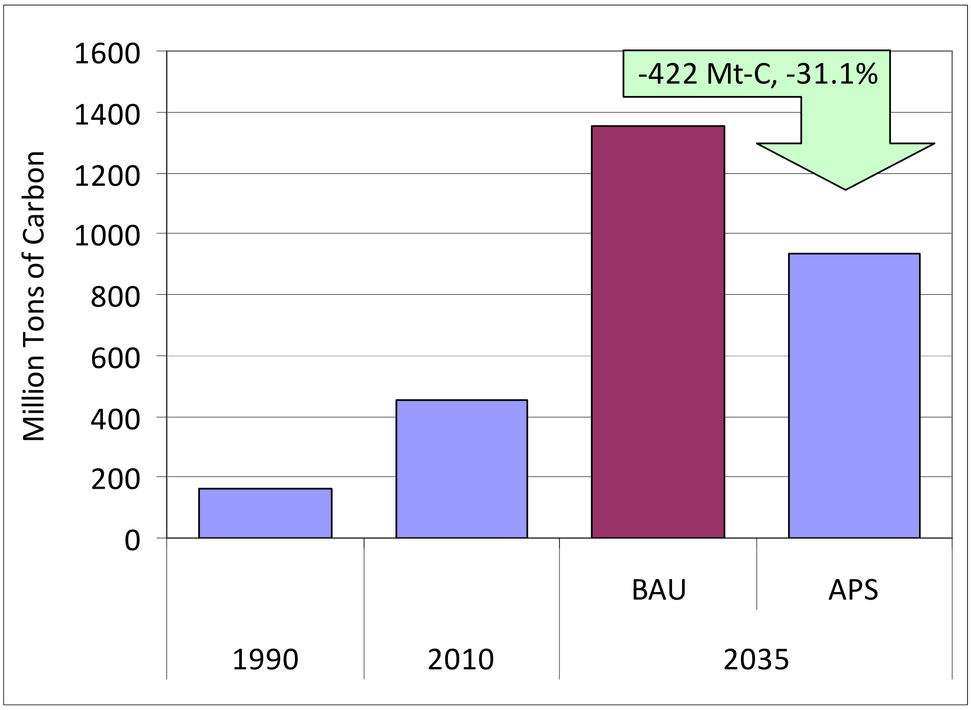


3.3. CO_2 Emissions from Energy Consumption

Under the BAU, CO_2 emissions from energy consumption are projected to increase by 4.5 percent per year from 451.9 Mt-C in 2010 to 1356.5 Mt-C in 2035. The projected growth in emissions is less than the projected growth in primary energy consumption reflecting the expected increased use of less carbon intensive energy sources in India.

In the APS, the annual increase in CO_2 emissions from 2010 to 2035 is projected to be 2.9 percent. The lower growth rate between the APS and the BAU scenario indicates that the energy saving goals and action plans of India are effective in reducing CO_2 emissions.

Figure 6-8: CO_2 Emissions from Energy Combustion, BAU and APS



4. Implications

- Energy security and access to energy are key challenges to India. Enhanced domestic production of energy is necessary.
- Hydrocarbons, particularly coal and oil will continue to dominate the energy mix in both BAU and APS. Use of domestic coal for secure supply as well as more efficient coal technologies such as IGCC, USC, etc. would be necessary. In long and medium-terms, R&D on cleaner energy development will play a key role.
- Energy efficiency and demand side management are important.
    - Industry will account for 38% of the incremental energy use to 2035; energy efficiency programs should be focused in this sector. Broadening the scope of PAT (Perform, Achieve, Trade) scheme will be important way in achieving this.
    - There are huge potential savings in the power sector. Advance technologies for power generation should be used

    - Curtail growth in energy consumption in the transport sector
    - Decrease distribution losses by using better technologies
- Rationalizing energy prices across fuels and sectors is necessary.

CHAPTER 7

Indonesia Country Report

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1. Background

Indonesia is the largest archipelagic state in Southeast Asia comprising of 17,504 islands scattered over both sides of the equator. The five largest islands are Java, Sumatra, Kalimantan (the Indonesian part of Borneo), New Guinea (shared with Papua New Guinea), and Sulawesi. The country shares land borders with Papua New Guinea, East Timor and Malaysia. Other neighbouring countries include Singapore, the Philippines, Australia, and the Indian territories of Andaman and Nicobar Islands.

Indonesia covers an area of 1,910,931 square kilometres and is the world's 16th largest country in terms of land area. The 2010 population census showed that Indonesia's population reached 237.6 million people, and it is still the world's fourth most populous country. Its average population density is 124 people per square kilometer. The population has continued to increase, reaching 241 million people in 2011, resulting in a population density of 126 people per square kilometer. By end of 2012, the population reached almost 250 million people.

Economic growth in Indonesia in 2011 was the fastest since before the Asian financial crisis as rising investment and domestic spending countered a slowdown in export demand due to Europe's debt crisis. Real GDP grew at almost 6.5 percent in 2011 after a revised 6.2 percent gain the previous year (2010). In 2011, Indonesia's real GDP was US$ 292 billion (constant 2000 US$) and reached. For 2012, the real GDP of the country was 311 billion rupiah, increasing at an average ate of 6.2% per year..

From 1990, GDP has grown at an average rate of 4.7 percent per year to 2010. GDP per capita in 2010 was around US$1200 dollars while in 1990 it was only US$600.

Indonesia is richly endowed with natural resources. It was previously an OPEC member, but the increasing demand for oil products had made the country became a net importer of oil. Indonesian crude oil proven reserves were 11.6 billion barrels in 1980, declining to 9 billion barrels by 1988. Since then, Indonesia's oil reserves continued to decline reaching 5.4 billion barrels in 1990 and 4.2 billion barrels in 2009. As of January 2013, proven crude oil reserves are estimated at around 3.5 billion barrels.

Indonesia is the world's largest liquefied natural gas (LNG) exporter. Its natural gas proven reserves were 2.9 trillion cubic meters (TCM) in 1990, these declined slightly in 2005 to 2.5 TCM. Proven reserves increased to 3.2 TCM (around 110 trillion cubic feet) in 2010. Indonesia is also a coal exporter with proven coal reserves of around 5.5 billion tons at the end of 2010.

In addition to fossil energy resources, Indonesia's non-fossil energy resources include hydro, geothermal, biomass and other renewables such as solar and wind. For hydro, the estimated potential is around 75 GW while the estimated geothermal potential is more than 28 GW.

Indonesia's total primary energy consumption was almost 159 Mtoe in 2010. Oil represented the largest share of primary energy consumption in 2010 at almost 46 percent, followed by natural gas at 25 percent and coal at 19 percent. The remaining share of about 10 percent represents hydro, geothermal and others.

Indonesia has around 34 GW of installed electricity generating capacity and generated almost 160.5 TWh of electricity in 2010. The state electricity company of Indonesia, PT PLN PERSERO, owns and operates generation plants with a combined capacity of about 26.5 GW in 2010 composed of: 75.0 percent oil, 6.0 percent coal, 3.7 percent gas, 13.7 percent hydro, and 1.6 percent geothermal. There are also wind and solar power plants but the capacity is still small.

2. Modelling Assumptions

Indonesia's GDP growth was 6.14 percent in 2010 because of high export demand for mining products and non-oil and gas products. In early 2013, the Indonesian Bureau of Statistics (BPS) announced that GDP growth will continue to increase and is expected to reach 6.7 percent in 2013, higher than 2012 which was recorded as 6.2 percent.

GDP growth is assumed to continue to be 6.7 percent per year until 2015. From 2015, the National Energy Council assumptions of 8 percent up to 2025 and 7.5 percent until 2035 have been applied. On the average, the assumed annual growth in Indonesia's GDP between 2009 and 2035 is around 7.5 percent.

Although the prediction of the GDP for Indonesia is around 7 to 7.5 percent per year, for the purpose of this study it was assumed that real GDP would grow slower at an average annual growth rate of 5.4 percent over the 2010 to 2035 period.

Population growth is assumed to increase at an average of 1.0 percent per year between 2010 and 2035. This is higher than the assumption used in previous study (0.9 percent per year) which was based on the assumptions of the National Energy Council.

With regards to future electricity supply, Indonesia will increase its usage of coal as part of the Government Crash Program for power generation. During the First Phase of the program an additional 10,000 megawatts (MW) of coal-fired electricity capacity will be built by 2014. In addition, the Government is also embarking on the Second Phase where additional capacities will be mainly coming from geothermal energy and other renewable energy sources. This is in line with the projected increasing share of renewable energy in the future electricity supply mix in response to the renewable portfolio standard (RPS).

Supply from gas-fired power plants is also expected to increase. However, improvements to gas supply infrastructure are required. In contrast, generation from oil-fired power plants is assumed to decline significantly. Last year's study assumed that nuclear will become part of the future electricity supply mix in Indonesia from 2018 onwards. This was deferred following the incident at the Fukushima nuclear power station in Japan in March 201. As a result of this deferral, nuclear power plants are only assumed to be available in the APS after 2020. In this regard, the study will include nuclear after 2020 with 2 units each with a capacity of 1000MW. The number of nuclear plants to be built by 2035 was limited to a maximum of 3 units with a total combined capacity of 3000MW.

For the energy efficiency scenario, the National Energy Council has yet to issue the National Energy Policy 2010-2050. In this regard, the national goal to achieve GDP energy elasticity of less than 1 by 2025 has been used as the energy saving target for this year's study. Like the previous study, specific energy saving targets by sector was assumed as shown in Table 7-1.

Table 7-1: Energy Conservation Potential to 2020

Sector	**Energy Conservation Potential (RIKEN) (%)**	**Energy Conservation Potential* (%)**	**Energy Conservation Potential** (%)**
Industry	15-30	31	20
Transportation	25	34	24
Residential/Commercial	10-30	34	16

Note: * Sectoral target submitted at ECTF in Myanmar in 2009. ** Sectoral target assumed for the study

3. Outlook Results

3.1 Business as Usual Scenario (BAU)

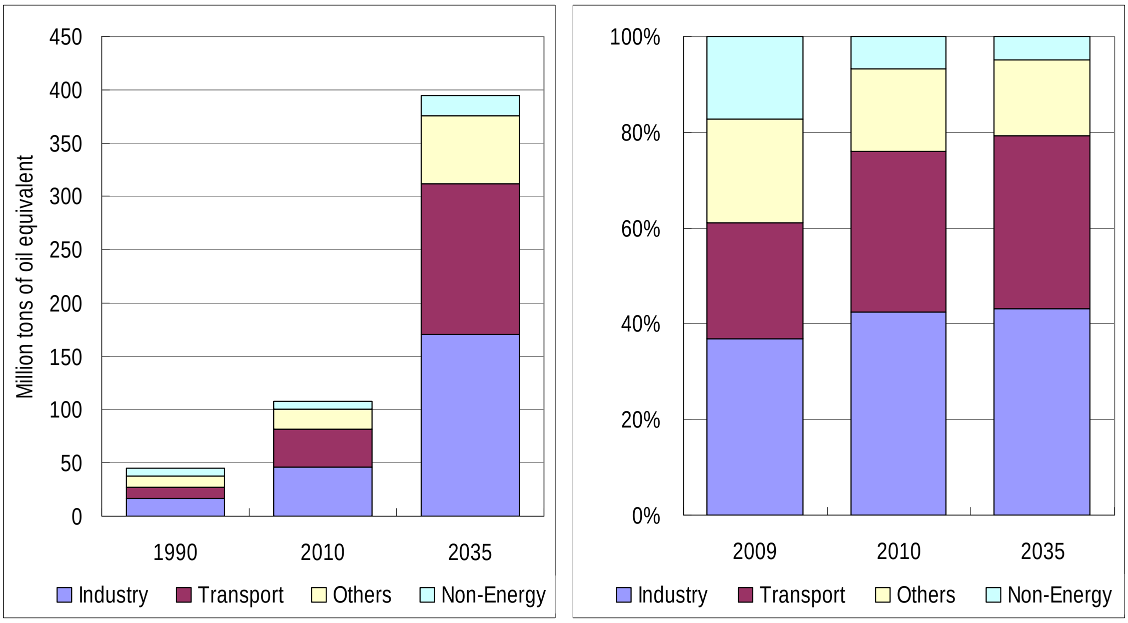
3.1.1. Final Energy Demand

Indonesia's final energy demand increased at an average annual rate of 4.4 percent between 1990 and 2010 period, increasing from 45 Mtoe to 108 Mtoe. Given the assumed economic and population growth, the growth in the final energy consumption will continue but at a faster rate of 5.3 percent per year between 2010 and 2035 in the BAU scenario.

This growth stems from the rapid increase of the energy consumed in the transportation sector, which is still heavily dependent on oil. In the past, the final energy demand of the transport sector grew at an average rate of 6.1 percent per year over the 1990-2010 period. In fact the transport sector experienced the highest growth as compared to the other sectors. It is expected that this growth will continue up to 2035, but at a slower rate of 5.6 percent per year for the BAU scenario.

Final energy consumption in the industrial and other sectors (mainly consisting of the residential and commercial), grew at an average rate of 5.2 percent and 3.3 percent per year, respectively over the 1990-2010 period. The final energy demand of these sectors for the period 2010-2035 are projected to increase more rapidly under the BAU scenario, at an average annual growth rate of 5.4 percent and 5.0 percent, respectively.

Figure 7-1: Final Energy Demand by Sector



The industrial sector had the highest share in the total final energy demand over the past decade (1990-2010). The share increased from 37 percent in 1990 to around 42 percent in 2010. For the future, the share of the industrial sector in the total final energy demand will increase to 43 percent in 2035. The rapid increase of the various alternative fuels demand will contribute to the increase of the sector's share in the total final energy demand mix.

The transport sector share in the total final energy demand had also increase from 22 percent in 1990 to 33 percent in 2010. This share will continue to increase, reaching 36 percent in 2035. The combined share of oil and alternative fuels for transport contributed more to the increase of the transport's share in the total final energy demand. Oil comprised majority of fuels in the transport sector while alternative fuels for transport grows rapidly at a rate of 6.6 percent for the period 2010-2035.

The remaining sectors share in the total final energy demand declined from 39 percent in 1990 to 24 percent in 2010. These sectors share are expected to continue declining to 21 percent by 2035 as a result of a slower growth in the total energy demand as compared to the industrial and transport sector.

By fuel type, coal experienced the fastest growth over the 1990-2010 period, at an average rate of 16.5 percent per year. This rapid growth of coal demand was due to its significant increase in the industrial sector, from 0.6 Mtoe in 1990 to almost 13 Mtoe in 2010. Electricity is also increasing significantly over the same period as industry expands and more households were electrified. Electrification rate has improved from 28 percent in 1990 to 66.5 percent in 2010. Total electricity demand increased from 2.3 Mtoe to 13 Mtoe, growing at an average rate of 8.9 per year.

As for natural gas and oil, the average annual growth of these fuels over the 1990-2010 period were similar at around 4 percent while other fuels demand (mostly biomass for industries and charcoal for households) remained the same, at around 6 Mtoe. In households, biomass is mainly used as a non-commercial fuel so not included in the current projection.

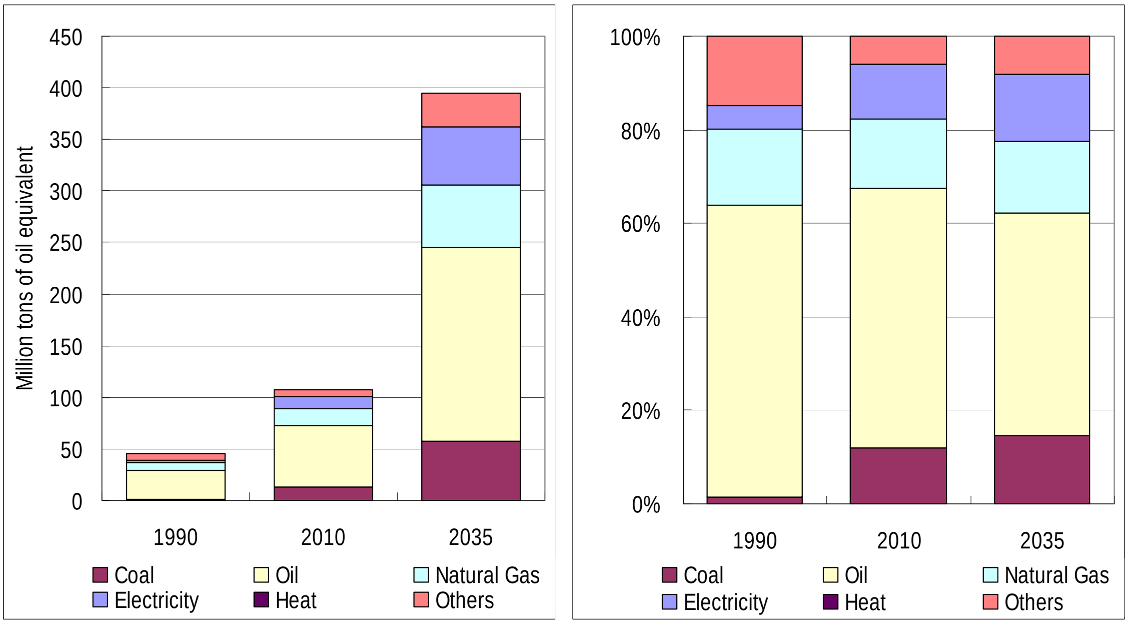
In the future, the demand of all fuels will continue to increase. For coal, the demand will increase at a much slower rate than the past. It is expected that coal demand will increase at an average rate of 6.2 percent per year, from 13 Mtoe in 2010 to around 58 Mtoe in 2035. Electricity is also expected to grow but at a slower rate than the past. The average annual growth rate for electricity demand is similar to that of coal, i.e 6.2 percent per year over the 2010-2035 period.

Natural gas and oil demand will grow at an average rate of 5.5 percent per year and 4.7 percent per year between 2010 and 2035. Other fuels demand will increase the fastest over the same period, at an average growth rate of 6.6 percent per annum. This is mainly due to the introduction of biofuels both in the transport sectors and the industries.

In terms of fuel, oil still plays a major role in the country’s final energy demand.

The relative importance of oil, however, has been declining with its share falling from 63 percent in 1990 to 56 percent in 2010. This decline in the share of oil in the total final energy demand is projected to continue as more alternatives fuels are being consumed by the end-use sectors. It is expected that this share will decline to around 47 percent in 2035.

Figure 7-2: Final Energy Demand by Fuel, BAU



3.1.2. Primary Energy Consumption

Primary energy consumption in Indonesia grew faster than the final energy demand at about 5.2 percent per year from 58 Mtoe in 1990 to 159 Mtoe in 2010. Among the major energy sources, the fastest growing fuels between 1990 and 2010 were coal and geothermal energy. Geothermal energy consumption grew at an average annual rate of 11.6 percent while coal grew at 10.8 percent a year. Oil consumption increased at a slower rate of 3.8 percent per year while natural gas consumption grew slightly faster at 3.9 percent per year. Despite the relatively slow growth in natural gas consumption, it still accounts for a relatively large proportion of primary energy consumption.

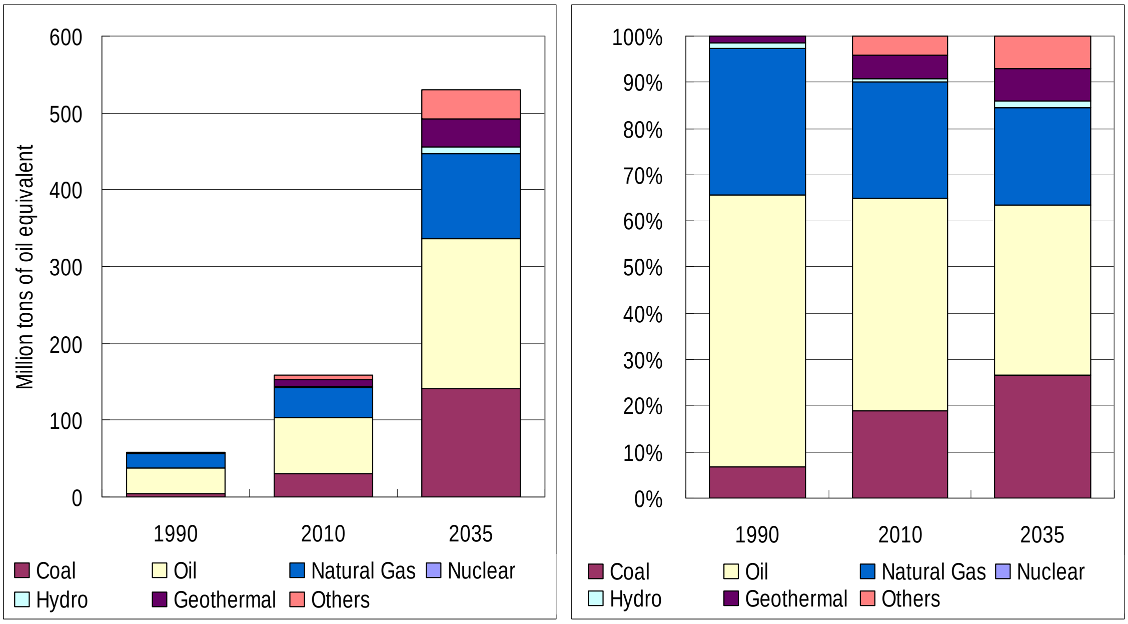
In the BAU scenario, Indonesia's primary energy consumption is projected to increase at an average annual rate of 5 percent reaching 530 Mtoe in 2035. Coal is projected to continue growing but at a slower rate of 6.4 percent per year over the projection period. Geothermal energy is also expected to increase over the projection period, but will be slower than the growth witnessed over the past two decades because of the difficulties expanding exploration in protected forest areas. In addition, exploration will also become more expensive as the areas to be explored become smaller and are increasingly located in difficult terrains such as those in the eastern part of Indonesia. The growth rate of geothermal energy consumption until 2035 is projected to be 6.3 percent per year.

Hydro, on the other hand, will increase at a faster rate of 6.8 percent per year between 2010 and 2035 compared with 1990-2010 periods. This is because more hydro plants will be built in the future such as in East Kalimantan. Consideration is being given to building more run-of river type hydro rather than reservoir type. The average annual growth rate of hydro will be 6.8 percent per year between 2010 and 2035.

Oil consumption is projected to increase at an average annual rate of 4.0 percent over the projection period. Natural gas consumption is expected to increase faster than oil at an average rate of 4.2 percent per year.

There is assumed to be no uptake of nuclear in the BAU scenario. Thus, other renewable energy will have a significant role in the future primary energy supply mix as the uptake of cleaner alternatives to oil increases. The rate of increase of other renewable resources such as solar, wind and biomass will be faster than the other fuels at an average annual rate of 7.4 percent

Figure 7-3: Primary Energy Consumption, BAU



Oil constituted the largest share of total primary energy consumption but declining from 59 percent in 1990 to 46 percent in 2010. The share of natural gas in the total mix also declined from 32 percent in 1990 to 25 percent in 2010. The declined in the shares of oil and gas indicated that its growth over the 1990-2010 period was slower than the other fuels.

Since both coal and geothermal experienced the rapid growth over the 1990-2010 period, its share in the total fuel mix has increased significantly. Coal shares in the total primary energy mix increased from around 7 percent to 19 percent while geothermal the shares increased from 1.5 percent to around 5 percent. Other renewables shares, except hydro, also increased from virtually zero in 1990 to 4 percent in 2010. Hydro's share remains slightly constant.

In the BAU scenario, oil's share will still be dominant throughout the 2010-2035 period and with a continously declining share. The share of oil in the total primary energy mix will be around 37 percent in 2035. Similarly, natural gas share will continue to decline over the projection period reaching 21 percent in 2035.

Hydro's share in the total primary energy mix will still be below 2 percent even though hydro grows faster than geothermal.

3.1.3. Power Generation

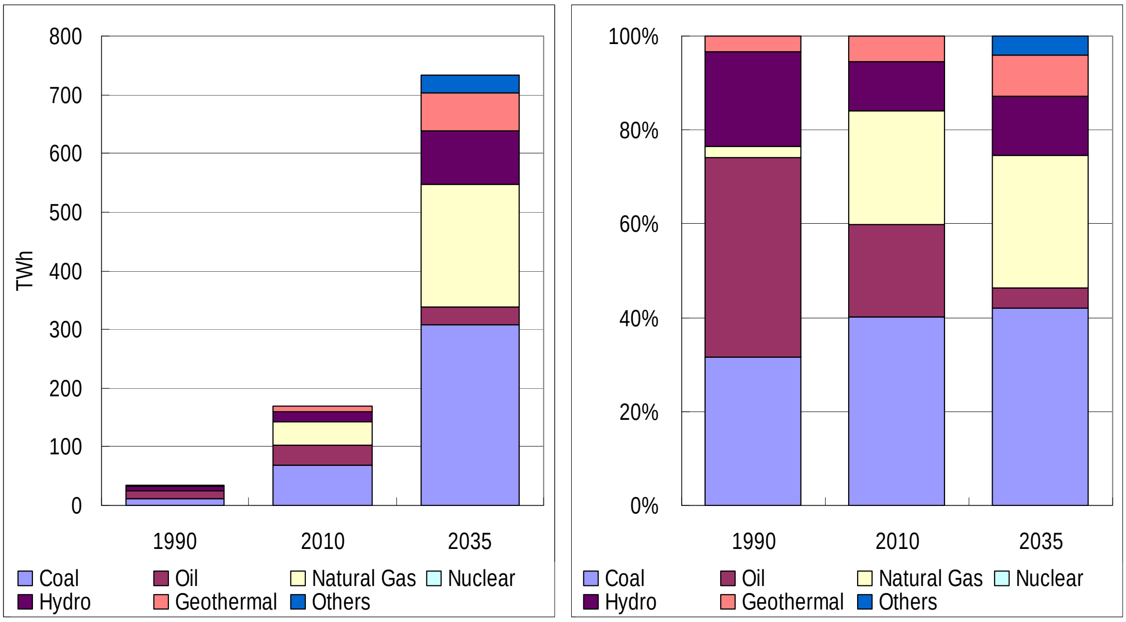
Power generation output increased at an average rate of 8.5 percent per year over the past two decades, from 33 TWh in 1990 to almost 170 TWh in 2010. The fastest growth occurred in the production of electricity from natural gas plants at almost 22 percent per year. This is due to the increase in gas turbine and combine cycle capacities as natural gas became increasingly available

In the BAU scenario, to meet the demand of electricity, power generation is projected to increase at a slower rate of 6 percent per year reaching 733 TWh in 2035. By type of fuel, generation from "Others" will have the fastest growth at an average rate of almost 26 percent per years. The main reason for this very rapid growth is that generation from these other sources was very small in 2010 but is expected to increase significantly as a result of the Government's policy to increase the use of new and renewable energy sources including solar PV, wind, oean energy, etc. which are classified as 'Others"

Generation from geothermal and hydro are also growing fast, but much slower than "Others", at 6.8 percent per year and 8 percent per year, respectively.

Power generation from natural gas will continue to increase but at a much slower rate of 6.7 percent per year while coal thermal power generation will be growing at an average annual rate of 6.2 percent. No nuclear plant is considered under the BAU scenario.

Figure 7-4: Power Generation by Type of Fuel (TWh)



The share of coal remains dominant in the total power generation of the country. The share of coal in total power generation increased from 31.5 percent in 1990 to 40.1 percent in 2010. It is expected under the BAU scenario, this share will continue to increase.2035, the share of coal in the total power generation will be 42 percent.

Oil had the largest share in power generation which was 42.6 percent in 1990. By 2010, the share of oil declined to 19.9 percent as natural gas production increased rapidly. Natural gas share in 2010 reached 24.1 percent and is expected to increase to 28.4 percent by 3035 under the BAU scenario,

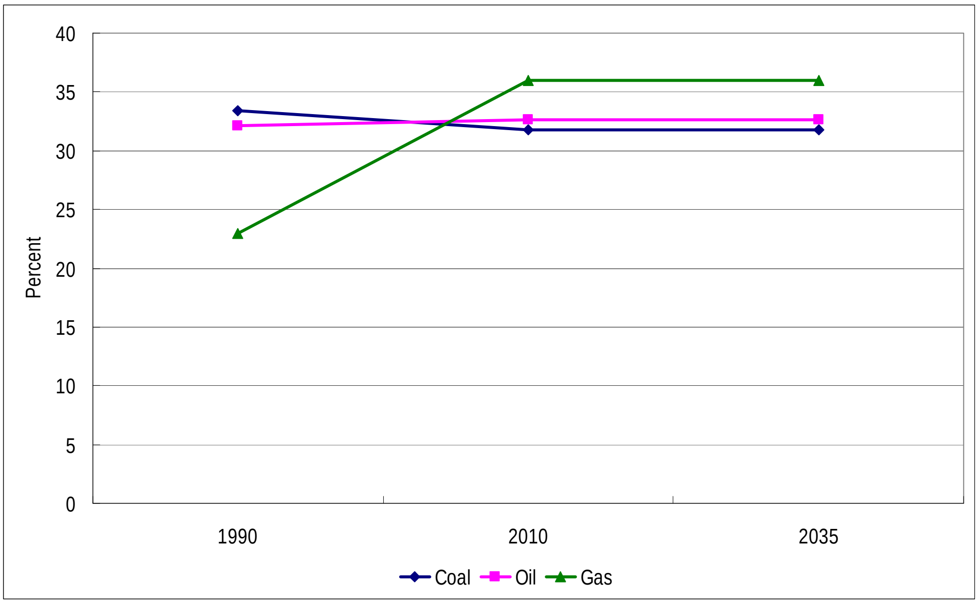
Hydro had also an important role in the total electricity production of the country. Its share in 1990 reached 20.1 percent. But in 2010, the share declined to 10.4 percent. It is expected under the BAU scenario, hydro share will experience slight growth to 12.5 percent in 2035.

Geothermal and other renewables share will constitute in total about 5.6 percent of the power generation.in 2010. It is expected that the role of these renewables will increase significantly in the future and thus, the share will increase to 12.2 in total by 2035.

The average thermal efficiency of fossil power plant was around 32.3 percent in 1990 and improved to 33.1 percent in 2010. In the BAU scenario, thermal efficiency of fosssil plants is expected to remain at around 33 percent in 2035.

By fuel, coal power plants thermal efficiency will be around 32 percent in 2035 while oil will remain at 33 percent and natural gas at 36 percent.

Figure 7-5: Thermal Efficiency, BAU

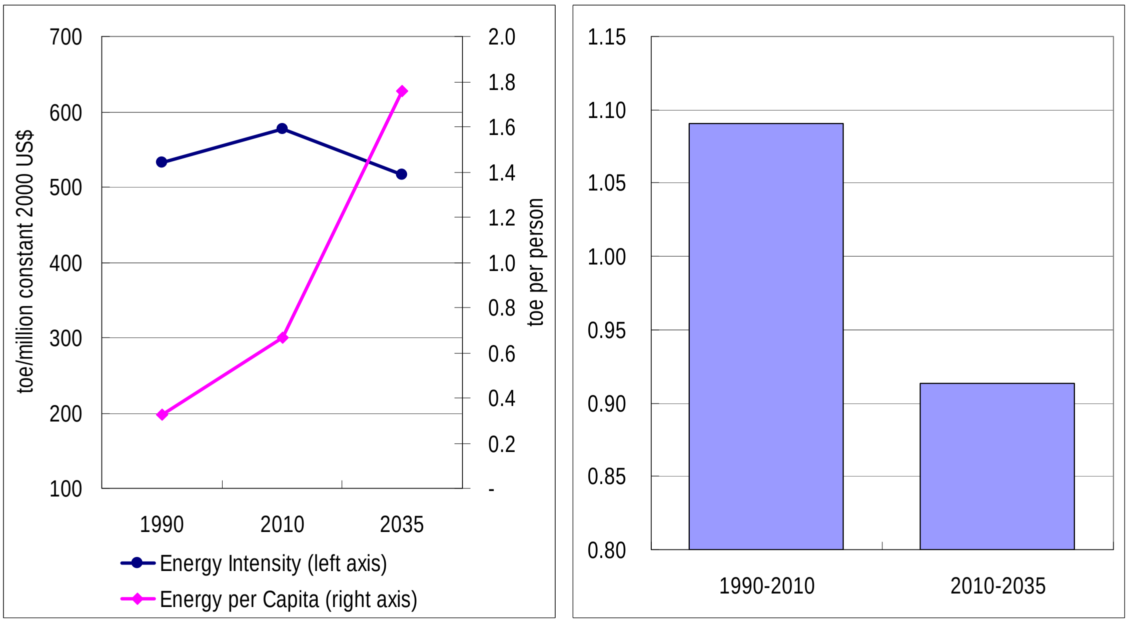


3.1.4. Energy Indicators

As a developing country, Indonesia's primary energy intensity (TPES/GDP) has been increasing until up to 2000. Since then, the intensity declined and reached a level of 577 toe/million 2000 USD in 2010. This is an indication that energy producers and consumers has started to effectively use energy through the implemetation of energy conservation measures and greater utilization of efficient energy technologies.

In the BAU scenario, the primary energy intensity is projected to decline at an average annual rate of 0.4 percent over the 2010 to 2035 period. The primary energy intensity of 2035 will be around 516 toe/million 2000 USD. Thus, the energy intensity ratio is expected to improve by almost 11 percent in 2035 as compared to 2010.

Figure 7-6: Energy Intensity and Energy per Capita



The per capita energy consumption, measured as the ratio of total primary energy consumption to the total population, has been increasing since 1990 from 0.33 to 0.67 in 2010. This level of energy consumption per capita is an indication that energy access of the society is still low which can be reflected by the ratio. The current electrification ratio is around 66.5 percent, indicating that there is still 33.5 percent of households in the country that have no access to electricity. The main reason is that there is a lack of energy infrastructure development particularly in the remote area and the outer islands due to the high investment cost.

Under the BAU scenario, the energy consumption per capita will continue to increase and will reach 1.76 toe per person in 2035. This result is in accordance with the existing national energy policy (2006) which targeted a level of 1.4 TOE in 2025.

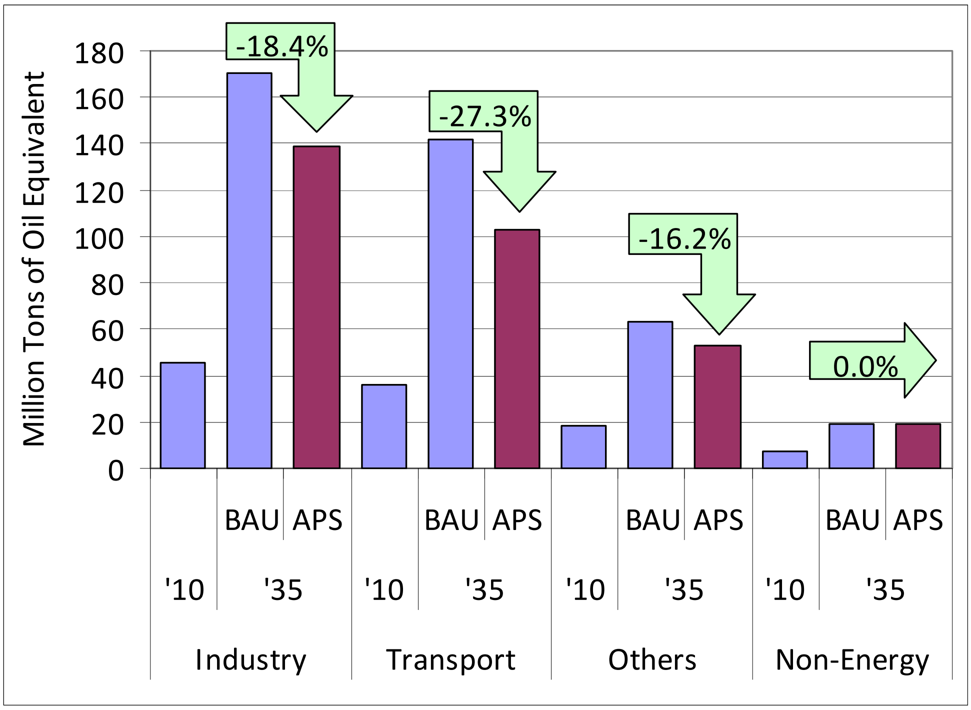
In the BAU scenario, the elasticity of final energy consumption is expected to continue declining and will reach 0.9 in 2035. Elasticity below 1.0 is an indicator that growth in final energy consumption will be slower than growth in GDP over the period 2010-2035.

3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Final Energy Demand

In the APS, final energy demand is projected to increase at a slower rate than in the BAU scenario, increasing at an average rate of 4.4 percent per year from 108 Mtoe in 2010 to 314 Mtoe in 2035. Slower growth under the APS, relative to the BAU scenario, is projected across all sectors as a result of the government program for energy efficiency and conservation, particularly in the transport sector. The growth rate of energy demand in the transport sector is projected to increase by 4.3 percent per year compared with 5.6 percent per year in the BAU. Figure 7-7 shows the final energy demand by sector in 2010 and 2035 in both the BAU and APS.

Figure 7-7: Final energy Demand by Sector, BAU and APS

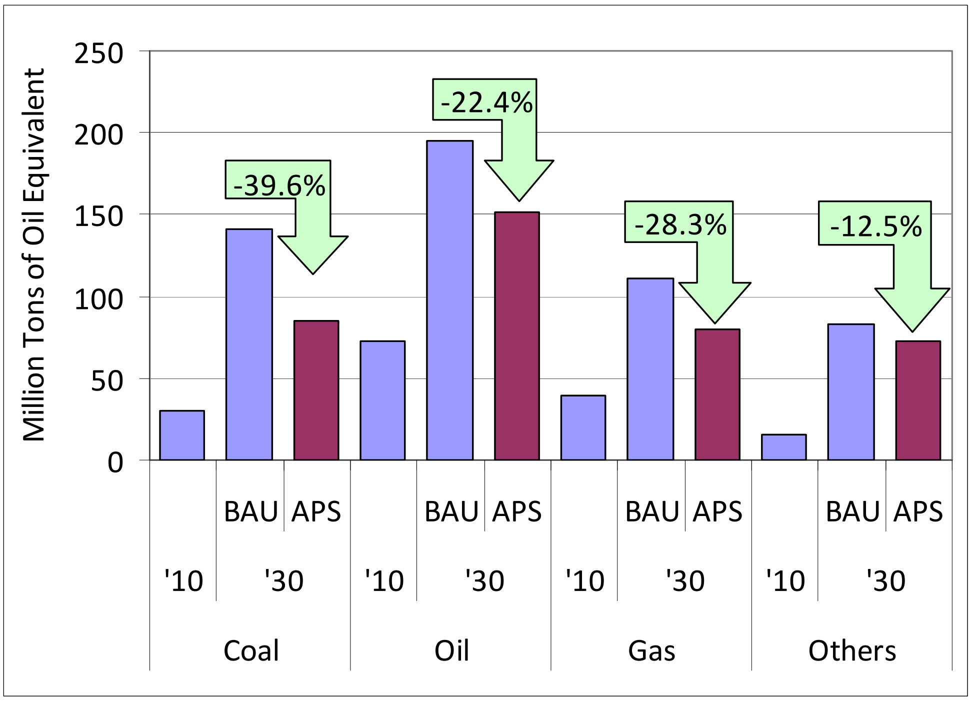


3.2.2. Primary Energy Consumption

In the APS, primary energy consumtion is projected to increase at a slower rate, relative to the BAU scenario, 3.7 percent per year to almost 390 Mtoe in 2035. All energy sources are projected to experience positive average annual growth rates. However, these will be slower than in the BAU scenario. The lower consumption relative to the BAU scenario reflects energy efficiency and conservation measures on the demand side.

In terms of final energy consumption savings, there is estimated to be a saving of almost 31 Mtoe in the industry sector, almost 40 Mtoe in the transport sector and around 10.2 Mtoe in the residential/commercial (other) sector by 2035 under the APS, relative to the BAU scenario.

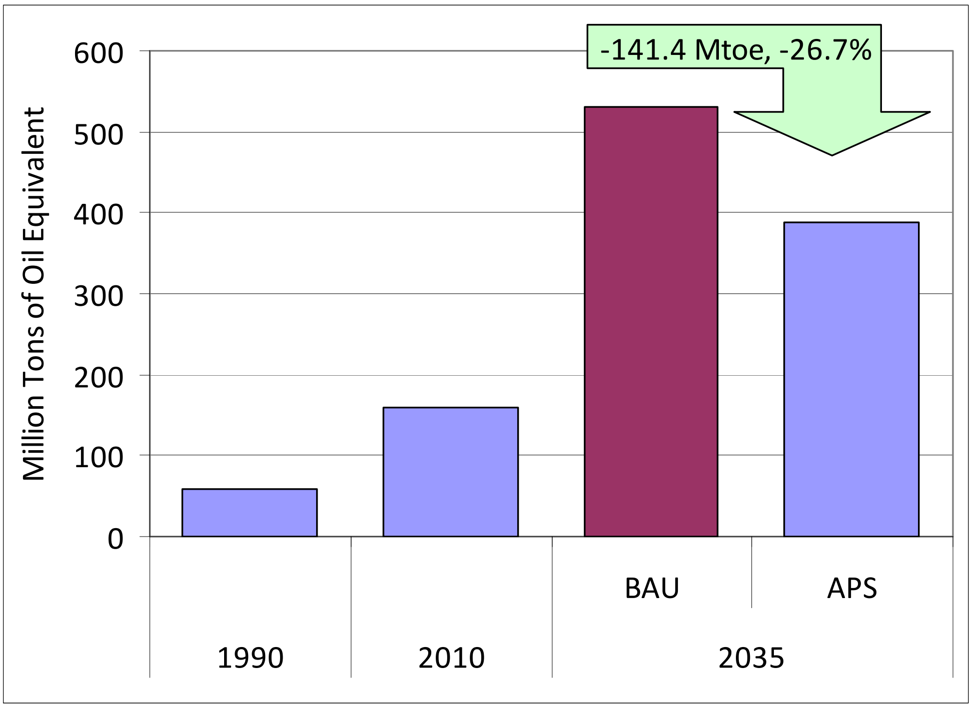
Figure 7-8: Primary Energy Demand by Source, BAU and APS



3.2.3. Projected Energy Savings

The energy savings (the difference between primary energy demand in the BAU scenario and the APS) that could be achieved through the energy efficiency and conservation goals and action plans of Indonesia are almost 141.4 Mtoe in 2035. This is lower than Indonesia's energy consumption in 2010 of around 159 Mtoe.

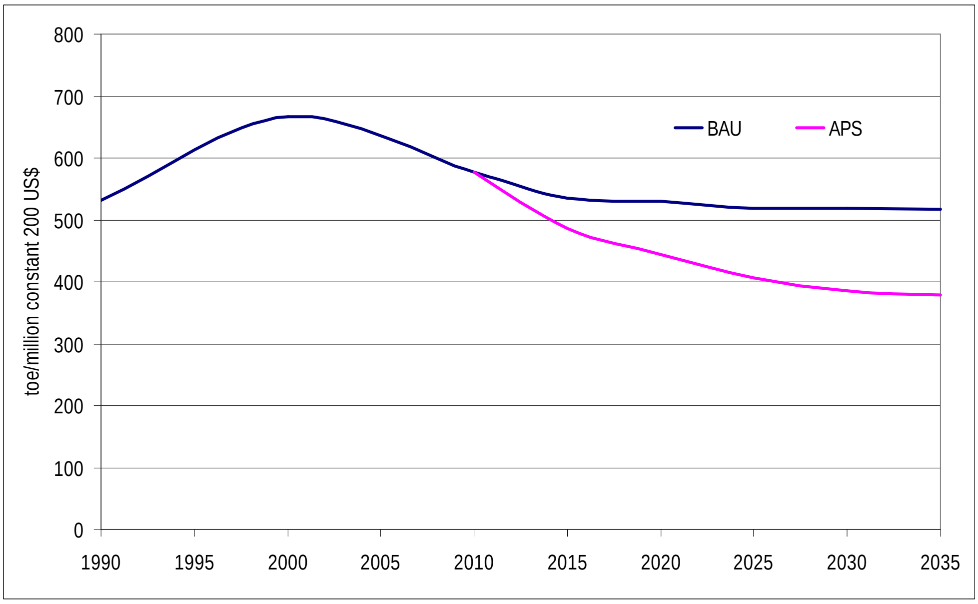
Figure 7-9: Total Primary Energy Demand, BAU and APS



3.2.4. Energy Intensities

Achieving the Government target of one percent per year reduction in energy intensity will require extensive implementation of the energy efficiency and conservation programs. Adaptation of the sectoral EEC targets under the Alternative Policy Scenario (APS) will result in a faster declining rate for the primary energy intensity; 1.8 percent per year over the projection period.

Figure 7-10: Energy Intensity, BAU and APS

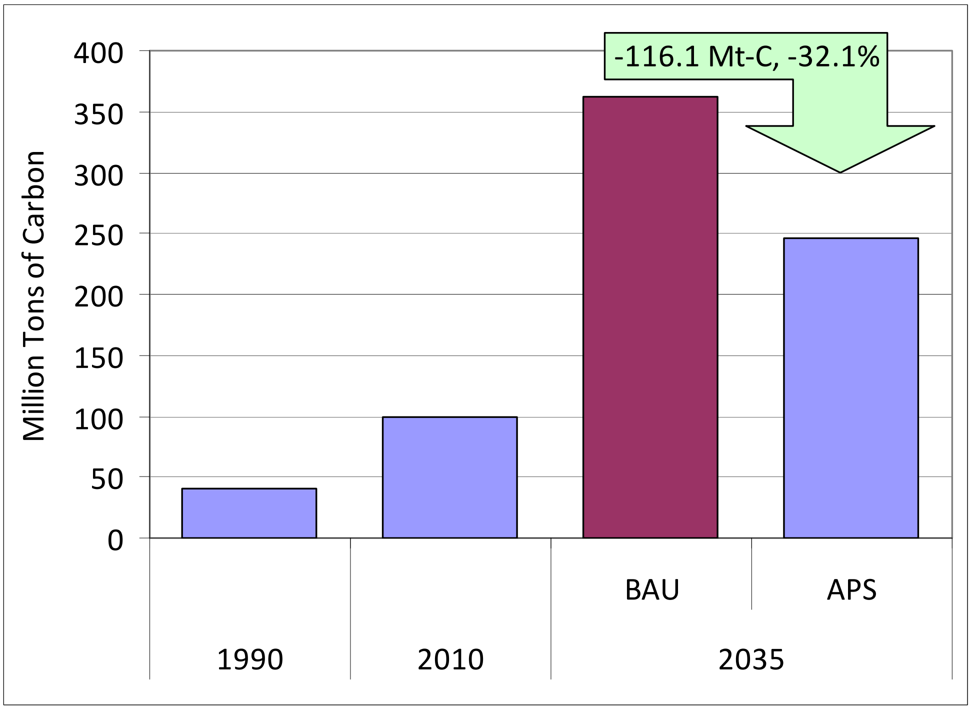


3.2.5. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase at an average annual rate of 5.3 percent from around 100 Mt-C in 2010 to 362 Mt-C in 2035 in the BAU scenario. This is driven by the increasing use of carbon intensive fuels, particularly the use of coal for power generation and industry, as well as oil in the transport sector.

In the APS, the annual average growth in CO_2 emissions from 2010 to 2035 is expected to be 32 percent lower than in the BAU scenario, increasing at 3.7 percent yearly. This lower growth rate is the result of an expected significant decline in coal consumption in the power sector in the APS, relative to the BAU scenario. The growth in emissions is projected to be slower than the growth in primary energy, indicating that the energy saving goals and action plans of Indonesia will be effective in reducing CO_2 emissions. The Government has committed to reduce CO_2 emissions in 2025 by 26 percent without international assistance and 41 percent with international assistance. This study result is above the committed target of 26 percent. Thus, more stringent energy saving and renewable targets need to be in place to achieve the committed CO_2 reduction targets of 41 percent.

Figure 7-11: CO_2 Emissions from Energy Combustion, BAU and APS



3. Implications and Policy Recommendations

Indonesia's primary energy intensity (TPES/GDP) has been declining since 2000 as a result of greater utilization of efficient energy technologies both by energy producers and consumers. Under the BAU scenario, the intensity declined lower than the target in the National Energy Policy of 2006 of one percent per year. Adapting the sectoral target under the APS will enable the country's projected target to decline even more at 1.8 percent per year. The elasticity of final energy consumption is also projected to decrease to below 1.0 only if the sectoral saving target is implemented fully as indicated in the APS scenario.

The primary energy consumption per capita is still below the neighboring countries like Thailand and Malaysia both under the BAU and APS scenario. Thus, there are still people without access to energy as indicated by the electrification ratio of 66.5 percent in 2010. Development of energy infrastructure particularly in the remote and small island areas will improve the electrification ratio, hence increase accesibility to energy.

The transport sector, which is the main consumer of oil in the country, will be crucial to achieving energy savings. The savings in oil consumption between the BAU scenario and the APS could reach around 27 percent in 2035 by introducing more efficient vehicles and boilers in the transport and industrial sectors, respectively. Developed countries in the region such as Japan and Australia should increase efforts to introduce newly improved technologies to developing countries as early as possible.

The APS scenario assumed implementation of programs for achieving the sectoral energy saving targets. In this regards, the follwoing measures will be necessary:

- Enhance policy to move away from subsidies, but with the option to assist low income households
- Improve policy on the use of alternative transport fuels to make it more implementable
- Better enforcement of regulations in the industry sector
- Expand labelling and performance standards on appliances in the residential sector
- Encourage private sector participation such as banking sector financing of energy efficiency projects energy

Pursuing energy efficiency and conservation programs is one of the measures to reduce CO_2 emission in order to achieve the committed target of 26 percent (without international support) and 41 percent (with international support). Increasing the share of renewable energy sources in the supply mix would enhance further reductions in CO_2 emissions.

Both the BAU and the APS scenario projected that renewable energy will play a major role in the country's energy mix. Efforts to enhance renewable energy has been undertaken by the Government such as inclusion of geothermal and hydro resources in the second crash program for the acceleration of the 10000 MW power development; domestc obligation (DMO) for biofuels, provision of Feed-in Tariff (FIT) for both geothermal and biomass power generation; finalization of the FIT for solar and wind energy sources, fiscal incentives to promote renewable energy development, etc. Nonetheless, further measures still need to be undertaken which can be attractive to increase private sector involvement such as improving the transparency and awareness of government support mechanisms; enhancing financial institution to participate in renewable energy projects, etc.

CHAPTER 8

Japan Country Report

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1. Background

Japan is a small island nation in Eastern Asia. It consists of several thousand islands spanning a land area of approximately 377,960 square kilometers and most of its land area is mountainous and thickly forested. Until 2010, it was the world's second largest economy after the United States with real gross domestic product (GDP) in 2010 of about US$ 5,029 billion (constant 2000 prices). In 2011, China surpassed Japan as the world's second-largest economy. Japan's population is currently about 127 million people with a per capita income of US$ 39,530 in 2010.

1.1. Energy Situation

Japan possesses limited indigenous energy resources and imports almost all of its crude oil, coal and natural gas requirements to sustain economic activity. Proven energy reserves included around 44 million barrels of oil (2010), 738 BCF of natural gas (2010), 350 Mt of coal (2011).

In 2010, Japan's net primary energy supply was 494.0 Mtoe. By energy type, oil represented the largest share at 41.1 percent, coal was second at 23.3 percent, followed by natural gas (17.4 percent), and nuclear energy (15.2 percent). Others, such as hydro, geothermal, wind and solar, represented the remainder of 3 percent. In 2010, net imports of energy accounted for about 82 percent of the net primary energy supply. With limited indigenous energy sources, Japan imported almost 99 percent of oil, 99 percent of coal, and 96 percent of gas.

Japan is large importer of coal: steam coal for power generation, pulp and paper, and cement production; and coking coal for steel production. Domestic demand for natural gas is met almost entirely by imports of LNG. Natural gas is mainly used for electricity generation, followed by reticulated city gas and industrial fuels. In 2010, primary natural gas supply was 86.0 Mtoe.

Japan’s final energy demand experienced a low growth of 0.4 percent per year from 300.1 Mtoe in 1990 to 324.6 Mtoe in 2010. The residential/commercial (other) sector had the highest growth rate during this period at 1.3 percent per year followed by the transport sector with 0.4 percent. Consumption in the industry sector decreased at a slow pace of 0.7 percent per year over the period 1990-2010. Oil was the most consumed product having a share of 61.3 percent in 1990, slightly decreasing to 52.8 percent in 2010. Electricity was the second most consumed product.

Japan’s primary energy demand grew at a faster rate than final energy demand at 0.6 percent per year from 436.6 Mtoe in 1990 to 494.0 Mtoe in 2010. Among the major energy sources, the large growing fuels were natural gas and coal. Natural gas consumption and coal consumption grew at an average annual rate of 3.4 percent and 2.0 percent respectively while nuclear energy grew at 1.8 percent over the period 1990-2010. Oil consumption declined by 1.0 percent per year over the same period.

Japan has 282 GW of installed electricity generating capacity and generated about 1,111 TWh of electricity in 2010. The generation amount by energy type is broken-down as: thermal (coal, natural gas and oil) at 64 percent, nuclear (26 percent), hydro (7 percent) and geothermal, solar and wind taking up the remainder of 3 percent.

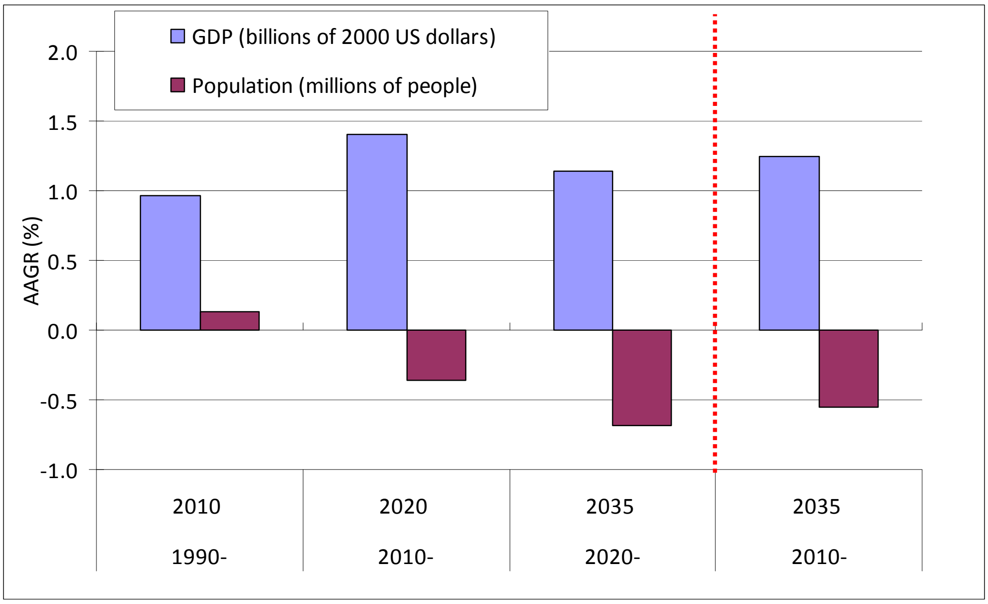
2. Modeling Assumptions

In this outlook, Japan's gross domestic product (GDP) is assumed to grow at an average annual rate of 1.2 percent from 2010 to 2035, and economic growth is projected to recover from economic recession. In 2013, Abenomics[1] is expected to increase GDP strongly. The industry structure, with the maturing of Japanese society and the Japan's economy, will become increasingly oriented toward services. Population growth, on the other hand, will decline by about 0.6 percent per year from 2010 to 2035 due to the declining birth rate. Japan's population is projected to decrease from 127 million in 2010 to 111 million in 2035.

The development of Japan's infrastructure and the expansion of its manufacturing industry will be saturated over the outlook period and production of crude steel, cement, and ethylene will gradually decline. The number of automobiles will decline with the decline in population.

[1] An economic program introduced by Prime Minister, Shinzo Abe upon his second term as Prime Minister of Japan in December 2012.

Figure 8-1: Growth rate of GDP and Population



Before the Great East Japan Earthquake, fourteen additional nuclear power plants were assumed to be constructed by 2030 and the capacity utilization rate was expected to grow through to 2035. However, it is now not clear as to how many nuclear power plants will be operating in 2035. The capacity of hydro power plants would be around 70 percent of the resource potential that would translate to an increase in capacity by 2035. Supply from oil fired power plants is projected to decrease, while natural gas power plant capacity is expected to increase to more than other fossil fuel power generation, due to natural gas high thermal efficiency and relatively small CO_2 emissions.

Figure 8-2: Power Generation, BAU

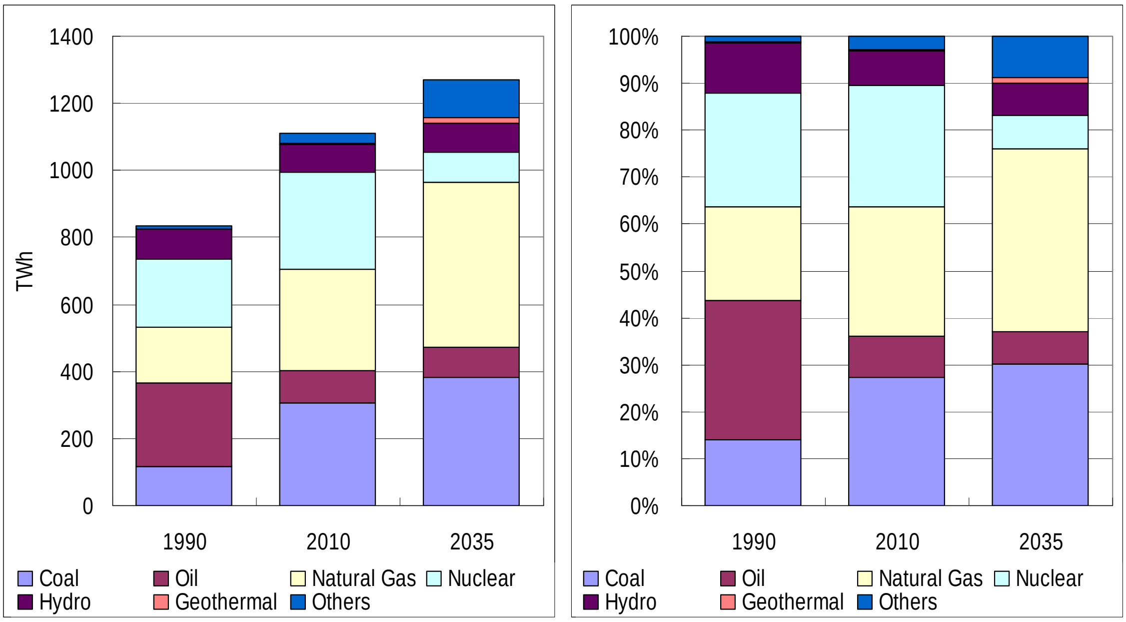
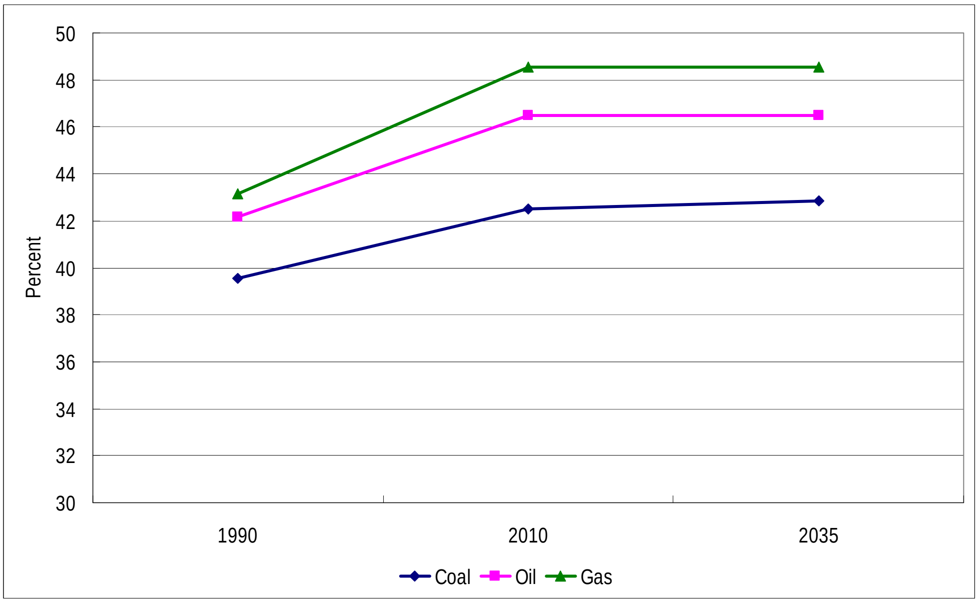


Figure 8-3: Thermal Efficiency, BAU



Japan's energy saving goals will be attained through the implementation of national energy efficiency programs in all energy consuming sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies. In the residential and commercial sectors, the 'Top Runner Program' is projected to induce huge savings in addition to programs on energy management systems, improvements in adiabatic efficiency, lighting systems, and heat pump systems. In the transport sector, efficiency improvements will be achieved from improvements in vehicle fuel efficiency, including increases in the stock of hybrid cars and structural changes in vehicles.

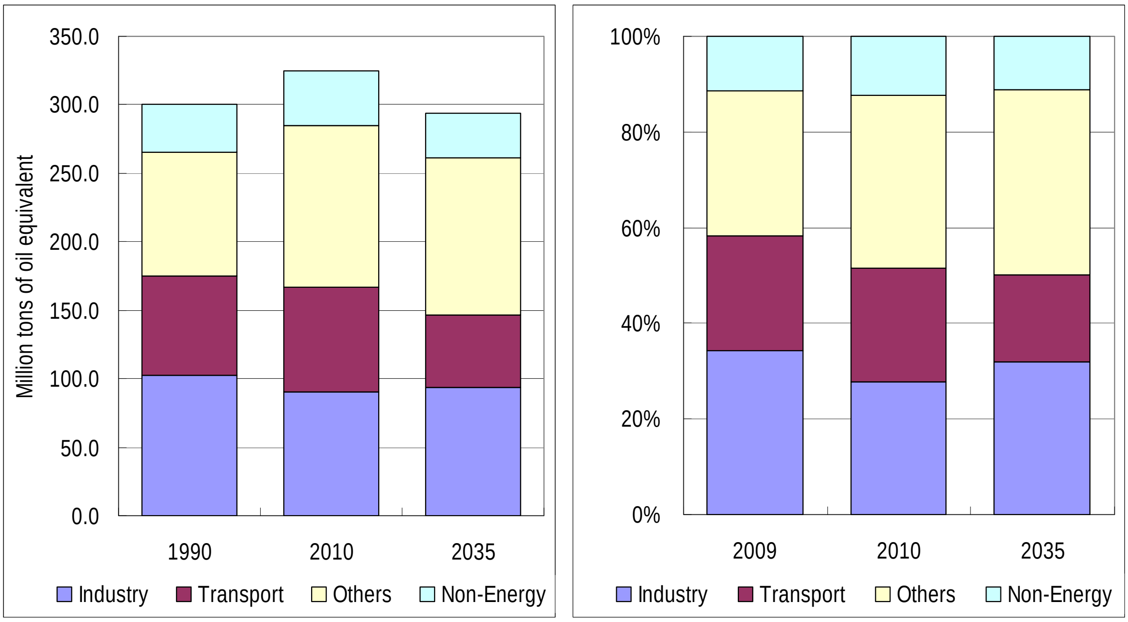
3. Outlook Results

3.1. Business as Usual Scenario (BAU)

3.1.1. Final Energy Demand

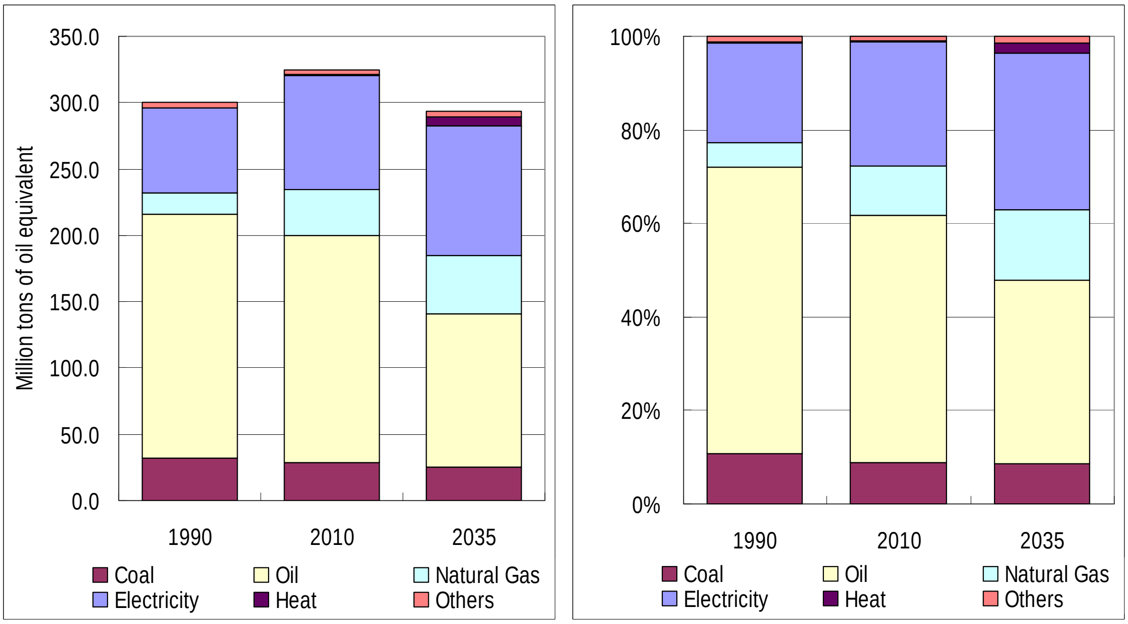
With the projected relatively low economic growth and the declining population, Japan's final energy demand from 2010 to 2035 is projected to decline at an average rate of 0.4 percent per year in the BAU scenario. This is also driven by the projected decline in the consumption of the transportation as well as residential and commercial (others) sectors brought about by improving energy efficiency. The final energy demand of the industrial sector is projected to increase at an average annual rate of 0.2 percent between 2010 and 2035.

Figure 8-4: Final Energy Demand by Sector



By fuel type, consumption of coal and oil is projected to decrease at an average annual rate of 0.5 and 1.6 percent respectively between 2010 and 2035. Consumption of natural gas and electricity are projected to increase, however, at a rate of 1.0 and 0.5 percent per year respectively over the period.

Figure 8-5: Final Energy Demand by Source, BAU

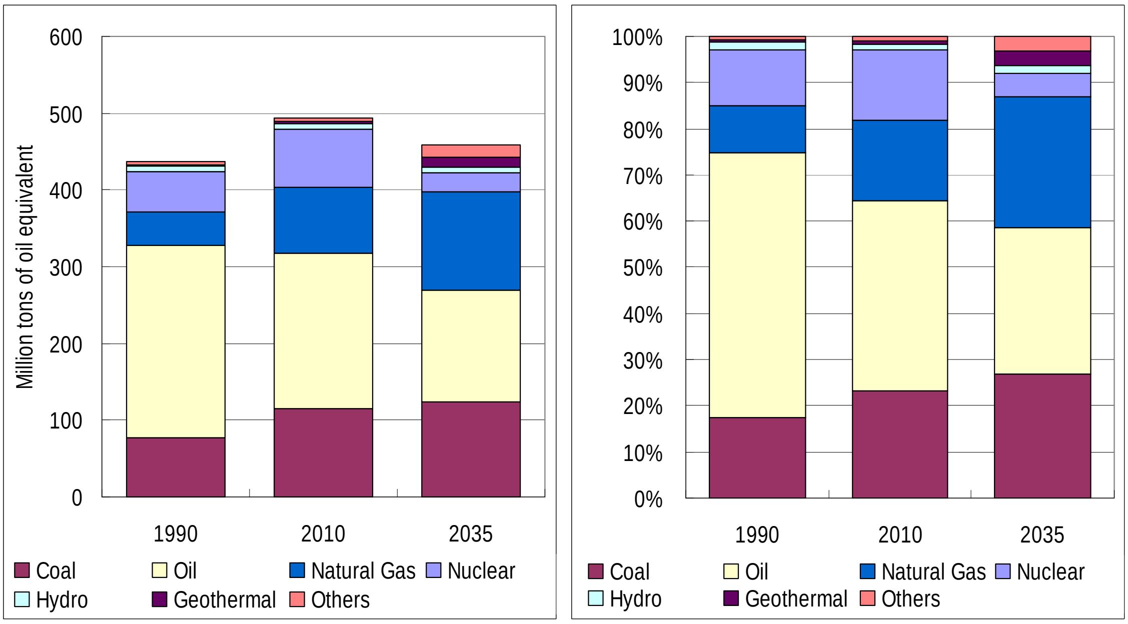


3.1.2. Primary Energy Demand

Under the BAU scenario, Japan's net primary energy supply is projected to decline at an average annual rate of 0.3 percent per year from 494.0 Mtoe in 2010 to 458.1 Mtoe in 2035. This decline is due to the decreasing use of oil and nuclear at annual average rates of 1.3 percent and 4.5 percent, respectively over the period 2010-35. The shares of oil and nuclear in 2010 and 2035 are projected to decrease from 38.7 percent to 31.7 percent and 13.9 percent to 5.2 percent, respectively.

Natural gas and coal consumption will, however, increase at average annual rates of 1.6 percent and 0.3 percent respectively over the same period.

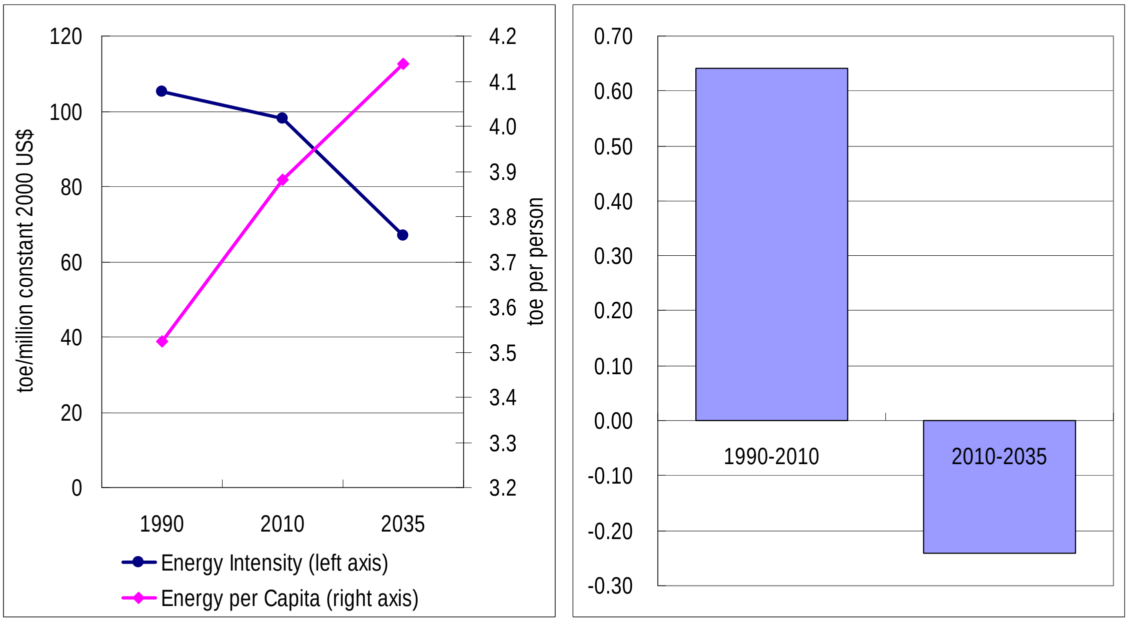
Figure 8-6: Primary Energy Demand, BAU



3.1.3. Energy Intensity and Elasticity

The primary energy intensity toward 2035 will be improved at faster rate than in the last decades. The elasticity[2] between 2010 and 2035 is expected to be negative due to further energy intensity improvement and the decrease in population.

Figure 8-7: Energy Intensity, BAU



3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Final Energy Demand

In the Alternative Policy Scenario (APS), final energy demand is projected to decline at a faster rate of 1.0 percent per year from 324.6 Mtoe in 2010 to 255.6 Mtoe in 2035. A rapid decline of 2.3 percent per year will be experienced in the transport sector due to the Top Runner Program and more aggressive energy management systems. Japan will implement continuous efforts to improve energy

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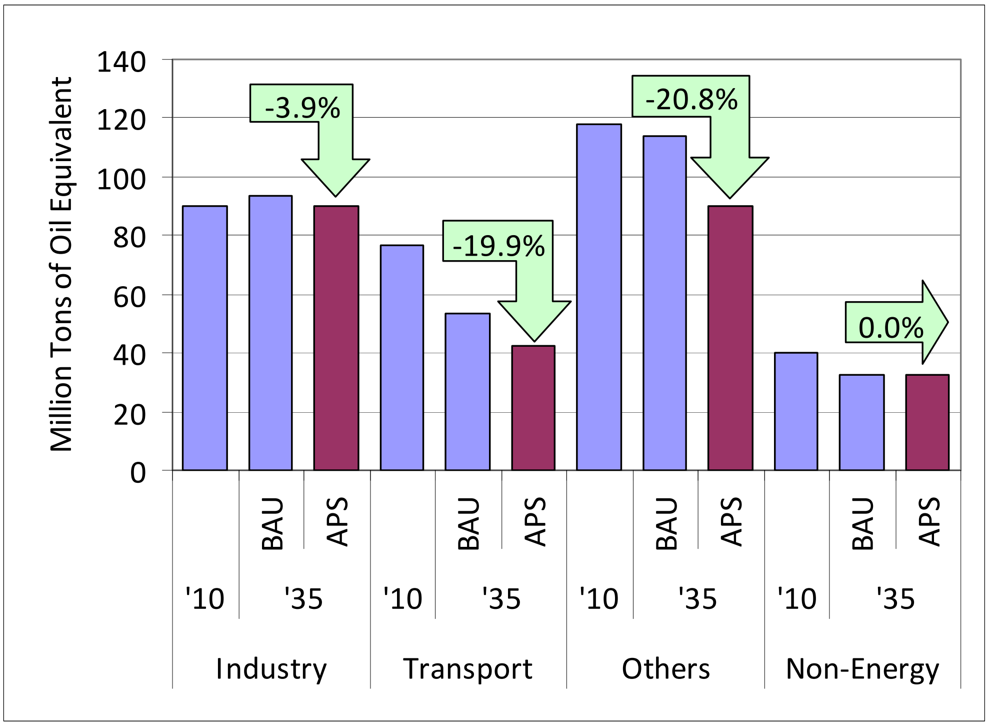
[2] Growth rate of GDP divided by the growth rate of energy consumption. For Japan, elasticity will be negative in the future as growth rate in energy consumption will be negative while growth rate of GDP is assumed to be positive.

efficiency, especially with regard to introducing energy efficient automobiles such as hybrid vehicles (HV), electric vehicles (EV) and plug-in hybrid electric vehicles (PHEV).

The industry sector and service sector will also improve their energy efficiency, but, despite their efforts, the steel and cement sectors will see a decline in energy efficiency. It will be difficult for these sectors to improve their energy efficiency drastically, because their capacity factors will be decreasing and they will use more renewable energy. The final energy demand by sector in the BAU and APS are shown in Figure 8-8.

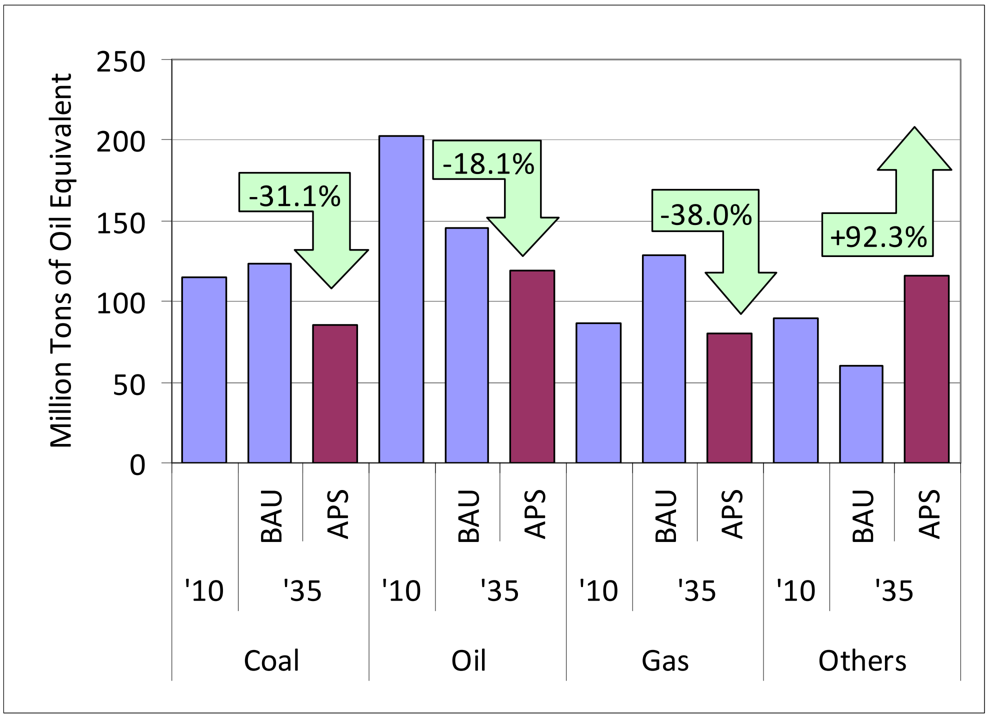
Figure 8-8: Final Energy Demand by Sector, BAU and APS



3.2.2. Primary Energy Demand

In the APS, the projected primary energy demand of Japan will decline at a rate of 0.8 percent per year to 400.1 Mtoe in 2035, lower by 93.9 Mtoe than the primary demand in 2010. Coal, oil and natural gas will have decreasing average annual growth rates of 1.2 percent, 2.1 percent and 0.3 percent, respectively. These decreases are mainly due to energy efficiency and conservation measures in the demand side.

Figure 8-9: Primary Energy Demand by Source, BAU and APS



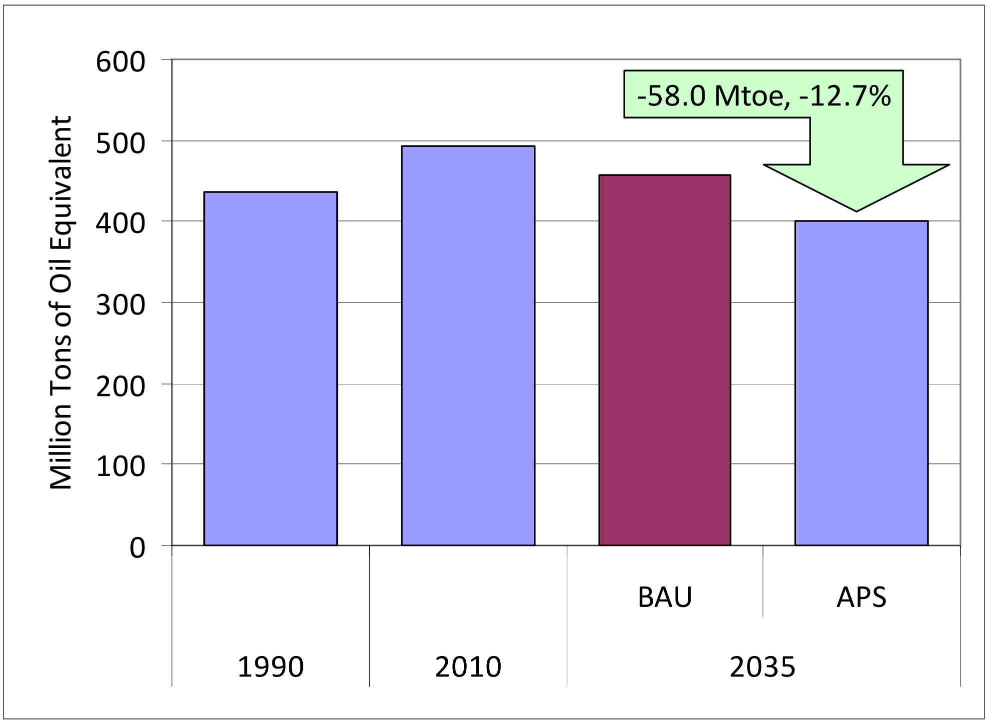
3.2.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Japan are 58.0 Mtoe, the difference between the primary energy demand of the BAU and the APS. This is equivalent to 12.7 percent reduction of Japan's BAU consumption in 2035.

In terms of savings in final energy demand, there is an estimated saving of 23.8 Mtoe in the residential/commercial sector, 10.6 Mtoe in the transportation sector in

2035 in the APS, relative to BAU. The energy savings in transportation achieved from 2010 to 2035 are 23.7 Mtoe and 34.3 Mtoe in the BAU and APS respectively, due to the increase of more efficient vehicles.

Figure 8-10: Primary Energy Demand, BAU and APS



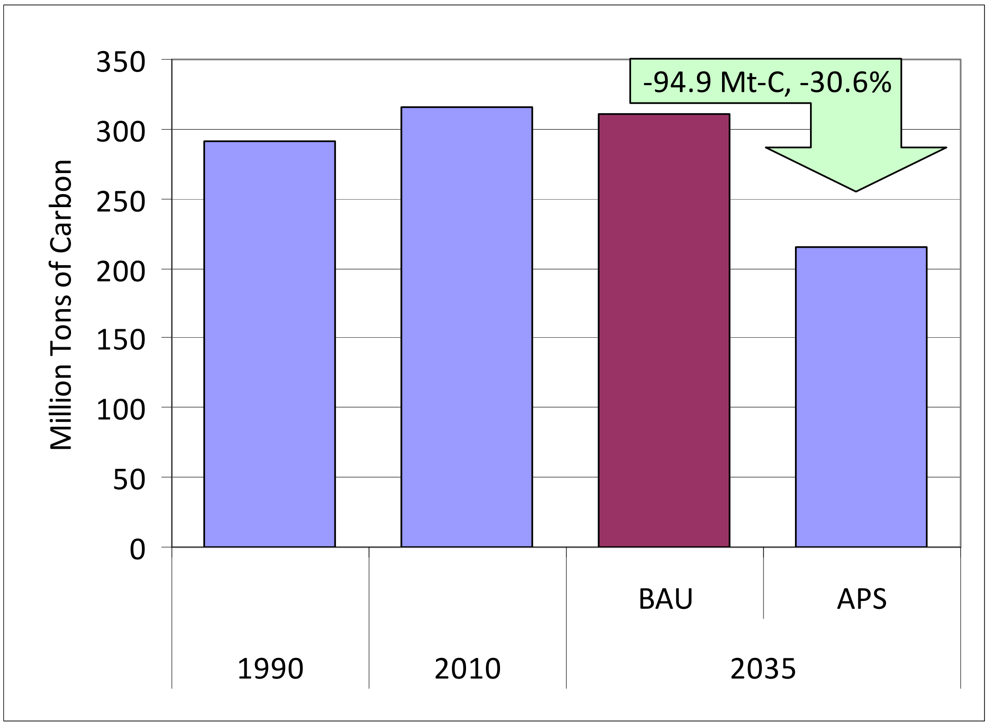
3.2.4. CO_2 Emissions from Energy Consumption

Under the BAU, CO_2 emissions from energy consumption are projected to decrease at average annual rates of 0.1 percent from 315.8 Mt-C in 2010 to 310.4 Mt-C in 2035. This decrease is lower than the decrease in primary energy demand indicating that Japan will need carbon intensive fuels to compensate for the limited nuclear power generation.

Under the APS, the annual decrease in CO_2 emissions from 2010 to 2035 is projected to decline at average annual rates of 1.5 percent. This decrease rate is also faster than the decrease in primary energy demand of 0.8 percent. In addition, CO_2 emissions in 2035 are projected to be lower than the 1990 level in the APS.

This indicates that the energy saving goals and action plans of Japan are very effective in reducing CO_2 emissions.

Figure 8-11: CO_2 Emissions from Fossil Fuel Combustion, BAU and APS



4. Implications and Policy Recommendations

Japan's primary energy intensity has been on a decline since 1980 and it is the lowest level in the world. This could be due to the enormous improvements in energy efficiencies in both supply side and demand side technologies that have been developed and implemented in Japan. The fact that Japan imports most of its energy requirements is another reason why the country in very aggressive in improving energy efficiency.

In the APS, CO_2 emissions in 2035 are projected to be lower than the 1990 level. This indicates that Japan could be on the downward trend to achieve its target of reducing GHG emissions by half from 2005 to 2050. However, to achieve the final target, Japan should effectively implement its policies on low carbon technology including energy efficiency and zero emission energy such as the Top Runner Program, renewable energy, and so on.

In addition, as the leader in the world in energy efficiency, Japan should introduce such successful policies to other countries as early as possible. By doing this, Japan is able to contribute to reducing world energy consumption. This would not only benefit Japan economically but it would also benefit from more available energy in the market.

Therefore, Japan should not only look at its own market but also to the world market as a whole when developing energy efficiency and low carbon energy policies. Reduced energy consumption of the world would mean more available energy for years to come.

The New Basic Energy Plan is still under discussion in Japan. Political change will occur under the new administration but this modeling analysis still considers the assumptions of previous administrations, namely METI's projection in 2010 and government discussion in 2012. While the current reduction target is 25% from 1990 to 2020, the Government has a policy to withdraw the current target and make a more realistic target consistent with the New Basic Energy Plan.

CHAPTER 9

Republic of Korea Country Report

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1. Background

The Republic of Korea is located in the southern half of the Korean Peninsula and shares a 238 km border with North Korea. It occupies 98,480 square kilometres and includes about 3000, mostly small, uninhabited islands. Korea is a mountainous country with lowlands accounting for only 30 percent of the total land area. The climate is temperate, with heavy rainfall in summer. Korea has a population of 49 million, about 85 percent of which live in urban areas. Korea has recorded tremendous economic growth over the past half century. The gross domestic product (GDP) plunged by 7 percent in 1998 due to the financial crisis, but has since rebounded. Another recent global economic crisis in 2008 could not keep Korean from continuing economic growth. However, due to the recent deterioration in the global economy, growth has slowed down, recording 2.0 percent in 2012, but is projected to reach around 2.6 percent in 2013 and 3.8 percent in 2014.[1] The Korean economy is dominated by manufacturing, particularly electronic products, passenger vehicles and petrochemicals. Agriculture, forestry and fishing made up only 2.7 percent of total GDP in 2010.

Korea has no domestic oil resources and has produced only a small amount of anthracite coal, but imports most of its coal, which is bituminous coal. Consequently, Korea has to import 97% of its energy needed and is the fifth-largest oil importer and the second largest importer of liquefied natural gas (LNG) in the world.

Although total primary energy consumption is dominated by oil and coal, nuclear power and LNG also supply a significant share of the country's primary

[1] Bank of Korea, 2013

energy. Total primary energy consumption increased by 5.0 percent a year between 1990 and 2010. The strongest growth occurred in natural gas (14.2 percent) and nuclear (5.3 percent). Oil use increased at a relatively slower rate of 3.3 percent a year.

Total final energy consumption (TFEC) in 2010 was 157.4 Mtoe, increasing at an average annual rate of 4.5 percent from 1990. The industry sector accounted for 28.4 percent of final energy consumption in 2010, followed by others (28.2 percent) and transportation (19.0 percent). Consumption of natural gas in the industry sector has grown eight-fold in the last decade and oil accounts for a relatively large share of industry consumption.

In 2010, electric power generators in Korea produced 496.7 TWh of electricity, with coal and nuclear combined providing almost three-quarters of Korea's electricity. Natural gas accounted for 20.4 percent of generation in 2010. Total electricity consumption grew at an average annual rate of 8.1 percent over the period from 1990 to 2010. When broken down by fuel, coal, natural gas and nuclear have grown by an average annual rate of 13.4 percent, 12.6 percent and 5.3 percent, respectively over the period from1990 to 2010.

Since the 1990s, the Korean government established three Basic Plans for Rational Energy Utilization in a row, which were revised at the end of each five-year period and contained a variety of policy tools and programs developed and implemented under the auspice of the Ministry of Trade, Industry, and Energy (MOTIE). Several energy savings measures were announced to encourage the general public to voluntarily conserve energy. As part of the measures, "Voluntary Energy Conservation Campaigns," were launched to reduce heating fuel consumption. Furthermore, the government urged energy-intensive industries to enhance energy efficiency of their products. In addition, MOTIE and the Board of Audit and Inspection of Korea formed a task force to examine 660 public and private organizations to measure their progress in implementing voluntary energy saving plans

The current Basic Plan for Rational Energy Utilization has a variety of key policy tools and programs to attain the energy savings target. Among them are Voluntary Agreements (VAs), Energy Audits, Energy Service Companies (ESCOs), Appliance Labeling and Standards, Fuel Economy, and Public Transit and Mode Shifting. These policy tools have been and will continue to play important roles in energy savings.

2. Modelling Assumptions

Korea's GDP had grown at an average annual rate of 5.1 percent between 1990 and 2010. In this report, Korea's GDP is assumed to grow at an average annual growth rate of 3.1 percent from 2010 to 2035. Following the global recession in 2009, the Korean economy has been a little bit shaken. However, the Korean economy is still in a good shape and its economic growth is expected to recover to 4.0 percent per year from 2010 to 2020, tapering off to 2.5 percent per year from 2020 to 2035.

Korea is expected to continue to rely heavily on coal and nuclear energy for power generation to meet the base load. Gas-fired power generation is projected to increase between 2010 and 2035, while oil-fired generation is projected to decline. Generation from hydro sources is projected to remain relatively stable. It is projected to be strong growth in electricity generation from wind power and solar PVs driven by the renewable portfolio standards (RPS) which was launched in January, 2012.

Korea's energy saving goal can be attained through implementing energy efficiency programs in all energy sectors. In the industrial sector, energy saving is expected from the expansion of Voluntary Agreement (VA), the highly efficient equipment program, the development of alternative energy and improvements in efficient technologies. The transport sector aims to save energy by enhancing the efficiency of the logistics system, expanding public transportation and improving the efficiency of vehicles. In the residential and commercial (other) sector, minimum efficiency standards program is projected to induce huge savings in addition to "e-Standby Korea 2010."

3. Outlook Results

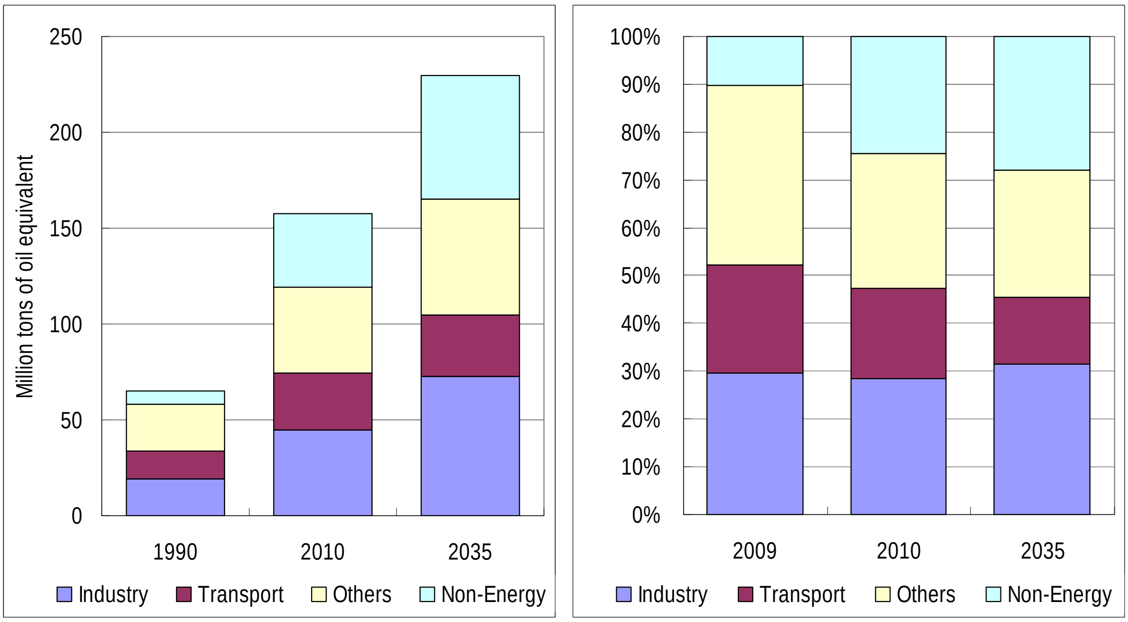
3.1. Business as Usual (BAU) Scenario

3.1.1. Total Final Energy Demand

Korea's final energy demand showed a growth of 4.4 percent per year from 64.9 Mtoe in 1990 to 157.4 Mtoe in 2010. The non-energy sector had the highest growth rate during this period at 9.1 percent per year followed by the industry sector with 4.3 percent. Energy consumption in the residential/commercial/public (other) sector grew at a relatively slow pace of 3.1 percent per year.

With an assumption of low economic and population growth, final energy demand in Korea is projected to increase at a low average rate of 1.5 percent a year between 2010 and 2035 under the BAU scenario. This stems largely from the slow growth in energy demand in the transportation sector. The strongest growth in demand is projected for the industrial sector, with an increase at an average annual rate of 1.9 percent between 2010 and 2035.

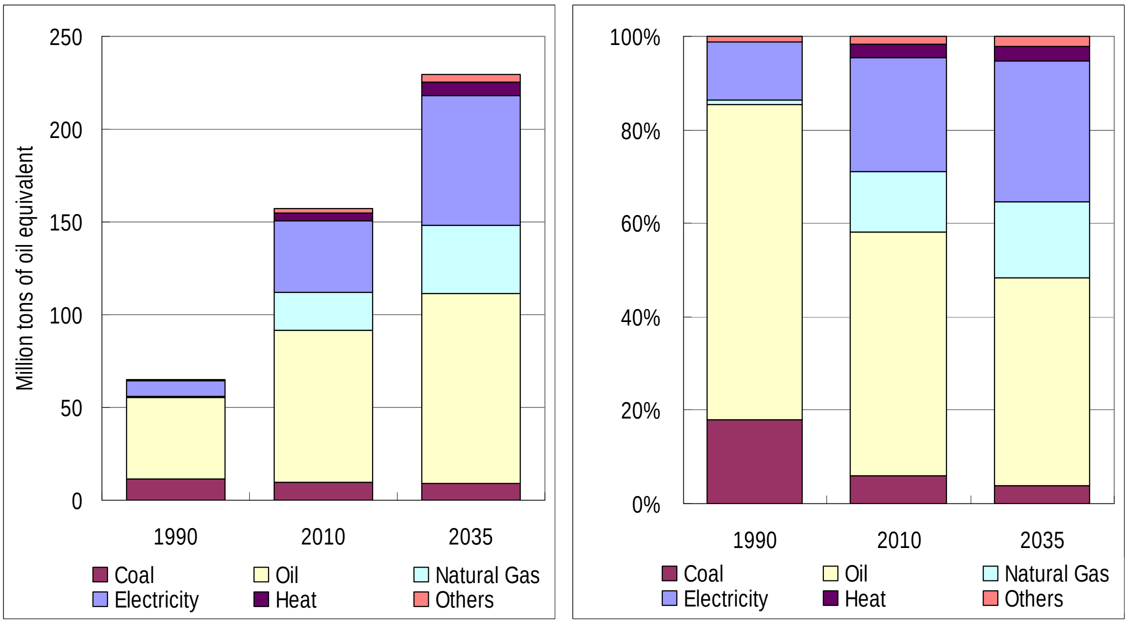
Figure 9-1: Final Energy Demand by Sector, BAU



The residential/commercial/public (other) sector has the largest share in the total final energy mix of Korea for 1990 (37.5 percent). In 2010, the share of this sector declined to around 28 percent due to the rapid increase of demand in the non-energy sector. The industry and transport sector also experienced a declining share in the total final energy mix over the same period. In the BAU scenario, the industry and non-energy sector will be growing at an faster than the transport and Other sector. Consequently, the share of these sectors will increase over the projection period. Industry sector share will increase from 28.4 percent in 2010 to almost 32 percent in 2035. Non-energy sector share will increase from 24.4 percent to 28 percent over the same period.

The demand for natural gas in the end-use sector has increased significantly over the 1990 to 2010 period, increasing at an average annual growth rate of 18.6 percent. Coal, on the other hand, declined at an average rate of 1 percent per year reflecting that Korea is moving towards cleaner fuel.

Figure 9-2: Final Energy Demand by Fuel, BAU



In the BAU scenario, natural gas demand will continue to increase but at a slower rate of 2.4 percent per year over the 2010 to 2035 period. Electricity demand which before was growing at an average rate of 8.1 percent per year has also slowed down to 2.4 percent per year over the projection period. Coal demand is expected to continously decline but only at a slower rate of 0.3 percent per year. Oil which are being used mainly in the transport sector, will still increase but at a rate of 0.9 percent per year.

Demand for oil, natural gas and electricity is projected to increase at an average annual growth rate of 0.9 percent, 2.4 percent and 2.4 percent, respectively over the period between 2010 and 2035. Coal demand is projected to decline by 0.3 percent per year reflecting a shift toward the increased use of natural gas in the industrial sector in order to reduce CO_2 emissions.

Oil was the most consumed product having a share of 67.3 percent in 1990, declining to 52.0 percent in 2010. The share of coal in the final energy demand has declined by 12 percent a year between 1990 and 2010 whereas the share of electricity has doubled to be the second largest consumed product. Natural gas with its rapid growth, has an increasing share from 1 percent in 1990 to almost 13 percent in 2010.

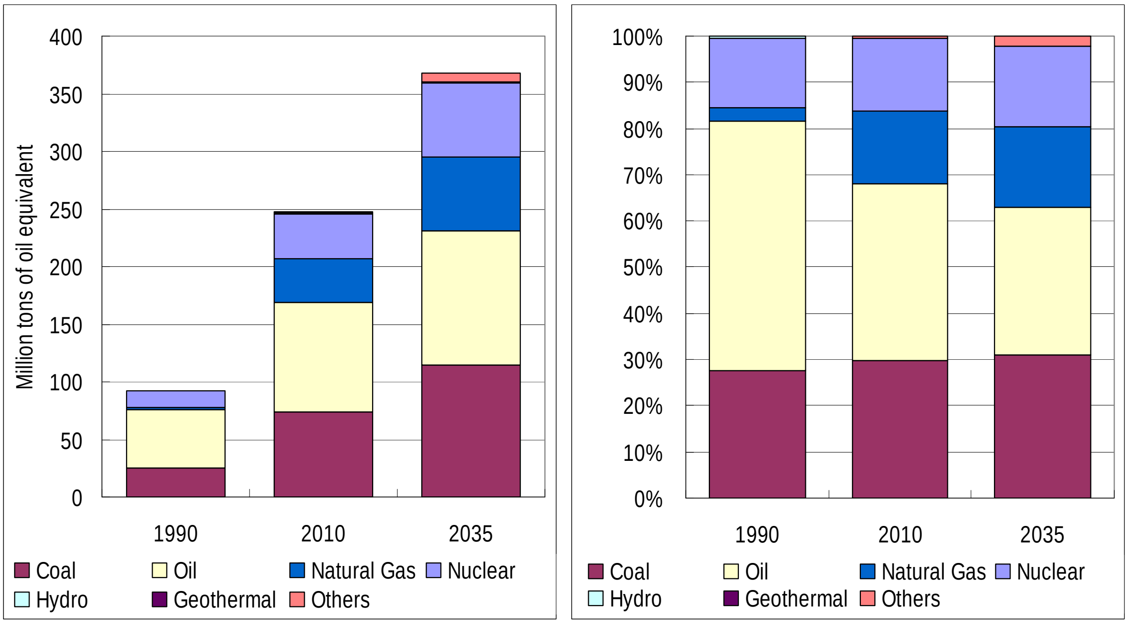
For the future, the share of oil will continue to decline. It is expected that oil share will decline to 44.6 percent by 2035 under the BAU scenario. Coal will will also decline and replaced by natural gas. The share of coal will reach 3.8 percent 2035 as compared to 6.1 percent in 1990. Natural gas, on the other hand, will have an increasing share from 12.9 percent in 1990 to 16.2 percent in 2035. Electricity share in the total final energy will also increase from 20.4 percent to 30.3 percent.

3.2. Primary Energy Demand

Primary energy demand in Korea grew at an average rate of 5.0 percent from 92.4 Mtoe in 1990 to 247.3 Mtoe in 2010. Among the major energy sources, natural gas was the fastest growing at an average annual rate of 14.2 percent. In contrast, coal grew at the rate of 5.4 percent a year, followed by nuclear and oil at 5.3 percent and 3.3 percent, respectively, over the same period.

In the BAU scenario, primary energy demand in Korea is projected to increase at an average annual rate of 1.6 percent to 367.8 Mtoe in 2035. Growth in all the energy sources is projected to slow down. While consumption of nuclear, natural gas, and coal will show an annual growth rate of around 2 percent, oil and other energy are projected to increase at a much lower rate or decrease over the period 2010-2035.

Figure 9-3: Primary Energy Demand, BAU



The growth in nuclear will largely be at the expense of oil. Between 1990 and 2010, oil share declined almost 30 percent, from 53.9 percent in 1990 to 38.5 percent in 2010. At the same time, the share of nuclear increased from 14.9 percent to 15.7 percent.

Natural gas share in the total primary energy mix increased significantly between 1990 and 2010; from 2.9 percent to 15.6 percent. Coal, however, increased slightly from 27.7 percent to 28.7 percent.

Under the BAU scenario, the share of oil continued to decline to around 32 percent by 2035, while nuclear share will increase to 17.5 percent. Natural gas share in the total mix will be similar to that of nuclear while coal share almost that of oil. Hydro share;s in the total emergy mix will remain constant.

3.3. Power Generation

The power generators in Korea produced 496.7 TWh of electricity in 2010, almost 5 times that of 1990 production. For fossil fuel, generation of electricity from coal grew the fastest over the 1990 to 2010 period at an average annual rate of 13.4 percent. Power generation from natural gas also grew rapidly during that time, but slower than coal at 12.6 percent. Oil power plants generates almost the same amount of electricity

Generation from nuclear plants has been growing at an average rate of 5.3 percent per year while from oil power plants remains the same.

Figure 9-4: Power Generation by Fuel Type, BAU

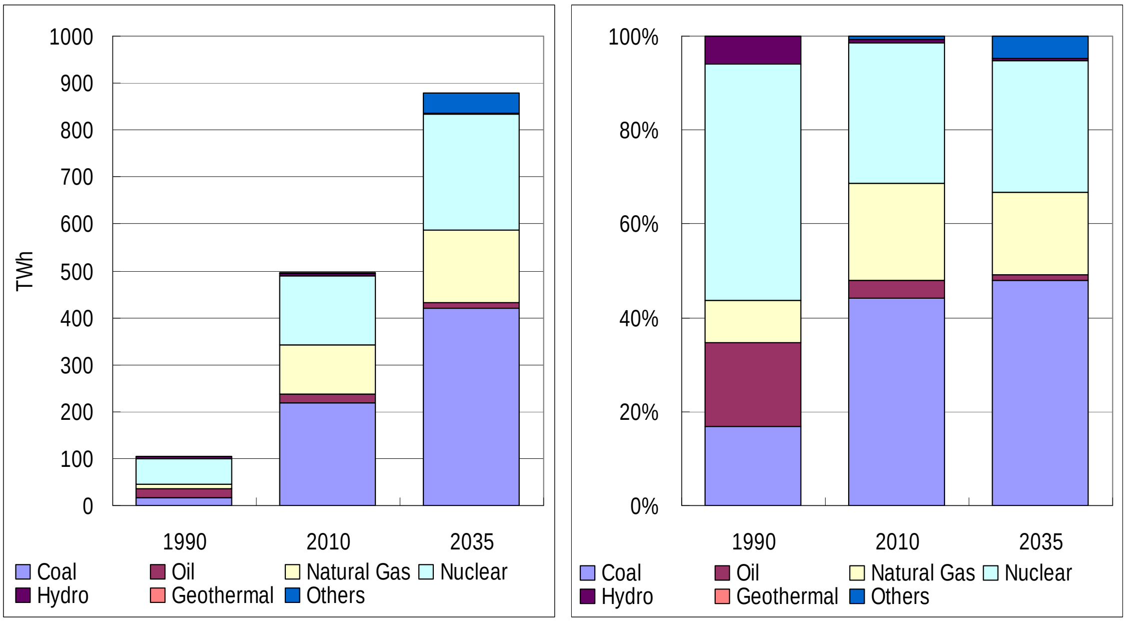
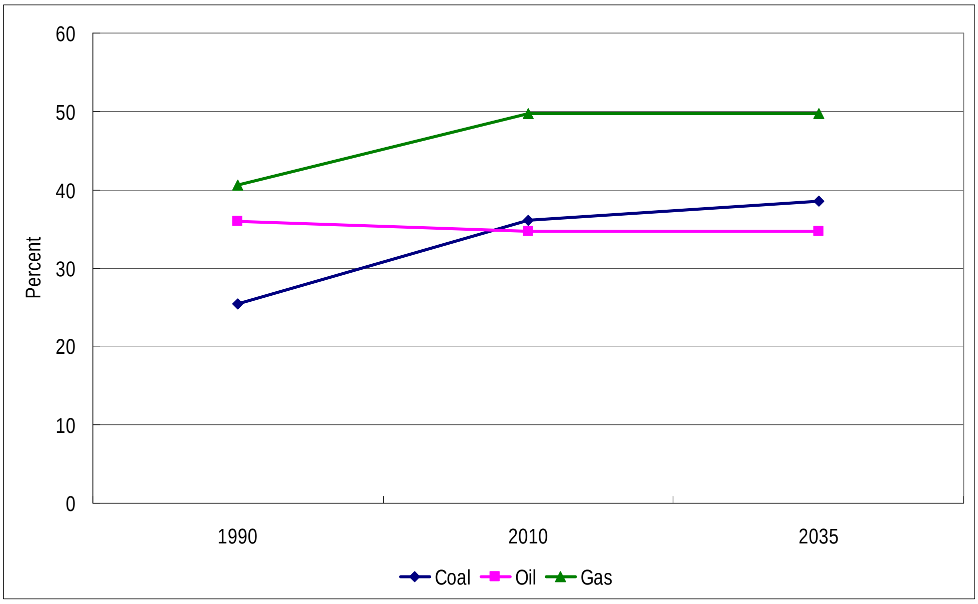


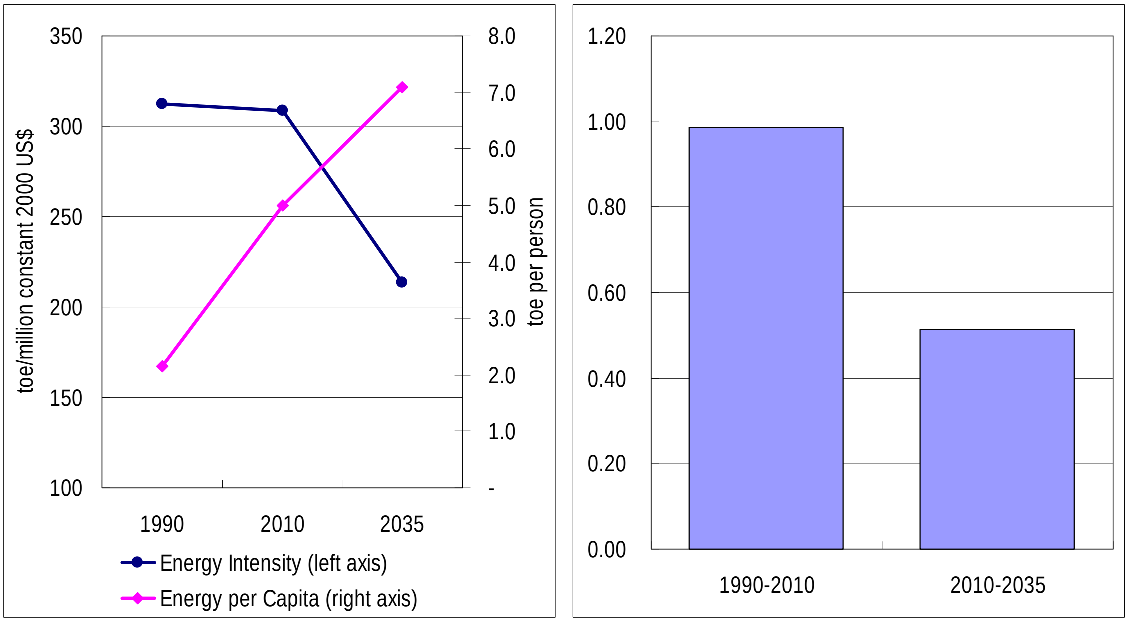
Figure 9-5: Thermal Efficiency of Electricity Generation



3.3.1. Energy Intensity

Korea's energy intensity from 1990 to 2010 decreased by 0.1 percent per year on the average from 312 toe/million US$ in 1990 to 309 toe/million US$ in 2010. The energy elasticity, or the growth rate of energy consumption divided by the growth rate of GDP, during this period was 0.99. Energy intensity is projected to further decrease by 1.8 percent per annum to reach 213 toe/million USD in 2035. Energy elasticity from 2010-2035 is projected to be 0.51.

Figure 9-6: Energy Intensity, Energy per Capita and Energy Elasticity

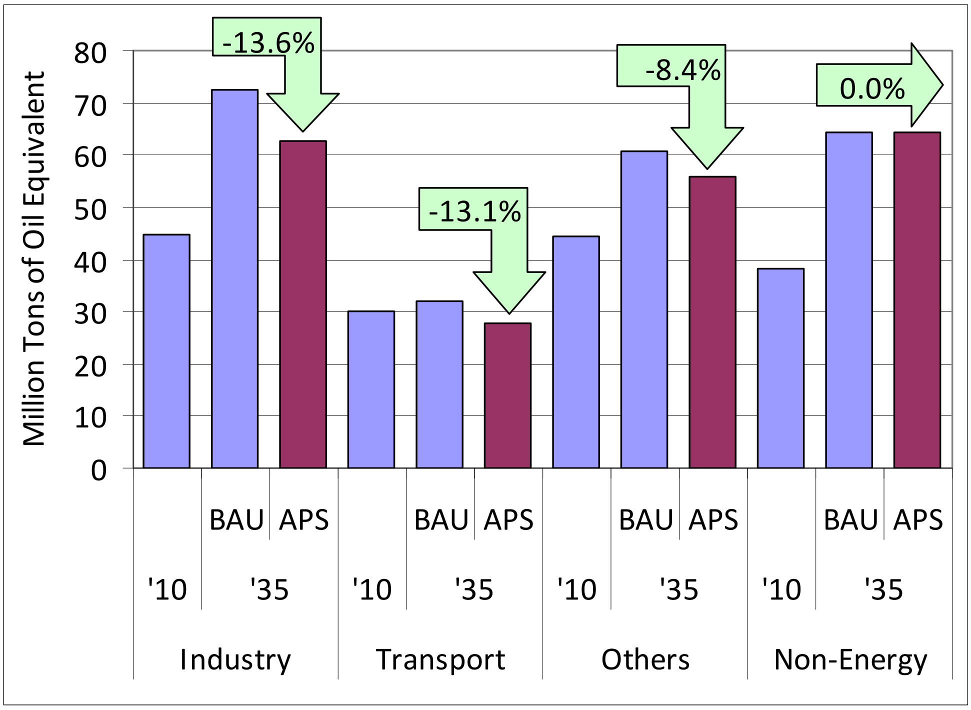


3.3.2. Energy Saving and CO_2 Reduction Potential

Final Energy Demand

In the APS, final energy consumption is projected to increase at an average annual growth rate of 0.5 percent from 157.4 Mtoe in 2010 to 210.6 Mtoe in 2035. The Non-energy sector is projected to have the fastest average annual consumption growth, increasing by 2.1 percent a year between 2010 and 2035. Energy consumption in the transportation sector is projected to decrease by 0.3 percent per year over the same period. The rate of growth is much slower across all sectors as compared to the BAU scenario (Figure 9-7).

Figure 9-7: Final Energy Demand by Sector, BAU and APS

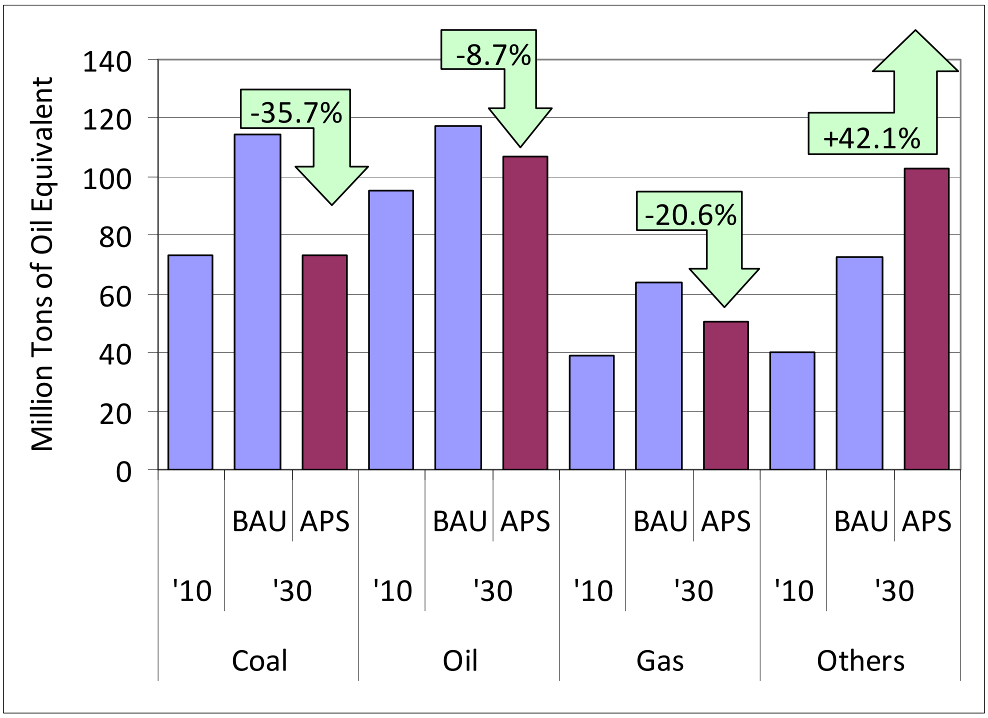


Primary Energy Demand

In the APS, primary energy demand is projected to increase at a lower rate of 1.2 percent per year to 334.2Mtoe in 2035. Coal and oil will stay at the same level of consumption as in 2010 whereas nuclear and natural gas will increase by 3.6 percent and 1.1 percent per year, respectively, between 2010 and 2035 Energy efficiency and conservation measures on the demand side will be the main contributors to the reduction in consumption growth.

Major energy policy approaches to reduce energy demand in Korea are as follows: First, market mechanism should be introduced in energy pricing in which rational energy use is induced through sharing information on full cost of energy production and consumption. Second, industrial structure should be transformed from the current energy-intensive industry into knowledge-based, service industries and green industries which consume less and clean energies. Third, energy efficiency standards and codes should be applied in product designing and production process as well as in designing and constructing a system such as factory, building and plant. Under these policy directions, the Korean government should develop and implement an action plan which contains milestones and strategies with specific and cost-effective policy tools.

Figure 9-8: Primary Energy Demand by Source, BAU and APS

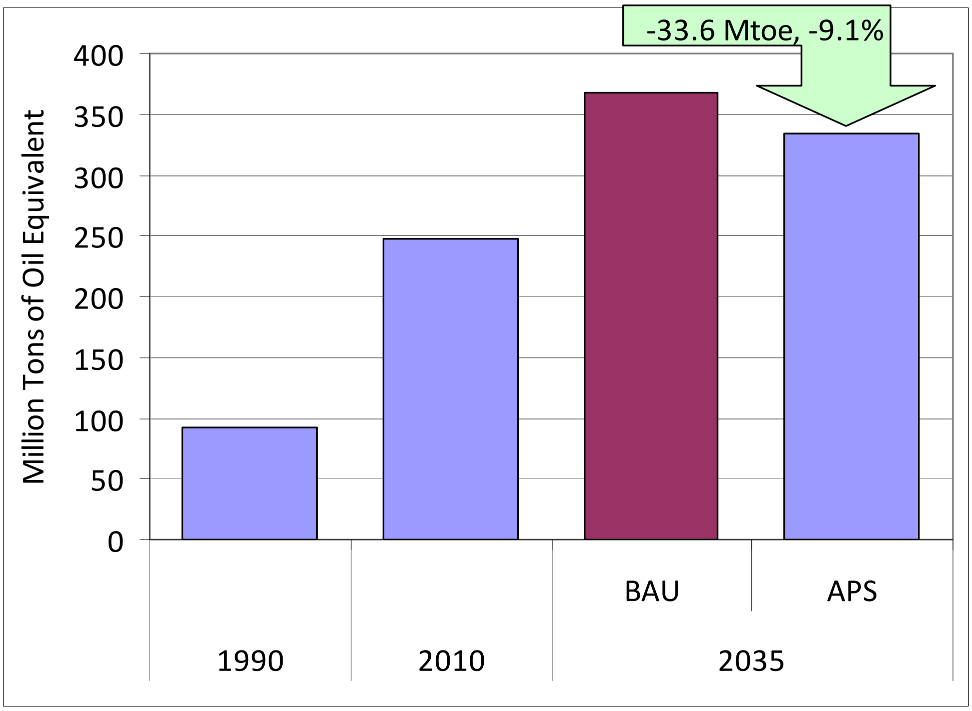


Projected Energy Saving

The energy savings that could be derived from the energy saving targets, action plans and policy tools in Korea is 33.6 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2035. This is equivalent to 13.6 percent of Korea's consumption in 2010.

In terms of final energy consumption savings in 2035, savings is estimated to be 9.9 Mtoe in the industry sector, 5.1 Mtoe in the residential/commercial (other) sector and 4.2 Mtoe in the transportation sector

Figure 9-9: Total Primary Energy Demand to 2030, BAU and APS

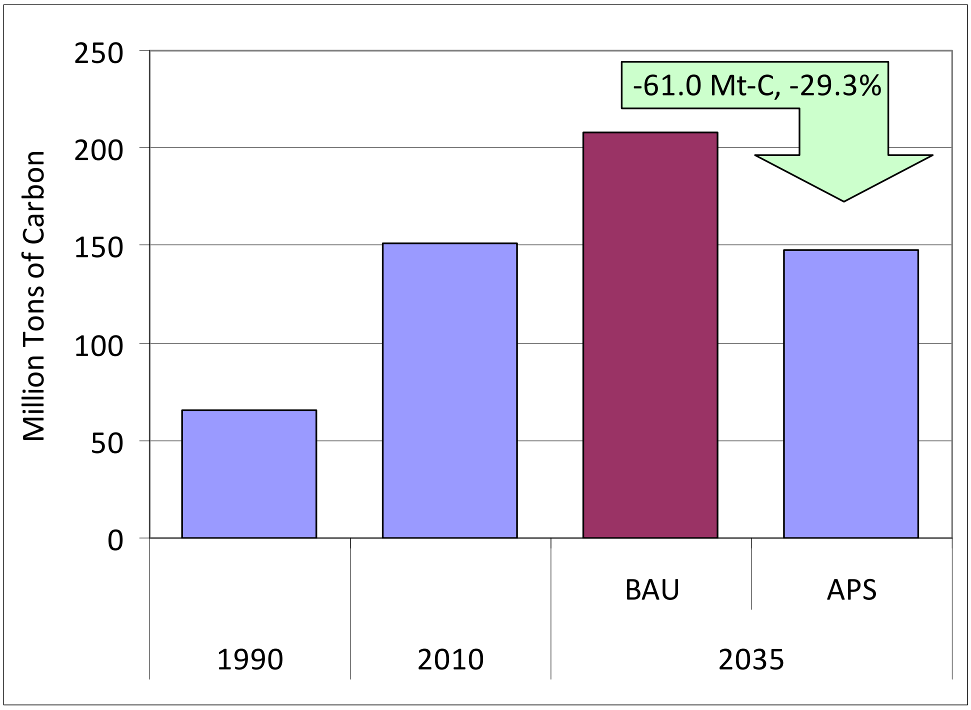


3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an annual average growth rate of 1.3 percent from 151.5 Mt C in 2010 to 208.4 Mt C in 2035 based on the BAU scenario. Such a growth rate is slower than that in primary energy consumption, indicating that Korea will be using less-carbon intensive fuels such as natural gas and renewable energies and employing more energy efficient, green technologies.

In the APS, CO_2 emissions are projected to decline at an annual average growth rate of -0.1 percent between 2010 and 2035. Difference in CO_2 emissions between BaU and APS is 61 Mt C, 29%. To attain such an ambitious target, the Korean government has to develop and implement cost-effective and consensus-based action plans for energy saving and CO_2 emissions reduction

Figure 9-10: CO_2 Emission from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

Korea's total primary and final energy consumption in the 1990s had rapidly increased at a rate faster than that of GDP whose growth has been driven by energy-intensive industries such as petrochemical, steel, and cement industries. Since 1997, the contribution of these industries to Korea's GDP has gradually declined, resulting in reduced energy intensity. However, the shift to a less energy–intensive industrial structure takes time, which indicates that energy-intensive industry will prevail for the short- to mid-term future. However, Korea will and has to transform its industrial structure into a less energy-intensive one in the longer term.

Up until now, Korea has promoted the diversification of energy resources and suppliers to reduce excessive external energy dependence and new & renewable energy sources, which contributes to enhance energy security as well as environmental preservation. It is highly recommended that Korea keep up with the current policy goals of transforming into a less energy-intensive, greener economic structure and implementation of policies to keep a balance between energy, economy, and the environment. Such nation-wide efforts and campaigns would eventually transform the Korean economy into a less energy-intensive and greener one in terms of energy savings as well as reduced CO_2 emissions. Such an achievement will position Korean as one of global leading nations in terms of low-carbon green growth.

CHAPTER 10

Lao PDR Country Report

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1. Background

1.1. Socio-Economic Situation

Lao People's Democratic Republic (Lao PDR) is a small country in South East Asia. It is a land lock country which is located in the middle of the South East Asia peninsula. It has a border with five countries namely China in the North, Vietnam in the East, Cambodia in the South, Thailand and Myanmar in the West. Lao PDR has a total area of 236,800 square kilometres and about 70 percent of that is covered by mountains. Lao PDR has population of 6,256,197 people (2010) in which 3,133,059 people is female. The female population is accounted a little bit more than 50 percent of the total population. The average of the population density is 26 people per square kilometre. Laos consists of 17 provinces. Its capital city is Vientiane. It has population of 768,743 people.

Since Lao PDR had changed its economic policy to the opened door policy in 1986, the economy has been progressing and expanding rapidly. The Gross Domestic Product (GDP) in 2010 increased 8.1 percent from the previous year. It was accounted about US$ 3,421 million at the 2002 constant price. If it is estimated by activity at the current price it was about US$ 6,840 million and it per capita was about US$ 1,088. The economy has been gradually changing from agriculture oriented activities to a more wide range of activities such as service and industry. In 2010, the service sector has gained 39.3 percent while agriculture sector has had only 28.4 percent of the all GDP. The industry sector also increased rapidly, because there are a lot of investments in mineral and hydropower sectors. Even though in 2010 it has contributed to the GDP only 25.9 percent, it was projected to take the bigger share in the GDP in the next 5 years.

1.2. Energy Supply-Demand Situation

Laos PDR's total primary energy demand in 2010 was 0.9 MTOE. The country's primary energy demand mix consists of four types of energy such as oil, hydro and coal. In 2009, electricity export reached 0.5 MTOE and accounted more than half of total energy consumed in the country. The export also accounted for 78.6 percent of total hydro power generation. The main fuel consumed in the country is oil products and is mainly used in the transportation sector. Since there is no refinery in Lao PDR, all of its oil product supply is imported from Thailand and Viet Nam. In 2010, Lao PDR imported 0.6 MTOE of oil products to supply the demand of transport and other sectors. Lao PDR's primary energy supply mix includes also coal. In 2010, 0.1 MTOE of coal was consumed in Lao PDR and mainly in industrial sector. In the future, coal demand is expected to increase as a coal power plant will start commercial operation in 2015.

The power sector plays a major role in the country's economy. Electricity became a source of revenue from abroad and at the same time as source of energy for economic activities. The electrification ratio in Lao PDR is 71 percent in 2010. According to the Lao PDR Government plan, the country will increase the electrification ratio to 71 percent in 2010 and 90 percent in 2020. This plan is among the priorities of the government to eradicate the country's poverty. Considering the increase of electricity demand in Lao PDR and the power production for export, optimisation of the power sector will be necessary for the future supply of electricity.

Luckily, Lao PDR is known as a rich country in terms of hydropower resources, because it has many rivers. According to the Mekong River Commission Study in 1995, Laos has a potential hydropower resource of 23,000 MW. Up to 2010, Lao PDR has only developed 8.4 percent of the total potential with total installed power capacity reaching 1927 MW. Almost 100 percent of the total power supply comes from hydro power source.

In 2010 Lao PDR produced around 8,171.6 GWh of electricity. From that, more than 81.3 percent (equivalent to 6,646.4 GWh) was exported to Thailand and the remaining, consumed domestically. Power export is projected to increase sharply because the Government has made commitment to help its neighbouring countries to fulfil their power demand. By 2020, Lao PDR has agreed to export 7,000 MW to Thailand and 5,000 MW to Viet Nam. The power source for export is mainly from hydropower. There is, however, one thermal power plant known as Hongsa Lignite Power Project which is being constructed for export purposes. This project alone has the installed capacity of 1,800 MW. At present, there are more than 50 hydropower sites planed for the export target in 2020. Most of exporting hydropower projects are being developed jointly between the Lao PDR Government and foreign investors.

1.3. Energy Policies

Since the Ministry of Energy and Mines has been established in 2006, Energy Policy gained a lot of public attention and support and it also has been developing in more complexity. In the past, it focused solely on power sector, now it covers most of energy types and energy related activities. Lao PDR's energy policy aims to develop a sustainable and environmentally friendly energy sector. It also has been improved dramatically because Ministry of Energy and Mines cooperate with ASEAN, other countries and international agencies. Many lessons and experiences learned from overseas have been incorporated into the policy.

1.3.1.Supply (Fossil, NRE, Nuclear, Bio fuels, etc)

On the energy supply side, the Lao PDR's Government has set up a number of measures and strategies to ensure the greater security of energy supply and promote sustainable development in the energy sector. The Government would like to provide sufficient energy for socio-economic development without shortage and disruption of energy supply. At the same time, the Government attempts to reduce the dependence on energy import and gradually diversify its energy supply. Now the renewable energy policy has been approved as a government decree. It aims to increase the share of renewable energy in total energy supply by 30 percent in 2020. This targeted obligation also includes blending 10 percent of bio-fuels in the oil supply for the transportation sector. This policy will help the country to reduce oil import. For the nuclear energy policy, although there is no nuclear power plant to be developed in the medium term, the Government is attempting to build its personal capacity to be ready to cooperate with other countries and develop the nuclear power plants in the long term when it is necessary.

1.3.2.Consumption (Energy Efficiency and Conservation, etc)

During the past decade, energy demand of Lao PDR increased significantly. In 1990, only 0.3 MTOE of energy had been consumed. In 2010, it increased to 0.9 MTOE and it is projected to grow to 6.8 MTOE by the year 2035. This requires a lot of investments in energy supply. In this regard, the country needs to use more its natural resources and to import more oil from abroad. These can cause negative impacts to the environment and increase greenhouse gas emission to the atmosphere. Therefore the Lao PDR's Government as well as the Ministry of Energy and Mines are taking this energy consumption aspect into account seriously. One of the most effective measures and policies to minimize the associated issues, which the Government is currently promoting, is the Energy Efficiency and Conservation program. In this program, 10 percent reduction in energy consumption by 2020 in all sectors is being proposed to the Government. If it has been approved the specific measures and activities will be discussed, developed and implemented in different sectors.

1.3.3. Energy Market Reforms, New Energy Policies under Consideration, etc

To promote greater security and sustainable development in energy supply, the energy organization structures have been frequently being reviewed and improved by the Government. Based on new developments in the country, suitable energy organizations are needed efficiently manage the energy sector. For example, the Department of Electricity is proposed to become the Department of Energy Policy and Planning. Its mandatory responsibilities are to accommodate a wide range of energy activities. Moreover, the energy market has been opened up to local and international investors. This strategy is aiming to promote competition and more investments in the energy industry. As a result, there are many new independent power producers (IPPs) that emerged to produce electricity for domestic and export requirements. Recently, Electricite du Laos, the state-owned power utility has been also divided into two companies: Electricite du Laos and Electricite du Laos-Generation (EdL-Gen).

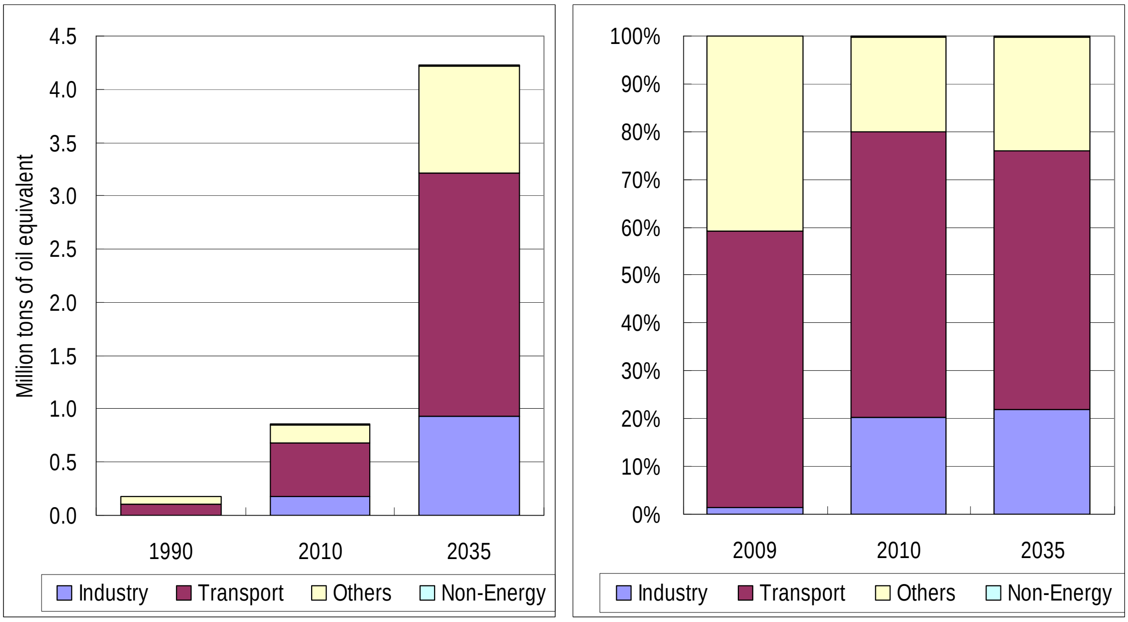
2. Energy and CO_2 Emission Outlook

2.1. Final Energy Demand

2.1.1. Business as Usual (BAU)

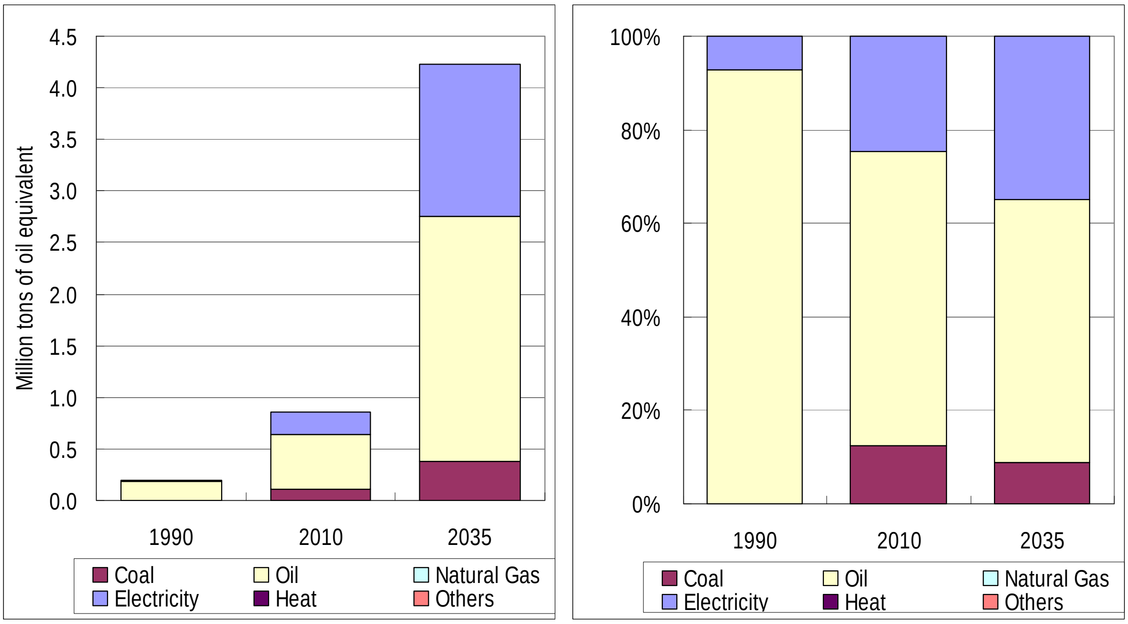
As Lao PDR strives to be industrialization and modernization, many sectors have been remarkably achieving their development targets in recent years and there is no exception for energy sector. Ultimate goals for energy sector are to supply energy to all economic sectors with timely, sufficient and secured manner. According to BAU estimation, total final energy demand has gone up from 0.25 MTOE in 1990 to 0.85 MTOE in 2010 with an annual growth rate of 7.6 percent a bit lower than that of TPES. For the period 2010 to 2035, the TOTAL FINAL ENERGY DEMAND is estimated to continuously increase from the figure in 2010 to 4.23 MTOE in 2035. For the growth rate of each sector, from 1990 to 2010 industrial sector has increased at a highest growth rate compared with two remaining sectors such as transport and other ones, it has grown at 24 percent while transport sector and other sector increased at only 8.5 percent and 4.4 percent respectively. In terms of a sectors' share, in 2009 transport sector has had 71.1 percent, others sector with 27.9 percent and industry sector 0.92 percent of the total final energy demand. However by the year 2035, unlike transport and other sectors, the share of the industry sector is estimated to rise to 21.9 percent, while the shares of transport and other sectors are expected to decrease to 54.27 percent and 23.79 percent respectively.

Figure 10-1: Final Energy Demand by Sector, BAU



The energies that Laos has been using so far are petroleum products, electricity, coal and biomass. The petroleum products, in the study referring to Oil, that are being used in the country are diesel, gasoline, bunker oil, and LPG. No natural gas and heat are being used in Laos so the concerned energies in this study would be only coal, oil and electricity. Biomass is not included in the study both for BAU and APS. Even though these final energies have been used not much in terms of energy type, and aggregated energies as well as per capita and per country compared with other ASEAN member states, they have been increasing rapidly during two decade ago. For example, in BAU in 1990 TOTAL FINAL ENERGY DEMAND estimated being used only 0.25 MTOE but increasing to 0.85 MTOE in 2010 with an annual growth rate of 7.6 percent and then increasing to 4.23 MTOE in 2035 with an annual growth rate of 6.6 percent. In TOTAL FINAL ENERGY DEMAND, 0.11 MTOE of coal had been used in 2010 and projected to increase to 0.38 MTOE in 2035 at a annual rate of 5.2 percent. Oil has gone up from 0.18 MTOE in 1990 to 0.54 MTOE in 2010 at an annual growth rate of 5.54 percent and it increased further to 2.28 MTOE in 2035 with an annual growth rate of 6.1 percent. Electricity has also been increasing fast in recent years. In 1990, it has been used only 0.01 MTOE but increased to 0.21 MTOE and 1.47 MTOE in 2010 and 2035 respectively, because from 1990 to 2010 and from 2010 to 2035 its annual growth rate was 14.4 percent and 8.1 percent respectively.

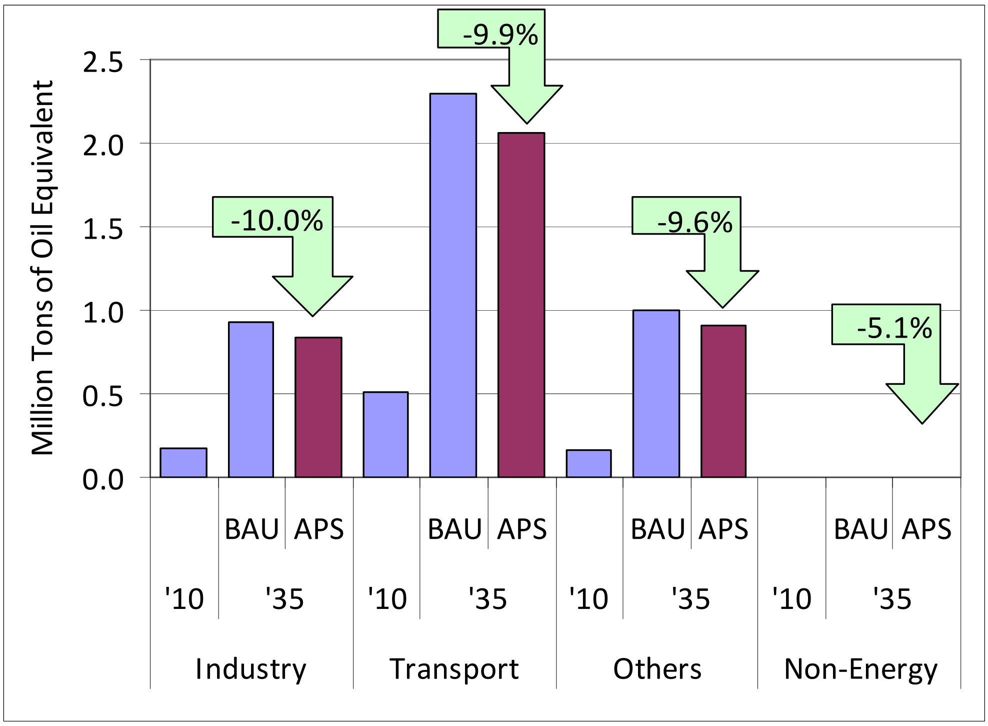
Figure 10-2: Final Energy Demand by Energy, BAU



2.1.2. Alternative Policy Scenario (APS)

In the APS, the growth of total final energy demand will be slightly lower than in the BAU. This is due to the energy policy of the Lao PDR Government planned to be implemented in the near future. The policy includes an increase of the renewable energy share in total energy supply by 30 percent by 2025, 10 percent blend of bio-fuels in oil supply for the transportation sector and the reduction of 10 percent in energy demand of all sectors. By implementing these measures, the total final energy demand is estimated to reduce from 4.2 MTOE in BAU to 3.8 MTOE in APS.

Figure 10-3: Final Energy Demand by Sector, BAU vs. APS



2.2. Primary Energy Demand

The total primary energy demand in Lao PDR increased from 0.3 MTOE in 1990 to 0.9 MTOE in 2010 at an average annual rate of 6.6 percent. Oil demand increased at an annual rate of 5.5 percent on the average while hydro electricity production increased by 12.4 percent per annum on the average. Coal started to figure in the primary energy mix in the late 2000's and had a 11.9 percent share in 2010.

2.2.1. Business as Usual (BAU)

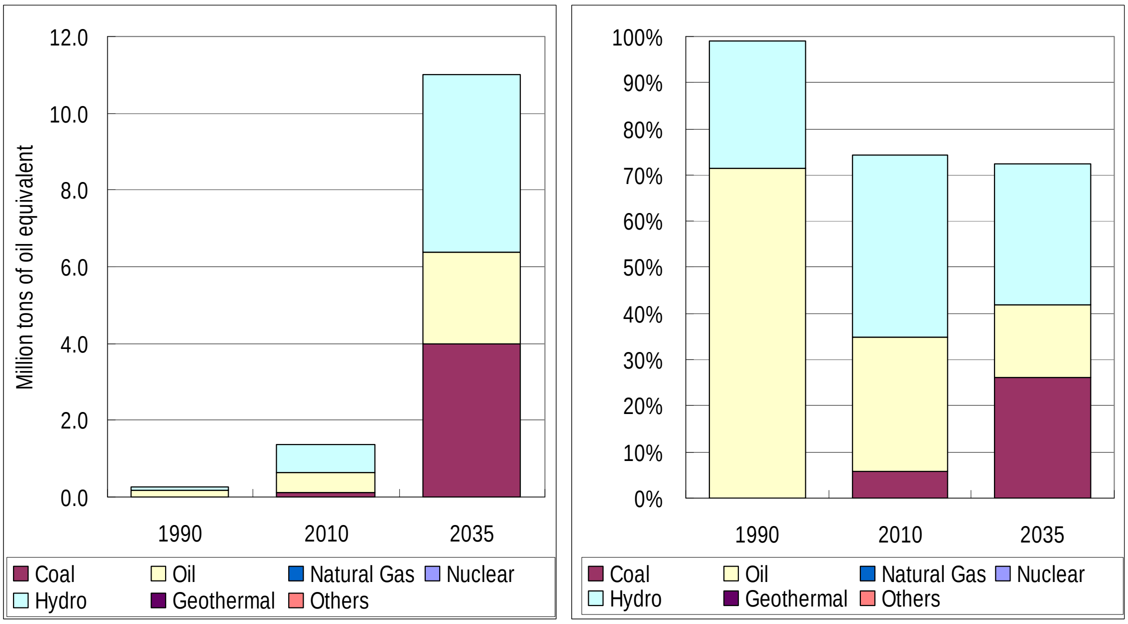
The total primary energy demand of Lao PDR will grow at an average annual rate of 8.5 percent from 2010 to 2035 under the BAU scenario, reaching. 6.8 MTOE by 2035. Looking at a share of that total in 2010, hydro has had a biggest share of 81.3 percent but most of the hydro energy had been exported to Thailand. The exporting figure shared 52 percent of the TPES in that year. So if considering only energy supplying domestically, hydro would share 29.3 percent of the TPES. Oil and coal shared in that total 60 percent and 11.9 percent respectively.

Coal will grow at the fastest rate of 15.6 percent during the period due to development of one big and first coal power plant in the country, the Hongsa Lignite

Power Plant which will be operated from 2015 onwards.

Hydro will also increase but at a lower rate compared with that of coal. It will increase from 0.7 MTOE in 2010 to 4.7 MTOE in 2035, at an average of 7.7 percent per year. Oil demand will rise at 6.1 percent per year on the average, from 0.5 MTOE in 2010 to 2.4 MTOE in 2035.

Figure 10-4: Primary Energy Demand in BAU



2.2.2. Alternative Policy Scenario (APS)

In the APS, the total primacy energy demand will increase at an average rate of 8.2 percent throughout the projection period between 2010 and 2035. It is projected to increase from 0.9 MTOE in 2010 to 6.4 MTOE in 2035. If compared with BAU, the total primary energy demand in APS will be 6.2 percent lower or equivalent to 0.4 MTOE. The reduction in total primary energy demand resulted from the implementation of a number of energy strategies and measures as mentioned above.

Figure 10-5: Primary Energy Demand by Energy, BAU vs. APS

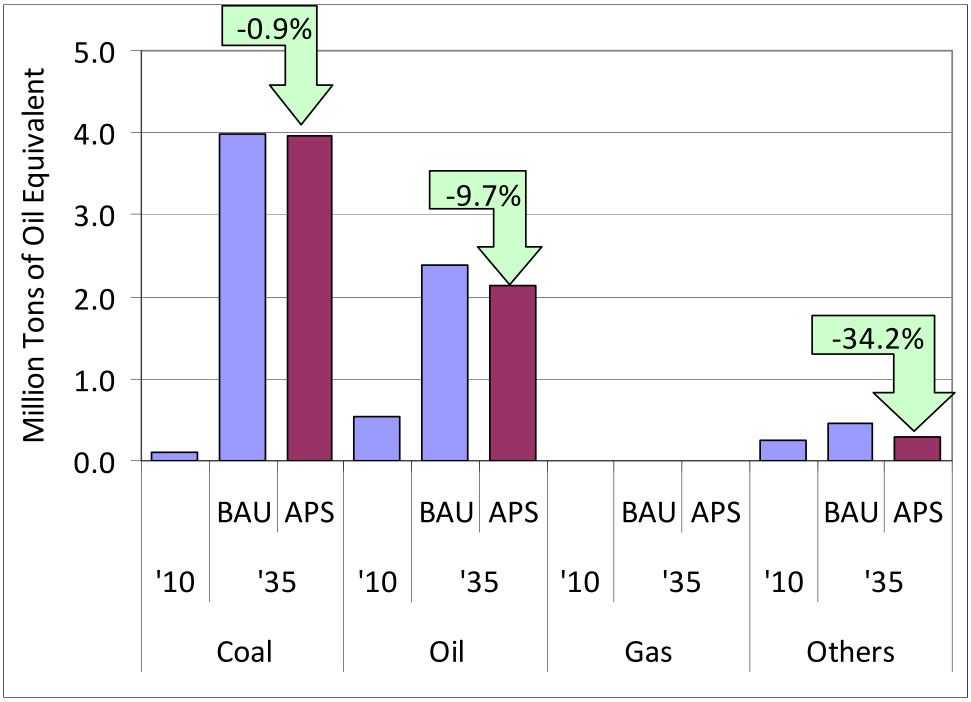
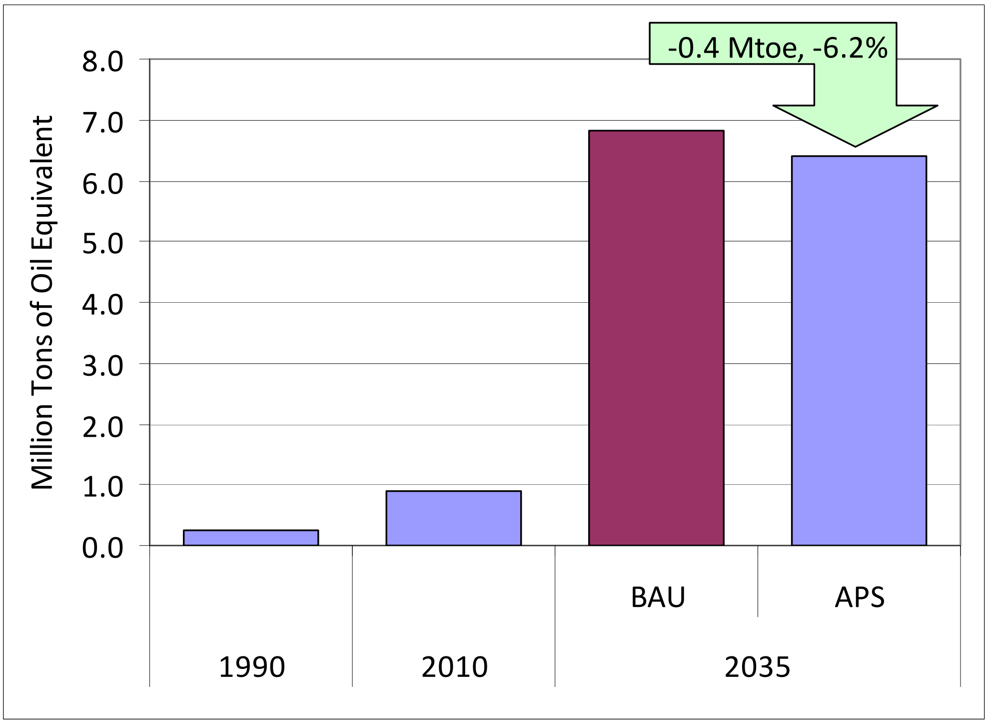


Figure 10-6: Evolution of Primary Energy Demand, BAU vs. APS



2.3. CO_2 Emission

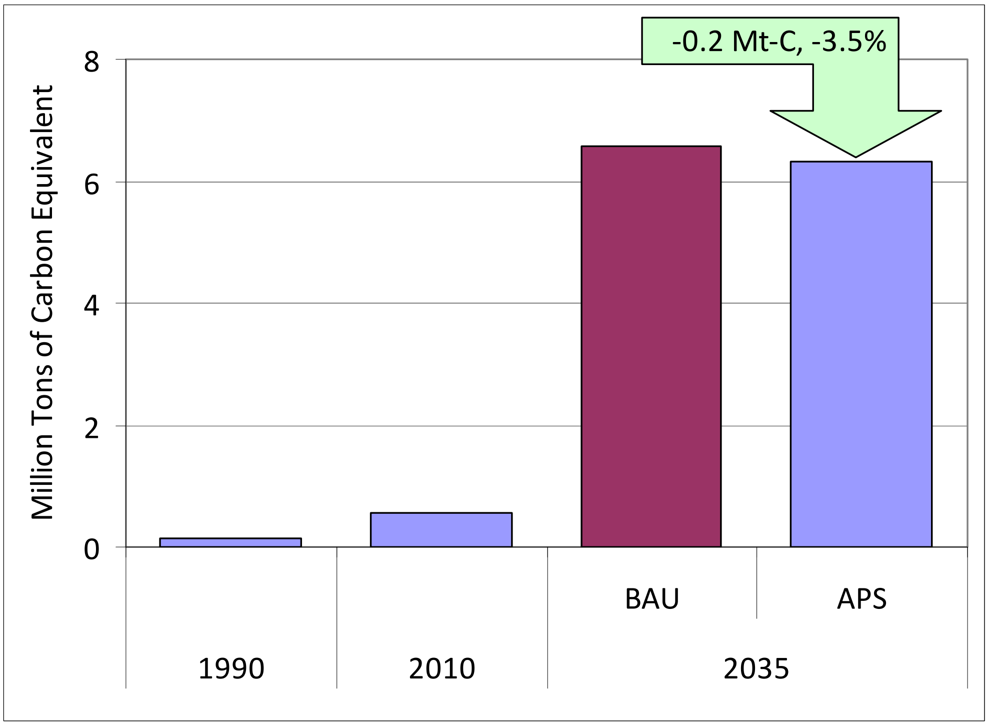
2.3.1. Business as Usual (BAU)

In the BAU, CO_2 emissions will increase from 0.4 Mt-C in 2010 to 16.8 Mt-C in 2035 at an average annual growth rate of 15.8 percent per annum. The high increase of CO_2 emission is due to the operation of a lignite power plant. Before the operation of this coal power plant, almost 100 percent of electricity generation in Lao PDR is from hydropower.

2.3.2. Alternative Policy Scenario (APS)

In the APS, the CO_2 emissions will be increasing but at a slower rate than the BAU case. The average annual growth rate of CO_2 emission in the APS will be 15.8 percent, reducing the total CO_2 emission to 0.2 Mt-C, roughly 0.9 percent lower than BAU.

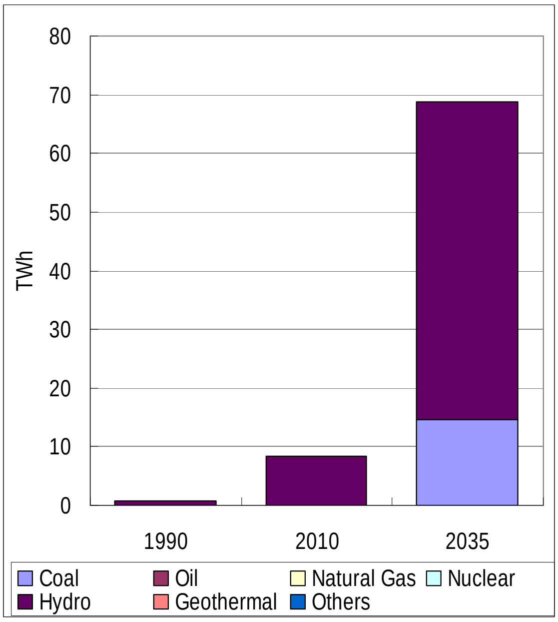
Figure 10-7: CO_2 Emission from Energy Combustion, BAU vs. APS

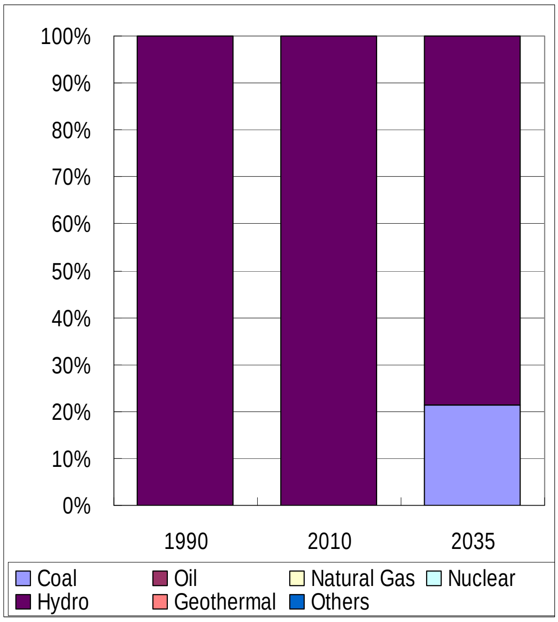


2.4. Power Generation

For many decades since Lao PDR started using electricity in 1960s, the power sources have been remaining hydropower types. The generation mix is only hydropower. Up to date there is still 100 percent of powers are being generated from hydropower. However in 2016 the first ever thermal power plant called Hongsa thermal power plant will be commissioning with an installed capacity of 1,878 MW. Its thermal efficiency is estimated to be around 35 percent. In 1990, there were 0.82 MTOE of power having generated. The power production has increased to 8.45 MTOE in 2010 and 54.1 MTOE in 2035 in which hydropower will still be shared by a largest as 78.6 percent of the total generation.

Figure 10-8: Power Generation and its mix in BAU



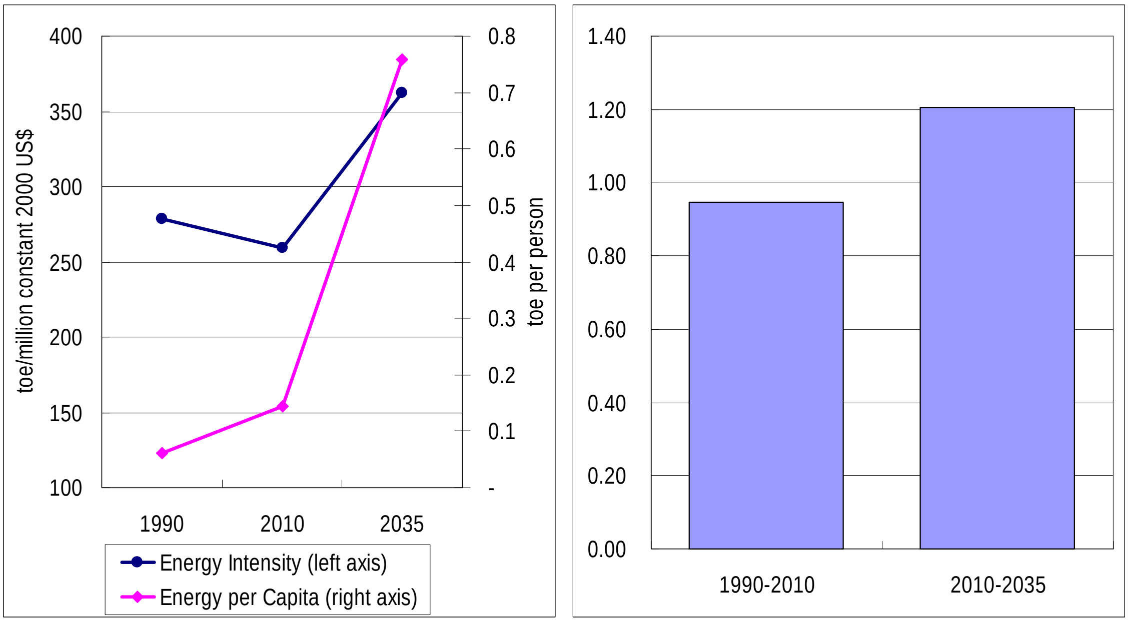


2.5. Energy intensity, energy per capita and energy elasticity

As the country has been accelerating the development in all sectors and increasingly exporting power to its neighbouring countries resulted to energy intensity fluctuated from 278.67 toe/million constant 2000 US$ in 1990 to 259.54 toe/million constant 2000 US$ and 339.49 toe/million constant 2000 US$ in 2010 and 2035 respectively. Therefore it has been still expecting to -0.31 from 2010 to

2035. In the same time, TPES per capita has been also increasing from 0.06 TOE in 1990, to 0.22 TOE and 1.22 TOE.

Figure 10-9: Energy Intensity, Energy per Capita and Energy Elasticity, BAU



Based on the annual growth rates of energy and GDP, during the years from 1990 to 2010 the energy elasticity was 0.94 while from 2010 and 2035 it will be 1.21. The periodical energy elasticity is shown in the below figure.

3. Findings and Policy Implication

3.1. Findings

In this energy outlook, the GDP of Lao PDR is assumed to grow at an average annual growth rate of 7.0 percent from 2010 to 2035 while population growth is assumed to grow at an average annual growth rate of 1.6 percent. By the year 2035, if the three energy measures of the Government are implemented, the total primary energy demand will decrease from 6.8 MTOE in the BAU to 6.4 MTOE in APS.

Consequently, the energy intensity of the APS in 2035 will also be smaller than the BAU, almost 22 toe/million US$ lower. The energy per capita of Lao PDR will also be 0.51 TOE lower in the APS as compared to the BAU, i.e.: 1.22 toe/capita versus 0.71 toe/capita respectively.

The CO_2 intensity will increase over the 2010-2035 period for both BAU and APS. However, in 2035 the CO_2 intensity of the APS will only reach 0.88 t-c/million 2000 US Dollar, 0.005 t-C lower than that of the BAU.

3.2. Issues

As Lao PDR strives to develop itself to modernization and industrialization, to achieve the Millennium Development Goals by 2015 and to get rid of the status of the least developed countries by 2020, the Lao Government has been focusing on the development of basic infrastructure. For the energy sector, the government endeavours increasing the modern energy consumption to all sectors and all regions of the country because using ratio or energy consumption per capita is still very low. Therefore energy saving is still not getting public attentions and support. But in recent years, this aspect is being seen as importance because every year the country has been using a lot of foreign currency to import energy especially oil. In addition, some months during the dry season the country encountered the shortage of electricity. So the government encourages the public to use energy more efficiently and save energy. To have effectiveness of energy saving the government has to develop policy, strategy, energy saving goals and law.

3.3. Policy Implication

In this study, Lao PDR will get the energy savings mainly through the implementation of the government's renewable energy and energy conservation programs. The programs consist of an increase of the renewable energy share in total energy supply by 30 percent by 2025, input 10 percent of bio-fuels in oil supply for the transportation sector and the reduction of 10 percent in energy consumption of all sectors.

In order to have energy reduction both in total primary energy supply and total final energy demand, as well as the reduction in CO_2 emissions, Lao PDR should extend the implementation of the renewable energy and energy conservation programs until 2035. As the energy conservation programs are important in achieving the energy reduction, it should be proposed to be a national policy. At the same time, there should be sound projects and programs to be implemented. In addition, the study on correlation between GDP and energy consumption should be carried out and energy statistics should be improved accordingly.

CHAPTER 11

Malaysia Country Report

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1. Background

Malaysia is located in Southeast Asia. Its 330,803 square kilometres of territory consist of Peninsular Malaysia and the Sabah and Sarawak States on the island of Borneo. Malaysia has a tropical, humid climate with temperatures averaging 86^{o}F (30^{o}C). The total population of Malaysia was 29.3 million in 2012. GDP grew at an average of 5.5 percent per year from 1990 to 2012. After experiencing a sluggish growth in 2009, the economy recovered and continued its strong growth momentum, expanding by 5.6 percent in 2012. The overall growth performance was driven by higher growth in domestic demand, which outweighed the negative impact from the weak external environment. Domestic demand recorded the highest rate of expansion over the recent decade, underpinned by higher demand and investment spending. Despite the uncertainties in the external environment, domestic consumer confidence picked up amidst positive income growth, continued strength in the labour market, the low inflation environment and supportive financing conditions.

Total population was 28.9 million in 2011 and increased to 29.3 million in 2012 with increasing population density. About 68.4 percent of the population is within the 15-64 age brackets. The urbanization rate is expected to continue to increase. Life expectancy at birth also showed an upward trend. This improvement can be attributed to the extensive network of health care services in Malaysia, mainly provided by the government. Income per capita increased from RM 29,661 in 2011 to RM 30,809 in 2012. GDP for 2012 was made up as follows: services (55.3

percent), manufacturing (27 percent), agriculture, livestock, forestry and fishing (7.4 percent), mining and quarrying (8.6 percent), and construction (3.4 percent). Unemployment decreased to 3.0 percent in 2012 from 3.1 percent in 2011.

Malaysia is well endowed with conventional energy resources such as oil, gas, and coal, as well as renewables such as hydro, biomass and solar energy. As of January 2012, reserves included 5.95 billion barrels of crude oil, 92.12 trillion cubic feet of natural gas and 1,483 million tons of coal. Malaysia is a net energy exporter. In terms of energy equivalent, Malaysia has gas reserves, which are four times the size of its crude oil reserves. Natural gas reserves off the east coast of Peninsular Malaysia are dedicated for domestic demand while those in Sarawak are allocated as revenue earner in the form of liquefied natural gas (LNG) exports. In 2011, Malaysia generated 123.6 terawatt hours (TWh) of electricity. Coal has become the largest fuel input in the power sector with a share of 46.6 percent, followed by natural gas at 39.3 percent, hydro at 6.6 percent and oil at 7.5 percent. In 2010, Malaysia had 28 gigawatts (GW) of installed generation capacity.

The role energy plays in achieving the goals of sustainable development in Malaysia had been recognised many years ago. The sustainability of energy resources have been strategically planned over the years with energy policies that have been developed after careful evaluation of the current and future energy needs and supply of energy. Malaysia's energy policies can be traced back to as early as the 1970s. The major energy policies implemented in the country are as follows:

(i) National Petroleum Policy (1975)
(ii) National Energy Policy (1979)
(iii) National Depletion Policy (1980)
(iv) Four Fuel Diversification Policy (1981)
(v) Five Fuel Policy (2001)
(vi) Biofuel Policy (2006)
(vii) New Energy Policy (2010)

2. Modelling Assumptions

The econometric approach is the method applied in forecasting the final energy demand. The historical correlation between energy demand as well as macroeconomic and activity indicators were derived by regression analysis using Microfit. Microfit is an interactive software package written for microcomputers, and is designed for the econometric modelling of time series data. It has powerful features for data processing, file management, graphic display, estimation, hypothesis testing, and forecasting under a variety of univariate and multivariate model specifications.

The future energy demand for various energy sources were estimated using assumed values of the macroeconomic and activity indicators. Future values of these indicators were also derived using historical data depending on the sufficiency for such analysis. In the model structure, energy demand is modelled as a function of activity such as income, industrial production, number of vehicles, number of household, number of appliances, floor area of buildings etc. In the residential sector for example, the demand for electricity could be a function of number of households, disposable income and penetration rate of electrical appliances. In the commercial sector, energy demand could be driven by building floor arrears, private demand and other factors that encourage commercial activities. However, due to unavailability of information on the activity indicators, the macroeconomic parameter i.e. the Gross Domestic Product (GDP) was the best variable to utilise in establishing the relationship with the energy demand trend. These macroeconomic indicators were mainly used to generate the model equations. In some cases where regression analysis was not applicable due to insufficiency of data or there was failure to derive a statistically sound equation, other methods, such as share of percentage approach, were used.

One of the main drivers of the modelling assumption is GDP growth rates. Based on a study carried out by Economic Planning Unit (EPU) under the Prime Minister Office of Malaysia, the assumption growth rates of future GDP was applied. Most of all the demand equations for Malaysia were using GDP as the key factor to determine future projections. The assumption of GDP growth rates are found below:

Table 11-1: GDP Growth Assumptions by Sector to 2035

Period	Growth Rates (%)
2010-2015	4.5
2015-2020	4.3
2020-2025	3.5
2025-2035	3.4

Source: Economic Planning Unit

Besides GDP future growth rates, the annual average population growth was also considered as one of main key driver for future energy growth. The assumption of future growth rates of population was obtained from the United Nations website. The future assumption of population growth rates as below:

Table 11-2: Population Growth Assumption to 2035

Period	Growth Rates (%)
2010-2015	1.57
2015-2020	1.43
2020-2025	1.29
2025-2030	1.15
2030-2035	0.99

Source: United Nations

As part of the government initiative to ensure the security of energy supply and at the same time conserve the environment and promote green technology, the introduction of feed in tariff (FiT) is an effort towards that direction. With a lot of renewable energy sources potential, Malaysia can fully utilise it resources by converting it to electricity. The implementation of FiT will promote and ensure that renewable energy supply can be part of Malaysia's future generation mix. Furthermore, this action will support the achievement of the Government's target to reduce up to 40 percent of the C02 emission intensity by 2020 from 2005 level. The introduction of biodiesel in the market gradually by region starting June 2011 is one of the other actions to meet the target. There is a target for biodiesel use to go nationwide by 2014. The implementation could not be made sooner because there were no enough blending facilities for the alternative fuel. The 2400 MW Bakun dam is expected to commercially produce its first 300 MW in July 2011. This definitely will increase hydro share in the fuel mix for Malaysia. As part of alternative energy for future, nuclear power was also considered to be a part of the future supply mix for power generation around 2023.

Improving energy efficiency is one of the most cost effective means of matching supply and demand. In Malaysia, there are additional reasons for focusing on energy efficiency. In residential sector, regulatory instruments in the form of Minimum Energy Performance Standards (MEPS) and appliance labelling will be developed for major domestic appliances (including refrigerators and air conditioners). The fiscal instruments in the form of tax incentives for manufacturers and importers of energy efficient appliances will be used as an interim measure until such time as MEPS and labelling standards are ready to be implemented. In the commercial sector especially the building sector, energy efficiency performance standards will form part of the building standard for new buildings and for significant retrofits. Training programs for architects and building equipment specifications will be used as a means of helping improve the long term efficiency of building stock. While for industrial sector, educational or training initiatives aimed at industry, consultants and suppliers will be implemented as a means of fostering efficiently configured industrial systems. Furthermore, mandatory energy efficiency audits will be introduced as a means of identifying opportunities to improve energy efficiency performance in particular applications. Barriers to development of co-generation (e.g. the ability to sell power to the grid) will be addressed as a means of facilitating its development. Under the Greater Kuala Lumpur plan, the new route of Mass Rapid Transportation (MRT) is now being undertaken by the Government to increase more public transportation in Klang Valley. The National Automotive Policy (NAP) was introduced on 22 March

2006 by the Ministry of International Trade and Industry (MITI) as the main thrust for the formulation of the strategic directions of the industry under the Third Industrial Master Plan (IMP3), 2006-2020. As transport is highlighted as one of the sector under the green technology policy, MITI launched the Review of National Automotive Policy (NAP) in early 2010 to review the existing NAP to foster more competitive market for local and international companies. In order to promote high value and green technology, the revised policy highlights the development of related Infrastructure to promote Hybrid and Electric Vehicles as the main agenda. The NAP Review assigns Ministry of Energy, Green Technology and Water to draw up a roadmap to develop the infrastructure for electric vehicles.

The details of future assumptions based on their respective scenarios as mentioned in table below:

Table 11-3: Energy Efficiency Assumptions

SCENARIOS	ASSUMPTIONS
Energy Efficiency (EEC)	1. Electricity Demand in Industrial Sector (INEL)
	Potential reduction of electricity demand in industrial sector from the year 2015 until 2035 by 0.8 percent per year.
	2. Total Energy Demand in Industrial Sector (INTT)
	Potential reduction of total energy demand (electricity + petroleum products + coal + natural gas) in industrial sector by 1.0 percent per year from
	3. Total Energy Demand in Commercial Sector
	Potential reduction of total energy demand in commercial sector by 1.0 percent per year from 2015 until 2035.

Table 11-4: Alternative Energy Assumptions

<table>
<tr><th>SCENARIOS</th><th colspan="7">ASSUMPTIONS</th></tr>
<tr><td rowspan="9">Renewable Energy (RE)</td><td colspan="7">1. By 2030, Malaysia will be expected to have these renewable energy (RE) capacities in power generation. The breakdown of the capacity based on type of fuels type are showed below:</td></tr>
<tr><th colspan="7">Cumulative Capacity (MW)</th></tr>
<tr><th>Year</th><th>Biomass</th><th>Biogas</th><th>Mini-Hydro</th><th>Solar PV</th><th>Solid Waste</th><th>Total</th></tr>
<tr><td>2015</td><td>330</td><td>100</td><td>290</td><td>55</td><td>200</td><td>975</td></tr>
<tr><td>2020</td><td>800</td><td>240</td><td>490</td><td>175</td><td>360</td><td>2065</td></tr>
<tr><td>2025</td><td>1190</td><td>350</td><td>490</td><td>399</td><td>380</td><td>2809</td></tr>
<tr><td>2030</td><td>1340</td><td>410</td><td>490</td><td>854</td><td>390</td><td>3484</td></tr>
<tr><td colspan="7">2. In 2014, 5 percent of Malaysia’s share of diesel demand in transport sector will come from biodiesel.</td></tr>
<tr></tr>
<tr><td>Nuclear energy</td><td colspan="7">2000 MW will be commissioned in 2023.</td></tr>
</table>

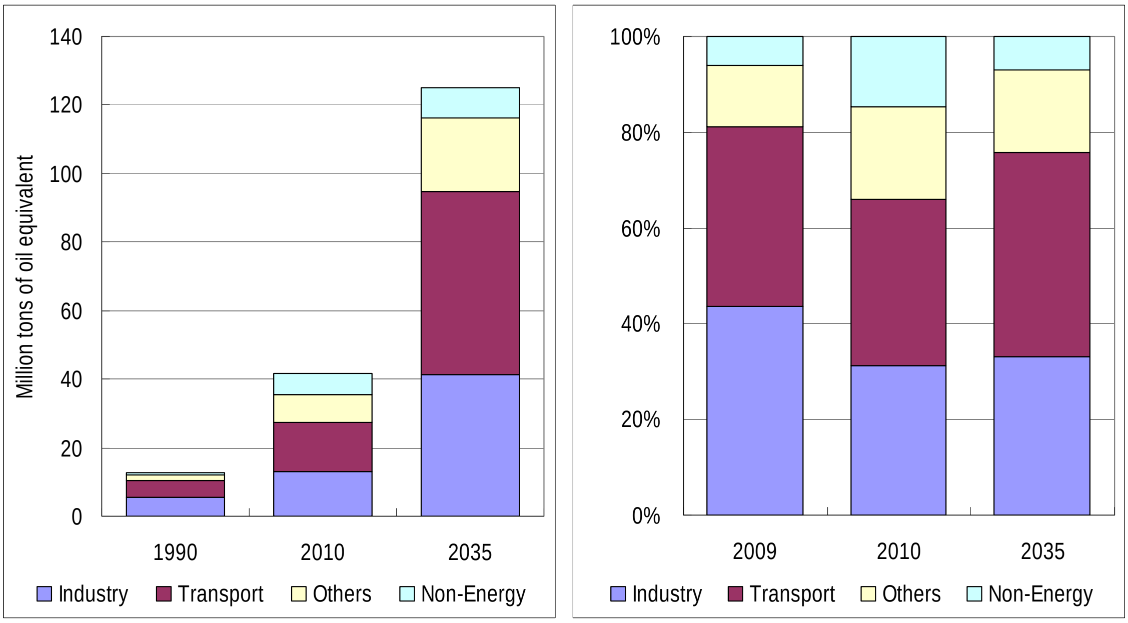
3. Outlook Results

3.1. Business-as-Usual (BAU) Scenario

Final Energy Demand

Total final energy demand in the BAU scenario will increase from 41.6 Mtoe in 2010 to 125.0 Mtoe in 2035. This illustrates an average growth rate of 4.5 percent per year. Natural gas demand will experience the highest growth over the same period at an average growth of 5.1 percent per year. Electricity demand will grow from 9.5 Mtoe in 2010 to 29.1 Mtoe in 2035 or 4.6 percent per year. Oil demand will increase at an average annual growth rate of 4.4 percent from 2010 until 2035. The final demand of coal that was usually consumed by cement industry will grow from 1.8 Mtoe in 2010 to 4.0 Mtoe in 2035 or 3.2 percent per year.

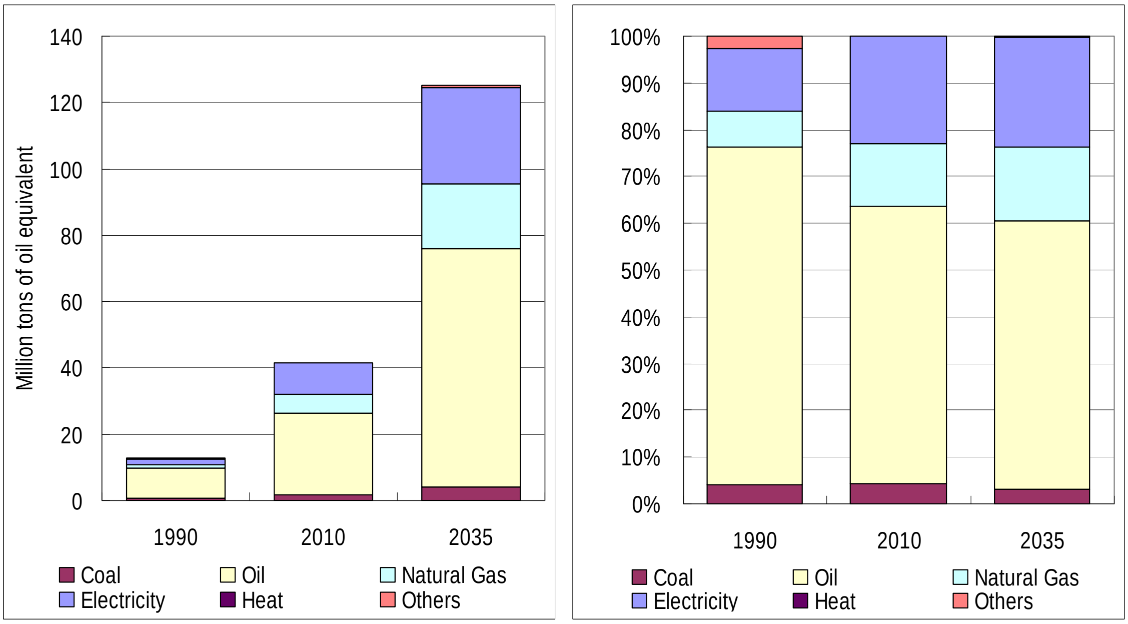
Figure 11-1: Final Energy Demand by Fuels, BAU



Analysis by share showed that oil will still dominate the country's total demand with 57.4 percent in 2035 as compared to 59.2 percent in 2010 followed by electricity with 23.3 percent in 2035 from 22.9 percent in 2010. The share of natural gas will increase to 15.8 percent as compared to13.5 percent in 2010. While the share of coal will decline from 4.4 percent in 2010 to 3.2 percent in 2035.

Final energy demand by sector showed that the transport sector will lead the growth with 5.4 percent per year from 2010 until 2035 followed by the industrial sector, growing from 13.0 Mtoe in 2010 to 41.3 Mtoe in 2035 or 4.7 percent growth per year. The other sectors will increase at an average rate of 4.0 percent per year from 2010 until 2035. Non-energy consumption is expected to increase from 6.1 Mtoe in 2010 to 8.7 Mtoe in 2035 or growth rate of 1.4 percent per year.

Figure 11-2: Final Energy Demand by Sectors, BAU

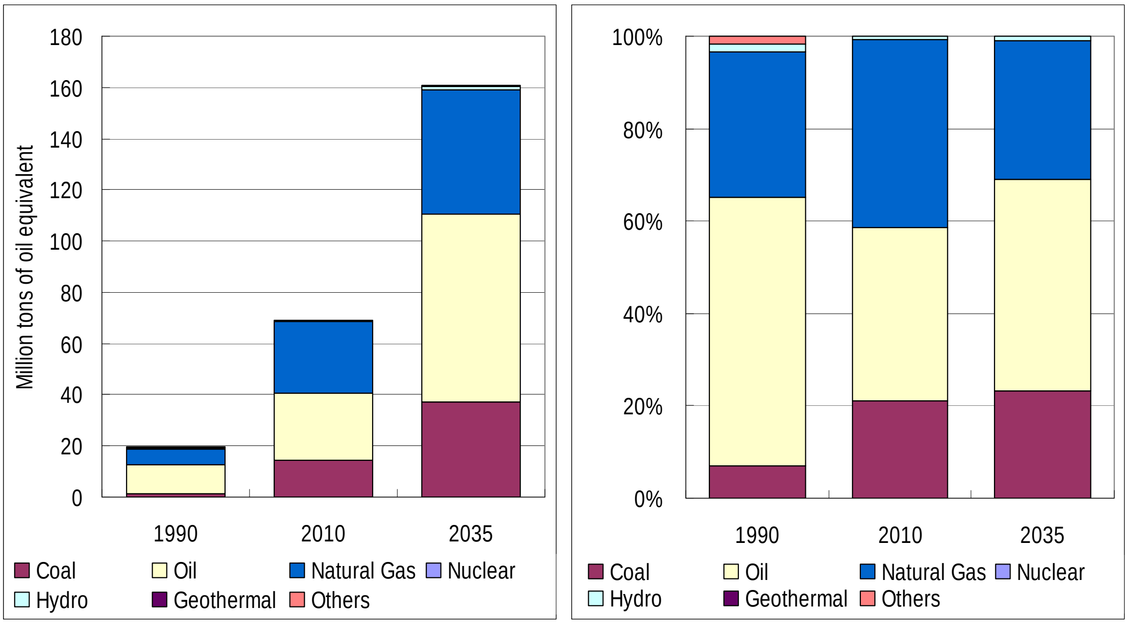


Analysis by share showed that the transport sector will still dominate the energy usage in 2035 with 42.7 percent as compared to 34.7 percent in 2010 followed by the industry sector with its share at 33.0 percent in 2035. Other sectors will consume around 17.3 percent of the total final energy demand in 2035 while the share of non-energy consumption is about 7.0 percent.

Primary Energy Demand

Total primary energy demand in the BAU scenario registered a growth at 6.5 percent per year from 1990 until 2010. The outlook results showed that the total primary energy demand is projected to increase by 3.4 percent per year from 2010 until 2035. Hydro will increase from 0.56 Mtoe to 1.6 Mtoe over the same period with an average annual growth rate of 4.3 percent. Oil supply will increase at 4.2 percent per year from 2010 until 2035. The supply of coal that was consumed mainly for power sector will be expected to increase by 3.8 percent per year from 2010 until 2035. Natural gas will experience an increase from 28.1 Mtoe in 2010 to 48.2 Mtoe in 2035 at an average annual growth rate of 2.2 percent.

Figure 11-3: Primary Energy Demand, BAU



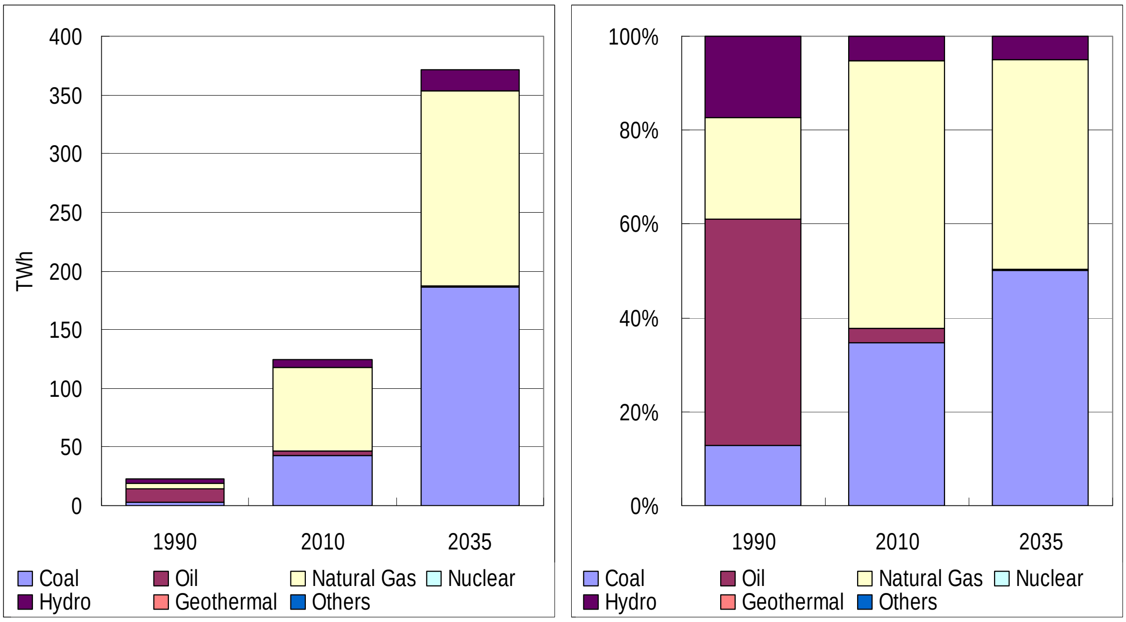
In terms of share by fuel type, oil will have an increasing share from 37.6 percent in 2010 to 45.7 percent in 2035. The share of coal will also increase from 21.1 percent in 2010 to 23.2 percent in 2035. Hydro will increase from 0.8 percent in 2010 to 1.0 pecent in 2035 while natural gas share will decline from 40.5 percent in 2010 to 30.0 percent in 2035.

Power Generation

In the BAU scenario, total power generation is expected to grow around 4.5 percent per year from 2010 until 2035 reaching 371.8 TWh. Coal will experience the fastest growth at 6.0 percent per year over the projected period. This will be followed by hydro at 4.3 percent per year, increasing from 6.5 TWh in 2010 to18.4 TWh in 2035. Electricity generation from natural gas will increase at an average annual growth rate of 3.5 percent per year from 2010 until 2035. Generation of electricity from oil is expected to decline by 5.1 percent per year from 3.7 TWh in 2010 to 1.0 TWh in 2035.

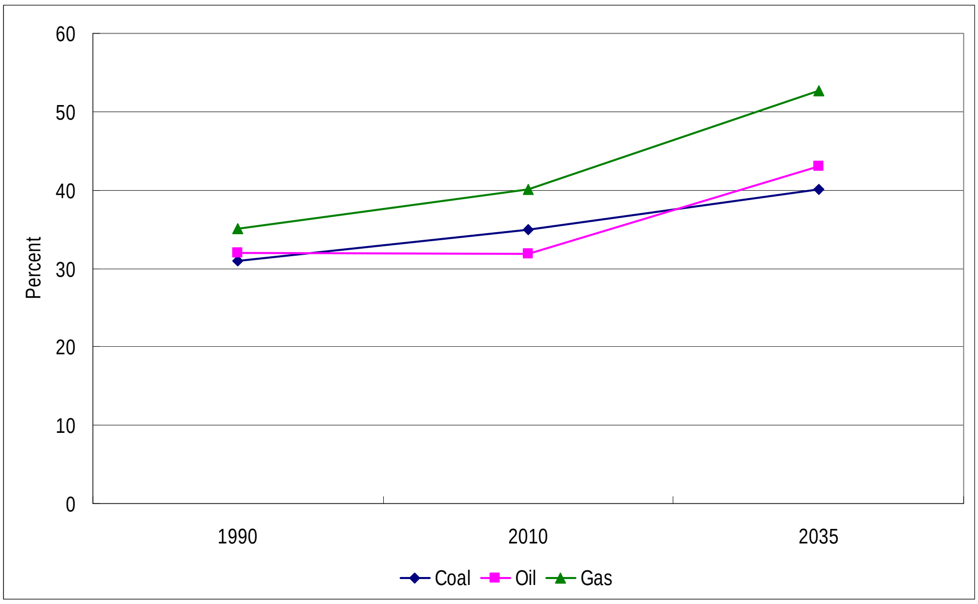
In terms of share, the power generation mix will be dominated by coal in 2035 with share of 50.1 percent compared to 34.7 percent in 2010. This will be followed by natural gas with a share of 44.6 percent in 2035 as compared to 57.1 percent in 2010. Share of hydro will be 4.9 percent of the total power generation in 2035. The share of oil and others will be very small, only 0.3 percent and 0.1 percent respectively.

Figure 11-4: Power Generation Mix, BAU



In the BAU scenario, the thermal efficiency of coal power plant will be expected to improve to 40.0 percent in 2035 compared to 35.0 percent in 2010. Oil power plant is projected to improve its efficiency to 43.0 percent in 2035 compared to 31.8 percent in 2010 while gas power plant will further improve to 52.7 percent by 2035 as compared to 40.0 percent in 2010.

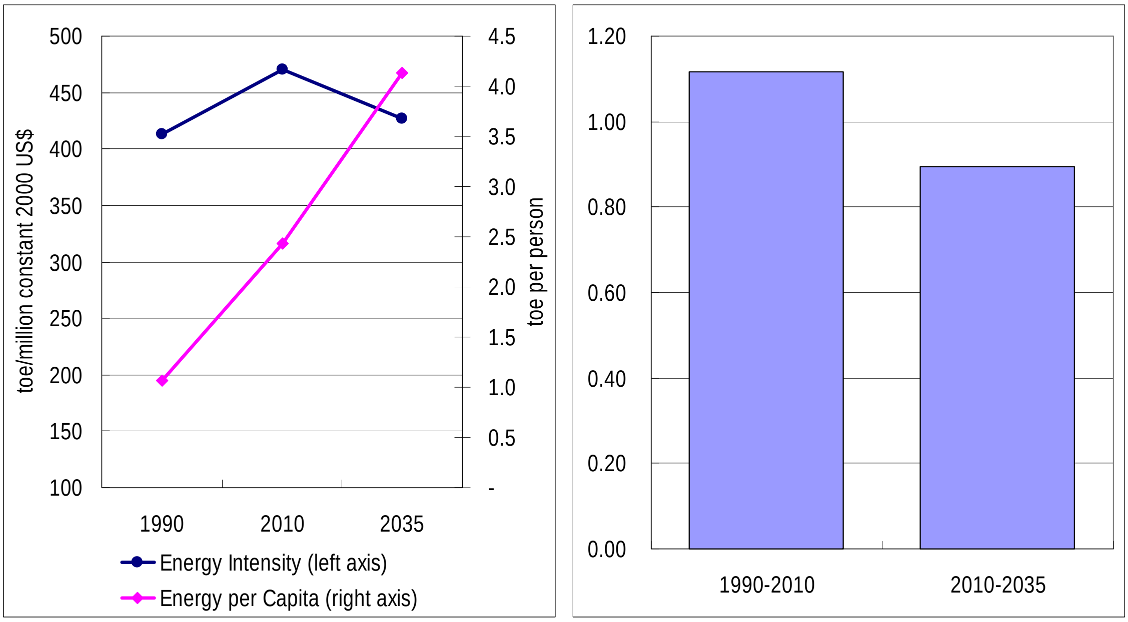
Figure 11-5: Thermal Efficiency by Fuels, BAU



Energy Intensity, Energy per Capita and Energy Elasticity

Malaysia energy intensity will be expected to decline to 427 toe/million USD in 2035 from 470toe/million USD in 2010. However, energy per capita will be increasing from 2.4 toe/person in 2010 to 4.1 toe/person in 2035.

Figure 11-6: Energy Intensity, Energy per Capita and Energy Elasticity, BAU

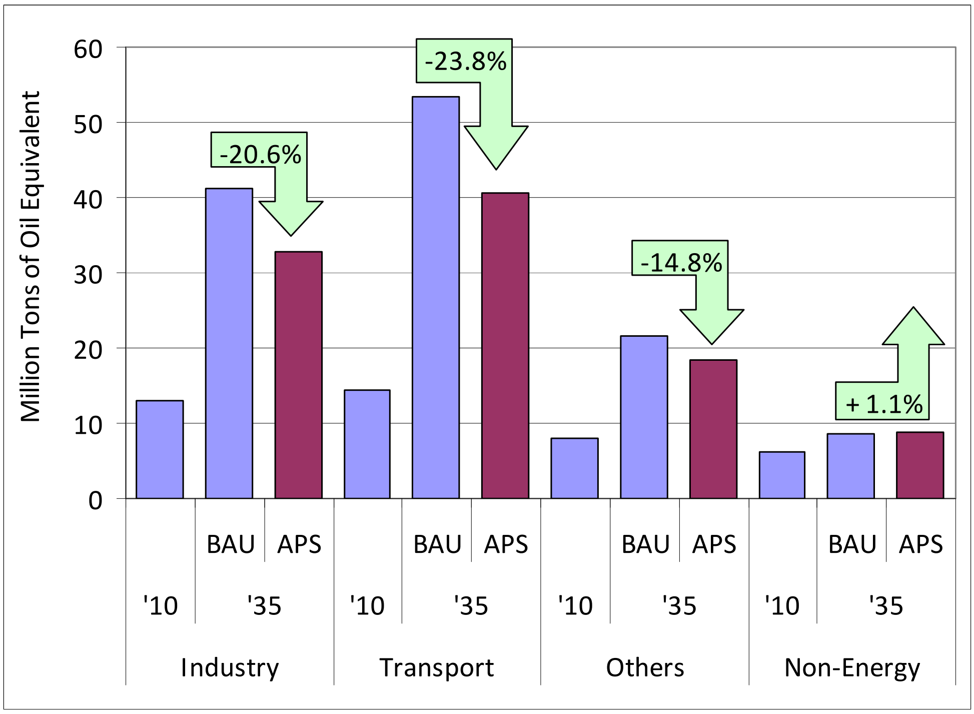


Energy elasticity, which is defined as the growth in energy consumption divided by the GDP growth for certain of time period, shows that from 1990 until 2010, Malaysia's energy elasticity was at 1.1 indicating the growth in energy consumption outpaced the growth in GDP. From 2010 to 2035, energy elasticity will improve to 0.9, indicating that energy consumption will grew at a slower rate that the growth in GDP.

3.2. Energy Saving and CO_2 Reduction Potential

In the Alternative Policy Scenario (APS), the growth in final energy demand will be 3.6 percent per year, slightly lower compared to that of the BAU scenario from 2010 level until 2035. The slower rate of increase in the APS is projected to be the result of improvements in manufacturing technologies as well as efforts to improve energy efficiency, particularly in the industrial sector. This, as a result, is equivalent to savings of 20.6 percent in industry sector in 2035. There is a potential saving of 23.8 percent in transportation sector in 2035 due to improvement of public transportation such as the expansion of electric train system and introduction of electric buses. Furthermore, the introduction of green vehicle such as electric vehicle (EV) and hybrid vehicle will contribute to the potential savings. In the "Others" sector, the growth rate of energy demand is projected to have a lower growth rate of 3.4 percent per year in the APS as compared to to 4.0 percent per year in the BAU scenario. The potential saving of 14.8 percent in 2035 can be achieved through the implementation of energy efficiency measures (Figure 11-7).

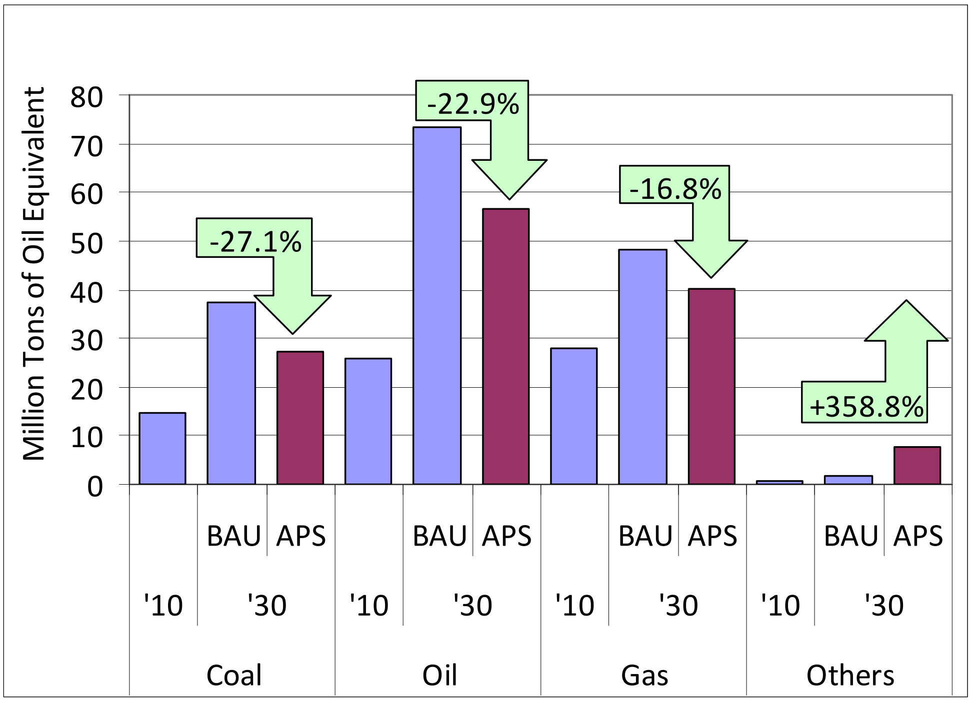
Figure 11-7: Final Energy Demand by Sector, BAU and APS



Primary Energy Demand

In the APS, the net primary energy supply is projected to increase at a slower rate than in the BAU scenario at 2.6 percent per year from 69.2 Mtoe in 2010 to 131.7 Mtoe in 2035. Hydro will be growing the fastest at 4.8 percent per year followed by oil at 3.2 percent between 2010 and 2035. The implementation of FiT in power generation has a big impact to the primary energy demand in 2035 as more power plants running on renewable energy are expected to be commissioned. On the other hand, coal and natural gas will have slower growth rates of 2.5 percent and 1.4 percent, respectively (Figure 11-8). The decline in the growth rate is mainly achieved as a result of energy efficiency and conservation measures on the demand side as well as the assumed higher contribution new and renewable energy to the primary energy mix. Nuclear power is also another future energy option that is projected to figure in the future primary energy mix.

Figure 11-8: Primary Energy Demand by Source, BAU and APS

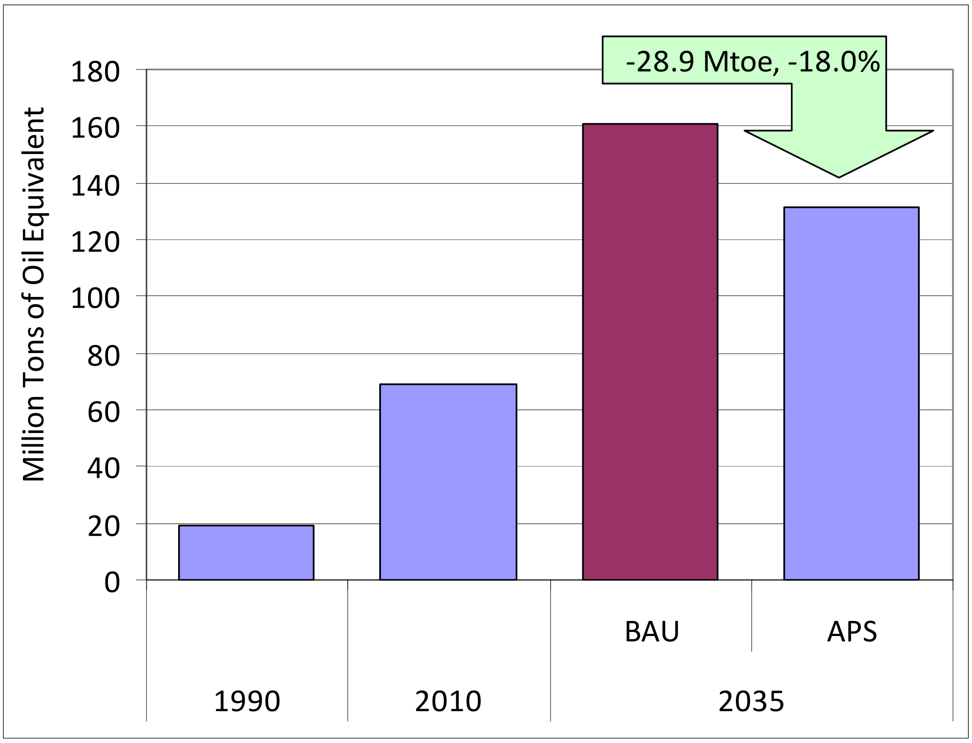


3.3. Projected Energy saving

The energy savings that could be achieved under the APS, relative to the BAU scenario, as a result of energy efficiency efforts in industrial and commercial sectors and fuel switching in transportation sector are estimated at about 28.9 Mtoe in 2035 (Figure 11-9).

The major saving that can be achieved from that total is from switching coal to renewable energy. While for the final energy demand, the saving of 24.3 Mtoe can be achieved in 2035 and would consist of 8.5 Mtoe in the industrial sector, 12.7 in transport sector and 3.2 Mtoe in the commercial sector.

Figure 11-9: Total Primary Energy Demand, BAU and APS



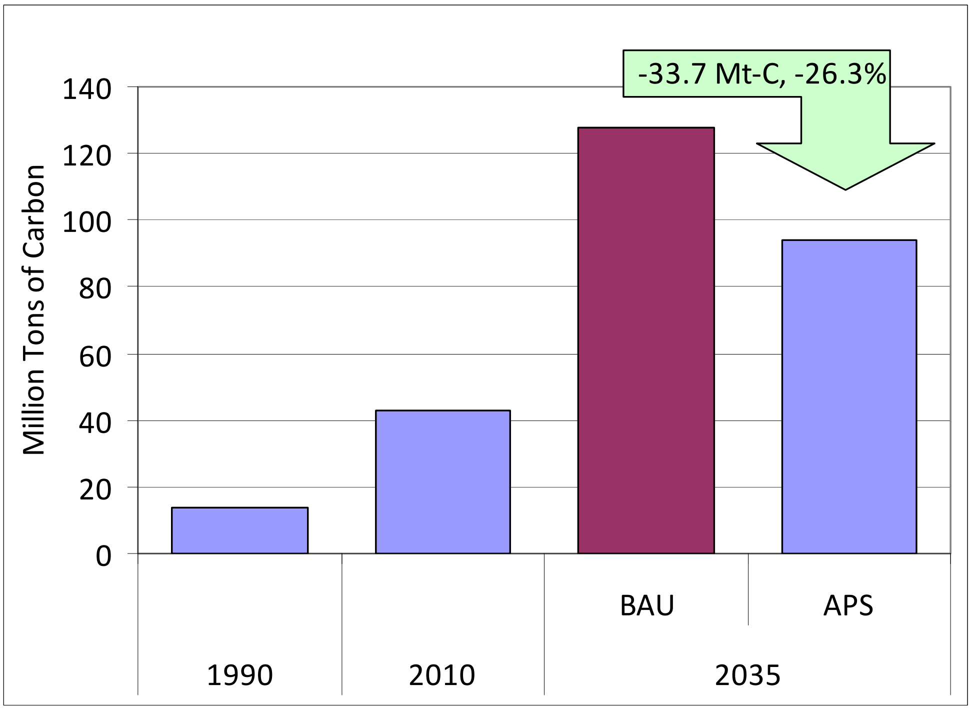
3.4. CO_2 Emissions from Energy Consumption

In the BAU, total carbon dioxide (CO_2) emissions from energy demand are projected to increase by 4.5 percent per year from 2010 level until 2035. In 2010, the CO_2 level was at 42.8 million tons of carbon (Mt-C) and is expected to increase to 127.9 Mt-C in 2035 under the BAU scenario.

In the APS, the annual increase in CO_2 emissions from 2010 to 2035 will be lower than in the BAU scenario at 3.2 percent per year, which is fairly consistent with the growth in primary energy demand. The reduction in CO_2 emissions in the APS of 33.7 Mt-C or 26.3 percent relative to the BAU scenario is also due to a significant decrease in coal demand for power generation in the APS, relative to the BAU scenario, as coal demand is being replaced by natural gas and other clean energy sources such as nuclear and renewable energy. Furthermore, the lower energy usage in industrial and fuel switching in transport sector have also contributed to the reduction.

This indicates that Malaysia's energy saving effort and renewable energy action plan would be effective in reducing CO_2 emissions.

Figure 11-10: CO_2 Emissions from Energy Combustion, BAU and APS



4. Conclusions

Malaysia has potentials to save energy in the BAU and APS scenario based on the future GDP and selected scenario assumptions. One of the interesting finding from the outlook result is that the transport sector will have the highest average annual growth rate (AAGR) in the BAU scenario at 5.4 percent from 2010 to 2035. This raised concerns since the sector will still consume mainly gasoline (petrol) and diesel which has become more costly and will definitely impact the emissions.

Due to that, the National Land Public Transport Master Plan of Malaysia has been developed to look into the development of future planning of public transport in short, medium and long term. The plan will surely reflect the usage of energy in the transport sector thus reducing the road congestion.

Furthermore, to promote of usage of better energy efficient vehicle, the

Government is now implementing full tax exemption for imported hybrid cars in the country until the end of 2013. As a result, many imported hybrid cars are now in the market. This policy should be continued in order to promote the usage of hybrid car in the country.

The development of Electric Vehicle (EV) Roadmap is now entering the 3rd phase of its implementation. By 2014 Malaysia will be expected to commercialize EV in the market. There will be around 100,000 EV on the road by 2020 or 10 percent of the market.

In order to reduce CO_2 emissions in the transport sector, the Government will introduce biodiesel (B10) in the market nationwide as currently, B5 has already been commercialized in the central region since November 2011. The Government is also planning to implement the usage of B40 into the power generation on a trial basis. The trial will be expected to be commissioned in power plants in Sabah.

CHAPTER 12

Myanmar Country Report

TIN ZAW MYINT AND NAY AUNG

Energy Planning Department (EPD), Ministry of Energy (MOE), Myanmar.

1. Background

1.1. Country Profile

Myanmar is the largest country in mainland of South East Asia. Myanmar's territorial area covers 676,577 square kilometres and shares a border of 5,858 km with Bangladesh and India to the north-west, China to the north-east and Thailand to the south-east. Approximately 48 percent of the total land area is covered with forest, and most of the land area is utilized for agriculture. Myanmar has a population of 58 million with an average annual growth rate of 1.0 percent.

Myanmar is geographically located at the tip of the South East Asia Peninsula and has three distinct seasons. It enjoys three to four months of heavy monsoon and abundant sunshine all year round, which makes it ideal for accumulating water resource for hydropower and for agriculture. Its topographic features favour the existence of numerous rivers, mountain ranges and sedimentary basins where mineral deposits and energy resources have accumulated abundantly. The delta regions where the two major river systems enter the Bay of Bengal and the 2832 kilometre coastal strip along the southern part is also a good area for the development of marine ecosystems and an abundant source for marine products and chemicals.

Myanmar is endowed with rich natural resources for production of commercial energy. The available current sources of energy found in Myanmar are crude oil, natural gas, hydroelectricity, biomass and coal. Besides these, wind energy, solar, geothermal, bio-ethanol, bio-diesel, and biogas are the potential energy sources found in Myanmar.

Myanmar's proven energy reserves comprise of 210 million barrels of oil, 20 trillion cubic feet of gas and 711 million metric tons of coal. The country is a net exporter of energy exporting substantial amounts of natural gas and coal to neighbouring countries. However, it imports around 50 percent of its total oil requirements.

1.2. Socio-economic status

The population of Myanmar grew at 1.0 percent per year between 1990 and 2010 to 48 million in 2010. Myanmar's gross domestic product (GDP) was US$ 20.3 billion (constant 2000) in 2010 and its GDP per capita grew from US$ 0.1 thousand in 1990 to US$ 0.4 thousand in 2010. With the objectives of enhancing economic development in Myanmar, five-year short-term plans have been formulated and implemented during the years 1992 to 2011. The first (1992-1995), second (1996-2000) and third plans (2001-2005) achieved average annual growth rates in GDP of 7.5 percent, 8.5 percent and 12.8 percent respectively. The last five-year plan (2006-2010) has been formulated to achieve an average annual growth rate of 12.0 percent in GDP.

1.3. Energy Consumption in the base year

Myanmar's total primary energy consumption was 6.0 million tons of oil equivalent (Mtoe) in 2010. Natural gas is mainly used for electricity generation and in industry. Myanmar has 3,460 megawatts (MW) of installed generation capacity and generated about 7.5 terawatt-hours (TWh) of electricity in 2010. During the same year, thermal (coal, natural gas and oil) and hydro accounted for 32.3 percent and 67.7 percent of total electricity generation, respectively.

2. Modelling Assumptions

2.1. GDP and Population Growth

In this report, Myanmar's GDP is assumed to grow at an average annual rate of around 7.0 percent from 2010 to 2035, slowing from 1990-2010's growth of 8.9

percent. Population is assumed to increase by about 1.0 percent per year from 2010 to 2035.

2.2. Energy Consumption and Electricity Generation

Hydro and natural gas dominated the electricity generation in Myanmar. Other fuels such as oil and coal also contributed in the country's generation mix, but in total only less than 15 percent in 1990. The Government's plan is to increase further the share of natural gas and hydro and other renewables in the total generation mix and decrease oil and coal shares. Myanmar has also plans to export electricity to neighboring countries such as Thailand from its hydro power plants.

2.3. Energy and Climate Change/Environmental Policies

The Myanmar Energy policy in general strives towards maintaining the status of energy independence by increasing indigenous production of available primary energy resources through intensive exploration and development activities. It also addresses electric power as the main driving power source for economic development and the need to generate and distribute in terms of volume, density and reliability. It also advocates the utilization of water resources, a renewable energy resource for generating electricity to save non-renewable sources of energy such as fossil fuels for alternative and future use. Energy Efficiency and Conservation is emphasized in order to save energy through effective energy management and to reduce energy consumption so as to minimize harmful environmental impacts. Encouragement is made to utilize new and renewable energy sources, especially solar and wind which are abundant under Myanmar's climatic condition. It also accepts the fact that utilization of traditional energy sources such as fuel-wood and charcoal still needs to be practiced. Regulatory and anticipatory actions are necessary for the sustained harvesting of this primary energy source.

Savings in Myanmar's energy consumption can be attained through implementation of energy efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from improvement in manufacturing technologies by at least 10 percent by 2020. In the residential and commercial (others) sector, efficient end-use technologies and energy management systems are also projected to induce significant savings. In the transport sector, efficiency improvements will be achieved by improved vehicle fuel economy and more effective traffic management.

Myanmar still lacks a national strategy and action plan for mitigating and adapting to climate change but several ministries have been implementing sector-specific initiatives relevant to climate change. The Government is encouraging the use of biofuel in the transport and agriculture sectors to reduce oil dependency and curb carbon dioxide (CO_2) emissions. These efforts are already in place although the amount of biofuel used in the country is still small for the time being. The Government through the Ministry of Energy has initiated the Clean Fuel Program to reduce carbon dioxide emissions by increasing the use of natural gas in the industrial sector and for power generation; this includes converting gasoline, diesel, and liquefied petroleum gas (LPG) vehicles to compressed natural gas (CNG) vehicles.

The Ministry of Environmental Conservation and Forestry (MOECAF), the designated national authority for clean development mechanism has submitted one hydro power project to UNFCCC for clean development mechanism consideration. The National Environmental Conservation Committee was formed in 2004 and re-formed in April 2011, replacing NCEA, and now serves as the focal organization for environmental matters. It is chaired by MOECAF, formerly the Ministry of Forestry; the Committee's membership includes19 ministries.

The Environmental Conservation Law was enacted by the Government in March 2012. The law provides the legal basis for implementing a range of enhanced environmental management measures. Simultaneously, the draft Environmental Conservation Rule which embodies regulations and technical guidelines, and creating the enabling conditions for their effective implementation is being drawn up and submitted to authorized body.

Myanmar's primary energy saving goal is to reduce energy consumption by 5 percent in 2020 and 10 percent in 2030, relative to the BAU scenario. Specifically, the goals could be achieved by the following strategies:

- In the industrial sector, improve energy efficiency by 10 percent against BAU and reduce energy related greenhouse gases by 2020.
- In the transport sector, have biofuel (E85, biodiesel) substitution of at least 8 percent by 2020.
- Increase the total installed power capacity of renewable energy to 15 percent

by 2020.

- Improve energy efficiency in the commercial/residential sector by 8 percent by 2020.

In addition, the following measures are considered important in achieving the goals:

- To develop energy statistics and support systems to help improve energy efficiency in all sectors by encouraging information dissemination and cooperation between the public and private sectors.
- To develop voluntary action plans for the private sector by 2010 – 2012.
- To develop labelling systems for appliances and buildings by 2015.
- To increase research and development.
- To develop an energy management system through the ASEAN Energy Manager Accreditation Scheme (AEMAS) Program by 2010 – 2015.

On a sectoral basis, the energy efficiency and conservation measures in Myanmar are listed below:

- In industry, gradual replacement of low efficiency equipment with higher efficiency alternatives will be encouraged.
- In the transportation sector, the state will encourage fuel switching in the transport sector to bio-fuels and natural gas as alternative fuels. The state also aims to achieve energy saving through exploiting more efficient transportation networks including road, waterways, rail, air and seaway and develop high-capacity transportation with greater volume capacity for freight and passenger. Improvement in fuel efficiency in the transport sector is also considered.
- In the residential and commercial sectors, the following are the measures that will be implemented:
    - Encourage the use of alternative energy and improvement in energy efficiency in existing buildings in the public and private sectors.
    - Promote the use of higher energy efficient appliances and energy saving equipment in the residential and commercial sectors.
    - Launch the use of bio-diesel (B 100) in rural communities.
- In the electricity sector, the following measures that will be implemented are:

- Develop and expand the energy mix and supply sources through utilization of the full energy potential of the country including frontier exploration and development and intensive research on oil, natural gas, coal, hydropower, geothermal, energy efficiency & conservation and new & renewable sources of energy.
- Replace transformers and install the capacitor banks in main sub-stations. Optimize the voltage, conductor size and loading of transformers.
-

2.4. The National Efficiency Policies

To reach a National Target for EE&C plans and programmes, the Government should implement the following actions:-

- Disseminate knowledge about EE&C to communities and encourage the use of local renewable energy resources instead of fossil fuels.
- Conduct workshops and seminars regarding EE&C to increase public awareness.
- Market promotion in energy efficient equipment and labelling of energy saving appliances such as air-conditioner, motor & pump, electric appliances, etc.
- Encourage the private sector to implement the EE&C programs on a voluntary basis through recognition programmes.
- Provide financial assistance on transferring advanced technology.
- Adoption of best practices is an effective action plan for energy saving in transport, residential & commercial sectors.
- To consider EE&C in both demand and supply sides of electricity.
- There should be proper policy measures and action plans to achieve energy savings targets.

2.5. Action Plan

The energy efficiency initiatives of Myanmar covered buildings, households and the industrial and transport sectors. These initiatives are listed as follows:

Table 12-1: Energy Efficiency Initiatives

SECTORS	EEC INITATIVES
Industrial	- Promote introduction of equipment and facilities with high energy conservation capacity. - Develop energy statistics - Develop goals for voluntary action plans - Develop R & D and AEMAS Program
Transportation	- Raise the fuel efficiency in terms of passenger-km, and km/litre, and - Fuel substitution with biofuels
Electricity	- Develop technology transfer and renewable energy knowledge in rural area - Assist sustainable renewable energy application in electricity generation
Household	- Labelling systems for buildings and appliances - Develop demand side management programs - Thorough management of energy and other resources

3. Outlook Results

3.1. Business As Usual (BAU) Scenario

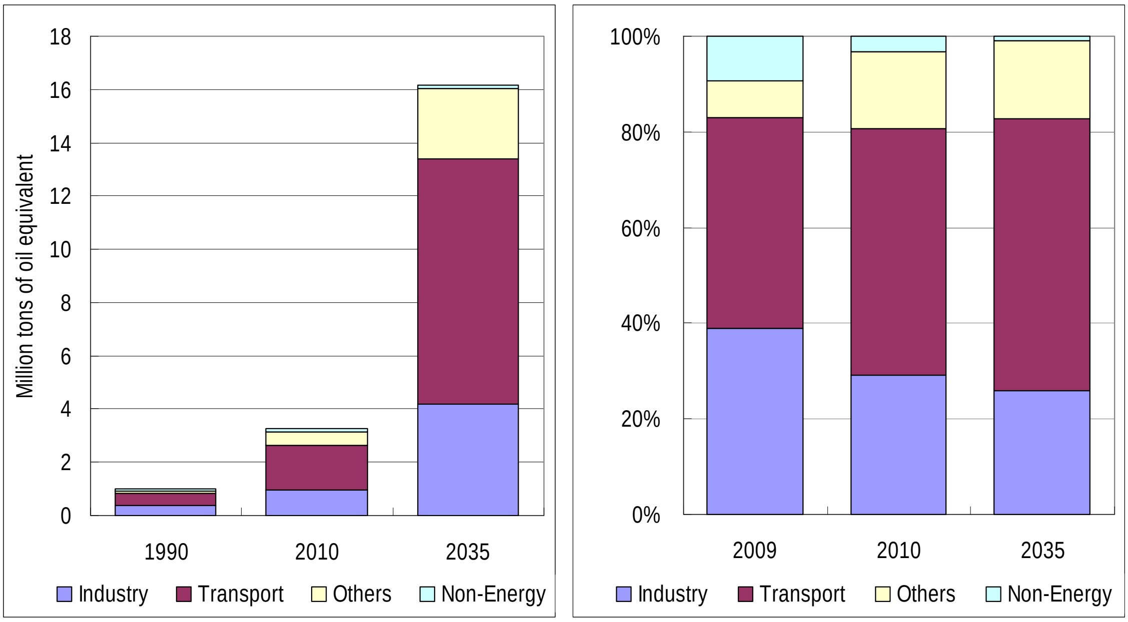
Final Energy Demand

The total final energy demand in Myanmar increased by about 6.0 percent per year from 1.0 Mtoe in 1990 to 3.2 Mtoe in 2010. The ‘others’ sector, which comprises the commercial, residential and agricultural sectors, was the fastest growing sector with an average annual growth of 9.9 percent between 1990 and 2010. Consequently, the share of this sector in the total final energy demand increased from around 8 percent in 1990 to 16 percent in 2010.

The transport sector accounted for more than 44 percent of the total final energy demand of Myanmar in 1990. With an average annual growth rate of 6.9 percent between 1990 and 2010, the share of the transport sector increased to 51.5 percent in 2010. The industrial sector share in the total final energy demand was the second largest in 1990 (39 percent). Since this sector grew on average lower than the transport and other sector (4.5 percent per year), the share of this sector declined to around 29 percent in 2010. Non-energy consumption grew at an average annual growth of 0.7 per year over the same period which resulted in a declining in its in the total final energy demand from 9.2 percent in 1990 to 3.3 percent in 2010.

Using the socio-economic assumptions stated above, final energy demand in Myanmar is projected to grow at an annual rate of 6.6 percent from 2010 to 2035 in the BAU scenario. Final energy demand is projected to grow the fastest to 2035 in the transportation sector with annual average growth of 7.1 percent. In the industry and others sectors, energy demand is projected to grow at an annual average rate of 6.1 percent and 6.7 percent, respectively. The non-energy sector will grow at an average annual rate of 1.3 percent (Figure 12-1).

Figure 12-1: Final Energy Demand by Sector, BAU

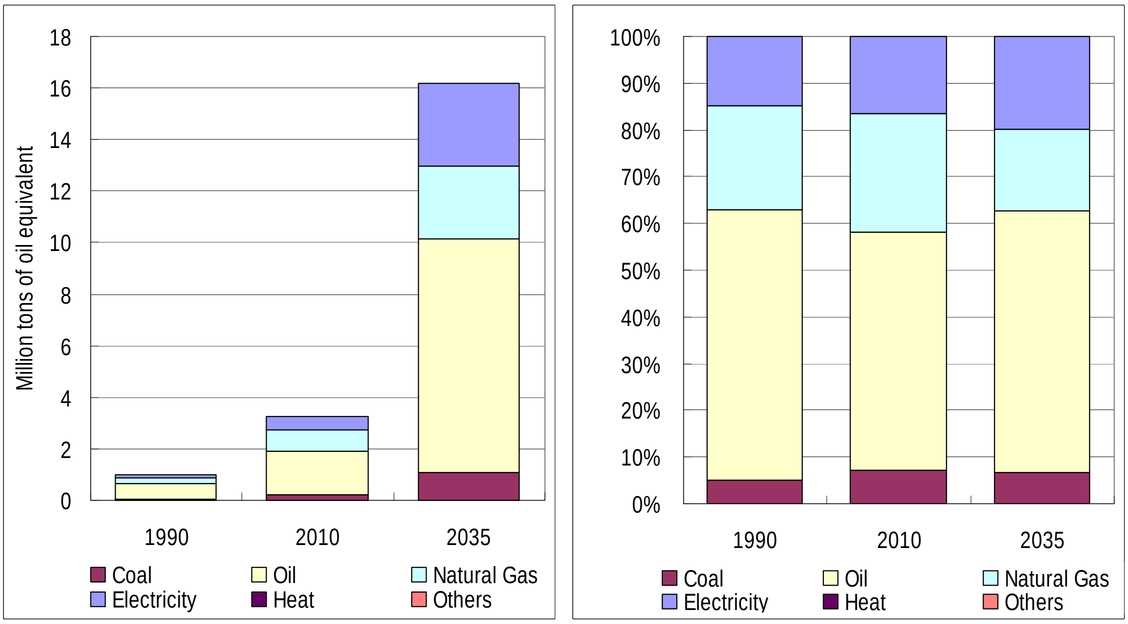


The respective growth of the sectors under the BAU scenario will result in a continous increase of the transport sector share in the total final energy demand and a decline in the industry and non-energy sector share. The transport sector share will increase to 57 percent in 2035 while the industry and non-energy sector share's will decline to 25.8 percent and 0.9 percent, respectively. The other sector share will remain at around 16 percent in 2035.

By fuel type, oil was the most consumed product in 1990 having a share of 58 percent in the total final energy demand of the country. Its share decreased to 51 percent in 2010 due to the higher growth of the other fuels. The sectoral consumption of natural gas increased from 0.2 Mtoe in 1990 to 0.8 Mtoe in 2010 while for electricity it increased from 0.1 Mtoe to 0.5 Mtoe over the same period. Coal demand increased the fastest at an average growth rate of 7.9 percent per year over the 1990 to 2010 period.

Under the BAU scenario, the share of natural gas will decline from around 25 percent in 2010 to 17.5 percent in 2035 indicating that its future use will grow slower than the other fuel. In contrast, oil share will continue to increase and will reach 56 percent in 2035 from around 51 percent in 2010 with an average growth of 7.0 percent per year. This is due to the rapid increase of the transport sector activities over the 2010 to 2035 period.

Figure 12-2: Final Energy Demand by Fuel, BAU

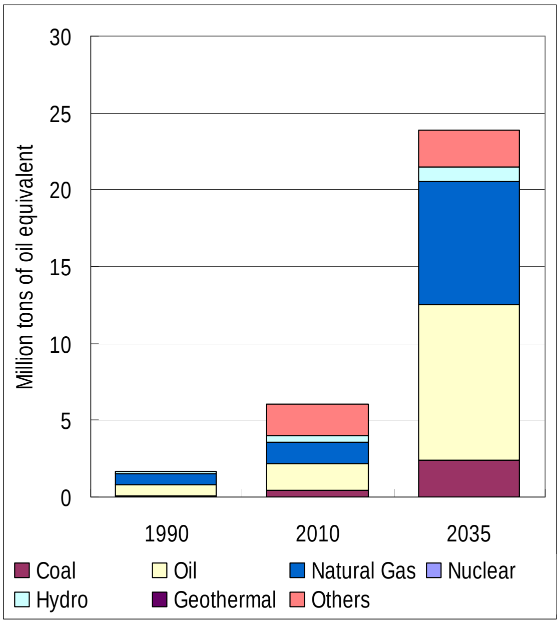


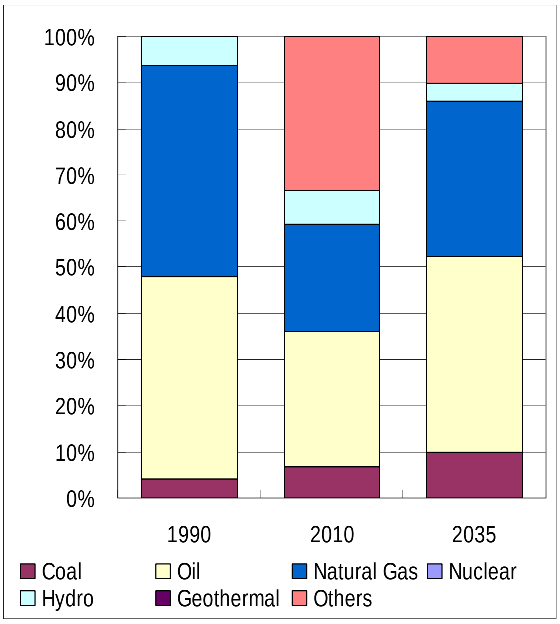
Coal is projected to have an average annual growth rate of 6.3 percent in the period 2010-2035, but not as fast as oil and electricity. Consequently, the share of coal will decrease from 7.2 percent in 2010 to 6.6 percent in 2035. Electricity demand will grow faster than oil and coal at an average annual growth rate of 7.4 percent per year during the same period. Its share will increase from 16.5 percent in 2010 to 19.8 percent in 2035.

Primary Energy Consumption

Primary energy Consumption in Myanmar grew at an average annual rate of 6.7 percent from 1.7 Mtoe in 1990 to 6.0 Mtoe in 2010. Among the major energy sources, the fastest growing were hydro and coal with average annual growth rates of 7.5 percent and 9.5 percent, respectively. Natural Gas consumption grew at an average annual rate of 3.1 percent over the same period. Oil consumption increased at 4.5 percent per year on the average over the same period. Oil and gas dominate the primary energy consumption mix in 2010 with respective shares of 29.2 percent and 23.4 percent, respectively.

Figure 12-3: Primary Energy Consumption by Source, BAU





In the BAU scenario, Myanmar's primary energy consumption is projected to increase at an annual average rate of 5.7 percent per year to 23.9 Mtoe in 2035. Coal, oil and natural gas are expected to grow at average annual rates of 7.2 percent followed by hydro at 3.1 percent and others at 0.7 percent over the period 2010-2035. The share of oil and natural gas will still dominate in the total primary energy mix of Myanmar, increasing to 42.4 percent and 33.6 percent respectively in 2035. Coal share will also increase from 6.8 percent in 2010 to 9.9 in 2035. Hydro share, on the other hand, will decline from and 7.3 percent in 2010 to 3.9 percent in 2035. This is due to the rapid increase of coal in the power generation.

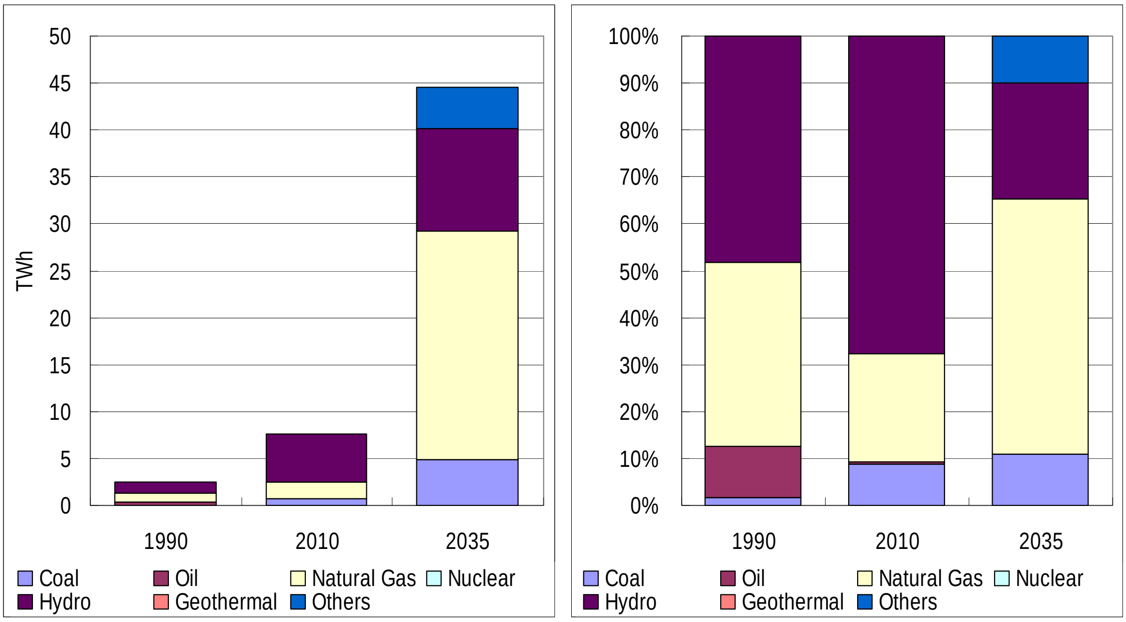
Power Generation

Hydro and natural gas dominated the power sector fuel mix in Myanmar. In 2010, the share of hydro in the power generatio mix reached 67.7 percent while natural gas share was 23.4 percent. The remaining fuel (coal and oil) accounted only 9.3 percent of the total generation mix.

Under the BAU scenario, oil-based power plant will cease operation by 2035 but coal-based power plant will have an increasing role as well as other new and renewable energy sources (wind, solar, etc.). The share of electricity generated from coal-based power plant will increase from 8.9 percent in 2010 to 10.9 percent in 2035 while other new and renewable energy share will reach 10 percent in 2035.

Electricity generation from hydro and natural gas will continue to dominate the generation mix of Myanmar. The share, however differs since generation of electricity from natural gas based plant will grow faster than those of the hydro plants over the 2010 to 2035 priod. Electricity from natural gas based plants will grow at an average annual rate of 11.1 percent while hydro power generation will increase at 3.1 percent.

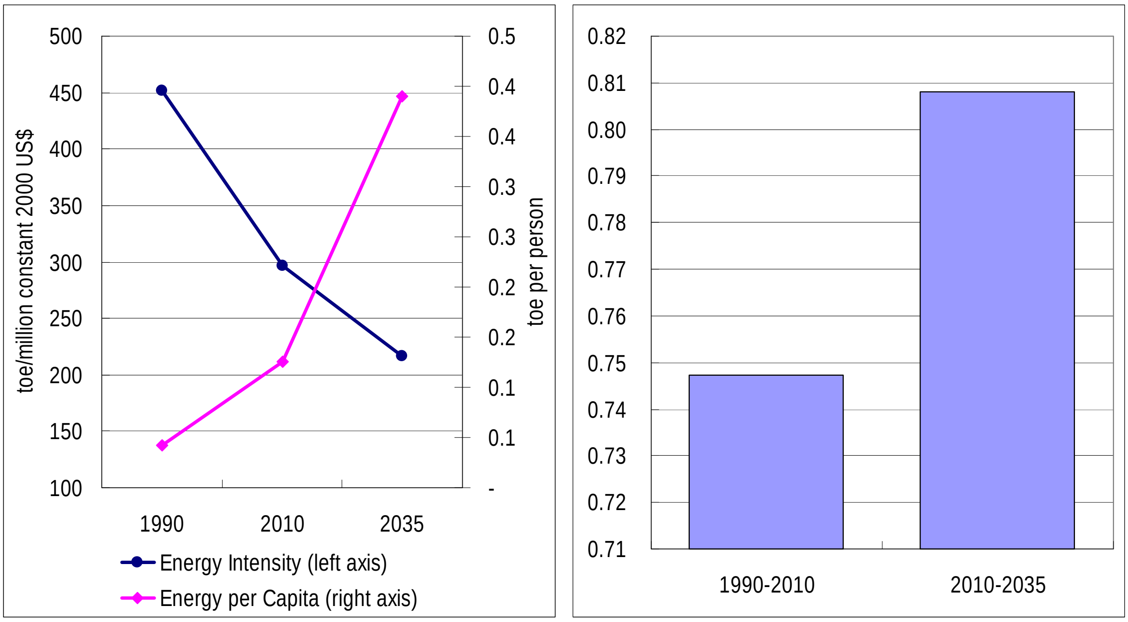
Figure 12-4: Power Generation Mix-BAU Case



Energy Intensity, Energy per Capita and Energy Elasticity

Myanmar's primary energy intensity (TPES/GDP) has been declining since 1990. In 2010, the primary energy intensity was 297 toe/million 2000 USD, lower than what it was in 1990 which was 451 toe/million 2000 USD. It is projected that the intensity will continue to decrease to 217 toe/million 2000 USD by 2035 at an average rate of 1.3 percent per year over the period 2010-2035. The energy consumption per capita grew from 0.04 toe in 1990 to 0.13 toe in 2010 and will increase to 0.39 by 2035, at an average annual growth rate of 4.6 percent. The energy elasticity was 0.7 from 1990 to 2010 and and will increase to 0.8 from 2010 to 2035.

Figure 12-5: Energy Intensity, Energy per Capita and Energy Elasticity

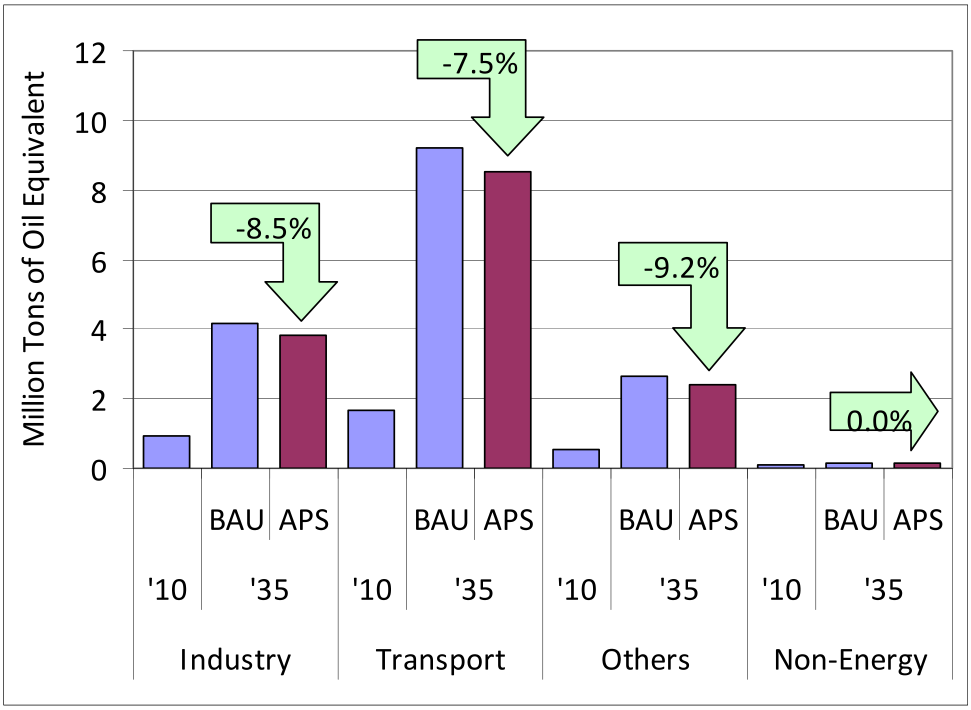


3.2. Energy Saving and CO_2 Reduction Potential

Final Energy Demand

In the APS, the growth in final energy demand is projected to grow at a lower average annual rate of 6.3 percent as compared to the 6.6 percent annual growth in the BAU. The reason for the slower growth rate is the result of technological improvement in manufacturing processes and the reduction of final energy demand of electricity and oil in the residential and commercial (other) sector.

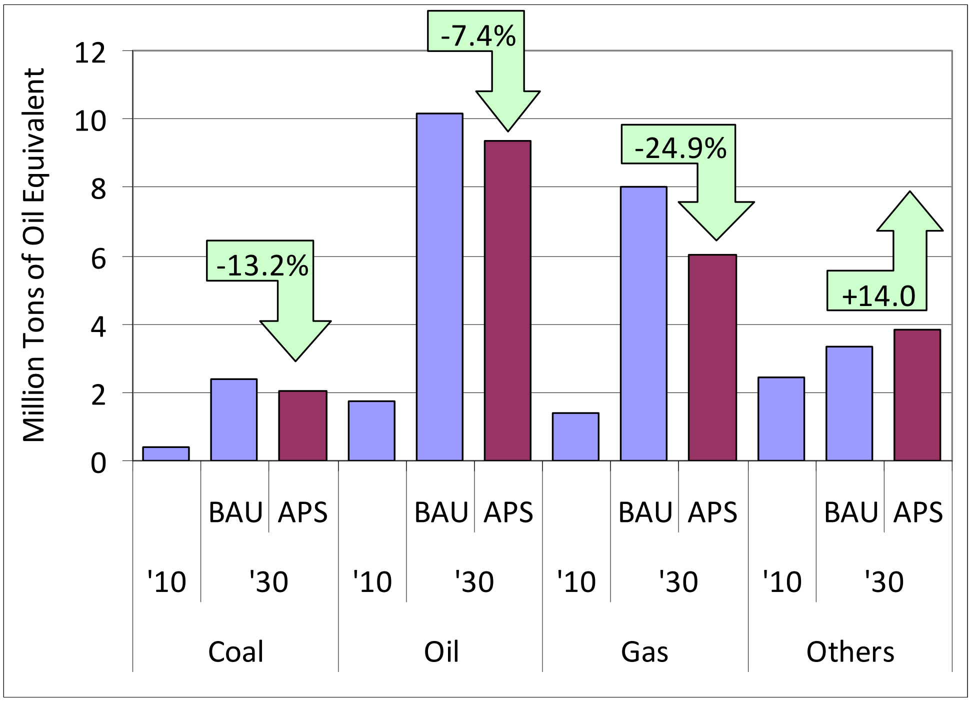
Figure 12-6: Final Energy Demand by Sector, BAU and APS



Primary Energy Consumption

In the APS, Myanmar's primary energy consumption is projected to increase at a slightly lower rate than the BAU's at 5.2 percent per year from 6.0 Mtoe in 2010 to 21.3 Mtoe in 2035. Oil will be the fastest growing at 6.9 percent per year followed by coal at 6.6 percent per year between 2010 and 2035. Hydro is expected to grow at average annual rate of 3.5 percent over the same period, lower than natural gas which is expected to grow at 6.0 percent per year.

Figure 12-7: Primary Energy Consumption by Source, BAU and APS



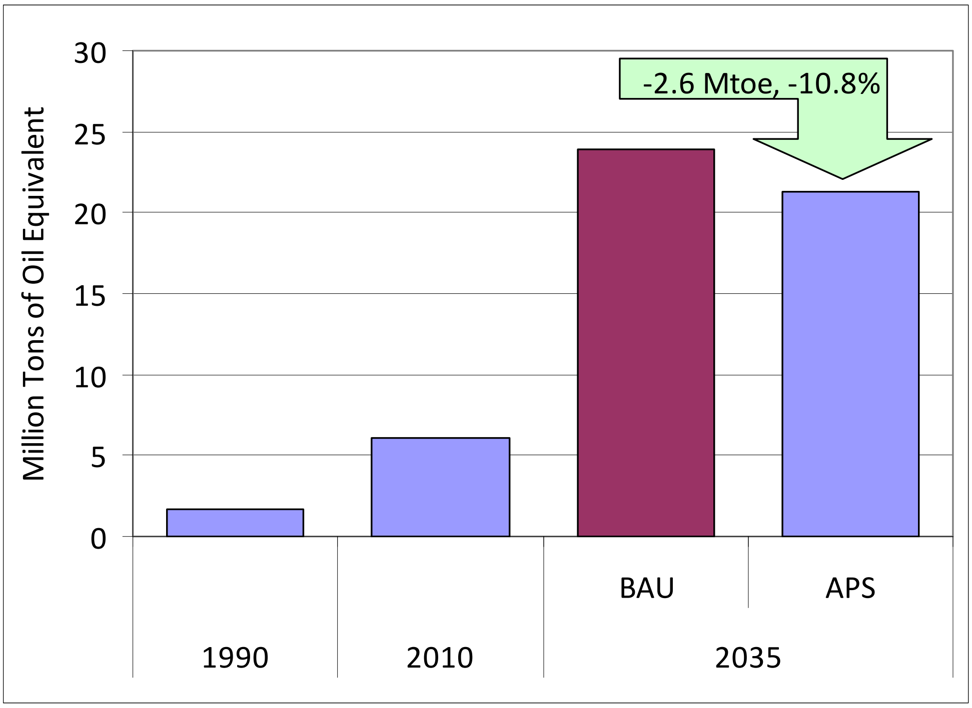
Projected Energy Savings

In Myanmar, commercial energy consumption is projected on the basis of energy requirements of the major sectors (industry, transport, agriculture and households). The choice of fuel type is determined by available supply, since energy demands have to be met mainly by domestic sources. Obviously, there is a gap between demand and supply but on the other hand, the demand is much higher than the actual requirement. Due to these constraints, coefficients, derived by time series regression, had been applied to allocate energy. These allocations are made in accordance with the priority of the State organizations and enterprises. For the private sector, allocations are made in accordance with the registered licensed capacity of the firm.

Future saving in energy could be due to saving in primary energy consumption in the residential, commercial, transportation and industrial sectors. In this regard, Myanmar has implemented a range of energy efficiency and conservation goals and action plans which target on energy savings in all sectors of the economy and in cooperation with both the private and public sectors. There is an estimated saving of 2.6 Mtoe in 2035 in the APS, relative to the BAU scenario. This is equivalent to 10.8 percent saving of the primary energy consumption in 2035 of the BAU scenario.

Myanmar has plans to decrease the growth in primary energy consumption by implementing a range of energy efficiency and conservation measures on the demand side.

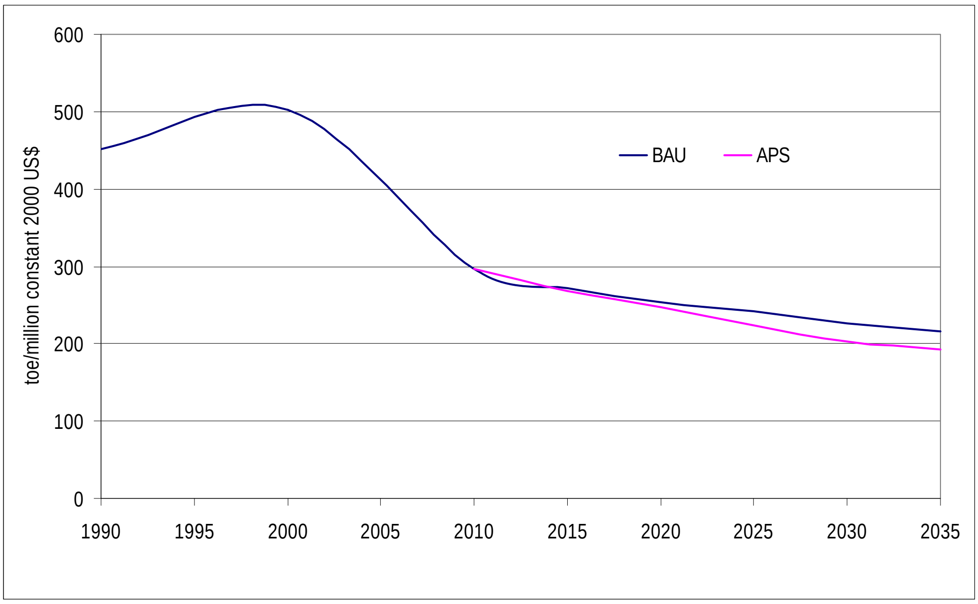
Figure 12-8: Evolution of Primary Energy Consumption, BAU and APS



Energy Intensities

The adaptation of the sectoral sectoral action plans and saving goals under the Alternative Policy Scenario (APS) will result in a faster declining rate for the primary energy intensity, 1.7 percent per year over the projection period.

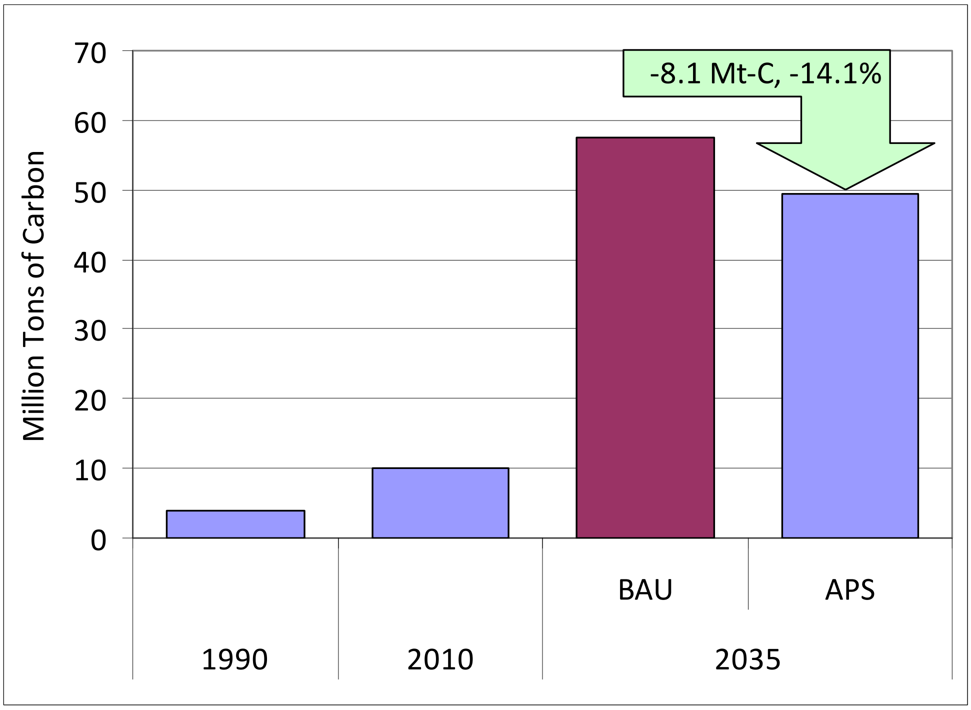
Figure 12-9: Energy Intensity, BAU and APS



CO_2 Reduction Potential

In the APS, the energy efficiency policy of Myanmar is projected to reduce growth in CO_2 emissions from energy consumption. In 2035, in the APS, CO_2 emissions from energy consumption are projected to reach about 13.5 million tons of carbon (Mt-C) which is about 14.1 percent below the BAU level.

Figure 12-10: CO_2 Emission from Energy Consumption, BAU and APS



4. Conclusions and Policy Implications

Although energy intensity will decline, energy consumption is still increasing due to economic, population and vehicle population growth. Myanmar should increase adoption of energy efficient technologies to mitigate growth in energy consumption and should also diversify energy availability. The energy saving will be targeted in the residential, commercial, transport and industry sectors.

In this regard, the following proposed actions can be taken into consideration:

- There is a need for a detailed and comprehensive energy sector assessment
- An integrated national energy policy including energy efficiency will be formulated by the National Energy Management Committee (NEMC)
- Due to the continuous dominance of the transport sector in final energy consumption, there should be an energy efficiency target for the transport sector in addition to those in industrial, commercial and household sectors
- There is a need for a detailed policy mechanism for the renewable energy sector

to implement the potential programs and projects

- Coordination mechanism and institutional arrangement and legal framework need to be adopted
- Needs to enhance private participation to ensure reliable electricity supply
- More aggressive exploration of the upstream energy sector needs financial and technical assistance in each energy subsector
- It should be developed and planned in conjunction with external stakeholders, who offer experiences, advanced technologies, new markets and investment.
- Better energy statistics would be needed for better analysis of energy saving potential in Myanmar
- Needs to improve energy management practices for industrial and commercial sectors
- Requires an energy efficiency labeling program for energy service companies and appliances

CHAPTER 13

New Zealand Country Report

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1. Background

New Zealand is an island nation in the Pacific about 2000 km southeast of Australia. It consists of two main islands (the North Island and South Island), and a number of smaller, mostly uninhabited outer islands. The land area is approximately 269,000 square kilometres, making it smaller than Japan or Italy, but larger than the United Kingdom. Most of New Zealand is hilly or mountainous and has a mild temperate climate. The population is currently about 4.4 million. Although there is some light and heavy industry, foreign trade is heavily dependent on agriculture, tourism, forestry, and fishing. In 2010, New Zealand had a gross domestic product (GDP) of about US$68.3 billion, or about US$15,634 per capita. While the latter figure is lower than those of many OECD countries, New Zealand tends to be ranked high in international quality-of-life surveys.

New Zealand possesses significant indigenous energy resources, including hydro, geothermal, wind, natural gas and coal. New Zealand is self-sufficient in electricity and natural gas, and is a net exporter of coal, but it meets most of its oil demand through imports. Energy reserves include around 15 million cubic metres (MCM) of oil and 52 billion cubic metres (BCM) of natural gas (each proven plus probable), as well as 8.6 billion tones of recoverable coal, 80 percent of which is lignite.

New Zealand's total primary energy demand was around 18.2 million tons of oil equivalent (Mtoe) in 2010. By fuel, oil represented the largest share at about 33 percent; gas and geothermal energy were second each with around 20 percent. New

Zealand obtains about 39.2 percent of its primary energy supply from renewable sources, including hydro, geothermal, woody biomass, and wind.

In 2010, electricity generation accounted for 38 percent of New Zealand's domestic coal use, with most of the remainder used for making steel or in other industrial processes. Electricity generation also accounted for 47 percent of gas use, and industry sector for 21 percent while commercial and residential use accounted for most of the remainder. Reticulated natural gas is only available on the North Island. Transport accounted for an estimated 76 percent of New Zealand's oil consumption. In the transportation sector, New Zealand heavily depends on private road vehicles and air transport, with oil providing 99 percent of New Zealand's transport energy.

New Zealand had 10 gigawatts (GW) of installed generating capacity which generated about 45 terawatt-hours (TWh) of electricity in 2010. The generation by energy type is broken down as: hydro at 55.1 percent, thermal (coal and gas) 26.6 percent, geothermal 13.1 percent, with wind and wood accounting for most of the remainder. Oil is used in electricity generation only as a minor source peaking supply.

2. Modelling Assumptions

In this outlook, New Zealand's GDP is assumed to grow at an average annual rate of 2.2 percent between 2010 and 2035. Population will increase by 22.7 percent to 5.4 million by 2035, relative to 4.4 million in 2010.

In the business as usual (BAU) scenario, an increasing amount of New Zealand's electricity supply is projected to be supplied by geothermal (Figure 13-1). Hydro will remain fairly steady as the best hydro sites have already been developed. Coal use in electricity generation will move away. Natural gas use will decrease at an average growth rate of 0.5 percent. Wind generation will continue to grow, but will still contribute only a small share on New Zealand's electricity by 2035.

Thermal efficiency for natural gas is assumed at the same level of 2010 as there will be no additional natural gas-fired power plants foreseen to be built until 2035.

Thermal efficiency for coal & oil will decline with the nations aging of power plants.

Figure 13-1: Power Generation -BAU

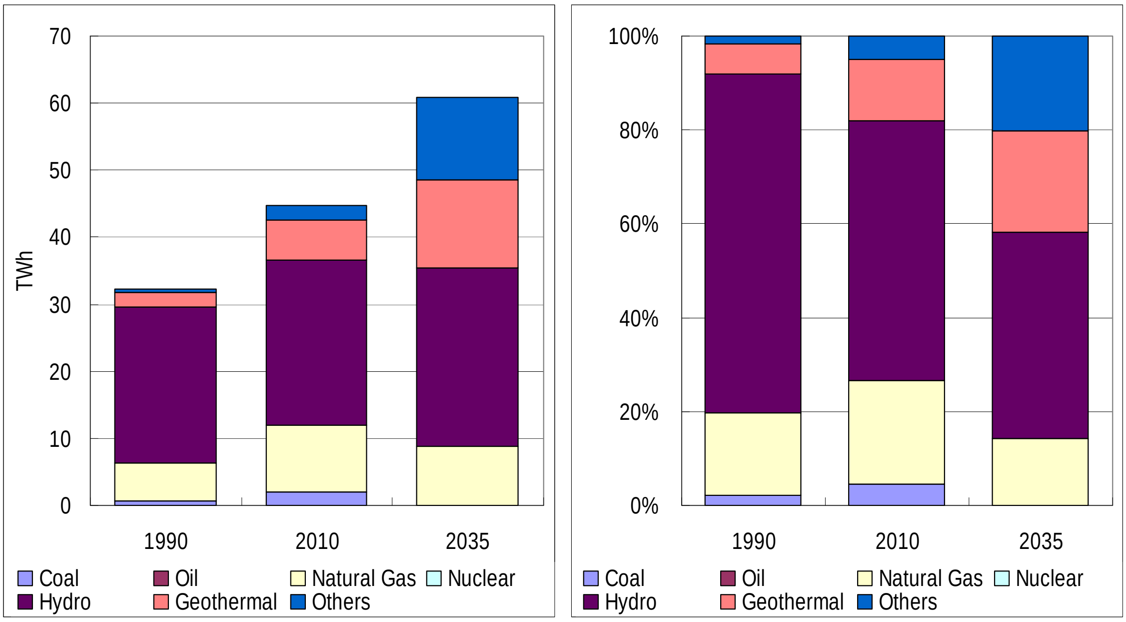
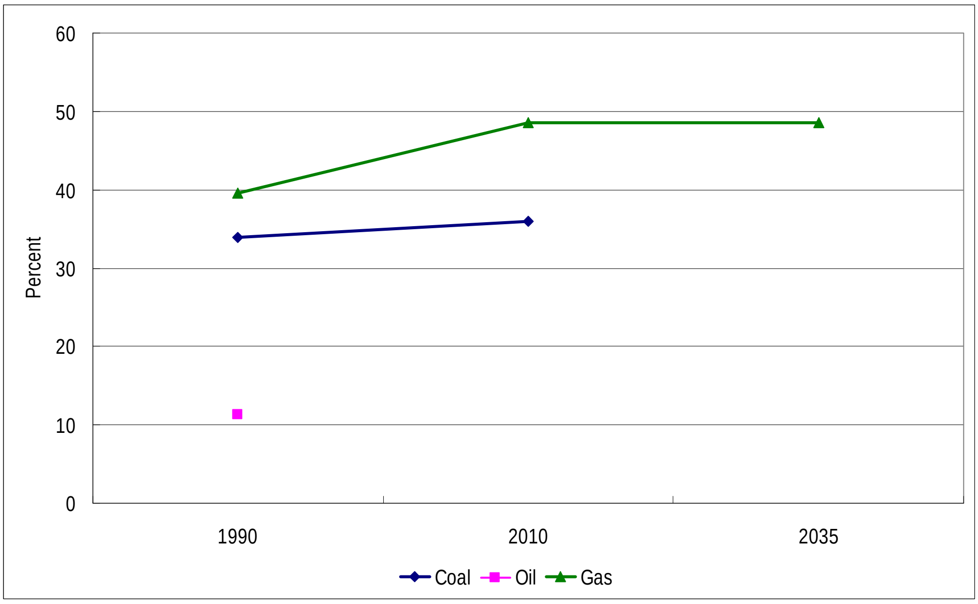


Figure 13-2: Thermal Efficiency - BAU



New Zealand's energy efficiency has improved at a rate of about 0.5-1.0 percent per year and this rate is assumed to be continued in the BAU scenario. New gas discoveries are assumed at an average of 60 petajoules per year (PJ/year) – about 1.6 BCM – with production from new discoveries starting in 2012.

The New Zealand government has agreed to implement an emissions trading scheme and has set a target for 90 percent of electricity to be generated from renewable sources by 2025. The government also maintains a range of programmes to promote energy efficiency at home and work, as well as the development and deployment of sustainable energy technologies.

3. Outlook Results

3.1. Total Final Energy Consumption

New Zealand's final energy consumption experienced a growth of 1.3 percent per year from 10.0 Mtoe in 1990 to 12.8 Mtoe in 2010. Oil was the most consumed energy source having a share of 40.4 percent in 1990 and increasing to 46.0 percent in 2010. Electricity was the second most consumed energy source during the same year with a share of 26.5 percent to the total.

Business as Usual Scenario

In the BAU scenario, final energy consumption from 2010 to 2035 is projected to grow at an average rate of 0.4 percent per year. The "Others" sector (primarily residential and commercial) will have the highest growth rate at 0.9 percent per year. The industry sector consumption is projected to increase at a slow pace of 0.4 percent.

By fuel type, final consumption of electricity will increase at an average rate of 1.3 percent per year. Final consumption of oil and natural gas will decrease by 0.1 percent and 0.3 percent per year on average, respectively. Coal consumption will however increase at 0.7 percent per year.

Figure 13-3: Final Energy Consumption by Sector and Shares by Sector - BAU

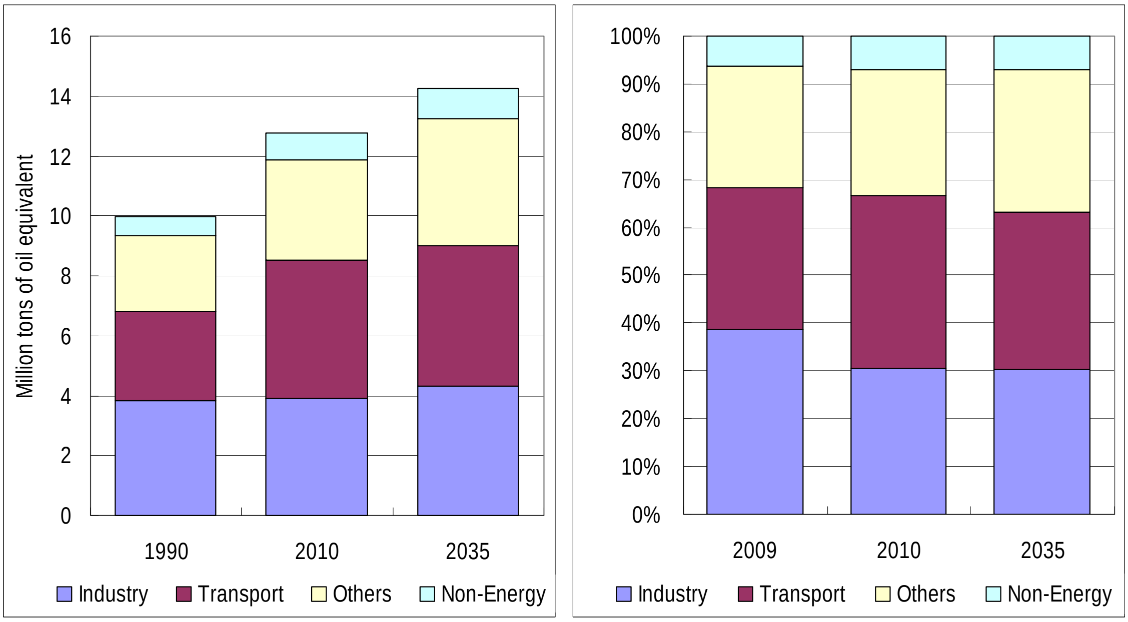
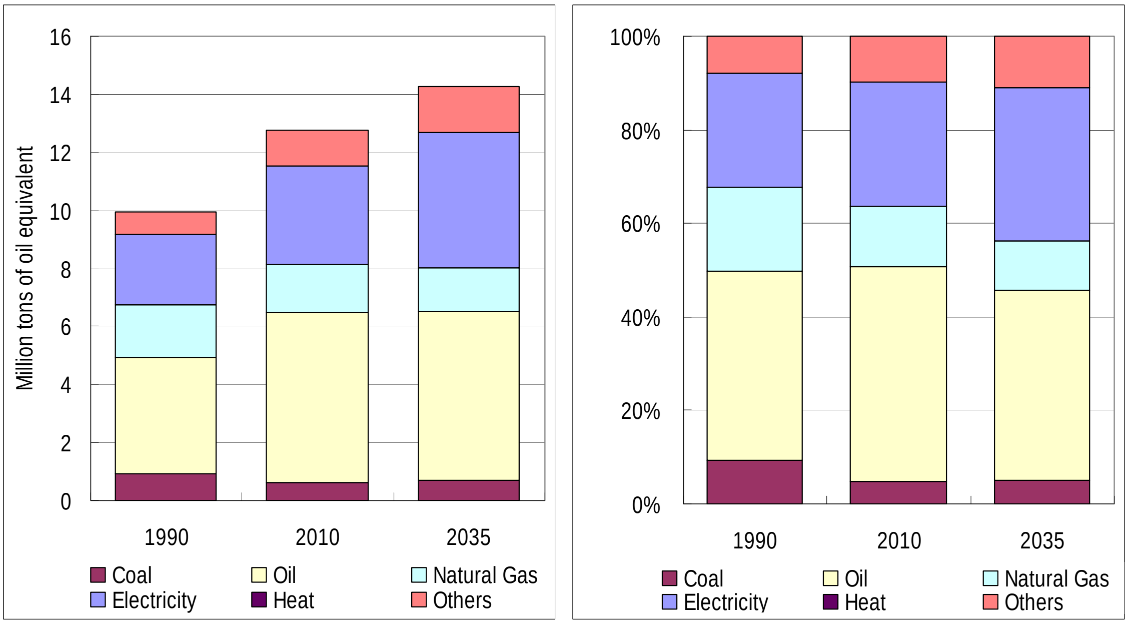


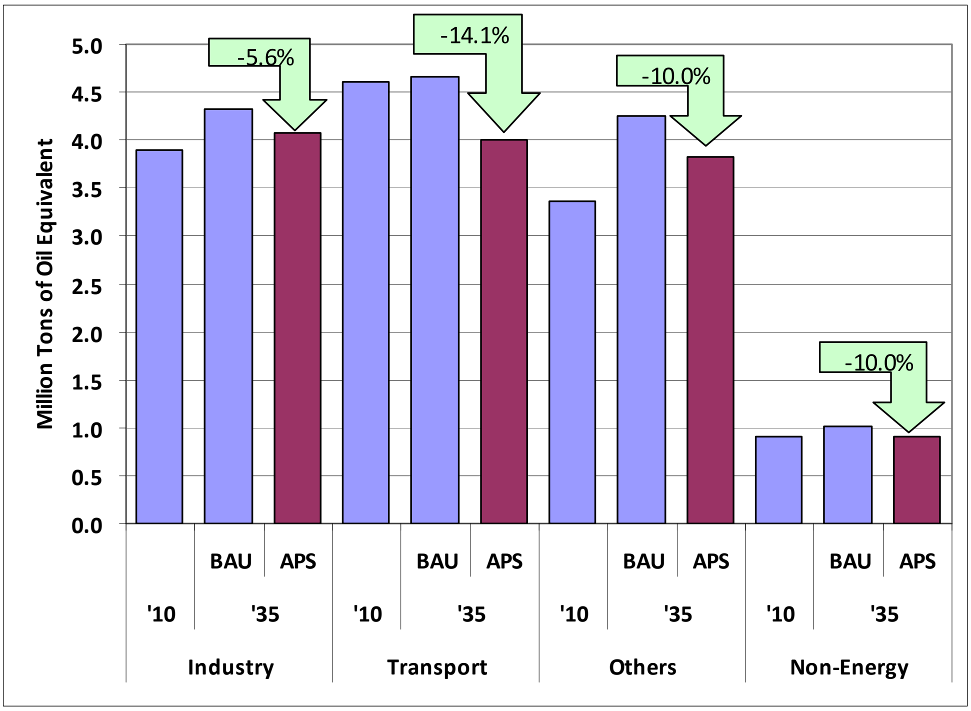
Figure 13-4: Final Energy Consumption by Source and Shares by Source - BAU



Alternative Policy Scenario

In the APS, final energy consumption will keep same level of energy consumption in 2010. Energy use in the other sector will increase at an average of 0.5 percent per year, reflecting increased use of efficient appliances at the residential and commercial sectors. Energy use in the transport sector will decline at an average of 0.6 percent, reflecting a shift to more energy efficient vehicle, particularly electric vehicles. The sectoral final energy consumption in New Zealand in 2010 and 2035 in the BAU and APS is shown in Figure 13-5.

Figure 13-5: Final Energy Consumption by Sector, BAU and APS



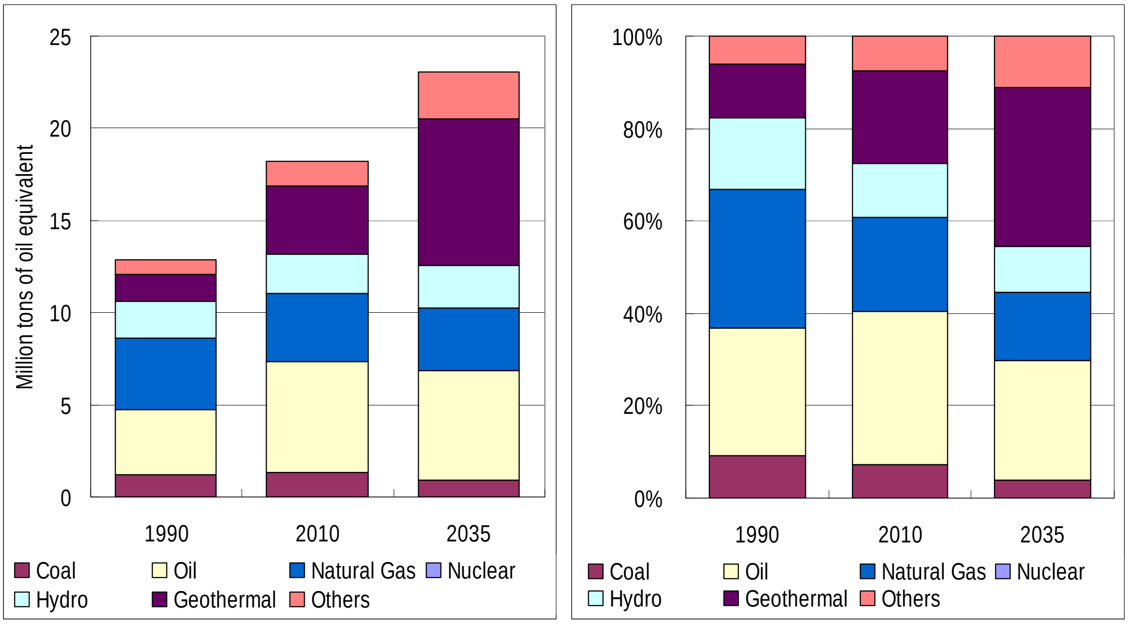
3.2. Primary Energy Demand

Primary energy demand in New Zealand grew at a rate of 1.7 percent per year from 12.9 Mtoe in 1990 to 18.2 Mtoe in 2010. The fastest growing primary fuel in absolute terms was oil from 3.6 Mtoe in 1990 to 6.0 Mtoe in 2010. The increase in oil demand is due to the rapid growth in transport energy demand. Natural gas declined at an average annual rate of 0.2 percent, reflecting the decrease in gas production from the Maui gas field. Geothermal energy use grew from 1.5 Mtoe in 1990 to 3.6 Mtoe in 2010 at an annual rate of 4.6 percent for electricity generation. Hydroelectricity production increased at a slower pace at 0.3 percent per year. Other energy sources which include biomass, solar and wind increased at 2.7 percent per year.

Business as Usual Scenario

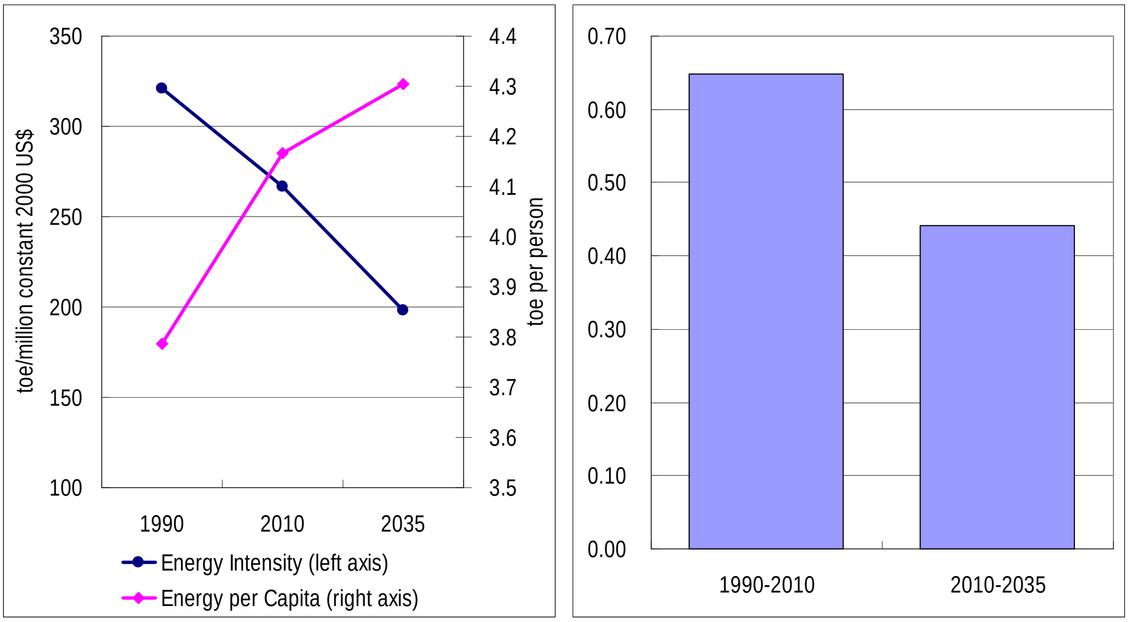
In the BAU scenario, New Zealand's primary energy demand will grow at an annual rate of 1.0 percent per year to 23.1 Mtoe in 2035. To the incremental growth of primary energy demand between 2010 and 2035, geothermal energy contributes the most, and will account 34.5 percent of the total primary energy demand in 2035. "Others" primary energy will grow by 2.5 percent per year reflecting mainly the expected growth in wind power. Meanwhile, primary fossil fuel will decrease at an average rate of 0.3 percent.

Figure 13-6: Total Primary Energy Demand and its Composition - BAU



The lower growth of primary energy demand relative to the GDP growth will result in lower energy intensity in the future. From 266 toe/million USD in 2010, energy intensity will decline to 165 toe/million USD in 2035. This decline is further illustrated by the lower energy elasticity in the period 2010-2035 of 0.44 from 0.65 in the period 1990-2010. Primary energy demand per capita will however increase from 4.17 toe/person in 2010 to 4.30 toe per person in 2035 (Figure 13-7).

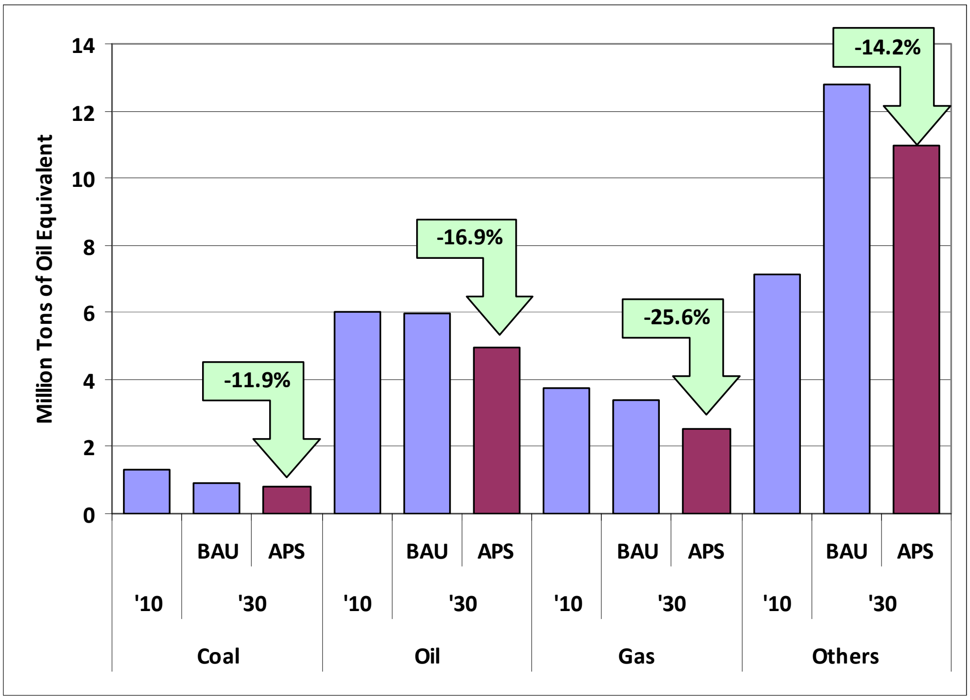
Figure 13-7: Primary Energy Intensity and Elasticity -BAU



Alternative Policy Scenario

In the APS, primary energy demand is projected to grow at a lower rate of 0.2 percent per year to 19.3 Mtoe in 2035. Geothermal primary energy is expected to grow by 1.7 percent per year, while ‘others’ primary energy, which includes wind and biomass, is expected to grow by 3.4 percent per year (note that the ‘Others’ shown in Figure 13-9 also includes hydro and geothermal). Oil and gas are expected to show significant declines of 1.5 percent and 1.9 percent per year, respectively.

Figure 13-8: Primary Energy Demand by Source, BAU and APS

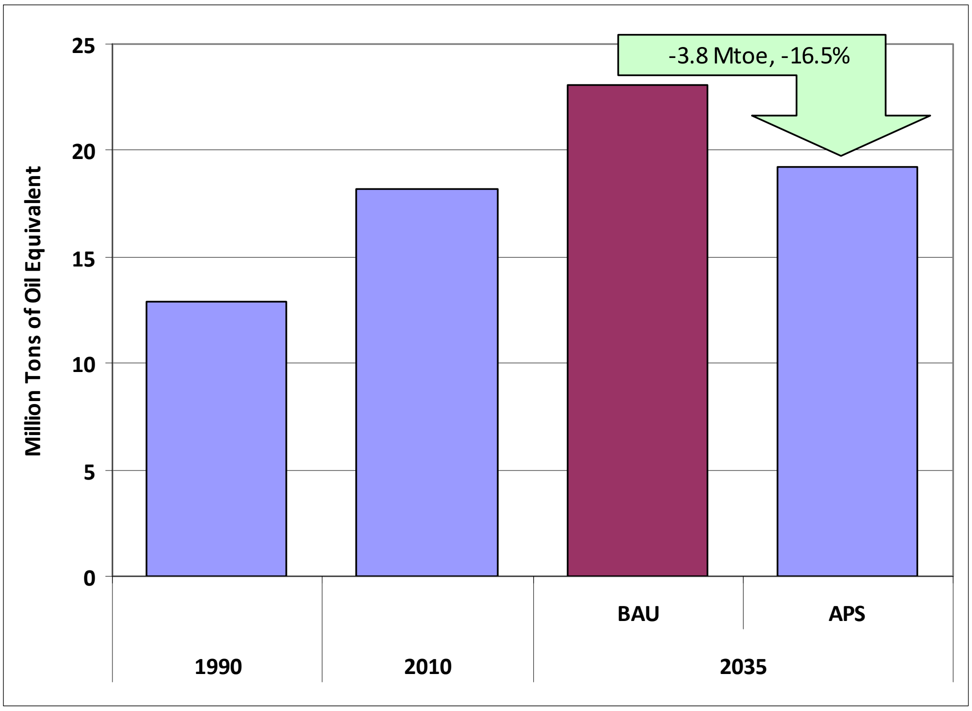


3.3. Projected Energy Savings

Under the APS, energy savings could amount to 3.8 Mtoe in 2035, the difference between the primary energy demands in the BAU scenario and the APS – 16.5 percent less than the BAU's in 2035 (Figure 13-9).

The above savings in primary energy are mainly due to a switch of automobiles to more efficient vehicles, particularly electric vehicles, in the transport sector, along with improved insulation and more efficient appliances in the residential and commercial sectors.

Figure 13-9: Total Primary Energy Demand, BAU and APS

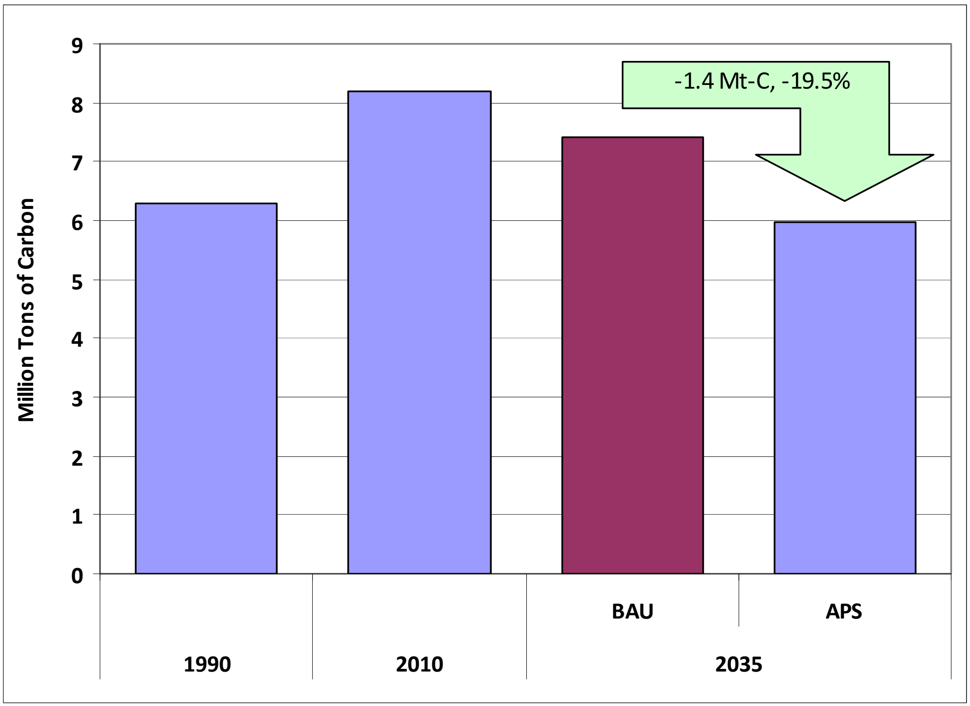


3.4. CO_2 Emissions

The carbon dioxide (CO_2) emissions in the BAU scenario will decrease by 0.4 percent per year from 8.2 million tons of carbon (Mt-C) in 2010 to 7.4 Mt-C in 2035. This decrease is roughly in line with decrease in coal primary energy demand.

In the APS, CO_2 emissions will decrease from 2010 to 2035 by 1.3 percent per year. Since primary energy demand, excluding geothermal is more or less stable over this period. The decrease reflects the switch to renewable energy in electricity generation, and the switch automobiles to electric vehicles in the transport sector. Figure 13-10 shows the CO_2 emissions from energy consumption in New Zealand from 2010 to 2035.

Figure 13-10: CO_2 Emissions from Energy Combustion, BAU and APS



4. Implications and Policy Recommendations

Although New Zealand's primary energy intensity (energy per dollar of GDP) has been declining since 1990, energy use has still grown steadily, reflecting economic growth, population and increasing numbers of private road vehicles.

New Zealand generates a high proportion of its electricity from renewable sources, particularly hydro, although emissions from this sector have been growing with large investment in fossil-fuelled generation. Emissions trading will incentivise investment in new renewable generation technologies, with geothermal and wind particularly as prospective options for New Zealand. New Zealand's large base of renewable generation, however, limits the room for CO_2 emissions reduction in the electricity generation sector.

New Zealand has many opportunities to improve energy efficiency, for example, through upgrading the poorly-insulated building stock and the inefficient vehicle fleet.

There are potential energy savings in the transportation sector in New Zealand. Growth in energy consumption in the transport sector has been slowed in recent years, mainly because of high fuel prices and a shift to smaller vehicles. Furthermore, reduction in emissions from the transport sector is possible through increased use of biofuels, and a switch to electric vehicles. Electric vehicles are a good match for New Zealand given the high proportion of electricity generated from renewables, and relatively short average trips.

CHAPTER 14

Philippines Country Report

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1. Background

1.1. Socio-economic

The Philippines, officially known as The Republic of the Philippines, with Manila as its capital city is an archipelago comprising of 7,107 islands. The country is located in the midst of Southeast Asia's main water bodies namely, the South China Sea, Philippine Sea, Sulu Sea, and Celebes Sea.

In 2012, the Philippine economy posted a 6.6 growth from 3.9 percent in 2011. The growth of the economy was largely due to the increase in the services sector which posted a annual growth of 7.7 percent. The industrial sector grew by 6.5 percent from its 2.5 percent gowth in the previous year. The increase in the industrial was driven by the growth in the construction business which grow double digit up to 14.4 percent. Meanwhile, Agriculture, Hunting, Forestry and Fishing posted a 2.7 percent. Gross domestic product (GDP) per capita of the country was US$1,400 per person in 2010.

1.2. Policy

The Department of Energy (DOE) of the Philippines is taking its long-term interest in adopting the use of clean, green and sustainable sources of energy in its energy security strategy. The country's long-term national energy plan makes sure that immediate need for energy is met while making sure that it will cause least damage to people and the environment. Notwithstanding the fact that fossil fuels contribute significantly to the country's energy and electricity needs in view of its cost and reliability, the 60.0 percent energy self-sufficiency level target of the country aims to harness indigenous energy. In particular, renewable energy sources like geothermal, wind, biomass, ocean and alternative fuels like biofuels and compressed natural gas (CNG), are seen to augment the country's energy requirement.

Another key component in the country's strategy on energy security is the need to take hold of the opportunities in energy efficiency and conservation. The launching of the National Energy Efficiency and Conservation Program (NEECP) in August 2004, is an evidence of the energy sector's commitment to continuously work in the development and promotion of new technologies and the practice of good energy habits in the household, business and transport sector. In line with the NEECP, the DOE has an energy saving goal of 10.0 percent energy savings on the total annual energy demand. The DOE will continue to exert better efforts to minimize demand for energy brought about by the country's economic growth by taking the lead in increasing public interest on the use of energy-efficient technologies and conservation practices. The government's energy efficiency and conservation campaign will maximize opportunities in the different economic sectors.

As the DOE walks the path towards energy development, it will continue to implement reforms in the power and downstream oil industries as they both affect socially sensitive issues such as pricing environment in electricity and petroleum.

Below are updates on some of the DOE's plans and programs:

Renewable Energy (RE)

The passage of Republic Act No. 9513 or Renewable Energy Act of 2008 establishes policy and program framework to advance RE resources and technologies, and increase their utilization. On June 14, 2011 the Government unveiled the National Renewable Energy Program (NREP) or the "Green Energy Roadmap" of the Philippines. The NREP is anchored on the DOE's Energy Reform Agenda, which aims to ensure greater energy supply security for the country. It establishes a policy and program framework for the promotion of renewable energy and a roadmap to guide efforts in realizing the market penetration targets of each renewable energy resource in the country. The roadmap is targeting 15,304 MW installed RE capacity by 2030. The NREP also provides for policy mechanisms to support the implementation of the RE Act. These policy mechanisms include: Renewable Portfolio Standards (RPS), Feed-in Tariff (FIT), Green Energy Option Program and Net-Metering for Renewable Energy.

The RPS sets the minimum percentage of generation from eligible RE resources, provided by the generators, distribution utilities and electric suppliers. Initially, an installation target of 760 megawatts (MW) from RE is set for the first three (3) years from 2013 to 2015 broken down as follows: biomass (250 MW), run-of-river hydro (250 MW), solar (50 MW), wind (200 MW) and ocean (10 MW).

On the other hand, the FIT provides guaranteed payments on a fixed rate per kWh for RE generation excluding generation for own use. On 27 July 2012, the Energy Regulatory Commission (ERC) approved the initial FIT rates which will apply to generation from renewable energy (RE) sources, particularly, run-of-river hydro, biomass, wind, and solar. Approved FIT rates for biomass, hydropower, solar and wind are 6.63 PhP[1], 5.90 PhP, 9.68 PhP and 8.53 PhP per kilowatt-hour (kWh). Currently, there is no FIT rate for ocean energy since further study and more data analysis must be first undertaken.

Alternative Fuels for Transport

<u>Biofuels</u>

The DOE is aggressively implementing Republic Act No. 9367 or the Biofuels Act of 2006. The law intends to tap the country's indigenous agricultural resources as potential feedstock for biofuels.

The mandatory 1.0 percent biodiesel blend in all diesel fuel sold in the country in May 2007 was increased to 2.0 percent in February 2009 on a voluntary basis. On the other hand, the country now enjoys an accelerated use of E10 (10.0) bioethanol blend as supplied by most of our gasoline retailers.

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[1] Philippine Peso.

To serve the technical requirements for biofuels program and ensure its continuous research and development, the DOE provided counterpart funding of PhP 50 million for the establishment of a vehicle testing facility located at the Department of Mechanical Engineering Laboratory, University of the Philippines in Diliman, Quezon City. Roundtable discussions with stakeholders on technical verification and relevance of emerging biofuel technologies also forms part of the DOE's initiatives on research and development.

Compressed Natural Gas (CNG)

Currently, there are 61 compressed natural gas (CNG) buses in the Philippines, of which 41 are commercially running. The CNG buses are plying the Manila-Batangas-Laguna routes. In addition there are 20 CNG buses that had completed technical evaluation and testing. As of June 2012, seven (7) bus operators have been accredited for CNG bus operation. The CNG Mother-refueling Station and the Daughter Station are operating in Batangas and Biñan, Laguna, respectively.

Auto-LPG

In terms of using LPG as an alternative fuel for transport, over 119,052 taxis nationwide were now running on LPG which is complemented by 219 auto-LPG dispensing stations. To date, 31 auto-LPG conversion shops with Philippine National Standard (PNS) licenses are being monitored by the DOE to ensure safe operation and standards compliant conversion of gasoline fed motor vehicles to auto-LPG.

In support of the Auto-LPG program of the government, the Development Bank of the Philippines (DBP) has included auto-LPG initiative in its "Clean Alternative Transport Fuel Financing Program," which provides reasonable financing package for auto-LPG related activities such as acquisition of auto-LPG vehicles. The LTFRB also extended the number of years of franchise for taxis that converted to auto-LPG by two (2) years. These schemes promoted large scale conversion of taxi fleets and encourage new player participation in the program.

E-Vehicle

To date, 623 of various types of electric vehicles (EV) are being demonstrated in various cities and municipalities (Makati, Taguig, Mandaluyong, Quezon, Puerto Princesa, Davao and Surigao del Norte) of the country. The E-vehicle program is one of the government's initiative towards sustainable, energy efficient and low-carbon transport future. In relation to the E-vehicle Program, the DOE launched in January 2012 its "Bright Now! Do Right. Be Bright. Go E-trike!" design-an-electric tricycle contest to encourage and promote the creativity and innovativeness of young Filipinos in crafting the Philippine version of the so called "Green Vehicle."

Barangay Electrification

Rural electrification has been one of the government's priority thrust. The goal is to achieve total barangay[2] electrification by end of 2010. As of August 2012, the country's total electrification level has reached 99.98 percent with 41,965 barangays already with access to electricity out of the 41,974 (formerly 41,980) barangays. Given the importance of electricity in the economic development of the country, the electrification program of the government is being extended up to household level. The government is targeting to achieve 90.0 percent household electrification by 2017.

As of 30 December 2011, household electrification level stands at 70.2 percent. This means that out of the 20.5 million households, 14.4 million are with electricity connection[3].

1.3. Energy

The country's total primary energy supply in 2011 reached 39.8[4] million tons of oil equivalent (Mtoe). Oil accounted for 32.0 percent of the total energy supply followed by geothermal which comprised 21.5 percent. Total production reached 23.7 Mtoe bringing energy self-sufficiency level of the country at 60.0 percent.

[2]Filipino term for a village, district or ward and is the smallest administrative division in the Philippines.
[3] Total number of households is based on 2010 Census.
[4] Energy Balance Table of the Philippines as of February 2013.

Meanwhile, the country's total electricity generation in 2011 reached 69.2 terawatt-hours (TWh). Coal-fired power plants remain the major resource for power generation with an installed capacity of 4,917 megawatt (MW). Coal comprised more than 36.0 percent or 25.3 TWh of the total electricity requirement of the country. Meanwhile, natural gas-fired power plants accounts for more than 29.8 percent or 20.6 TWh. Natural gas resource provides for more than 41.0 percent of the total electricity requirement of Luzon grid. Currently, the country has 3 existing natural gas power plants with a combined installed capacity of 2,861 MW. On the other hand, the combined share of renewable energy to the total power generation mix was 29.0 percent.

2. Modelling Assumptions

Two scenarios were developed to assess the energy savings potential of the country. The Business As Usual (BAU) scenario serves as the reference case in the projection of the energy demand and carbon dioxide (CO_2) of the energy sector. The BAU incorporates the existing energy policies, plans and programs of the Philippine government relating to the energy sector which are being implemented and will be pursued within the forecast period. The virtue of this scenario rests on assessing the effects of such measures which may evolve either as a consequence of need (energy security) or the commercialization of energy technologies (economics) given the interaction of market forces. On the other hand, the Alternative Policy Scenario (APS) will test the impact of possible policy interventions in terms of possible utilization of efficient and environment-friendly technologies to the future energy use together with its corresponding CO_2 emission.

Gross domestic product (GDP) is assumed to grow at an annual rate of 5.7 percent for the period 2010-2035. The growth rates are consistent with the projections of National Economic Development Authority (NEDA) and the Development Budget Coordination Committee (DBCC).

The population of the country is expected to grow at the rate of 1.6 percent yearly for the period 2010-2035. Population growth is based on the adjusted 2000 Census-based medium population projections using the results of the 2007 census of population including the population level of 93.34 million for 2010.

As part of the government's initiatives to ensure security of energy supply and at the same time to conserve the environment and promote green technology, the targets set under the National Renewable Energy Program were incorporated in the model to test its impact in the total primary energy supply. The NREP lays down the foundation for developing the country's renewable energy resources, stimulating investments in the RE sector, developing technologies, and providing the impetus for national and local renewable. The NREP sets out indicative interim targets for the delivery of renewable energy within the timeframe of 2011 to 2030.

Meanwhile, the intensified development and utilization of alternative fuels for transport is seen as a continuing strategy to reduce the country's dependence on imported oil. It also cushions the impact of highly volatile petroleum prices on the economy as well as assisting in promoting clean and environment-friendly energy sources. The major alternative fuels being promoted are biofuels which include biodiesel (cocomethyl esther) and bioethanol, autogas (LPG as transportation fuel), compressed natural gas (CNG), and electric vehicles. A roadmap on electric vehicle is now being prepared by the Government to identify action plans and measures related to electric vehicles in the country.

Further, the energy saving goals of 10.0 percent reduction of annual final energy demand of the country will be achieved through a range of measures including intensified energy utilization management programs in the commercial and industrial sectors, power plants and distribution utilities as well as the continuous use of alternative fuels and technologies. The information and education campaign being conducted by the Department of Energy (DOE) as well as the "Palit Ilaw[5]" Program also contributes to the energy saving goals. In the residential and commercial sectors, the utilization of more efficient electrical appliance is projected to induce savings. Energy labelling and rating on major electrical appliance will help consumer to choose more efficient electrical products.

[5] Filipino term for "change lamps" wherein the DOE distributes CFL lamps for free to consumers in exchange of their existing incandescent bulbs.

3. Outlook Results

3.1. Business as Usual Scenario (BAU)

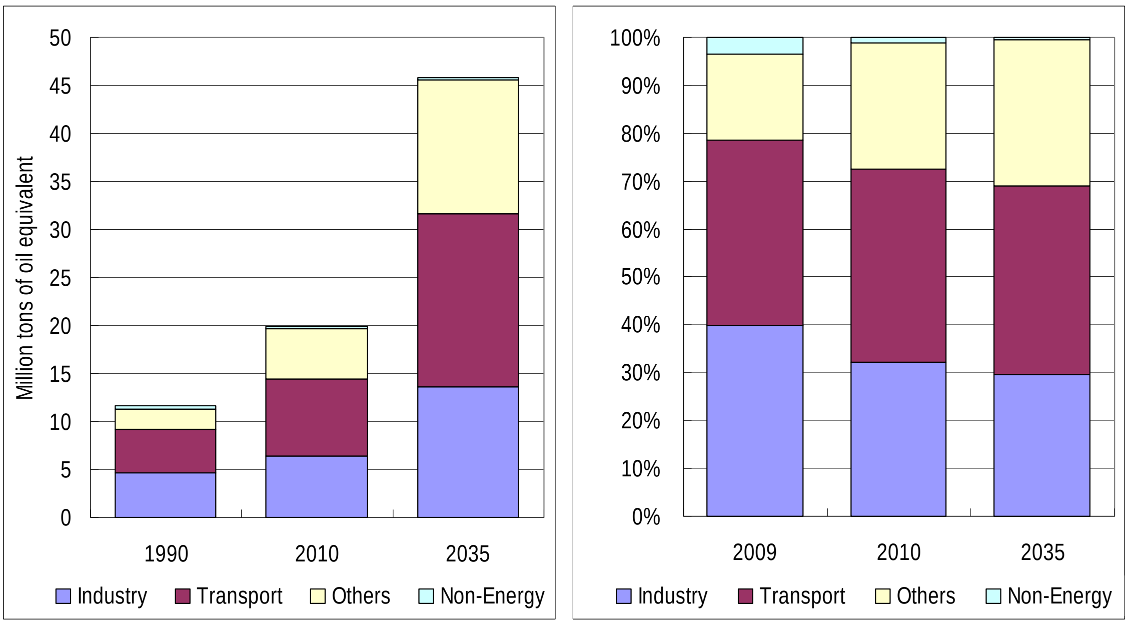
Total Final Energy Demand

Total Final Energy Consumption by Sector

The Philippines' final energy demand grew from 11.6 Mtoe in 1990 to 19.9 Mtoe in 2010 at an average annual growth rate of 3.2 percent. Over the period 1990-2010 energy demand in the other (residential/commercial) sector grew the fastest at 4.7 percent per year followed by the transport sector with average growth of 2.9 percent per year. The industrial sector grew by 1.6 percent per year.

Final energy demand is expected to grow at an annual average rate of 3.4 percent in the BAU scenario over the period 2010-2035. This is due to increasing activities in all sectors with the residential/commercial (other) sector growing the fastest at 4.0 percent per year. On the other hand, transport and industrial sector are expected to grow at an average rate of 3.3 and 3.1 percent per year, respectively.

Figure 14-1: Final Energy Demand by Sector, BAU

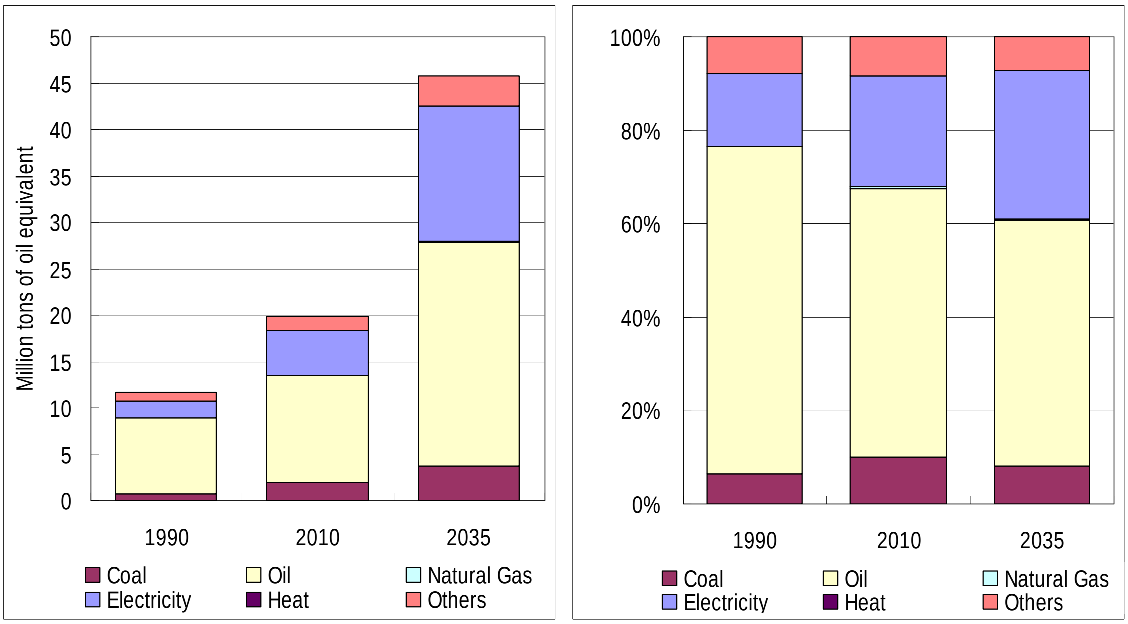


More than 40.0 percent of the country's end-use energy requirement is being consumed in the transport sector. This trend will continue throughout the planning period. On the other hand, more than 30.0 percent of the total final energy demand will be used in the industrial sector while the rest will be utilized by the remaining sectors (Others and Non-energy). By 2035, demand in the residential and commercial (Others) sector will overtake the demand in the industrial sector due to the growing commercial establishments and business as well as the growing needs of the household.

Total Final Energy Demand by Fuel

In terms of fuel, electricity demand is projected to grow the fastest at an average rate of 4.6 percent per year followed by natural gas at an average rate of 3.4 percent. Natural gas is used in industry and transport. Oil which is mainly used for transport is expected to grow at an average rate of 3.0 percent per year from 2010 to 2035. Demand for coal will grow at an average annual rate of 2.5 percent over the same period. Bulk of the end-use demand for coal is use in the cement industry.

Figure 14-2: Final Energy Consumption by Fuel, BAU



On a per fuel basis, oil was the most consumed fuel with a share of 70.0 percent in 1990 which decreased to 57.5 percent in 2010. Demand for oil will further decreased up to around 52.0 percent by end of 2035 due to the used of other alternative fuel especially in the transport sector. Currently, the country has an existing policy provided under the Biofuel's law which mandates the use of biofuel blend in diesel and gasoline fuels. This is aside from other alternative fuels used in the transport sector like, compressed natural gas, auto-LPG and e-vehicles. The reduction in oil demand is also attributed to the government's mandate to reduce oil consumption by 10.0 percent on all government offices.

Electricity is the second most consumed fuel for end-use. The share of electricity demand will increase from 15.7 percent in 1990 to 23.9 percent in 2010. The share of electricity will continuously increase, so that by the end of 2035, its share will be around 32.0 percent of the total final energy demand. The increasing share of electricity may be attributed to the increasing demand in the end-use sectors, industry, commercial, residential sector, transport, specifically, e-vehicle, expansion of Light Rail transit (LRT) and Metro Rail Transit (MRT) and others.

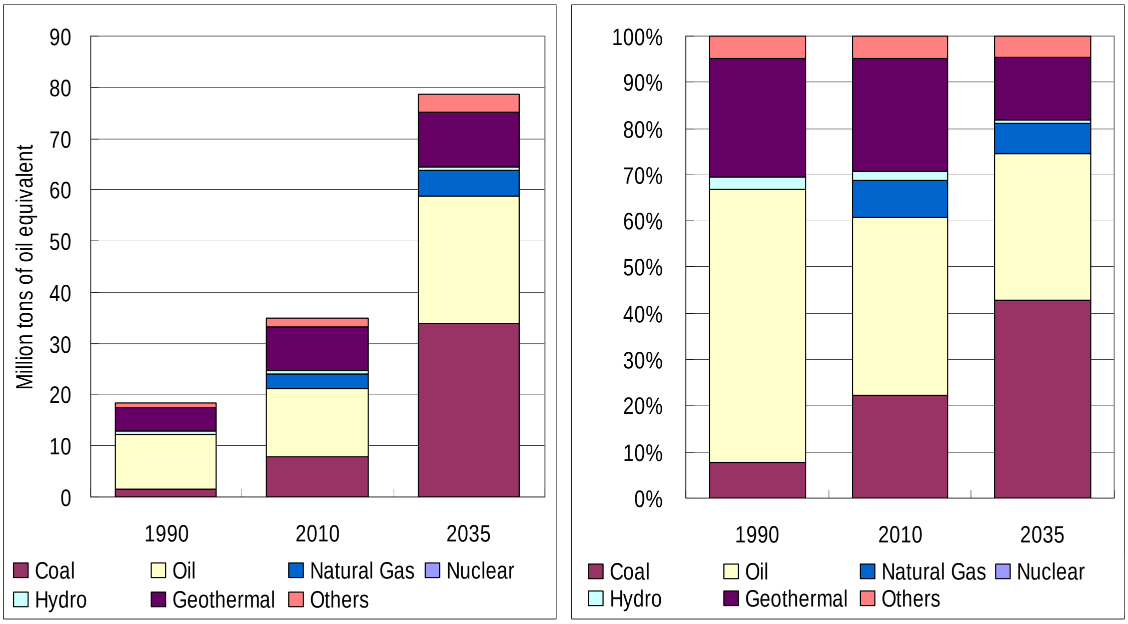
Total Primary Energy Demand by Fuel

Primary energy consumption in the Philippines grew at an annual average rate of 3.2 percent, from 18.4 Mtoe in 1990 to 34.9 Mtoe in 2010. Among the major energy sources, consumption of coal grew the fastest at 8.8 percent per year followed by geothermal and others (other renewable energy), both at 3.0 percent per year. Hydro grew only at an average annual rate of 1.1 percent and oil at 2.5 percent per year.

For the period 2010 to 2035, the country's primary energy demand is expected to increase by 3.3 percent per year from 34.9 Mtoe in 2010 to 78.7 Mtoe in 2035. Demand for all major energy sources is projected to increase with coal use growing the fastest at 6.1 percent per year. Natural gas is also expected to expand with a growth rate of 2.3 percent per year during the same period.

Oil will account for the largest share on the total energy supply of the country but with decreasing share 58.9 percent in 1990 to 38.5 percent in 2010. By 2035, majority or 43.0 percent of the country's energy requirement will be sourced from coal. Coal will be largely used for power generation. Combined share of renewable energy comprised 19.0 percent of the total energy supply.

Figure 14-3: Primary Energy Demand by Sector, BAU



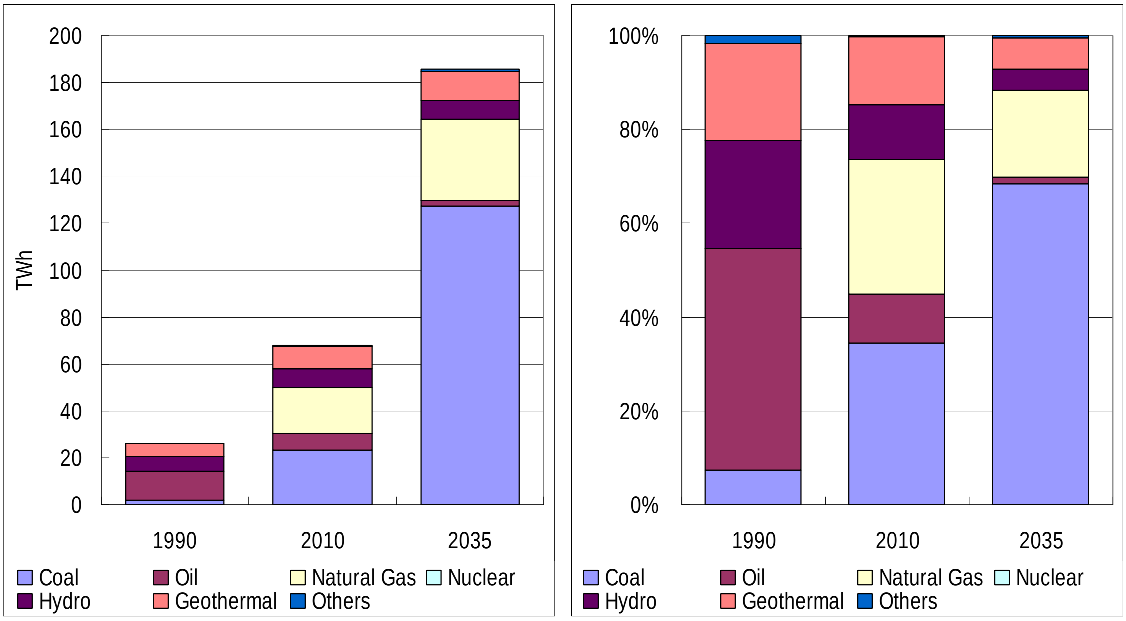
Power Generation

Total power generation in 2010 reached 67.7 terawatt-hours (TWh), more than double of the country's level in 1990. Power generation is expected to increase by 4.1 percent yearly. Other fuels (solar and wind) is expected to increase an average rate of 10.4 percent followed by coal for power generation is expected to increase at an average rate of 7.0 percent per year. Natural gas for power generation is expected to increase by 2.3 percent per year. Hydro and geothermal are also expected to grow at an average annual rate of 0.3 and 0.9 percent, respectively. Alternatively, oil will have a decreasing trend of 4.2 percent.

In 2010, coal comprised bulk of the country's power generation mix having a share 34.4 percent followed by natural gas having a share of more than 28.0 percent. Oil, which is the country's primary source of electricity in 1990 decreases it share from more than 47.2 percent share to only more than 10 percent in 2010. This trend will continue up to 2035. By end of 2035, the share of renewable energy for power generation will be around 12.0 percent.

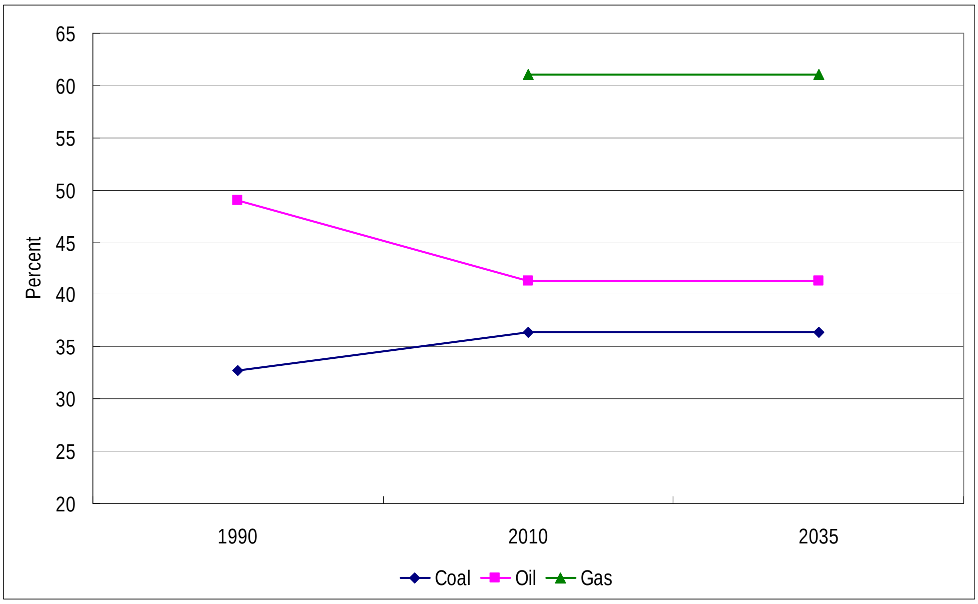
Between the periods 2010 to 2035, most of fuel for power generation will be supplied by coal at around 70.0 percent. On the other hand, natural gas will grow by 3.0 percent per year maintaining its share to the total power generation mix at more than 18.0 percent.

Figure 14-4: Power Generation by Fuel, BAU



Thermal efficiency is a factor that determines the generation output that will be produced by its power plant. For this study, thermal efficiencies of each plant were determined through the so called "process efficiency" of each power plant. Process efficiency is computed by dividing fuel output over fuel input multiplied by 100. Under the BAU, thermal efficiencies of coal, oil and natural gas under the BAU is projected to be maintained for the planning period. Coal thermal efficiency is set at more than 36.0 percent, while oil is at around 40.0 percent. Meanwhile, natural gas thermal efficiency is set at more than 60.0 or 61.0 percent. Natural gas for power generation only started in the Philippines in the late 1990s.

Figure 14-5: Thermal Efficiency by Fuel, BAU

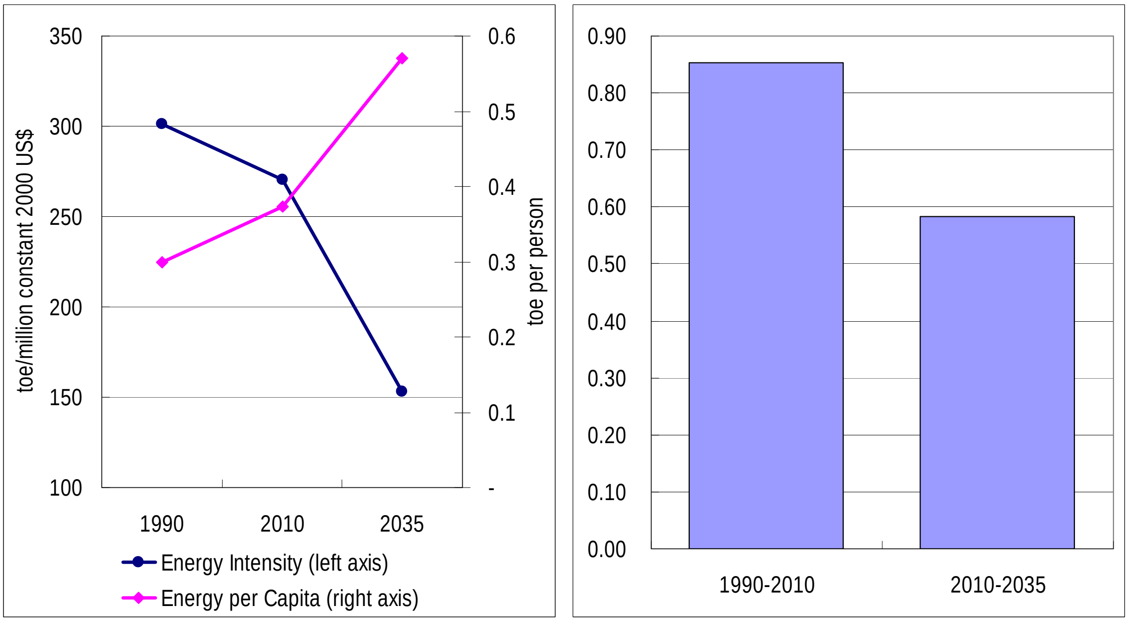


Energy Indicators

Under the BAU, energy intensity of the country tends to decrease at a rate of 2.2 percent for the period 2010 to 2035. Energy intensity is the ratio of total primary energy over GDP. Energy intensity improvement for the period 2010 to 2035 will result to about 43.0 percent. The improvement in intensity is due to the government's efforts in promoting energy conservation and efficiency in the different sectors of the economy. Meanwhile, energy per capita has an increasing trend from 0.30 toe in 1990 to 0.37 toe in 2010. The increasing trend will continue until 2035, where energy per capita will increase to 0.6 toe. The increasing trend is due to the improvement in the living standard and income of people.

Relatedly, for the period 1990-2010, elasticity of energy demand stood at 0.9 or less than 1.0, indicating an efficient use of energy. Energy elasticity is the relationship between changes in the primary energy demand and the changes in GDP. Meanwhile, energy elasticity for the period 2010-2035 would be approximately 0.6 indicating a more efficient use of energy resources and technology.

Figure 14-6: Energy Intensity, Energy Per Capita and Energy Elasticity



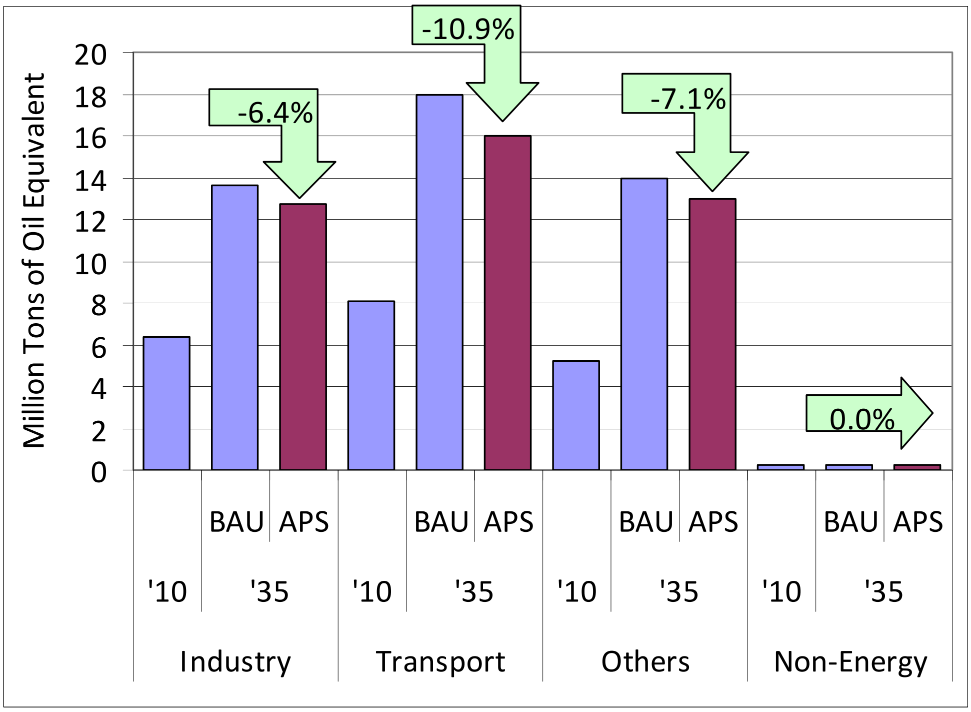
3.2. Energy Savings and CO_2 Reduction Potential

Total Final Energy Demand

In the APS, final energy demand is projected to increase at a slower average rate of 3.0 per year compared with BAU scenario of 3.4 percent. Energy demand under APS will reach 42.0 Mtoe in 2035; this is 8.3 percent lower than the BAU.

On a sectoral basis, most of the reduction will come from the transport sector which will decease by almost 11.0 percent. Reduction of demand of the transport sector may be attributed to the energy sector's efforts on energy efficiency and conservation, which include among others, the use of alternative fuels in the transport sector and the energy sector's campaign related to energy efficiency and conservation, specifically in the transport sector. Also, demand in the other sectors (residential and commercial) will be lower compared to the BAU. Amount of savings under the APS case will be around 1.0 Mtoe or 7.1 from 13.6 Mtoe in the BAU to 12.7 Mtoe in the APS. Gains under the other sector may be attributed to the government's energy information and education campaign as well as the energy labelling program which is mostly on technological improvements in basic household appliances and lighting products. The energy labelling program ensures that consumers have the information they need to make the right decision when they purchase these household appliances and lighting fixtures. The government is now on its way expand the scope of appliances and lighting products to be covered by energy standards and labelling. Meanwhile, the industrial sector is projected to grow at an average annual growth rate of 2.8 percent. The projected savings from the industrial sector will be more than 6.0 percent compared to BAU (Figure 14-7).

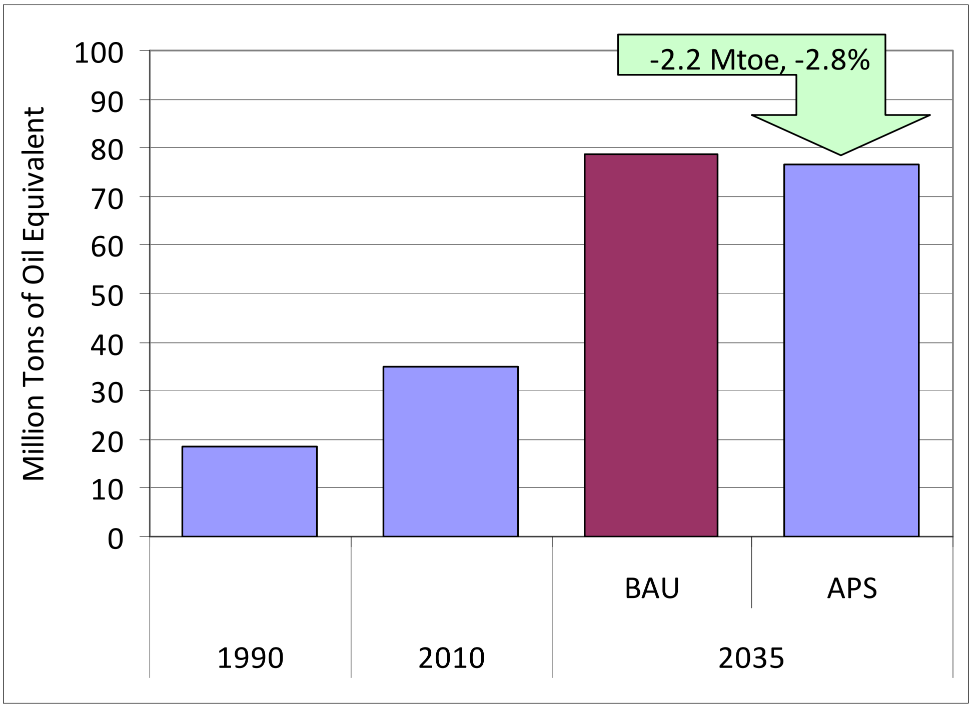
Figure 14-7: Final Energy Consumption by Sector, BAU and APS



Primary Energy Supply

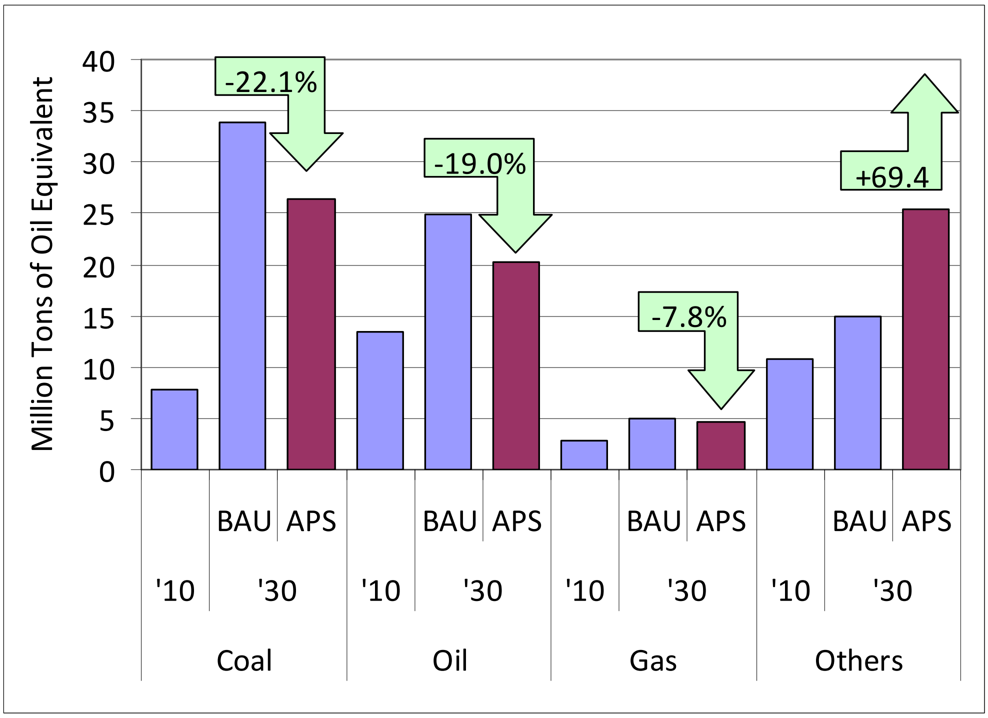
In the APS, primary energy supply is projected to increase at an annual average rate of 3.2 percent increasing from 34.9 Mtoe in 2010 to 76.5 Mtoe in 2035. For the period 2010-2035, although coal accounts for the largest share of 34.4 percent in the total primary supply by 2035, its average annual growth rate would be lower at 5.0 percent as compared to the 6.1 percent growth in the BAU. Natural gas consumption will grow at an average annual growth rate of 2.2 percent while oil will temper its growth from 2.5 percent in the BAU to 1.6 percent in the APS.

Figure 14-8: Evolution of Primary Energy Supply, BAU and APS



The share of renewable energy sources such as hydro, geothermal and "others" (including solar, wind, biomass and biofuels) is expected to reach more than 33.0 percent by 2035, which is more than 14.1 percent higher than the BAU. The full operation of the policy mechanisms under the Renewable Energy Law will further expand the contribution of renewable in the total primary energy supply mix.

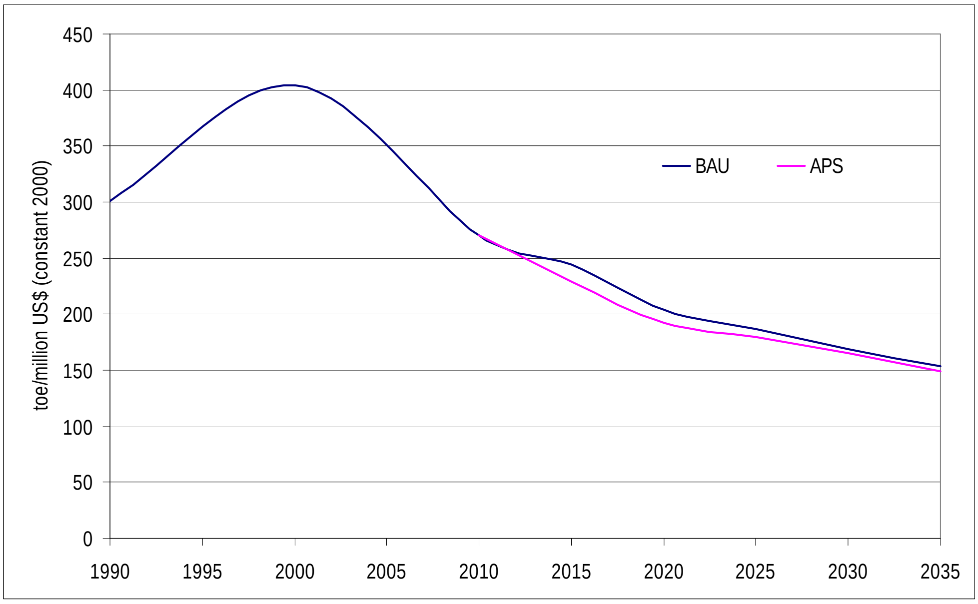
Figure 14-9: Total Primary Energy Supply, BAU and APS



Energy Indicators

Compared to the BAU scenario, energy intensity in 2035 under the APS will be around 45.0 percent lower from the 2010 level. Energy intensity reduction under the APS is 2.0 percentage points lower than the 43.0 percent intensity reduction in the BAU. The improvement in intensity is due to the government's efforts in promoting energy conservation and efficiency in the different sectors of the economy. Meanwhile, energy per capita in 2035 will be 1.7 percent lower compared to BAU.

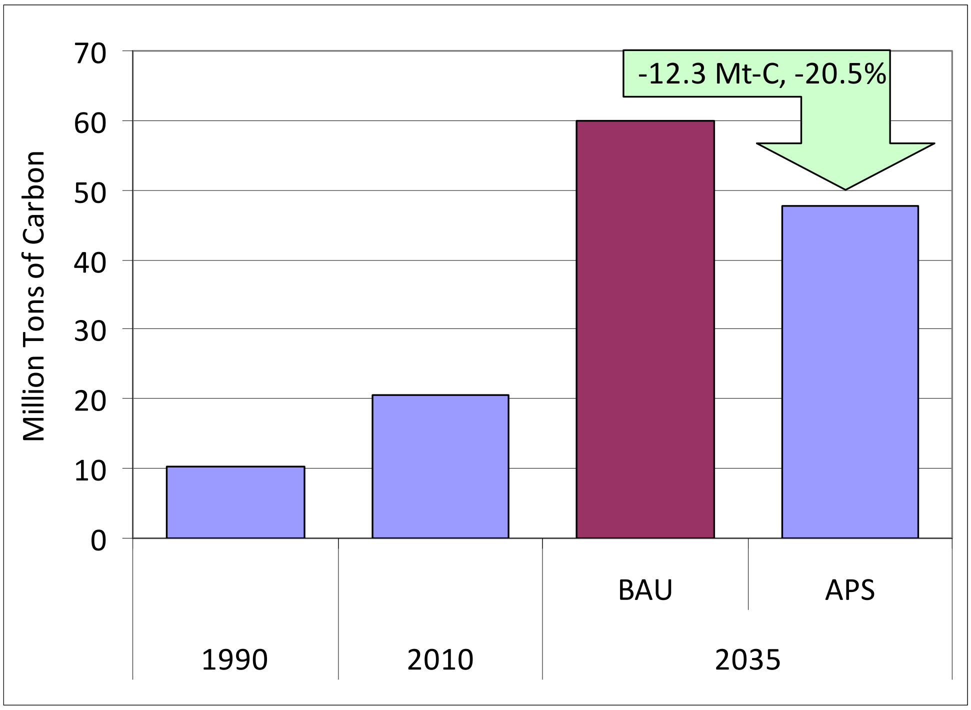
Figure 14-11: CO_2 Emission from Energy Consumption, BAU and APS



CO_2 Reduction Potential

CO_2 emissions from energy consumption are projected to increase by 3.3 percent per year under the APS from 4.4 percent growth under BAU. CO_2 emission reduction is expected to be around 12.3 million metric ton of carbon (Mt-C) which is 20.5 percent lower than the BAU. The decrease in CO_2 indicates that the energy saving goals, action plans and policies in the promotion of renewable energy together with the switch to more efficient and less carbon intensive technologies will be effective in reducing CO_2 emissions in the APS. (Figure 14-11)

Figure 14-11: CO_2 Emission from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

In 2035 total final energy savings of 3.8 Mtoe could be achieved in the APS relative to the BAU. This is equivalent to 8.3 percent reduction in total final energy consumption, around 3.0 percent reduction in the primary energy demand, and 20.5% reduction in CO_2 emission.

Energy intensity improvement under the APS will reach 45.0 percent by 2035. This means implementation of energy plans and programs in energy efficiency and conservation of the government; responses to surging oil prices and their inflationary effects on the prices of basic commodities; and changing economic structure of the country to rely more on its service sector rather more than on energy intensive industries will reduce energy intensity by 45.0 by year 2035 (2010 level as base year). This is consistent with the Asia-Pacific Economic Cooperation's (APEC) target to reduce APEC's aggregate energy intensity (energy demand per unit of gross domestic product - GDP) by forty-five (45%) percent by 2035 with 2005 as the base year.

Improvement in the energy intensity of the Philippines to 2035 is expected to be driven in part by the country's changing economic structure to rely more on its service sector rather than on energy intensive industries. In addition, energy per capita consumption by 2035 is expected to be 0.55 toe/person which is 1.7 percent lower than the BAU level of 0.57 toe/person.

In response to the result of the study, the government should pursue its programs and projects that will further increase and enhance the utilization of indigenous, clean and efficient alternative fuels. The full implementation of the Renewable Energy Act of 2008 to expand the utilization and development of indigenous energy such as geothermal, hydro solar, wind and others will not only promote the use of clean energy but will also lessen country's need for energy imports. The FIT, RPS and other policy mechanism provided under the law will boost the utilization of RE.

Moreover, the use of alternative fuels such as CNG, autogas (LPG for transportation), biofuels and electric vehicles for transport will reduce the effects of continuous increases in the prices of crude oil in the world market as well as reduce greenhouse gas emissions. The governments efforts in the promotion of alternative fuels in the transport sector will help not only reduce energy requirement but will also lessen emission coming from the transport sector.

Special attention should also be given to the industrial sector since it is the second largest consuming end-use sector of the economy and is growing almost at the same rate as the transport sector and could have high potential energy savings.

Furthermore, the country must set a quantitative sectoral energy savings target for easy evaluation and monitoring. To institutionalize energy efficiency and conservation, incentives towards greater participation is needed. Currently, the Philippines has a specific quantitative energy saving requirement as provided under Administrative Order (AO) No. 110, "Directing the Institutionalization of a Government Energy Management Program". The AO requires the reduction of at least ten percent (10%) in the cost of the consumption of fuel and electricity among others in the government. This can be duplicated or expanded to other sectors if there is an existing energy conservation law which will require strict regulation and implementation.

Finally, there is a need to pass the Energy Conservation Law to realize the targets set by the government. The Law will institutionalize energy conservation and enhance the efficient use of energy in the country.

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CHAPTER 15

Singapore Country Report

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1. Background

Singapore is a small island-state in Southeast Asia, located along the Straits of Malacca between Malaysia and Indonesia. It is the most urbanized and industrialized country in the ASEAN, with a yearly GDP per capita of S$65,048 in 2012[1] and is fully electrified. It has a national policy framework to maintain a balance among the policy objectives of economic competitiveness, energy security and environmental sustainability.[2] Singapore has a national target of improving energy intensity by 20.0 percent by 2020 and 35.0 percent by 2030 as compared to 2005[3]. It also has a voluntary target of reducing carbon dioxide (CO_2) emissions by 7-11 percent below business-as-usual levels in 2020,[4] which will be increased to 16.0 percent below business-as-usual levels if there is a global agreement on climate change.

[1]Singapore Department of Statistics (2013).
[2]Ministry of Trade and Industry of Singapore (2007).
[3]Singapore Government (2009).
[4]National Climate Change Secretariat (2012).

Singapore's Policy Initiatives

An inter-agency Energy Efficiency Programme Office (E^2PO), led by the National Environment Agency (NEA) and the Energy Market Authority (EMA), was established in May 2007 to help promote and facilitate the adoption of energy efficiency in Singapore.[5]

Since January 2008, the Mandatory Energy Labelling Scheme (MELS) imposed the compulsory display of energy labels on household appliances.[6] Currently, all registrable refrigerators, air-conditioners and clothes dryers sold in Singapore must have an energy label. Televisions will be included in the scheme from 2014 onwards.[7] NEA is reviewing the design of energy labels and is looking into incorporating the estimated energy cost of operating appliances to help consumers make more informed decisions.[8] MELS has so far been successful and will continue to improve energy efficiency and mitigate growth of energy use in the residential, commercial and transport sectors. NEA also launched a "10% Energy Challenge" national campaign in 2008 to promote electricity saving in households.[9] The further efficacy of these existing labelling standards and educational campaigns in facilitating energy conservation and efficiency improvements will depend on how responsive end-users are to these initiatives.

After introducing the MELS and the Fuel Economy Labelling Scheme (FELS), NEA subsequently implemented Minimum Energy Performance Standards (MEPS) for household air conditioners and refrigerators. MEPS eliminate energy inefficient appliances from the market by prohibiting the sale of appliances that fall short of a specified minimum efficiency level. It helps consumers avoid being locked into using inefficient appliances with high operating costs and encourages suppliers to bring more energy-efficient appliances to the market as technology improves. MEPS standards have recently been tightened this year, and will start to incorporate clothes dryers and general lighting in 2014.

The Building and Construction Authority (BCA) of Singapore launched the BCA

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[5]Energy Efficiency Programme Office (2013b).
[6]National Environment Agency (2008a).
[7]Ministry of the Environment and Water Resources (2013).
[8]Ministry for the Environment and Water Resources (2012b).
[9]National Environment Agency (2008b).

Green Mark Scheme in January 2005 to promote environmental awareness in the construction and real estate sectors. Since April 2008, all new buildings and existing buildings undergoing major retrofitting works with a gross floor area above 2000 square meters must meet Green Mark Certified standards. The BCA Green Mark Scheme promotes the adoption of green building technologies and reduces the use of electricity in the commercial sector via efficiency improvements and conservation.[10] This scheme has recently been extended to include data centres. The BCA has also recently developed a web-based carbon emission calculator that takes into account a building's lifespan and major construction materials to help builders quantify the carbon impacts of each carbon-related Green Mark criteria.[11] In the case of building standards, there are some uncertainties as to how effective these standards will be in the long run, even if relatively detailed calculations about expected energy savings from engineering measurements can be made.

Certificates of Entitlement (COEs) give Singaporeans the right to own a vehicle. COEs are integral to the Vehicle Quota System (VQS), a landmark scheme implemented to regulate the growth of the vehicle population in Singapore. Under the VQS, the vehicle population growth rate has been capped at 1.5 percent per year between 2009 and 2011,[12] down from the 3.0 percent cap in place three years ago given the constrained expansion of roads and highways in Singapore's urban environment. The actual compound annual growth rate of the vehicle population between 1990 and 2008 was 2.8 percent per year. The existing annual vehicle growth rates imposed by the Land Transport Authority (LTA) for a period of 3 quota years (2012-2014) is 1.0 percent in 2012 and 0.5 percent in 2013 and 2014.[13]

The Fuel Economy Labelling Scheme (FELS) mandated fuel economy labels to be affixed to vehicles at the point of sale. The FELS has been complemented by a Green Vehicle Rebate (GVR) Scheme which provides rebates of up to 40.0 percent of the vehicle's Open Market Value for green vehicles such as electric, petro-electric hybrid, Compressed Natural Gas (CNG) and Bi-fuel (CNG/Petrol) vehicles, narrowing their cost differentials. The GVR seeks to encourage the purchase of

[10] Building and Construction Authority Singapore(n.d.).
[11] Energy Efficiency Programme Office (2013a).
[12] Land Transport Authority (2010).
[13] Land Transport Authority Singapore (n.d.).

green vehicles, which are more fuel efficient and emit less air pollutants than their internal combustion equivalents.

The old Rebate Scheme based on engine type expired on 31 December 2012. Under the current scheme, buyers of cars with low carbon dioxide emissions (≤ 160 g carbon emissions per kilometre) will enjoy tax rebates (of up to SGD 20,000) to offset the Additional Registration Fee[14]. This is referred to as the Carbon Emission-based Vehicle Scheme (CEVS). To give consumers and the automobile industry more time to adjust, those who buy cars with high CO_2 emission (≥ 211 gCO_2/km) will face registration surcharges (of up to SGD 20,000) levied in cash six months later (July 2013). The majority of car buyers will not be affected either way by the new Scheme if they keep to their usual buying patterns. Around 60.0 percent of cars registered in 2011 fall into a neutral category (with 161-210 gCO_2/km carbon dioxide emission), implying neither rebates nor surcharges will be faced.[15] The new Scheme will be in place for two (2) years and be reviewed at the end of 2014.

The Government launched the Energy Efficiency National Partnership (EENP) programme in 2010 to help companies put in place energy management systems and implement projects to improve energy efficiency. The Government introduced mandatory energy management requirements for large energy users who consume more than 15GWh in the industry sector. Under the Energy Conservation Act from April 2013 onwards, these large energy users have to appoint an energy manager, monitor and report energy use and greenhouse gas emissions and submit annual energy efficiency improvement plans to the government from 2014 onwards.[16] The Energy Conservation Bill, which was passed in Parliament on 9 April 2012, consolidates laws on energy efficiency. The Energy Conservation Act will be jointly administered by the Ministry of Environment and Water Resources, which will oversee the measures in the industry and household sectors and the Transport Ministry, which will oversee the transport measures.[17]

[14]Additional Registration Fee is a tax imposed upon registration of a vehicle and calculated based on a percentage of the Open Market Value of the vehicle.
[15]Ministry of Transport (2012).
[16]National Environment Agency (2013).
[17]Ministry of the Environment and Water Resources (2012a).

2. Modelling Assumptions

Two scenarios were developed to assess the energy saving potential of the energy efficiency and conservation policies in Singapore. The "Business As Usual" (BAU) scenario forecasts energy demand and CO_2 emissions by incorporating energy policies implemented up until the end of 2012, while the "Alternative Policy Scenario" (APS) projects energy use and CO_2 emissions with a comparatively higher uptake of energy efficiency and conservation policies. In this case, demand management policies are assumed to be more effective, as human behaviour is more "elastic" or responsive to such policies.

In 2010, the overall thermal efficiency of gas fired power plants in Singapore was 49 percent. According to the International Energy Agency (IEA), the average thermal efficiency of combined cycle gas turbine (CCGT) generators was 57.0 percent and that of conventional power plants was 41.1 percent.[18] It is assumed that the efficiency of gas and thermal power plants will improve under both the BAU and APS scenarios. By 2035 under APS, it is assumed that gas-fired turbines will attain 54.0 percent efficiency, while thermal power plants will attain an efficiency of approximately 41.0 percent. In both scenarios, the share of electricity contributed by solar power reaches 5 percent by 2035.

Another assumption made is that gasoline demand is linearly proportional to Singapore's car population. The LTA has capped the growth rate of vehicles at 1.5 percent between 2009 and 2011. The annual vehicle population growth rate was further reduced to 1.0 percent in 2012 and is currently at 0.5 percent till 2014.

A joint study conducted by the Building and Construction Authority (BCA) and the National University of Singapore (NUS) demonstrated that retrofitting to achieve the standard BCA Green Mark certification can result in a 17.0 percent reduction in energy demand.[19] If measured by the area of the buildings where owners are responsible for paying for the utilities, the average savings are even higher at nearly 30.0 percent. In 2005, the total number of buildings awarded the Green Mark Scheme was 17. As in March 2013, there were around 1500 Green Mark building

[18] International Energy Agency (2010).
[19] Yu, *et al.* (2011).

projects in Singapore.[20] At this pace, Singapore is on track to achieve its target of having 80.0 percent of its existing and future buildings Green-Mark-certified by 2030.[21]Given our understanding of the vintage of building stock in Singapore and building stock replacement rates, a 17.0 percent reduction in electricity use relative to the baseline case in the BAU scenario, and a 20.0 percent reduction in the APS has been assumed in the commercial sector.

With reference to the IEA's Energy Technology Transitions for Industry 2009, the application of Best Available Technology (BAT) could reduce energy use in the industry sector by 13-29 percent.[22] Hence, the energy saving potential in the industry sector is taken to be 5.0 percent and 10.0 percent in 2030 in the BAU and APS scenarios, respectively.

Singapore has a long-term aim of expanding ethylene production to a range of 6-8 million tons per year by 2020.[23] Singapore's petrochemical complex primarily uses LPG and naphtha to produce olefins, ethylene, and propylene. Most ethylene plants in Singapore are naphtha-based; therefore, capacity additions in the petrochemical sector will affect naphtha demand. In 2010, naphtha accounted for 99.0 percent of the petrochemical feedstock in Singapore and LPG 1.0 percent.[24]In December 2012, a new 220 megawatt petrochemical co-generation plant was added to ExxonMobil's existing petrochemical operations, adding 2.6 million tons per year to its finished product capacity.[25] According to the IEA, 155.0 GJ of naphtha is required to produce one ton of ethylene. If the share of naphtha in the production of ethylene increases to 100.0 percent by 2020 and the above conversion factor is used, the production of 6.0 million tons of ethylene implies the demand of 22.2 Mtoe of naphtha in the non-energy sector.

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[20]Building and Construction Authority Singapore (2013).
[21]Building and Construction Authority Singapore (n.d.).
[22]International Energy Agency (2009).
[23]Economic Development Board (2007).
[24]International Energy Agency (2012).
[25]ExxonMobil Chemical (2012).

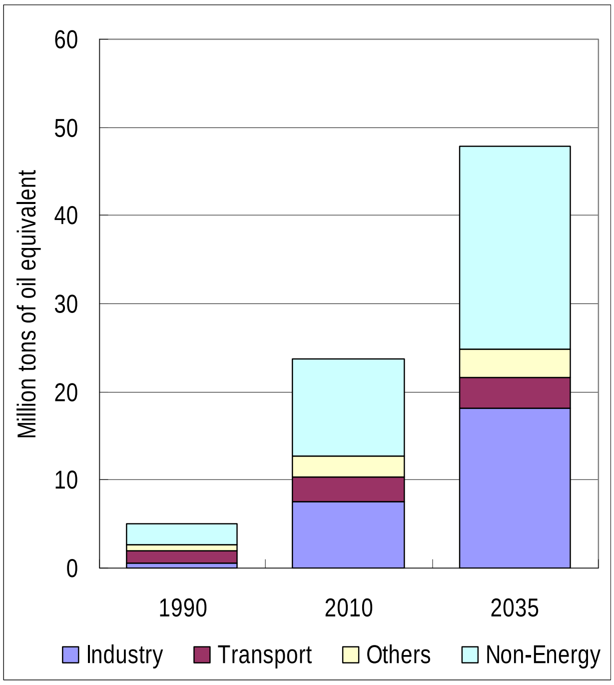
3. Outlook Results

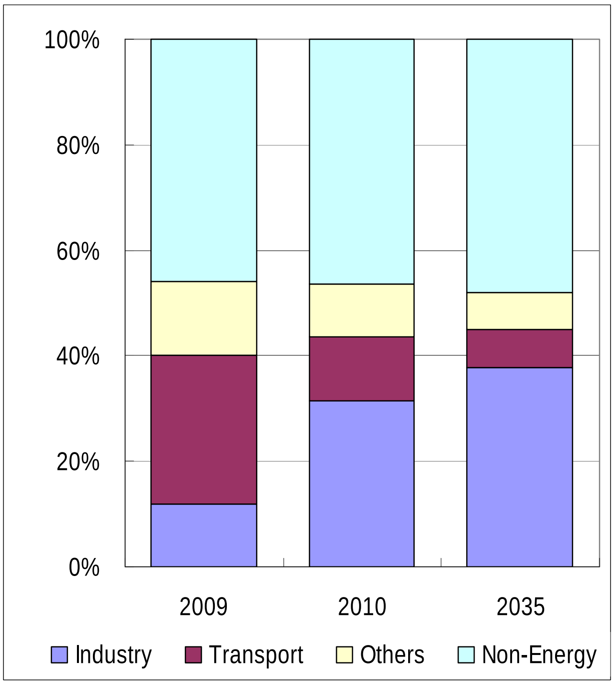
3.1. Business-as-Usual

3.1.1. Total Final Energy Demand

Singapore's total final energy demand grew at an annual rate of 8.1 percent from 5.0 Mtoe in 1990 to 23.7 Mtoe in 2010. Also for the same period, oil constitute majority of the country's final energy demand from 3.8 Mtoe in 1990 to 19.1 percent in 2010. More than 46.0 percent of the country's final energy is consumed for non-energy uses, particularly as feedstock for petrochemical production. In year 1990, 28.0 percent of the total final energy demand is used in the transport sector although its share to the total final energy demand declined to more than fifty (50) percent reaching around 11.9 percent only in 2010.

Figure 15-1: Final Energy Demand by Sector, BAU





Under the BAU, total final energy demand is projected to grow by 2.8 percent a year between 2010 and 2035. The fastest growth is expected to occur in the industry sector, increasing by 3.6 percent a year. This is followed by the non-energy sector which is projected to grow by 3.0 percent a year (Figure 15-1 above). The transport sector is projected to grow by 0.8 percent per year while the "others" (residential and commercial) sector is projected to grow by 1.3 percent per year.

Under the BAU, non-energy consumption will comprise the highest share in the total final energy demand followed by the industrial sector. By end of 2035, non-energy use will reach almost 50.0 percent of the total final energy demand of the country. Similarly, the industrial sector's share will increase from a mere 12.0 percent share in 1990 to around 37.8 percent in 2035.

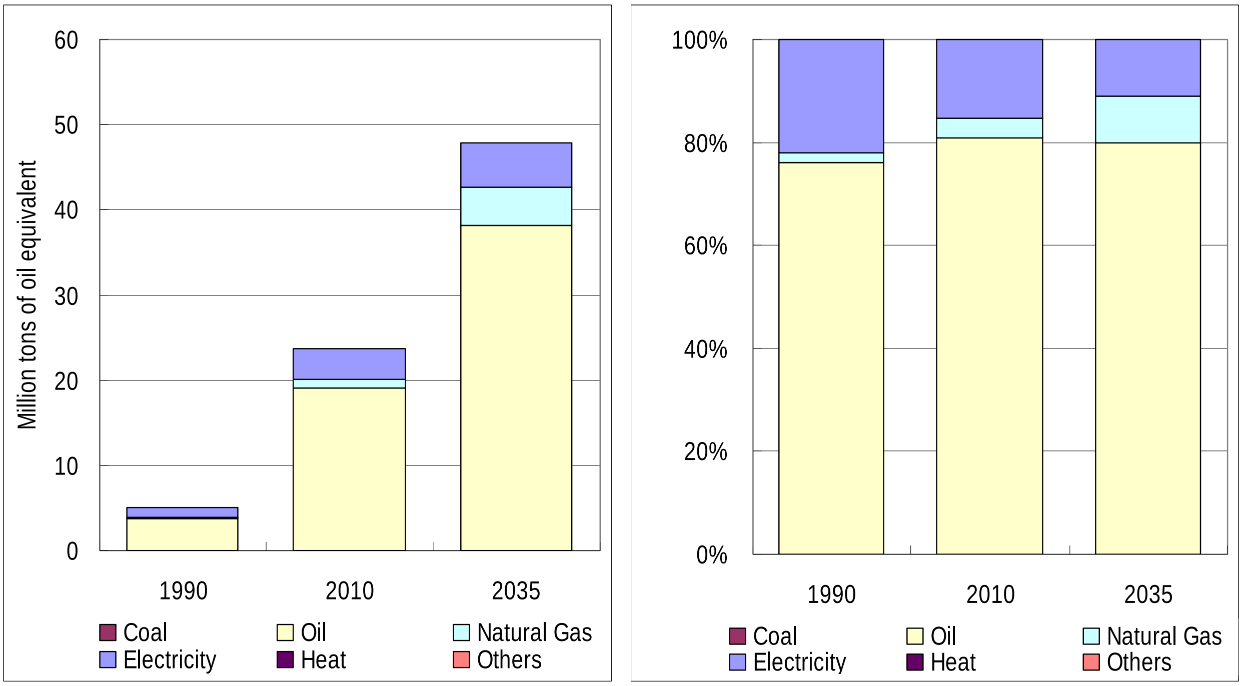
The transport sector share in the total final energy demand for the period 2010 to 2035 is expected to decrease to 7.3 percent from its 11.9 share in 1990. The decrease is due to the country's promotion for more efficient technology and use of mass transit for transport.

By fuel type, electricity experienced the fastest growth over the 1990 to 2010 period, at an average rate of 11.8 percent per year. The rapid growth of electricity was due increasing demand for electricity, particularly of the productive sectors of the economy (industry and commercial sectors). Also for the period 1990 to 2010, demand for natural gas grew at an average annual growth of 8.4 percent yearly.

Under the BAU, the share of natural gas is expected to expand increasing at an average growth of 6.4 percent per year. Meanwhile, there will be a minimal growth on electricity demand of 1.5 percent per year.

Oil still plays a major role in the country's final energy demand. For the past two decades, that is, periods 1990 to 2010, the share of oil increased from 76.0 percent to around 81.0 percent. Under the BAU, oil's share to the total final energy demand will remain at around 80.0 percent until 2035. Further, natural gas usage will increase from its share of 3.9 percent in 2010 to 9.1 percent in 2035. Meanwhile, the share of electricity in the final energy demand will be decreased to around 11.0 percent starting 2025 and this level will be maintained until 2035. Figure 15-2 shows the final energy demand by fuel in 1990, 2010 and 2035.

Figure 15-2: Final Energy Demand by Fuel, BAU



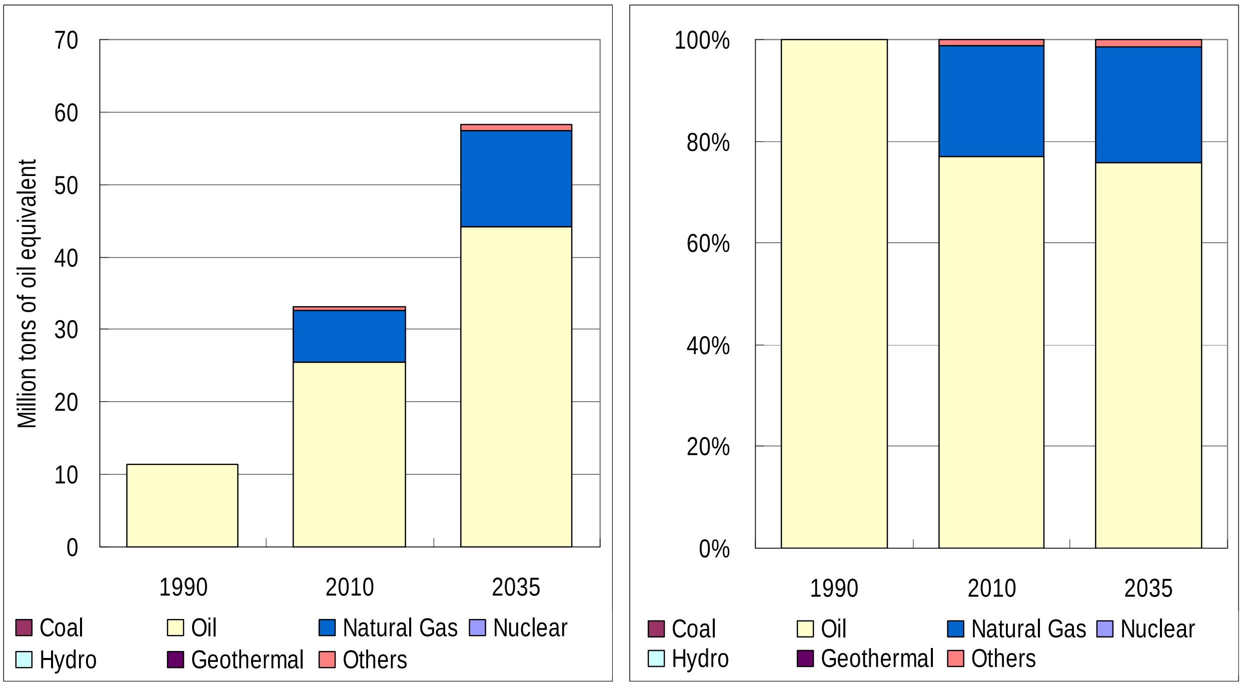
3.1.2. Total Primary Energy Demand

Total primary energy demand grew by 5.5 percent per year, from 11.4 Mtoe in 1990 to 33.1 Mtoe in 2010. Singapore's only source of energy in 1990 was oil, of which consumption increased by 4.1 percent yearly from 11.4 Mtoe in 1990 to 25.5 Mtoe in 2010. Following the construction of pipelines for gas-fired power plants, the first of which sourced gas from Malaysia in 1991, and two (2) more recent pipelines from Indonesia, the share of natural gas has increased. Consumption of natural gas increased rapidly from 0.4 Mtoe in 1992 to 7.2 Mtoe in 2010 at a growth rate of 16.4 percent per annum. To expand the country's import capability and sourcing options, Singapore has recently commenced commercial operations with its newly constructed LNG terminal, which will reach a throughput capacity of 6.0 million tons per year by the end of 2013[26], and 9 million metric tons per annum (Mtpa) thereafter in the near future.

[26] Boon, 2013

Primary energy demand in the BAU is projected to grow by 2.3 percent per year between 2010 and 2035. Among the energy sources, natural gas is expected to grow the fastest at 2.5 percent a year followed by oil at 2.2 percent. Natural gas demand is expected to grow in line with the expansion of gas-fired power plants (Figure 15-3). Other sources of energy will increase their collective share to Singapore's energy mix from 0.4 Mtoe (1.2 percent) in 2010 to 0.9 Mtoe in 2035 (1.5 percent).

Figure 15-3: Total Primary Energy Demand, BAU



Over the next few years, Singapore's net generation capacity will increase by more than 2000 MW or about 20.0 percent of current installed capacity and will comprise by more efficient CCGTs[27]. Nevertheless, oil is expected to remain the primary energy source accounting for 76.0 percent of primary energy demand in 2035 followed by natural gas at 23.0 percent.

3.1.3. Power Generation

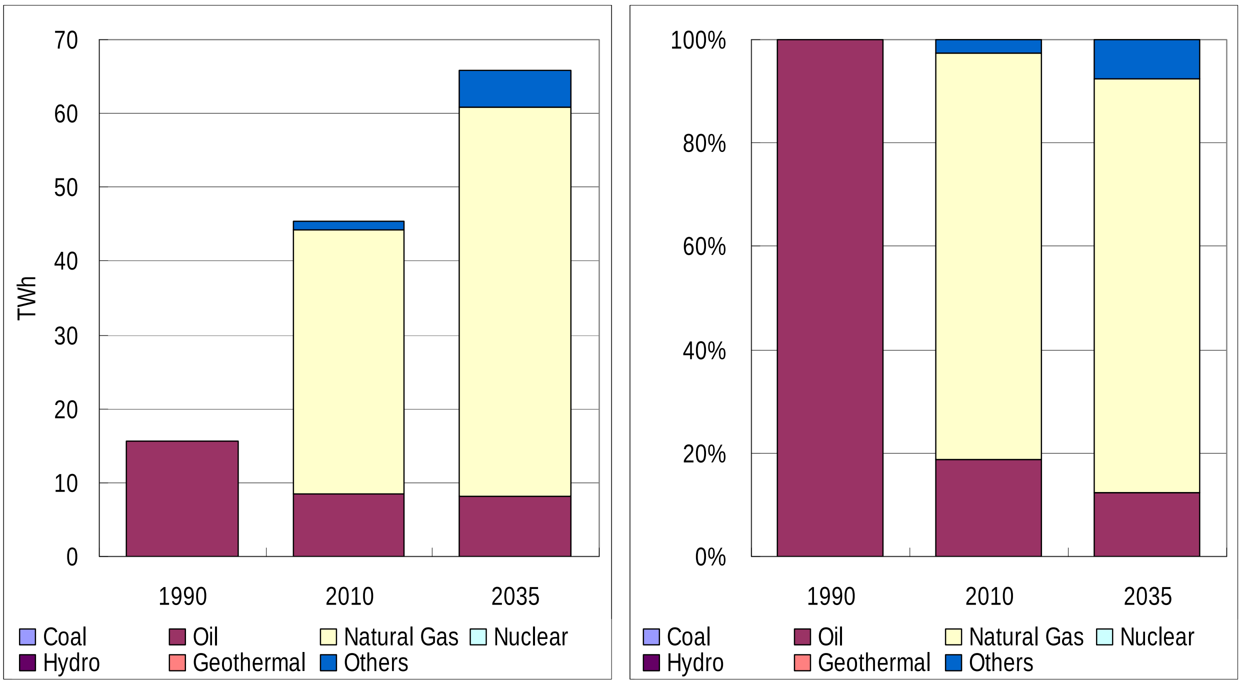
Electricity generation grew by 5.5 percent per year from 15.7 TWh to 45.4 TWh over the period 1990 to 2010. The electricity generation mix has changed

[27]Ministry of Trade and Industry (2012).

significantly over the past decade. Natural gas, which accounted for 28 percent of electricity generation in Singapore in 2001, grew rapidly to supply 79.0 percent of Singapore's electricity by 2010. Currently, fuel oil use for thermal power generation is around 18.4 percent[28] and is seen as a reasonable "balancing" alternative to a total dependence on natural gas. Biomass takes up a small proportion of the mix, at around 3.6 percent

In the BAU scenario, power generation is projected to increase at a slower rate of 1.5 percent per year reaching 65.8 TWh in 2035. By type of fuel, generation from "Others" will have the fastest growth at an average rate of almost 6.0 percent per year. "Others" power generation is expected to increase its share from a minimal share of 2.6 percent in 2010 to 7.6 percent in 2035.

Figure 15-4: Power Generation by Type of Fuel (TWh), BAU



By 2035, almost 80.0 percent of the country's power generation mix will come from natural gas under the BAU. On the other hand, the share of oil will be at 12.4 percent over the same period.

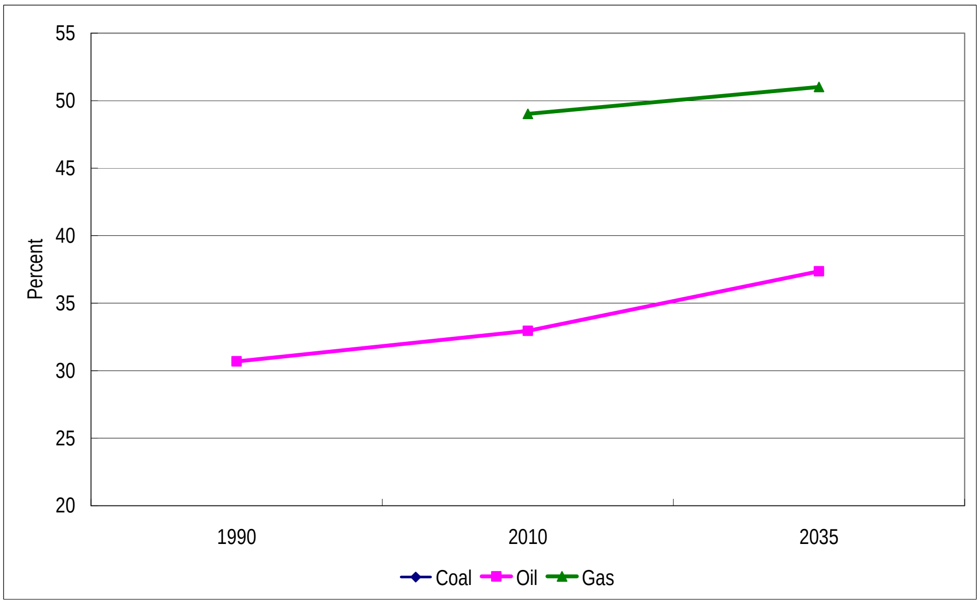
The average thermal efficiency of fossil power plant was around 30.7 percent

[28] Energy Market Authority (2012).

in 1990 and improved to 44.8 percent in 2010. In the BAU scenario, thermal efficiency of fosssil plants is expected to improve at around 48.6 percent in 2035.

By fuel, natural gas plants thermal efficiency will be 51.0 percent in 2035 while oil will be at 37.4 percent.

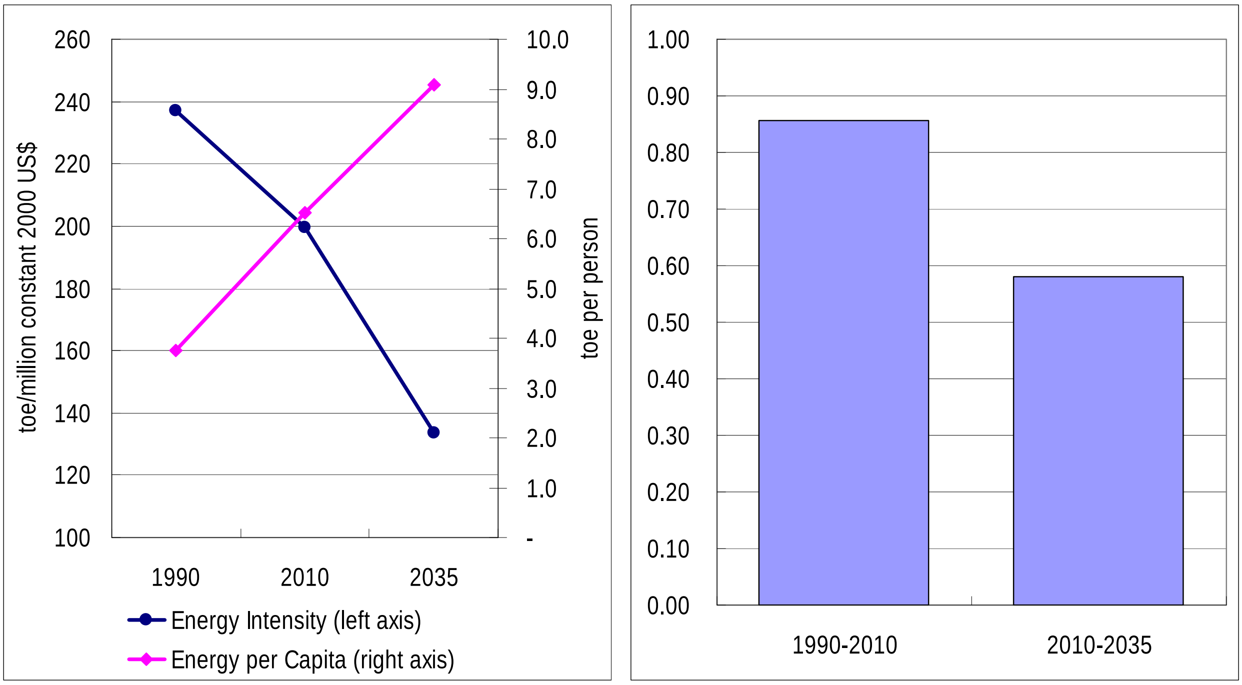
Figure 15-5: Thermal Efficiency, BAU



3.1.4. Energy Indicators

Total primary energy intensity which is computed as the ratio of total primary energy demand over GDP is expected to drop by 33.0 percent from 2010 to 2035 from 200 toe/million 2000 USD to 133 toe/million 2000 USD in 2035. This is an indication that energy producers and consumers has started to effectively use energy through the implemetation of energy conservation measures and greater utilization of efficient energy technologies.

Figure 15-6: Energy Intensity, Energy Per Capita and Energy Elasticity, BAU



The per capita energy demand, measured as the ratio of total primary energy demand to the total population, has been increasing since 1990 from 3.7 toe/person to 6.5 toe/person in 2010. This level of per capita energy demand is high compared to other East ASEAN countries which is an indication that energy access of the society is very high.

Under the BAU scenario, the energy demand per capita will continue to increase and will reach 9.1 toe per person in 2035.

Further, the elasticity of final energy demand under the BAU is expected to decline from 3.3 in periods 1990 to 2010 to around 0.7 in 2035. Elasticity below 1.0 is an indicator that growth in final energy demand will be slower than growth in GDP over the period 2010 to 2035.

3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Total Final Energy Demand

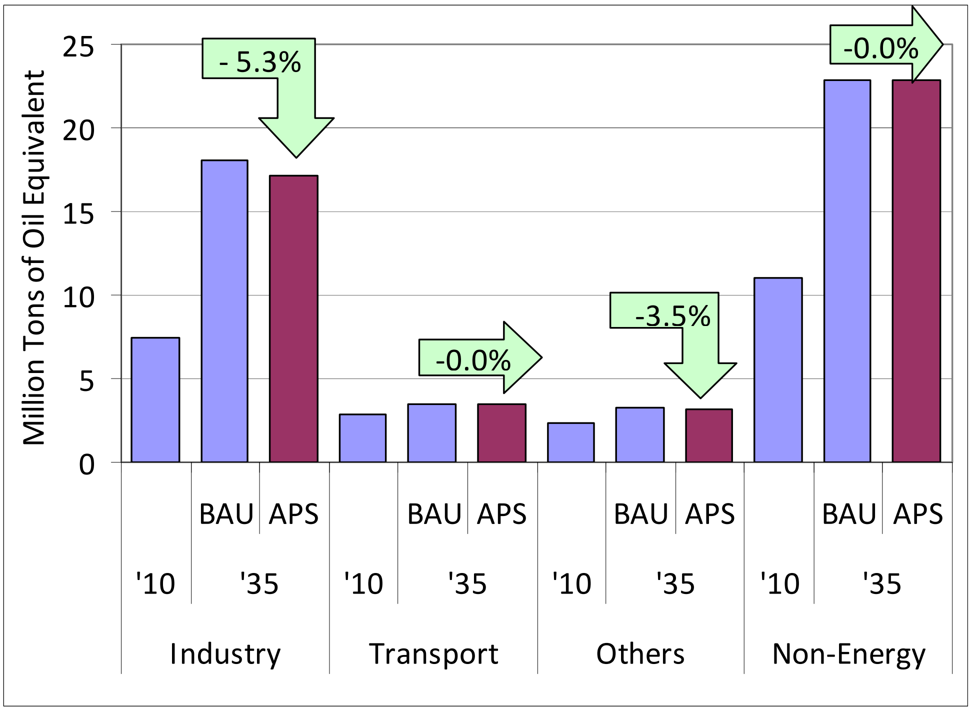
Final energy demand under the APS is projected to increase by 2.8 percent per year between 2010 and 2035. Akin to the BAU, the industry sector is projected to exhibit the fastest growth under the APS at 3.4 percent, followed by the non-energy sector at 3.0 percent and the other (residential and commercial) sector at 1.2 percent.

The industry sector realizes the largest saving at around 5 percent (Figure 15-7). In addition, a 10.8 percent improvement will be achieved on the use of electricity for the period 2010-2035.

In terms of final energy demand savings, it is projected that the industrial sector and the other (residential and commercial) sectors will have savings of 952 ktoe and 115 ktoe, respectively.

Both in the BAU and APS, the Energy Labelling Scheme, the EENP programme and BCA Green Mark Scheme retard the growth of energy use in the industry and other (which includes commercial and residential) sectors. Similarly, the VQS reduces energy use in the transport sector.

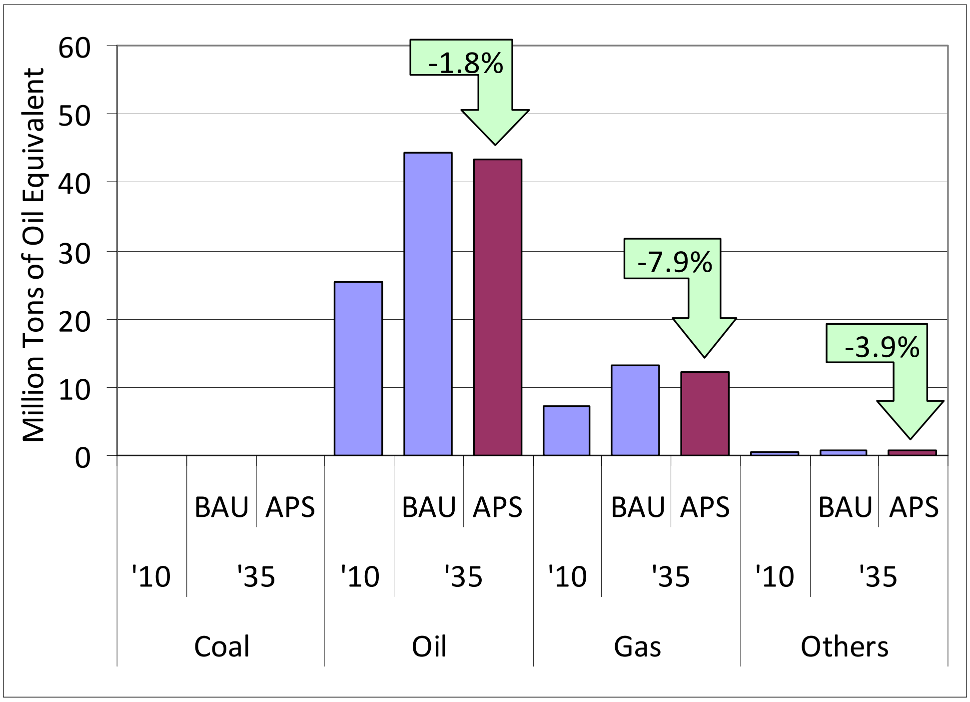
Figure 15-7: Total Final Energy Demand by Sector, BAU and APS



3.2.2. Total Primary Energy Demand

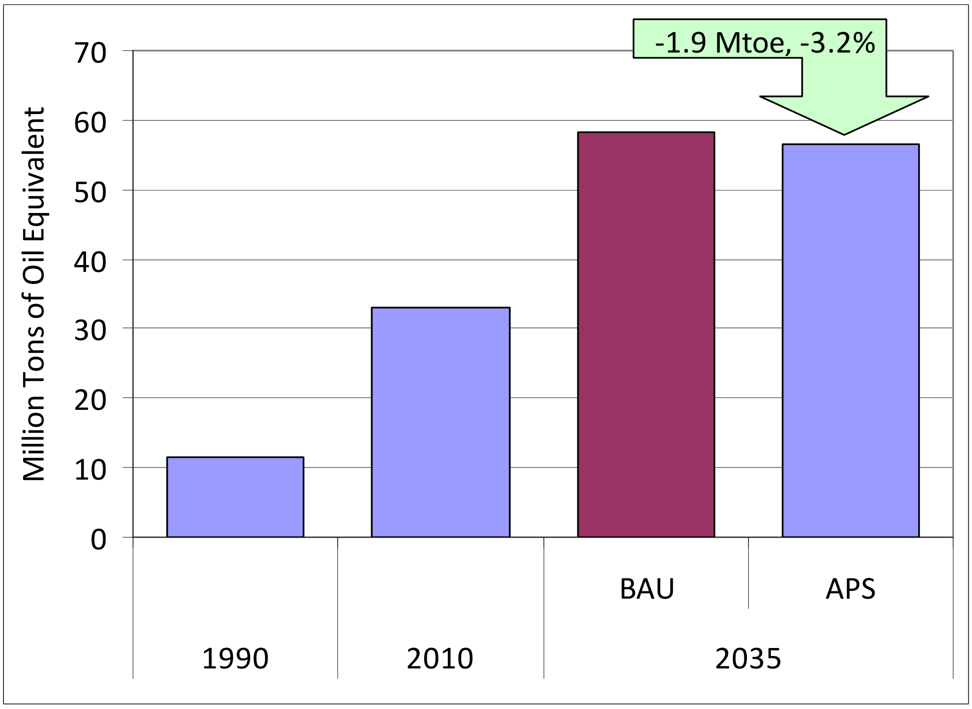
Results of the APS show that primary energy demand for the period 2010-2035 is expected to grow by 2.2 percent a year. In 2035, the difference between the growth rates of the BAU Scenario and the APS results in a 3.2 percent reduction in energy use. Natural gas will have a slower growth rate of around 2.1 percent a year, registering the largest decrease of 7.9% in comparison to BAU (Figure 15-8). Oil will still be the country's primary energy source with a 76.9 percent share, followed by natural gas with a 21.6 percent share.

Figure 15-8: Total Primary Energy demand by Source, BAU and APS



In 2035 it is estimated that Singapore's EEC goals, action plans and policies could result in savings of 1.9 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure 15-9). This is about 5.6 percent of Singapore's demand in 2010.

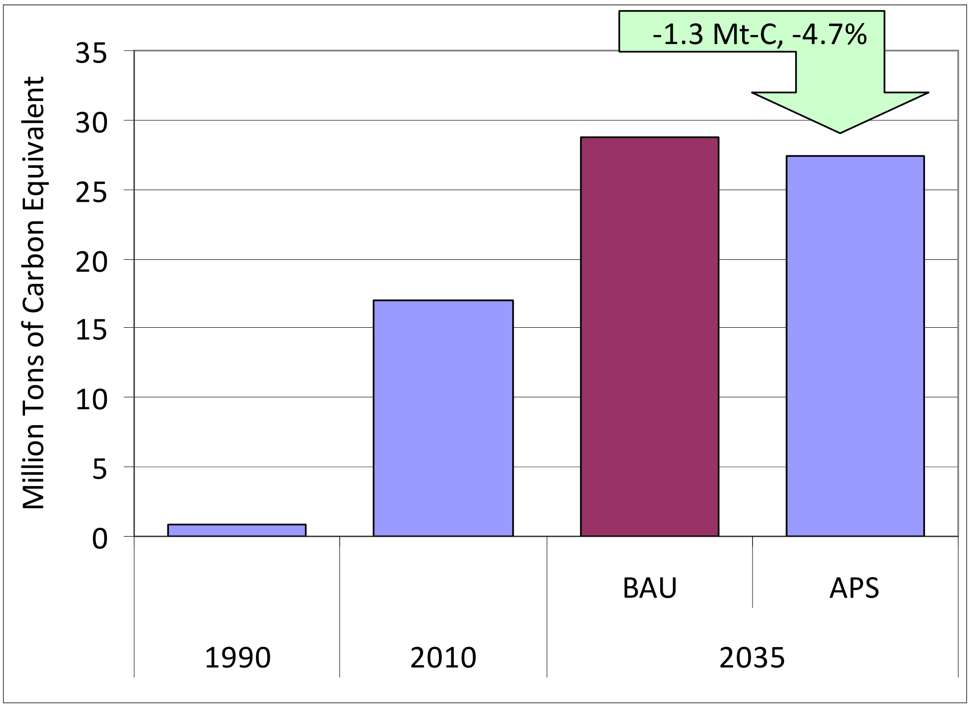
Figure 15-9: Total Primary Energy Demand, BAU and APS



3.2.3. CO_2 Reduction Potential

Carbon dioxide (CO_2) emissions from energy demand are projected to increase at an average annual rate of 2.1 percent, from 17.0 Mt-C in 2010 to around 28.7 Mt-C in 2035 (Figure 15-10). In the APS, the annual average growth in CO_2 emissions from 2010 to 2035 is expected to be lower than in the BAU scenario at 1.9 percent, which is also a 4.7% decrease from the BAU.

Figure 15-10: CO_2 Emissions from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

The impetus for a reduction in energy use and emissions is provided by the host of programs instituted by the government that seek to incentivize the use of less carbon-intensive fuels and to improve energy efficiency. These programs includes a number of funding schemes, including the Clean Development Mechanism Documentation Grant that help provide companies with financial assistance for the engagement of carbon consultancy services, and Grant for Energy Efficient Technologies (GREET) to help encourage industry investments in energy efficient equipment or technologies.[29] Despite the limitations posed by its small size and paucity of renewable energy sources, Singapore's long-term commitment to building a sustainable city will ensure that the efforts of using energy efficiently and in an environmentally viable manner will continue to receive broad support.

[29] Energy Efficiency Programme Office (2013).

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CHAPTER 16

Thailand Country Report

SUPIT PADPREM

Energy Information System Development Division
Energy Policy and Planning Office (EPPO), Ministry of Energy (MoEN), Thailand

1. Background

Thailand is in the middle of the South East Asian mainland, with the Pacific Ocean on the south-east coast and the Indian Ocean on the south-west coast. Its land area is approximately 513,115 square kilometres, with great plains in the centre, mountainous areas up north and highlands in the north-east. It has a small economy, with GDP in 2010 of around US$187.5 billion (in 2000 US$ terms). In 2010, the population was 67.3 million and income per capita was around US$ 2,800.

Thailand is an energy importer, especially crude oil, because of very limited domestic resources. Thailand's indigenous energy resources include natural gas, coal (only lignite) and biomass. In 2010, proven reserves were 0.2 billion barrels (32 million cubic metres) of oil, 10.6 trillion cubic feet (0.3 trillion cubic metres) of natural gas and 1,181 million tonnes of lignite.

Thailand's total primary energy supply (TPES) was 112.2 Mtoe in 2010. Oil accounted for the largest share at around 33.6 percent, followed by natural gas (27.5 percent), coal (13.3 percent). Others accounted for the remainder (25.6 percent). In 2010, net imports of energy accounted for 56.1 percent of TPES. Due to very limited indigenous oil resources, Thailand imported around 95.5 percent of its crude oil and most of its bituminous coal. Although Thailand produces large quantities of natural gas, about 19.6 percent of its use was imported from Myanmar.

In Thailand, natural gas is used as a major energy source for power generation. In 2010, primary natural gas supply was 39.1 Mtoe, around 80.4 percent was from domestic supply with the rest imported from neighbouring countries. Coal was mainly consumed for power generation and by industry. In addition, it was also heavily used in cement and paper production.

Thailand has 31GW of installed electricity generation capacity and power generation was about 147.0TWh in 2010. The majority of Thailand's power is generation using thermal sources (coal, natural gas and oil), accounting for 96.3 percent of generation, followed by hydro (2.0 percent) and geothermal, solar, small hydro and biomass making up the remainder.

2. Modelling Assumptions

As a result of economic crises in 1997 and 2008, GDP growth during 1990 to 2010 was a moderate 4.4 percent per year. Thailand's GDP is assumed to grow at slightly stronger average rate of 3.9 percent per year between 2010 and 2035. Population growth is also projected to be reasonably slow at around 0.3 percent per year between 2010 and 2035, compared with average growth of about 0.9 percent per year between 1990 and 2010.

Coal and natural gas are projected to be the largest energy sources for power generation. Conversely, the shares of fuel-oil and diesel power plants are projected to decline. Nuclear power and renewable energy are projected to increase their shares in the power generation mix.

Thailand's energy saving goals is expected to be achieved through the implementation of energy efficiency programs in all sectors. In the industrial sector, improvements in technology development in manufacturing processes should help improve energy efficiency. In the residential and commercial (other) sector, large energy savings are projected, driven by programs to promote public awareness of energy efficiency and energy efficiency labelling. In the transportation sector, further development in the Bangkok metro area railway network will contribute to energy savings. Significant improvements in energy efficiency in passenger vehicles are also expected to be achieved in line with new developments in car technologies and the introduction of the Eco car program.

Government policies will continue to encourage the increased use of alternative fuels, such as nuclear power and biofuels. Reductions in the growth of CO_2 emissions are also expected to be achieved through the increased adoption of more energy efficient and lower emissions technologies. In particular, in the APS, nuclear power and renewable energy sources are expected to help reduce CO_2 emissions from electricity generation. Gasohol and biodiesel as oil alternatives are also expected to help curb CO_2 emissions from transportation.

3. Outlook Results

3.1. Business-as-Usual (BAU) Scenario

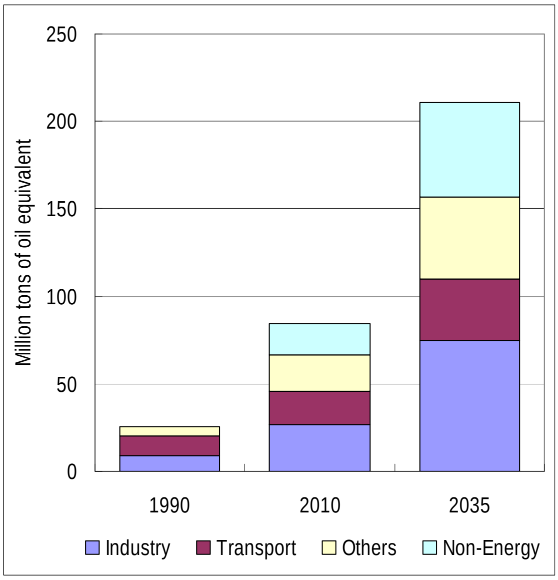
Total Final Energy Consumption

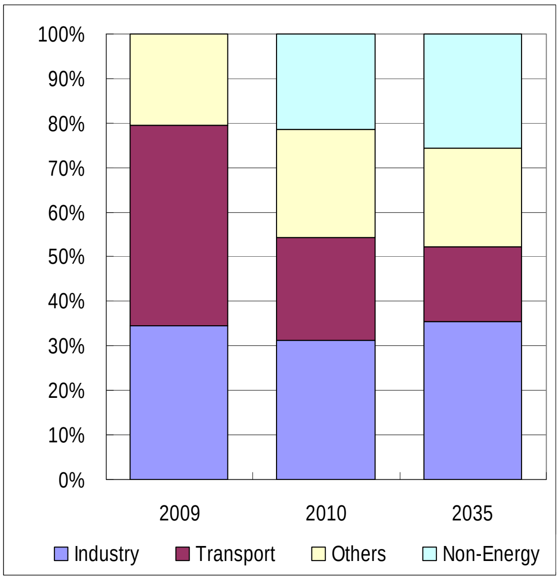
Between 1990 and 2010, Thailand's final energy consumption grew at a robust rate of 6.2 percent per year from 25.4 Mtoe in 1990 to 84.6 Mtoe in 2010. Given moderate economic growth and low growth rate in population, final energy consumption is projected to grow at a moderate rate of around 3.7 percent per year between 2010 and 2035.

The transportation sector was the largest consumer in 1990, using 11.4 Mtoe. While consumption in the sector increased only 2.7 percent a year between 1990 and 2010, the share of transport declined from 45.0 percent in 1990 to 23.0 percent in 2010. The industry sector is projected to remain the largest consumer, accounting for 35.4 percent of final energy demand in 2035. In contrast, the transportation sector will account for the smallest proportion of final energy demand (16.9 percent) in 2035, continuing the declining share observed since 1990.

Strong growth in energy consumption in the industrial sector of about 5.7 percent per year between 1990 and 2010 increased final energy use in the sector from 8.7 Mtoe in 1990 to 26.5 Mtoe in 2010. By 2010, the industrial sector had overtaken transport as the largest consumer, accounting for around 31.3 percent of final energy consumption.

Figure 16-1: Final Energy Demand by Sector

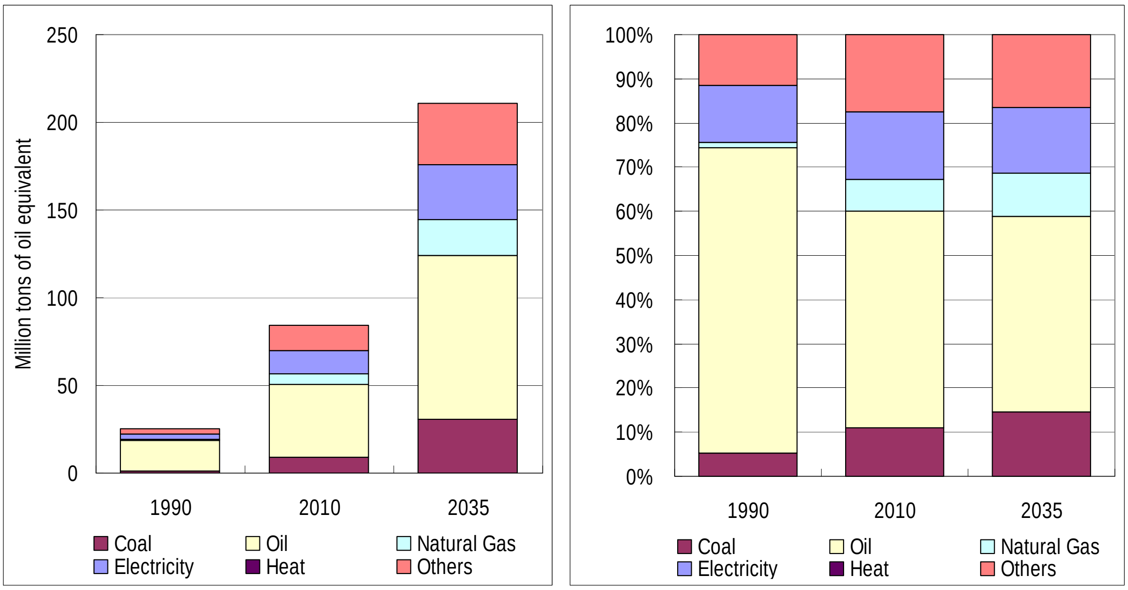




Oil has been the dominant energy source in final energy consumption accounting for 41.7 Mtoe or a 49.3 percent share in 2010. Electricity was the second largest energy source, accounting for 12.8 Mtoe or a 15.2 percent share in 2010.

Oil is expected to remain the largest final energy source throughout the projection period although oil and electricity shares are projected to decline from 49.2 and 15.2 percent in 2010 to 44.2 and 14.8 percent in 2035 respectively (Figure 16-2). In 2035, the shares of coal and natural gas in final energy consumption are projected to increase to 14.6 percent and 9.9 percent, respectively.

Figure 16-2: Final Energy Consumption by Sector

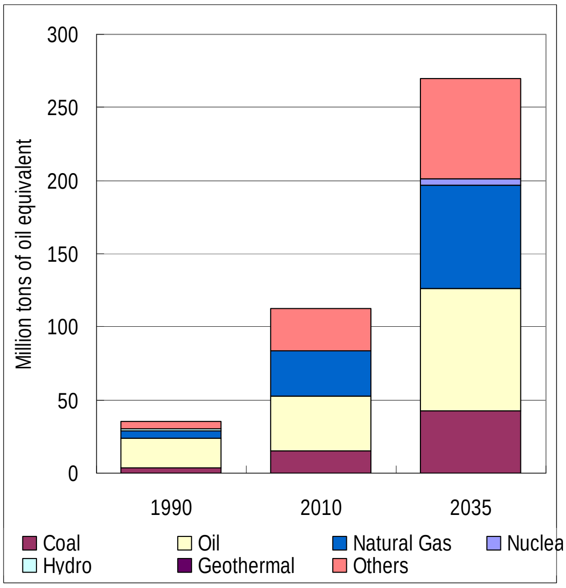


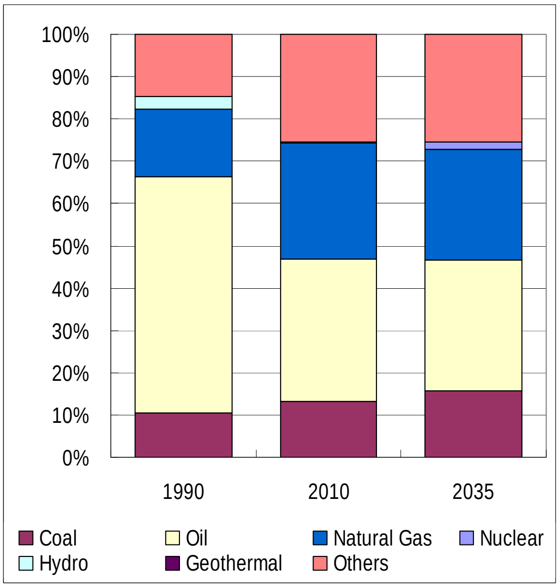
Total Primary Energy Demand

Primary energy demand grew at an average annual rate of 5.9 percent from 35.4 Mtoe in 1990 to 112.2 Mtoe in 2010, driven largely by fast economic development between 1990 and 1996. This growth in primary energy consumption was achieved despite the severe economic crisis in 1997-1998 and the world economic crisis in 2008. In 2010, the major sources of primary energy were oil, natural gas and coal with shares of 33.6 percent (37.7 Mtoe), 27.5 percent (30.9 Mtoe) and 14.9 percent (13.3 Mtoe), respectively. Although oil remained the largest source between 1990 and 2010, its share in primary energy demand shrank from 55.6 percent in 1990 to 33.6 percent in 2010. Natural gas, which is mainly consumed in the power generation sector, became an important source of energy with its share in primary energy demand increasing significantly from 16.0 percent in 1990 to 27.5 percent in 2010. The share of hydropower declined from 3.1 percent in 1990 to only 0.2 percent in 2010.

In the BAU scenario, primary energy demand is projected to grow at about 3.6 percent per year from 2010 to 2035, reaching 269.8 Mtoe in 2035 (Figure 16-3). The highest average annual growth rate is expected in coal (4.3 percent), with consumption expected to reach 42.3 Mtoe in 2035. Following the very strong average annual growth in natural gas of 8.8 percent between 1990 and 2010, growth is expected to slow to about 3.4 percent per year between 2010 and 2035. It is recognized that future growth in natural gas consumption in power generation may be limited, with the potential for nuclear and other alternative fuels to be used instead in line with government plans.

Figure 16-3: Primary Energy Demand by Source, BAU and APS



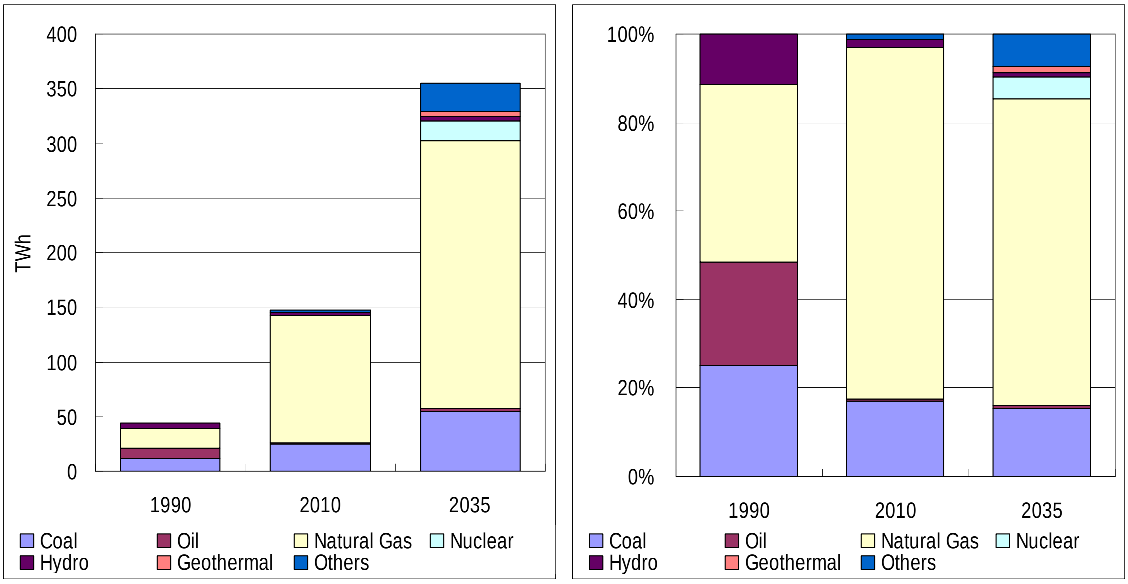


Power Generation

In 1990, total power generation was 44.2 TWh and increased to 147.0 TWh in 2010 with an average growth rate of 6.2 percent per year. From the Figure 16-4, natural gas has been a major fuel for power generation since 1990, at least. Natural gas in power generation grew with robust rate at around 9.9 percent per annum from 17.8 TWh and a share of 40.2 percent in 1990 to 116.6 TWh and a share of 79.3 percent in 2010. Coal had the second largest share of 25.0 percent in 1990 but its share shrank some to 17.0 percent in 2010. Oil became the smallest source in power generation with only 0.8 TWh in 2010.

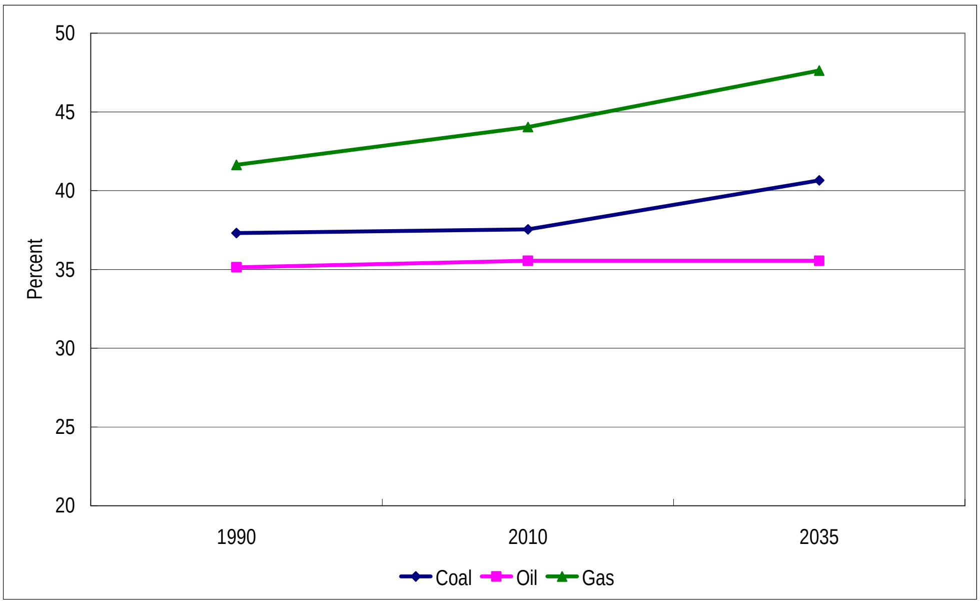
In the BAU, power generation is expected to grow moderately around 3.6 percent per annum from 2010 till 2035 and will reach 355.0 TWh in 2035. In 2035, natural gas will remain the dominant fuel in power generation with the highest share of about 69.2 percent or 245.5 TWh. Coal also remains the second largest with 15.4 percent, or 54.8 TWh. Nuclear will start use as a new energy in 2026, and in 2035 it is expected to take a share of only around 4.9 percent or 17.5 TWh. Hydro has had no growth since 1990, and will only grow at 1.0 percent to 2035 on the average.

Figure 16-4: Power Generation Mix in Thailand, BAU



Thermal efficiency of power generation from natural gas will continue to have the highest thermal efficiency from 35.2 percent in 1990 and 44.0 percent in 2010 and further increasing to 47.6 percent in 2035. Coal efficiency did not change much from 1990 till 2010 but change significantly by 2035. Thermal efficiency of oil power plants will remain at almost the same level as in 2010 (Figure 16-5).

Figure 16-5: Thermal Efficiency of Power Generation in Thailand, BAU

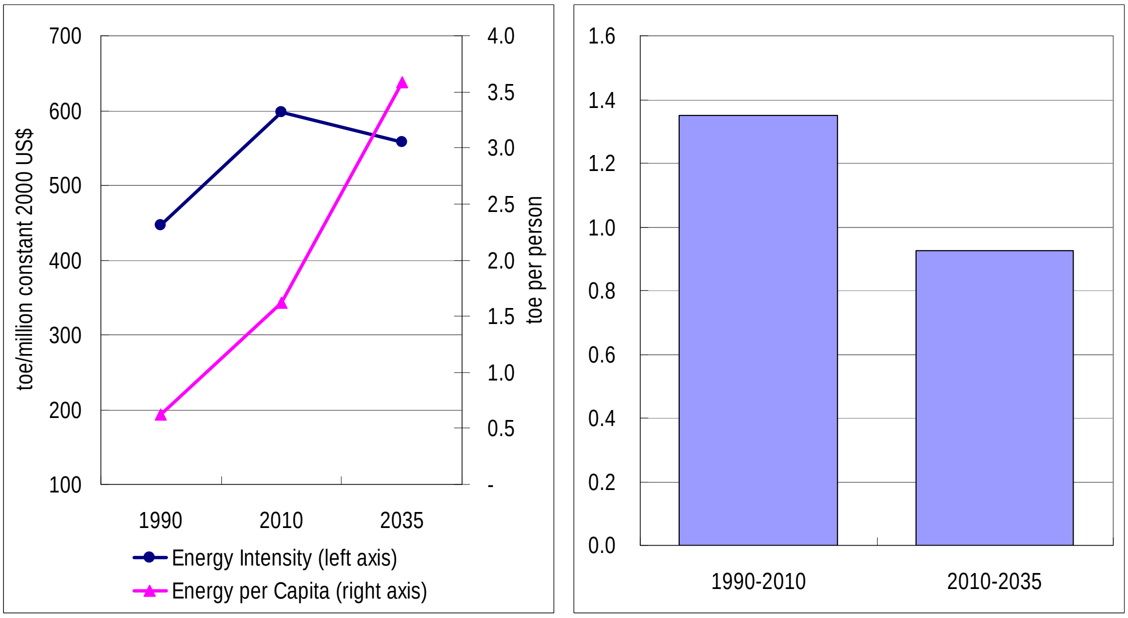


Energy Intensity, Energy per Capita and Energy Elasticity

Energy intensity reached 598 toe/million constant 2000 US$ in 2010. In BAU case, energy intensity is expected to gradually decline and in 2035 will be 557 toe/million constant 2000 US$. On the other hand, energy per capita will move upward from around 1.6 toe per person in 2010 3.7 toe per person in 2035.

Energy elasticity between 1990 and 2010 was above 1.0, or around 1.4. It means that the growth in energy consumption outpace the growth in GDP. However, there will be a great change in energy elasticity in the future. Unlike in the past, even in the BAU, energy elasticity could be 0.9. It means that, the growth in energy consumption will be growing at a slower pace than GDP growth.

Figure 16-6: Energy Intensity, Energy Per Capita and Energy Elasticity

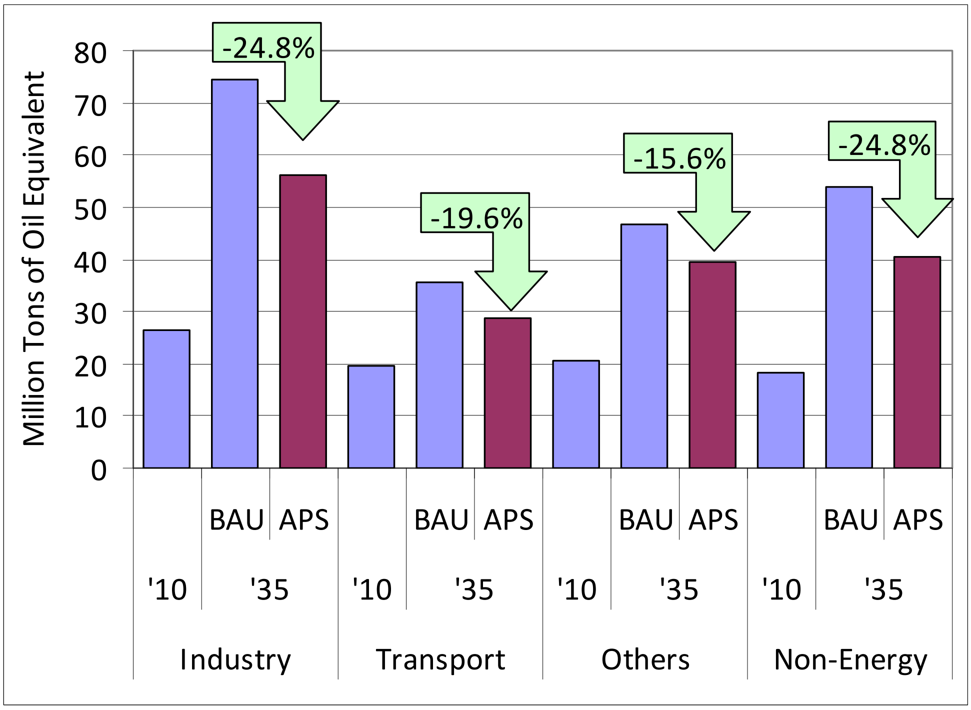


3.2. Energy Saving and CO_2 Emission Reduction Potential

Final Energy Demand

In the APS, final energy demand is projected to grow at 2.7 percent per year, from 84.6 Mtoe in 2010 to 164.7 Mtoe in 2035, much slower than the BAU average annual growth rate of 3.7 percent. The majority of energy savings will be achieved through energy efficiency improvement programs implemented in the industry and transportation sectors. Improvements will also be achieved in other sectors as shown in Figure 16-7.

Figure 16-7: Final Energy Consumption by Sector, BAU and APS

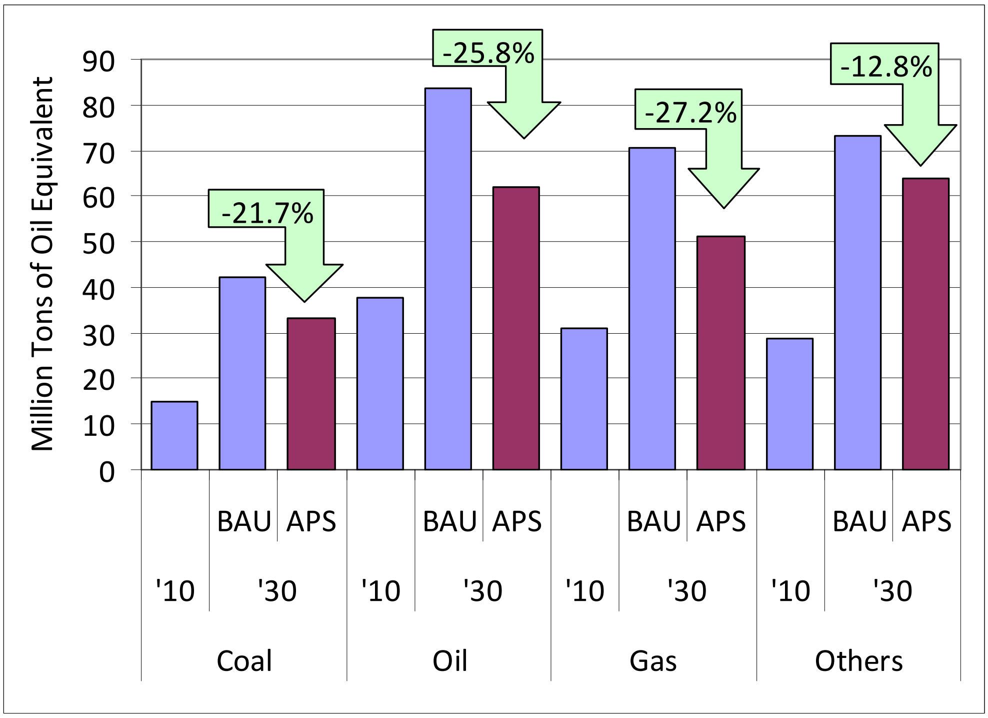


Primary Energy Demand

In the APS, growth in primary energy demand is projected to be much slower than in the BAU scenario, increasing at 2.5 percent per year (compared with 3.6 percent in BAU) to reach 210.5 Mtoe in 2035. Primary energy demand is expected to be about 22.0 percent lower in the APS than in the BAU scenario in 2035 – an energy saving of about 59.3 Mtoe.

Oil is also projected to increase at an annual average rate of 2.0 percent from 37.7 Mtoe in 2010 to 62.1 Mtoe in 2035 and natural gas use is projected to increase at an annual average rate of 2.1 percent from 30.9 Mtoe in 2010 to 51.3 Mtoe in 2035. The lower growth rates, relative to the BAU scenario, are mainly achieved through energy efficiency and conservation measures on the demand side. The differences in the projections between the two scenarios are shown in Figure 16-8.

Figure 16-8: Primary Energy Demand by Source, BAU and APS

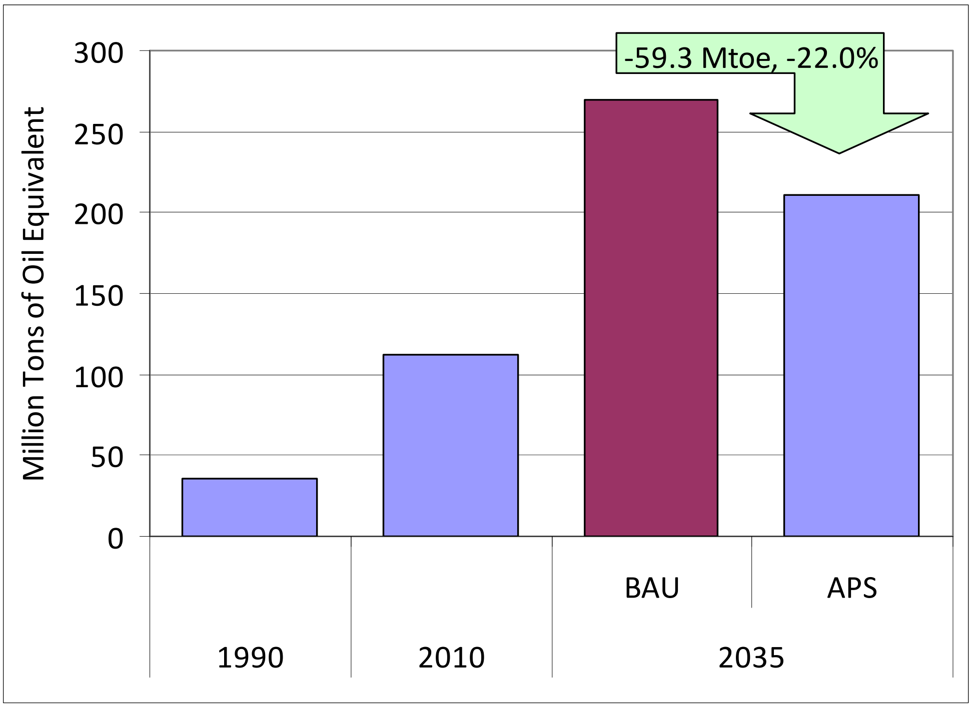


Projected Energy Savings

The difference between primary energy demand in the BAU scenario and the APS in 2035 is 59.3 Mtoe (Figure 16-9). This represents the potential energy savings that could be achieved if energy efficiency and conservation goals and action plans were implemented. This energy saving is equivalent to about 52.9 percent of Thailand's primary energy demand in 2010. Oil will contribute the largest energy savings (21.5 Mtoe) followed by natural gas (19.3 Mtoe).

In final energy consumption, the savings in the APS, relative to the BAU scenario in 2035, could reach 46.1 Mtoe. The largest savings are expected to be achieved in the industry sector at 18.5 Mtoe. Both the transportation and other sectors are expected to achieve energy savings of 14.4 Mtoe.

Figure 16-9: Total Primary Energy Demand, BAU and APS

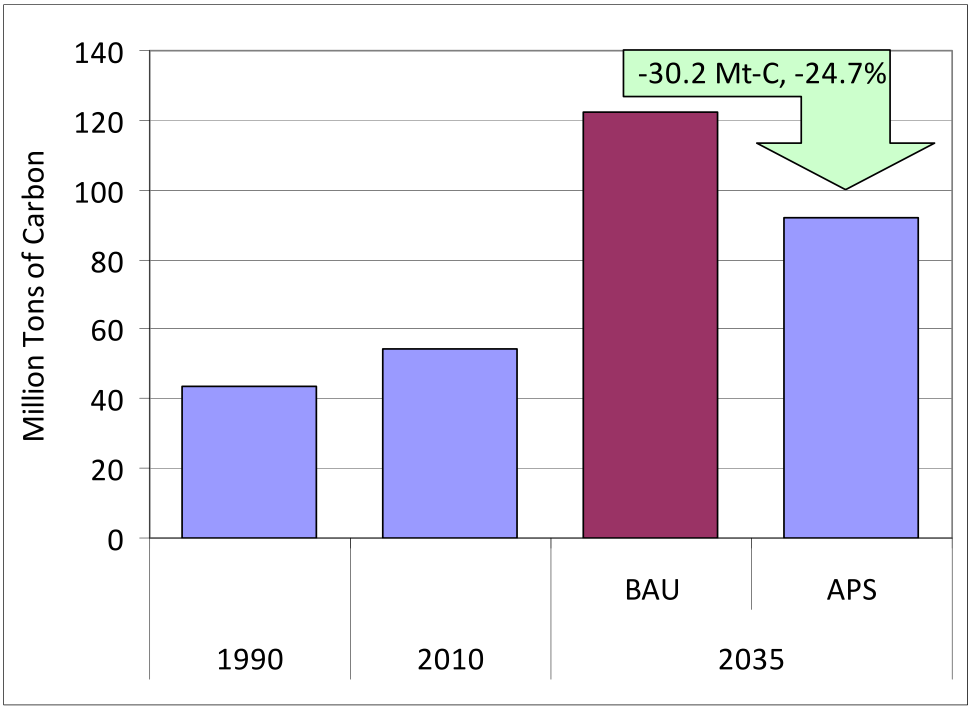


3.3 CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 3.3 percent per year on average from 54.5 Mt-C in 2010 to 122.2 Mt-C in 2035 under the BAU scenario. Thailand plans to promote the use of less carbon intensive energy sources such as nuclear and renewable fuels.

Under the APS, the average annual growth in CO_2 emissions from 2010 to 2035 is projected to be about 2.1 percent, with emissions of 92.0 Mt-C in 2035. The reduction in CO_2 emissions between the APS and BAU scenario highlights the range of benefits that can be achieved through energy efficiency improvements and savings via action plans (Figure 16-10).

Figure 16-10: CO_2 Emissions from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

Strong economic growth prior to the Asian Financial Crisis in 1997 contributed to relatively high energy intensity in Thailand between 1990 and 2010. However, the energy intensity of the economy has declined since it recovered from the 1997 crisis. Furthermore, Thailand's energy efficiency programs in a wide range of areas (including industry, transportation and residential sectors), and high world oil prices, are expected to contribute to a continued decline in the energy intensity of the Thai economy.

Improving energy efficiency will also help Thailand (which is an oil importer), to address the challenges posed by high world oil prices. Thailand is committed to reducing the intensity of energy consumption, especially in oil, and is also looking for more sustainable energy sources and environmentally friendly fuels. It is recognised that the more Thailand saves energy, the less sensitive it will be to fluctuations in world energy prices and supply. It is wise and rational to save more and more sustainable. Furthermore, Thailand realises that energy savings is important and should put more effort on it.

Although Thailand has an alternative policy for future 20 years, oil will remain a major energy source for this economy. Oil is one of the most sensitive energy in terms of price and its security. Thailand probably focuses more on oil saving in the future to less depend on it. Furthermore, energy use in transportation sector will become the smallest in the future, compared to the rest. Nonetheless, this sector is also less productivity in the economy than the others. It means that it consumes more energy, but produces less. The more saving effort in Transport sector, the more benefit to economy as a whole will be.

CHAPTER 17

Viet Nam Country Report

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1. Background

Viet Nam has a total land area of about 331,111 square kilometers and lies in the centre of South East Asia. In 2010, Viet Nam had a population of 86.9 million and GDP of US$ 62.8 billion in 2000 US$ terms. The industry sector contributes the most to Viet Nam's GDP (41.9 percent), followed by the commercial sector (41.7 percent) and agriculture (16.4 percent). GDP per capita was 723 US$ per person in 2010.

Viet Nam possesses considerable indigenous energy resources. It has 3,390 million tons of proven recoverable reserves of coal, 460 million cubic meters of crude oil reserves and 610 billion cubic meters of gas reserves.

Viet Nam's total primary energy supply (TPES) was 40.9 Mtoe in 2010. Oil represented the largest share of Viet Nam's TPES at 39.7 percent; coal was second at 33.9 percent, followed by natural gas (19.5 percent), hydro (5.8 percent) and others (1.0 percent). Viet Nam is a net exporter of crude oil and coal but is an importer of petroleum products because of capacity limitations at the Dung Quat oil refinery (6.5 million tons a year) that could meet around 30 percent of domestic demand.

Coal is mainly used in the industry sector with consumption of 9.7 million tons of oil equivalent (Mtoe) in 2010, while gas is largely used for electricity generation.

Viet Nam had 20.9 GW of installed generating capacity and generated 92.2 TWh of electricity in 2010. Most of Viet Nam's electricity generation comes from thermal sources (coal, natural gas and oil), accounting for 70.1 percent of total generation, and hydro (29.9 percent).

2. Modelling Assumptions

In this outlook, Viet Nam's GDP is assumed to grow at an average annual rate of 7.0 percent from 2010 to 2035. Growth is projected to be slightly lower in the first half of the outlook period increasing at 7.0 percent per year between 2010 and 2020. For the period 2020-2035, the country's economic growth will be faster at an annual rate of 7.1 percent per year. Population growth is projected to increase at a much slower rate, increasing by 0.8 percent per year between 2010 and 2035.

The share of electricity generated from coal-fired power plants is projected to increase considerably, at the expense of other energy types (thermal and hydro). Viet Nam is expected to increase its imports of electricity, particularly from Lao PDR and China. The use of nuclear energy is assumed to start in 2020 in line with Viet Nam's nuclear power development plan. In the BAU scenario, it is assumed that the first unit of nuclear power with capacity of 1,000 MW will be installed in 2020. An additional six (6) units of nuclear power with total capacity of 6,000 MW is expected to be installed in 2030.

Viet Nam's energy saving goal between the periods 2006 to 2010 is assumed to be between 3-5 percent of the total energy consumption equivalent to 5.0 Mtoe. For the years 2010 to 2015, energy saving goal is targeted at 5-8 percent of total energy consumption, equivalent to 13.1 Mtoe. In line with the national target on energy efficiency and conservation (EEC), Viet Nam's energy saving goals beyond 2015 is assumed to follow the trend of earlier periods.

The energy savings goals are expected to be attained through the implementation of energy efficiency programs in the industrial, residential and commercial sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies and the introduction of energy management systems. In the transport, residential and commercial sectors, fuel substitution, efficient end-use technologies, and energy management systems are projected to induce significant savings.

To complement the demand side energy efficiency measures on the supply side, renewable energy technologies, particularly small hydro, wind and biomass are expected to come online intensively from 2010 in line with the master plan on renewable energy development. Installed electricity generating capacity from renewable energy is assumed to reach 8,100 MW in 2035 with wind contributing 5,200 MW, small hydro 2,400 MW and biomass 500 MW. The installed capacity of nuclear power plants is expected to reach 11,000 MW and 15,000 MW under the APS scenario by 2030 and 2035 compared with 6,000 MW by 2030 in the BAU Scenario.

Viet Nam has considered the use of biofuels to reduce dependency on oil and curb CO_2 emissions. According to the Prime Minister's decision 177/2007/QD-TTg approving the master plan on biofuel development, Viet Nam is assumed to produce 250,000 tons and 1.8 million tons of biofuels (both ethanol and biodiesel, in which ethanol fuel accounts for around 2/3 of the total) in 2015 and in 2025, respectively.

3. Outlook Results

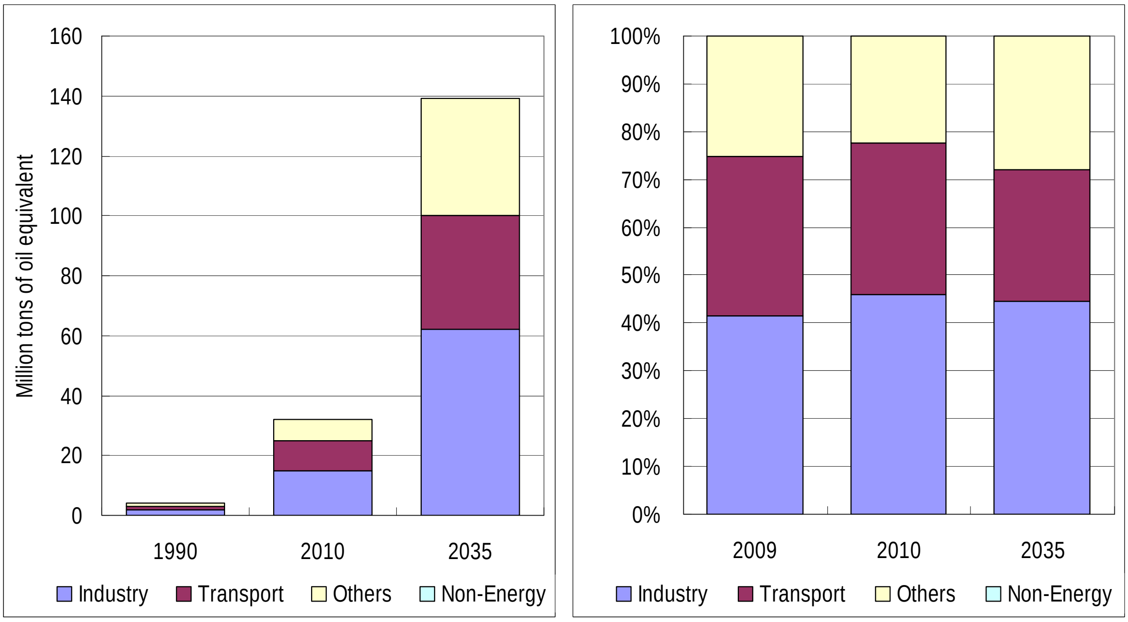
3.1. Business-as-Usual (BAU) Scenario

3.1.1. Total Final Energy Demand

Viet Nam's final energy consumption in 2010 increased at 10.7 percent per year which is 7.6 times more than its 1990 level of 4.2 Mtoe. The fastest growth occurred in the industrial sector (11.2 percent per year) followed by the transport sector (10.4 per cent) and the residential/commercial (others) sector (10.0 percent per year).

For the period 2010 to 2035, final energy consumption is projected to increase at an average rate of 6.1 per year under the BAU. The growth is driven by assumed strong economic growth which is assumed to be at an average annual growth of 7.0 percent and the rising population. On a per sector basis, the strongest growth in consumption is projected to occur in the residential/commercial (others) sector, increasing by 7.0 percent per year. This is followed by the industry sector (5.9 percent per year) and the transportation sector (5.4 percent per year).

Figure 17-1: Final Energy Demand by Sectors, BAU



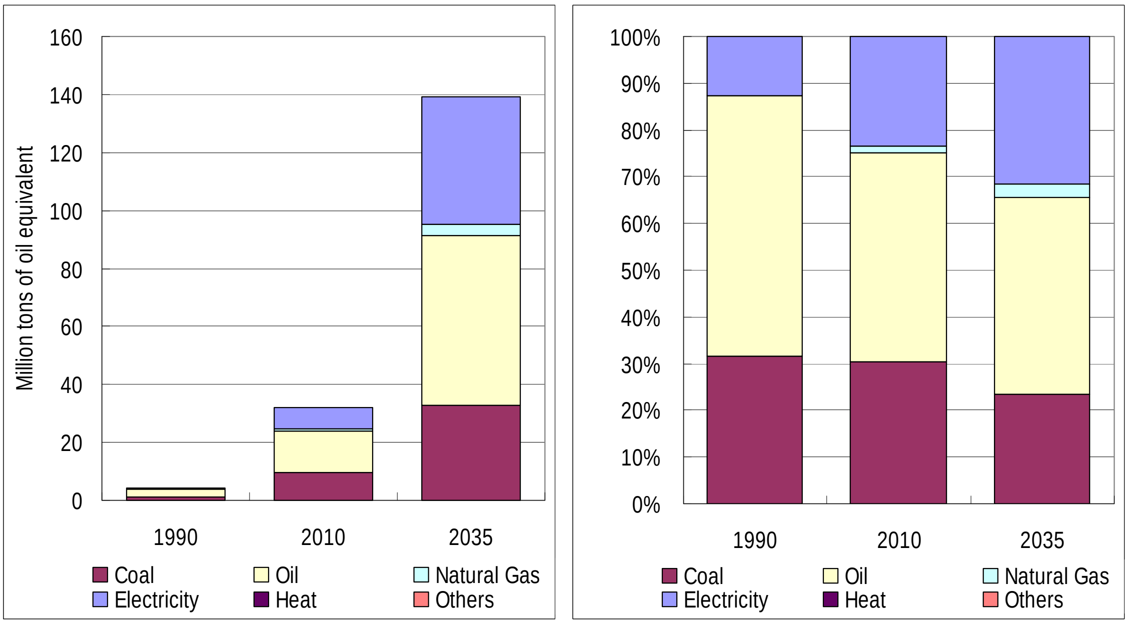
Bulk of the country's energy requirement or more than 40 percent comes from the industrial sector. The trend will still continue though starting 2020 it will have a decreasing share up to 2035. Starting 1990 up to 2035, the transport sector tends to be the second largest consuming sector in Viet Nam. The share of energy consumption in the transport sector will decrease slowly from 33.5 percent in 1990 to 27.4 percent in 2035. Meanwhile, the residential/commercial (others) sector will have an increasing share from 22.3 percent in 2010 to 28.0 percent in 2035. The increasing share of the sector is an impact of the growing population and the growing economy. The impact of economic growth will translate to improvement of standard of living, thus increasing an individual's consumption.

Meanwhile, oil is the most consumed product, accounting around 60.0 percent of total final energy consumption in 1990, declining to 44.8 percent in 2010. Coal is the second most consumed product, accounting for 31.5 percent of total final energy consumption in 1990, declining to 30.3 percent in 2010. The share of electricity consumed from 1990 to 2010 had an increasing trend from 12.6 percent to 23.3 percent.

On a per fuel basis under the BAU, natural gas is projected to exhibit the fastest growth in final energy consumption, increasing at 8.6 percent per year between 2010 and 2035. Electricity is projected to have the second highest growth rate of 7.4

percent per year, followed by oil of 5.8 percent and coal of 5.0 percent.

Figure 17-2: Final Energy Demand by Fuel, BAU



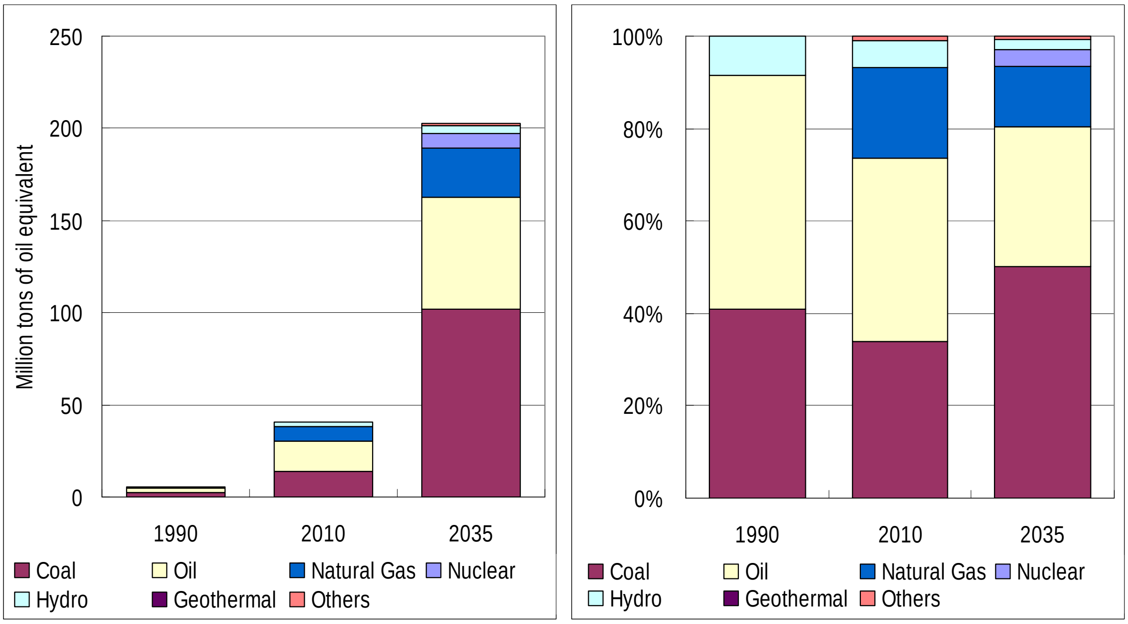
The oil fuel products take the largest share of 44.8 percent in 2010. Oil consumption is projected to decline to 42.1 percent in 2035. Coal which is used primarily for power generation will still be the country's second most consumed fuel with a share of 30.3 percent in 2010 though its share will decline up to 23.5 percent in 2035. On the other hand, the share of demand for electricity will post an increasing trend of 23.3 percent in 2010 to 31.6 percent in year 2035.

3.1.2. Total Primary energy demand

Primary energy demand in Viet Nam grew at a rate of 10.6 percent, from 5.4 Mtoe in 1990 to 40.9 Mtoe in 2010. Among the major energy sources, the fastest growing were natural gas, coal and oil. Natural gas consumption grew at an average annual rate of 48.3 percent between 1990 and 2010 while coal and oil grew at 9.6 percent and 9.3 percent per year, respectively. Hydro energy grew by 8.5 percent per year over the same period, however, it only accounts for a small proportion (5.8 percent) of total primary energy demand 2010 (see Figure 17-3).

In the BAU, for the period 2010 to 2035, Viet Nam's primary energy demand is projected to increase at an annual rate of 6.6 percent per year or 5.0 times from 40.9 Mtoe in 2010 to 202.9 Mtoe in 2035. The fastest growth is expected in coal, increasing at an annual average rate of 8.3 percent followed by other (such as imported electricity) and oil growing at a rate of 5.6 and 5.4 percent, respectively. Similarly, natural gas is expected to grow at an annual rate of 4.9 percent over the same period.

Figure 17-3: Primary energy demand, BAU



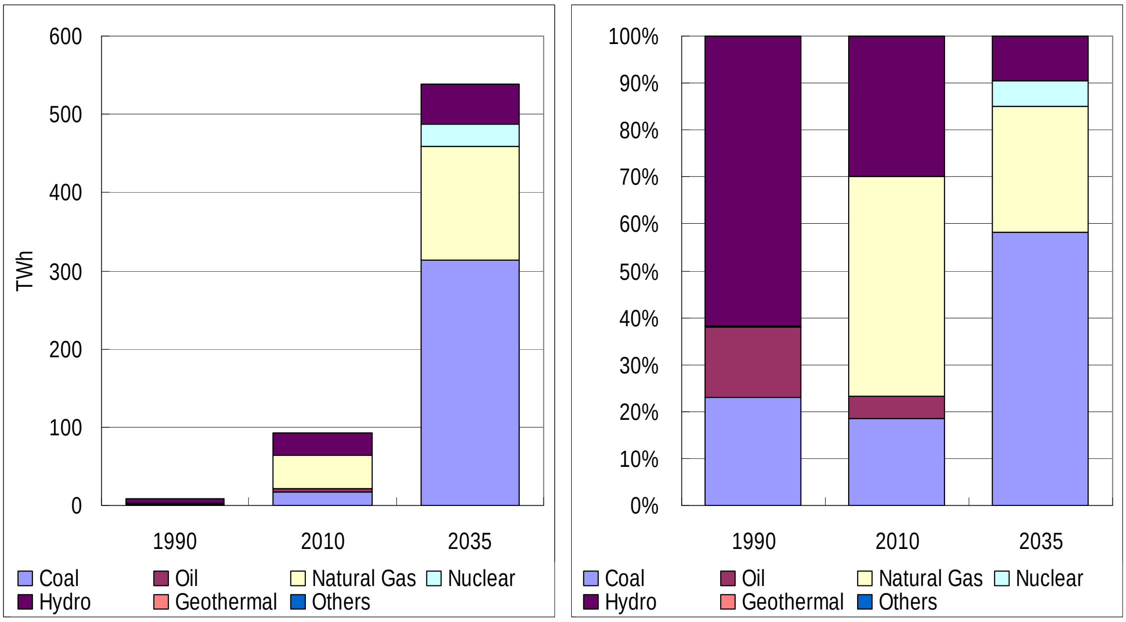
The share of coal is projected to increase from 33.9 percent in 2010 to 50.1 percent in 2035. The growth in coal is due to the projected decline from oil and natural gas. The share of gas is expected to decrease from 39.7 percent to 30.2 percent. The share of oil by 2035 is expected to decline up to 13.1 percent from 19.5 percent in 2010.

3.1.3. Power Generation

Power generation output increased at a rate of 12.5 percent per year or 10.6 times from 8.7 TWh in 1990 to 92.2 TWh in 2010. The fastest growth occurred in the natural gas thermal power generation (55.9 percent per year) followed by the coal thermal (11.3 per cent), the hydro power (8.5 percent per year) and oil thermal (6.4 percent).

To meet the demand of electricity under the BAU, power generation is projected to increase at an average rate of 7.3 percent per year or 5.8 times between 2010 and 2035. The fastest growth occurred in the coal thermal power generation (12.4 percent per year) followed by the natural gas (5.0 per cent) and hydropower generation (1.2 percent per year).

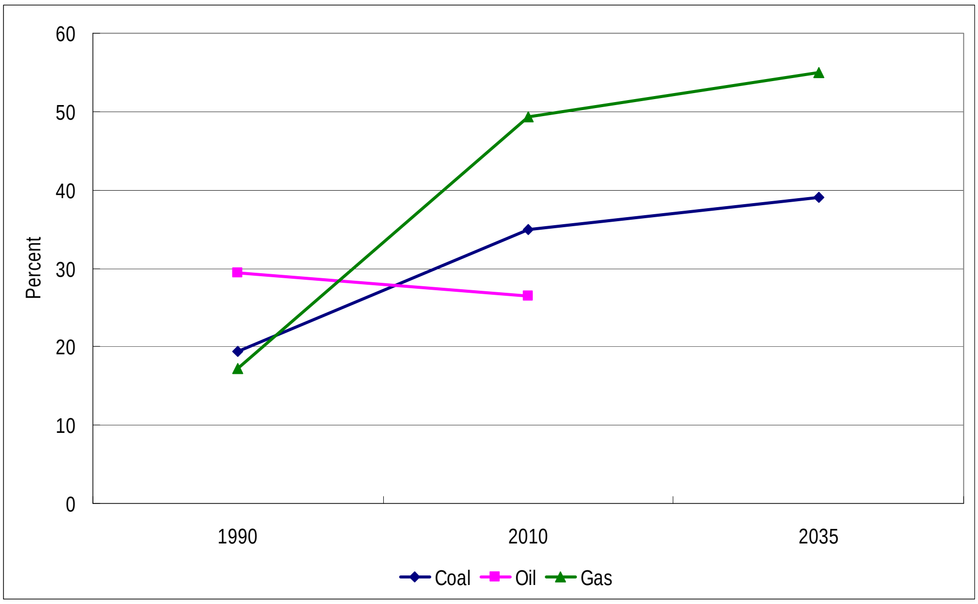
Figure 17-4: Power Generation by Type of Fuel, BAU



By end of 2010, majority of the country power requirement comes from natural gas which comprised around 47.0 percent of the total power generation mix. The share of hydropower generation is around 30.0 percent while the rest were from coal and oil power generation.

In the BAU, most of fuel for power generation for the period 2020 to 2035 will be supplied by coal increasing from 44.6 percent to around 58.0 percent, respectively. On the other hand, the share of natural gas in the total power generation will decline such that by end of 2035 it share will be around 27.0 percent from its 2010 share of 47.0 percent.

Figure 17-5: Thermal Efficiency, BAU



There are two (2) main types of thermal power technologies in Viet Nam namely, coal and natural gas. Thermal efficiencies of coal and gas thermal power plants have an increasing trend from 35.0 to 49.4 percent in 2020 to 39.0 percent and 55.0 percent in 2035, respectively. Thermal efficiency determines the amount of fuel input needed to produce an output.

3.1.4. Energy Indicators

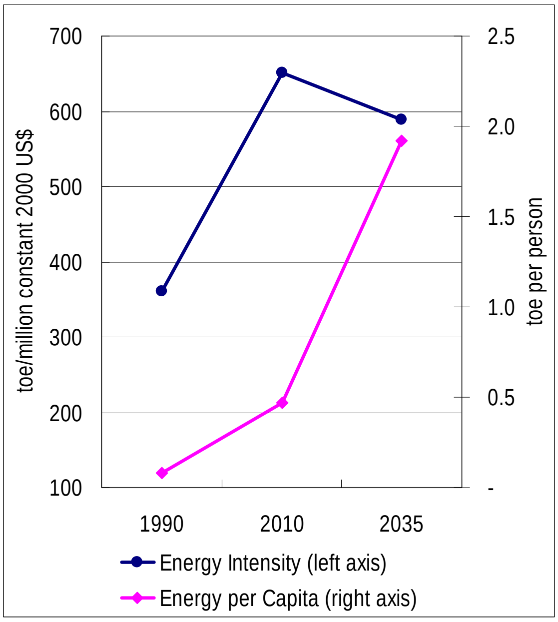
For the period 1990-2010, Viet Nam's energy intensity showed an increasing trend. Energy intensity of the country grew from 361.3 toe/million 2000 US$ in 1990 to 651.1 toe/million 2000 US Dollars in 2010. The major reason is due to the high energy requirement in the industrial sector, particularly, the industries' sub-sectors such as cement, iron and steel of high energy intensities is developed fast in recent years.

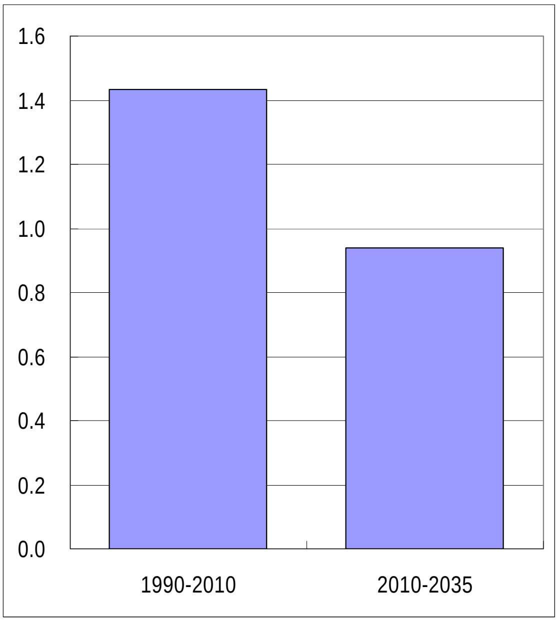
By 2035, energy intensity under the BAU is estimated to improve by 9.0 percent compared to the 2010 level of 651.1 toe/million 2000 US Dollars. The improvement is a good indication that energy will be used efficiently in the future for economic development.

Meanwhile, energy per capita had an increasing trend, that is, 0.1 toe/person in

1990 to 0.5 toe/person in 2010. In the BAU, energy per capita will also have trend of increasing from 0.5 toe/person in 2010 to 2.0 toe/person in 2035. This indicates that in the future, the living standards and people's income will increase resulting to increase in energy demand per capita.

Figure 17-6 : Energy Intensity and Energy Per Capita





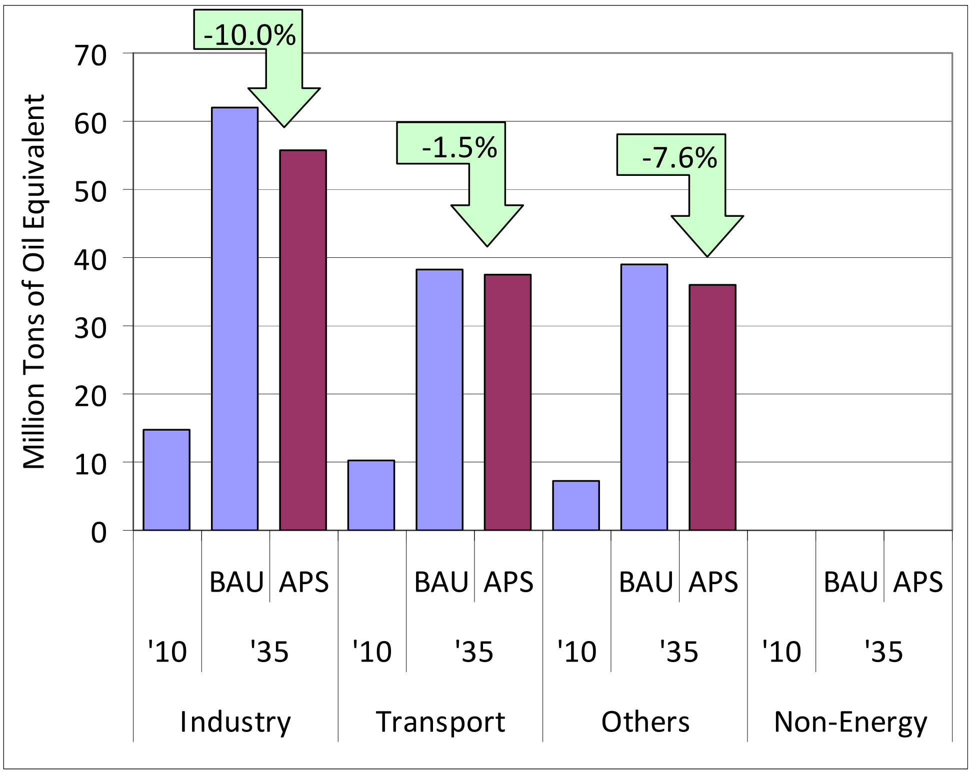
The relationship between changes in primary energy demand and changes in GDP is known as the elasticity of energy demand. In the period of 1990 to 2010, the elasticity of energy demand is 1.44, which is higher than 1.0, which means that there was an inefficient use of energy. For the period 2010 to 2035, the elasticity of energy demand in the BAU is projected to be reduced to around less than 1 or 0.95 from 1.4 in the period of 1990 to 2010 which is a good indication that energy will be used efficiently for economic development.

3.2. Energy Saving Potential and CO_2 Reduction Potential

3.2.1. Final Energy Consumption

In the Alternative Policy Scenario (APS), final energy consumption is projected to increase at a slower rate of 5.7 percent per year (compared with 6.1 percent in BAU) from 32.0 Mtoe in 2010 to 129.4 Mtoe in 2035 due to Energy Efficiency and Conservation (EEC) programs. Savings in the final energy consumption will amount to 9.7 Mtoe or 7.0 percent compared to BAU in 2035. The bulk of the savings are expected to occur in the industry sector (6.2 Mtoe), followed by the residential/commercial (others) sector (3.0 Mtoe) and the transportation sector (0.6 Mtoe). Improvement in end-use technologies and the introduction of energy management systems is expected to contribute to the slower rate of consumption growth, particularly in the industry, transport and others sector (residential and commercial sectors).

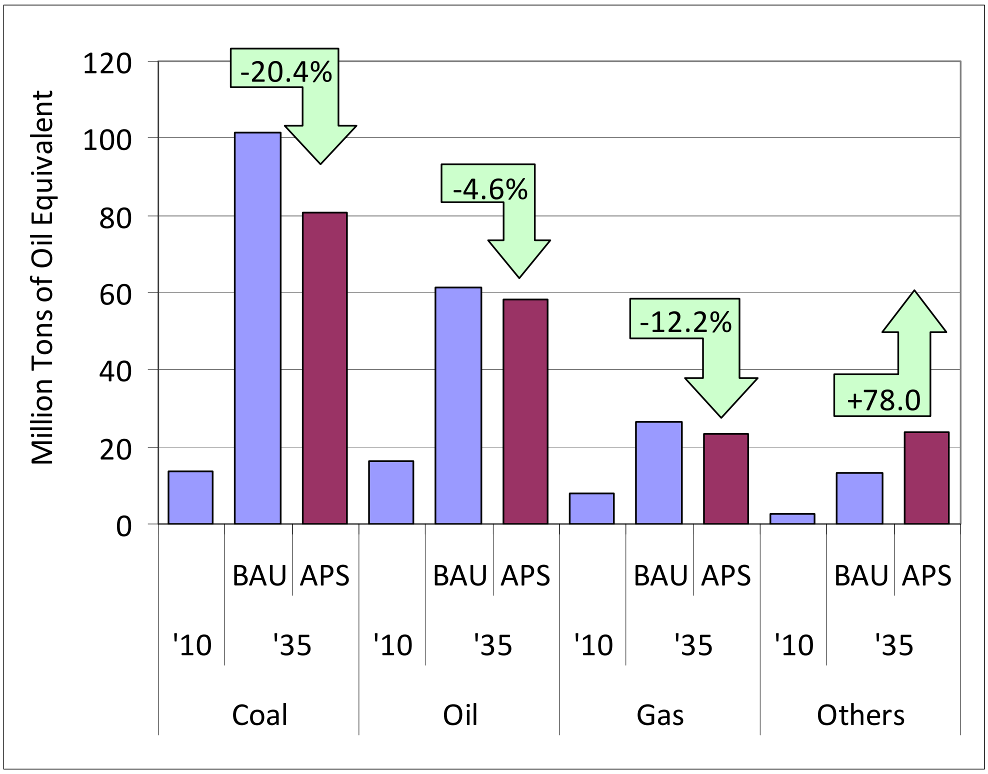
Figure 17-7: Final Energy Consumption, BAU vs. APS



3.2.2. Total Primary energy demand

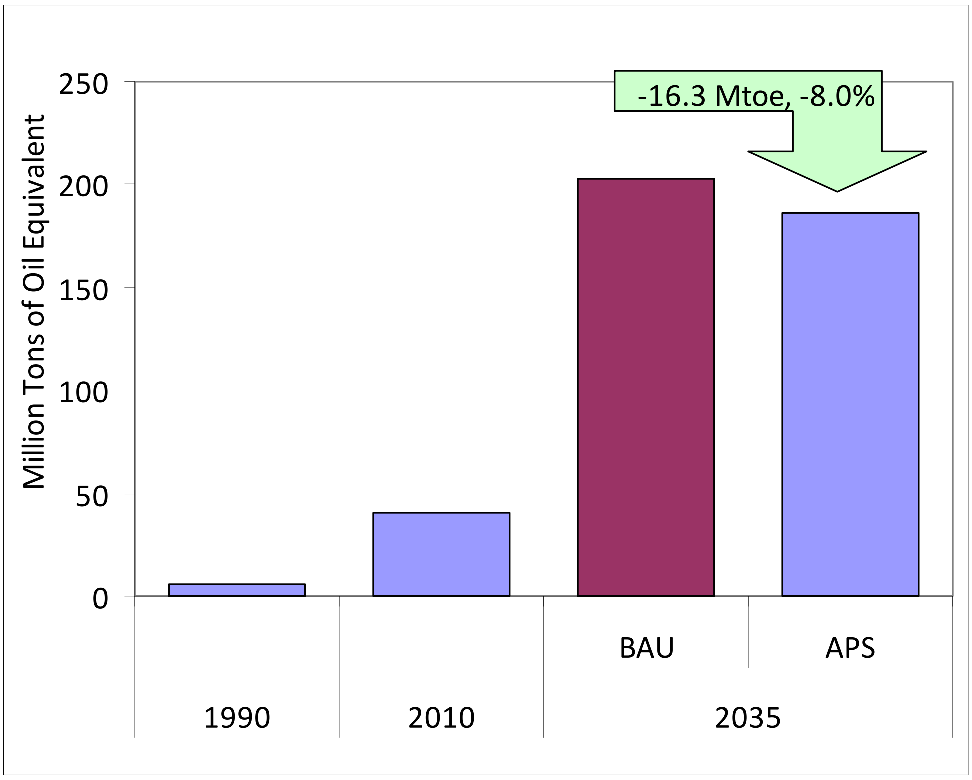
In the APS, primary energy demand is projected to increase at a slower rate of 6.3 percent per year from 40.9 Mtoe in 2010 to 186.6 Mtoe in 2035. Also, coal is projected to grow at an average annual rate of 7.3 percent compared with 8.3 percent in BAU, followed by oil and natural gas with 5.3 percent and with 4.4 percent (compared with 5.4 percent and 4.9 percent in BAU), respectively over the same period. The slower growth in consumption, relative to the BAU scenario, stems from EEC measures on the demand side and the more aggressive uptake of renewable and nuclear energy on the supply side. Coal has highest energy saving potential with 20.4 percent, followed by natural gas (12.2 percent) and oil (4.6 percent).

Figure 17-8: Primary energy demand, BAU and APS



The savings that could be derived (the difference between primary energy demand under both scenarios) from the energy saving and conservation goals and action plans of Viet Nam amount to 16.3 Mtoe. This is equivalent to 8.0 percent of total Viet Nam's primary energy consumption in 2035 (Figure 17-9).

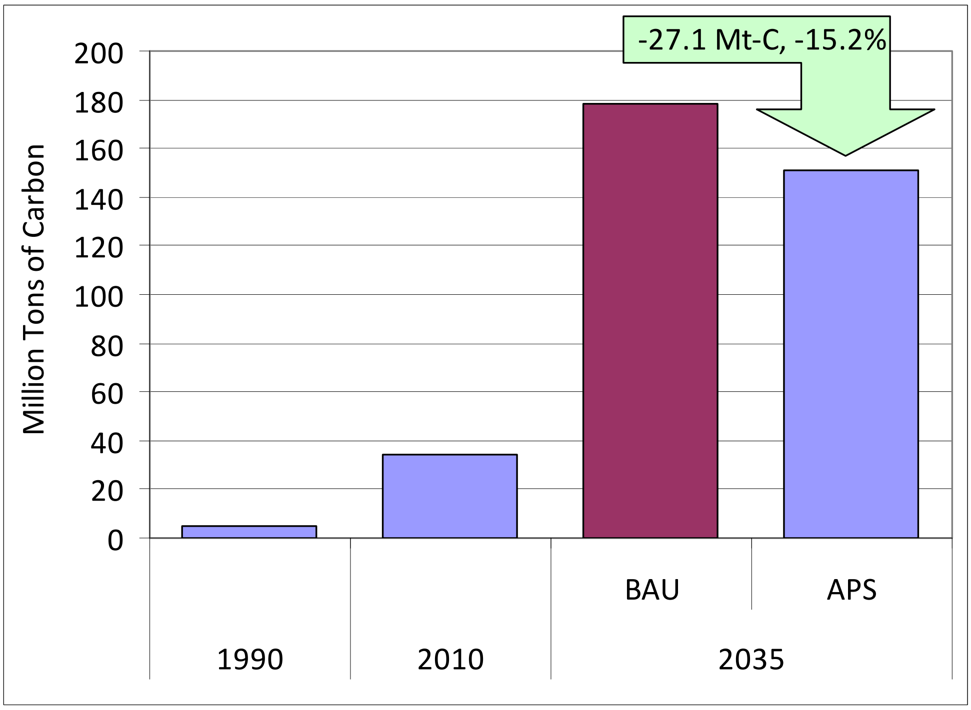
Figure 17-9: Evolution of Primary energy demand, BAU and APS



3.2.3. CO_2 Reduction Potential

CO_2 emissions from energy consumption under the BAU are projected to increase by 6.8 percent per year from 34.2 million metric ton of carbon (Mt-C) in 2010 to 184.9 Mt-C in 2035. Meanwhile, under the APS, the annual increase in CO_2 emissions between 2010 and 2035 is projected to be around 6.1 percent yearly which is 0.7 percentage points lower than the BAU. Improvement on CO_2 emissions under the APS will be around 27.1 Mt-C (15.2 percent reduction) in 2035, indicating that the energy saving goals and action plans of Viet Nam are very effective in reducing CO_2 emissions (Figure 17-10).

Figure 17-10: Evolution of CO_2 Emissions, BAU and APS



4. Key Findings and Policy Implications

From the above analysis on energy saving potential, some keys findings could be recognized as follows:

- Energy demand in Viet Nam is expected to continue to grow at a significant rate, driven by robust economic growth, industrialization, urbanization and population growth. Energy efficiency and conservation measures have the potential to contribute to meeting higher demand in a sustainable manner.
- Viet Nam's energy intensity, which is amongst the highest in the world, indicates high saving potential. However, the energy saving potential derived from the EEC goals of Viet Nam (16.3 Mtoe) seem to be modest (because energy efficiency goals focus heavily on the industry sector and buildings) compared with its potential.
- Annual growth of energy demand in residential and commercial (other) sectors is projected at highest rate of 7.0 percent in BAU and it's share is increasing continuously from 22.3 percent in 2010 to 28.0 percent in 2035.

This shows that residential and commercial (other) sectors have large potential on energy saving.

- Electricity demand is increasing with an annual growth rate of 7.4 percent in BAU and is projected to decline to 6.9 percent in APS. This decline seems to be modest compared with its potential.
- Coal thermal power plants will be the major source of energy for power generation in Viet Nam in coming years. Its share in the total of power generation output is increasing continuously from 18.5 percent in 2010 to dominated share of 58.1 percent in 2035. This is the area with the largest energy saving as well as the GHG mitigation potential in Viet Nam.

From the findings above, the following actions are recommended to effectively implement EEC activities in Vietnam:

- **Establishment of new targets and a roadmap for EEC implementation**: The targets for EEC in Viet Nam have been set up for a short-term period (2006–2015) and focused on the industry sector and buildings. The new targets for long term should be set up based on an assessment of energy saving potential for all energy sectors, including residential and commercial sectors, which have large potential on energy saving up to 2035.
- **Compulsory energy labeling for electrical appliances:** Annual growth of energy demand in residential and commercial (other) sectors is projected at highest rate of 7.0 percent in BAU, especially demand on electricity use. Therefore, compulsory energy labeling for electrical appliances is an effective management measure for energy saving.
- **Priority for development of advanced coal thermal power technology:** Coal thermal power plants will be the major power generation in Viet Nam up to 2035. Therefore, advanced coal thermal power or energy effective technologies should be prioritized for coal thermal power plant development at stage of project design.
- **Priority for renewable energy development:** Coal is projected to comprise the majority share of power generation by 2035 which will result to the country's reliance on coal imports for power generation. Renewable energy

technology-based power generation is an important factor for energy independence, energy security and GHG abatement. Therefore, it is necessary to build up the strategy and mechanisms to support renewable energy development.

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Decision 177/2007/QD-TTg dated 20 November 2007 of the Prime Minister Approving the Master Plan on Biofuel Development Until 2015 with Perspective of 2025.

ANNEXES

ANNEX 1

Revision of Power Ratings of Variable-load Appliances in the Pilot Residential End-Use Energy Consumption Survey

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Green Tech Solutions, Malaysia

A1-1: Introduction

In conducting the pilot residential end-use energy consumption survey, it was recognized that there were constraints and potential sources of inaccuracy if certain technical considerations were not taken into account in the interpretation and analyses of the survey data. Unlike commercial buildings where energy consumption breakdowns through sub-metering are available, data can be easily extracted for accurate analysis of end-use energy consumption from the records of sub-metering readings. Survey of residential energy consumption needs to rely on respondents' response with accuracy in furnishing data such as utility bills, power ratings of appliances, quantity of appliances and fittings and estimated duration of usage. The following sections discuss the constraints and potential sources of inaccuracy, which were based on a review conducted on the Malaysian survey results.

A1-2: Constraints of the Pilot Survey

It should be noted that this pilot survey has its limitations due to the limited scope and scale of the survey. The WG members from the ASEAN and China were requested to conduct the survey for 6 months from September 2011 to February 2012. Each country was asked to collect at least 10 samples from urban households and 10 samples from rural households.

The pilot survey was conducted mainly on voluntary basis through each country's representative, who in turn needs to rely on his/her own resources and goodwill of his/her networking contacts (predominantly his colleagues) in order to access to some of the urban and rural households. The lack of coverage with respect to the extensiveness on locations of households and their respective social strata might have caused limitation on the survey results. Some of the rural households may not be distinctly rural and vice versa. Some of the rural households could be semi-urban households, for example. The small sampling size is likely to be influenced by the inherent inconsistency due to the demographic conditions and limited survey data. Nevertheless, the pilot survey study would serve to provide an exercise and illustration on the methodology and format for conducting and analyzing residential end-use energy consumption survey.

A1-3: Analysis of Pilot Survey Results

Power Rating of Household Appliances

Energy consumption for the usage of various household appliances can be calculated from the power ratings of appliances and the duration of usage provided in the survey data filled in by survey respondents from the following formula:

$$\text{Energy Consumption (kWh)} = \text{Power Rating (kW)} \times \text{Usage Duration (h)}$$

This calculation method is correct for constant load usage such as lighting, for example, 14 watt CFL (compact fluorescent light) for a daily usage duration of 5 hours would consume an estimated 2.1 kWh per month but a 1-hp (0.746 kW) split-unit air conditioner for a daily usage of 5 hours would not consume 112 kWh per month (i.e. 0.746 kW x 5 x 30). This is because the energy consumption profile of an air conditioner is not a constant-load process. This observation was verified through an experiment conducted in Malaysia, where power data-logging exercises on a 1-hp split-unit air conditioner and a refrigerator were conducted. This exercise was conducted in an office in Subang Jaya in Selangor, Malaysia but it was representative of typical household appliance. Electrical load profiles of the air conditioner and refrigerator were plotted and are shown below.

Figure A1-1: Power data-logging of a 1-hp split unit air-conditioner to establish electrical load profile & determine diversity factor (DF)

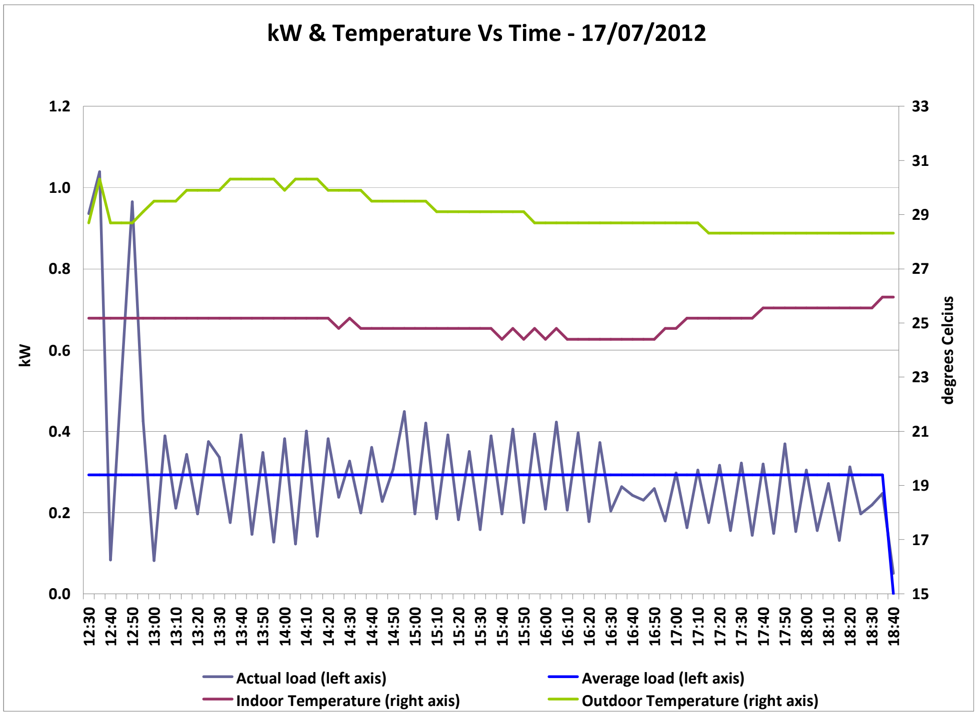

Figure A1-1 shows that the outdoor temperature during this experiment was about 29^0 to 30^0C and the indoor temperature was about 25^0C with air conditioner switched on. Except for the start-up load registered at a peak of about 1 kW, the steady-load range was about 0.2 kW to 0.4 kW, which can be translated to a constant load of about 0.3 kW. Therefore, the energy consumption of this particular air-conditioning exercise could be estimated to be 1.2 kWh (based on 0.3kW x 4h) instead of 2.984 kWh if the estimation was based on the air conditioner's power rating of 1-hp (i.e. 0.746 kW x 4h).

Figure A1-2: Power data-logging of a 150 W refrigerator to establish electrical load profile & determine diversity factor (DF)

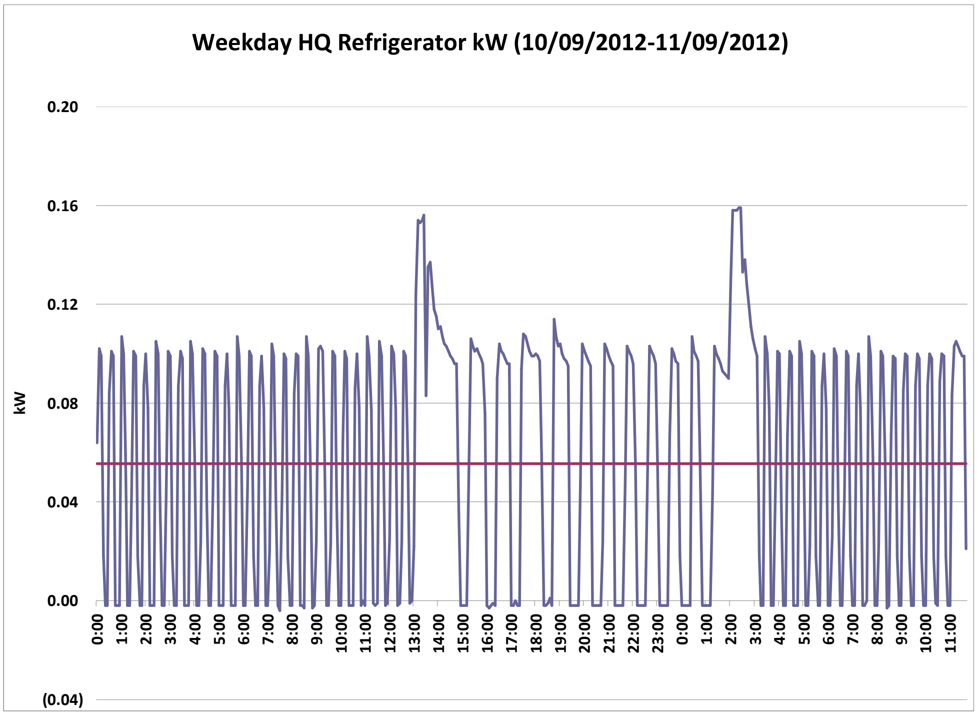

Figure A2-2 shows that the electrical load profile of a refrigerator which has a power rating of 150 W. The average electrical load worked out to be about 0.058 kW and the daily energy consumption of this particular refrigerator could be estimated to be 1.392 kWh instead of 3.6 kWh if the estimation was based on the refrigerator's power rating of 150 W (i.e. 0.15 kW x 24h).

Diversity Factors

It can be seen from these two experiments that appliances such as air conditioners and refrigerators have variable electrical loads due to the functioning of such appliances, which undergo power "on-off" or modulating phenomenon. Therefore, the estimation of energy consumption of variable load appliances will need to apply a diversity factor, which is an approximate value to take into account of the fluctuating loads. Based on the experiments mentioned in the above, the diversity factor for the air conditioner worked out to be 0.4 (i.e. 1.2kWh / 2.984kWh). However, it was recognized that the experiment was conducted in an office room within an air-conditioned office environment. The heat gained and cooling energy leakages would be much less than a residential environment. It was recommended that the diversity factor for split-unit air conditioners be based on industry-practice value of 0.6.

Similarly, the diversity factor of refrigerators worked out to be 0.386 (i.e. 1.392kWh / 3.6kWh). Again, due to the fact that the experiment was conducted in an office environment where the ambient temperature was generally lower than that of a residential environment, it was thought that the diversity factor for refrigerators used in residential environment should be higher due to the higher ambient temperature and generally higher load contents for household refrigerators. It was noted that the diversity factor derived from a Japan refrigerator pilot survey was 0.4. This value was further deliberated in the WG meetings. To take into account of the climate in Southeast Asia that can affect the performance, the diversity factor for refrigerators in the analysis of survey data was taken as 0.45.

Table A1-1: Diversity Factors for typical household appliances

Appliances	**Power Rating** (Watt)	**Diversity Factor**
Air-conditioners		0.6
Fans	Ceiling fans: 73 Stand fans: 58	0.7
Refrigerators		0.45
Water heaters	3,600	0.8
Lighting	Fluorescent lamps T8 (120cm): 36 + 6 = 42 T8 (60 cm): 18 + 6 = 24 T5 (120cm): 28 + 2 = 30 T5 (60 cm): 14 + 2 = 16	40%
Washing machine		Nil
Rice cooker		Nil

It was mentioned above that lighting has a constant-load consumption profile but due to the questionnaire in the survey form which asked for quantity of light fittings in a household and the fact that not all light fittings are switched on all the time, a usage factor of 40 percent would be applied for the estimation of lighting energy consumption.

A1-4: Other Observations

Other observations made in the review of the survey data obtained in Malaysia were highlighted and discussed in the WG meetings as follows:

1. Some of the energy consumption units (kWh) filled in did not tally with the utility billing amount if the tariffs were taken into consideration.
2. Not all the survey forms returned were provided with 6 months' data as some were 3, 4, and 5 months.
3. Some households do not have electric range/stoves, microwave ovens, food processors, blenders, etc. For these appliances, the energy consumptions were recommended to be classified under "other appliances" category.

ANNEX 2

Best Energy Mix for Road Transportation in Indonesia

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Pertamina

A2-1: Introduction

Historically, indigenous oil, gas and coal reserves have played an important role in Indonesia's economy. Indonesia's vast reserves and resources of these three commodities have allowed extensive utilization as sources of energy, industrial raw material and national income. The extensive use of energy has contributed to the increase of economic growth which is represented by GDP. Between 2002 and 2030, it is projected that the Indonesian population will grow at 1 percent annually whereas GDP grows at 4.6 percent. [1]

The increase of population growth has in turn resulted in higher energy demand. The total energy consumption in Indonesia in the year 2000 was 778 million barrels

[1] Fuerte Jr. (ed.), (2006).

of oil equivalent (BOE). Within 11 years, this increased to 1,114 million BOE. The energy consumption by the transportation sector experienced the largest increase within this period. From the year 2000 to 2011, the energy consumption by the transportation sector grew at a rate of 6.5 percent annually from 139 million BOE to 277 million BOE. Meanwhile, oil production decreased 4 percent annually from 2000-2011 due to depletion of reserves and lack of investment for exploration and development. [2]

The transportation sector consumes over 60 percent of Indonesian oil, 70 percent of which attributed to road transportation. Summarizing, road transportation, the main contributor of energy consumption in transportation sector, will account for 87 percent of the total transport energy demand by 2030. The Asia Pacific Energy Research Centre predicts that the number of passenger vehicles will increase from 3.4 million units in 2002 to 13.9 million units by 2030 thus drastically increasing oil demand. [3]

An issue that arises is the continued financial burden to the Indonesian government due to the policy of subsidizing gasoline and diesel fuels for road transport. The increasing demand of these fuels will be accompanied by increasing subsidy, further made worse if domestic oil production continues to decline. It is thus necessary to explore alternative energy resources or fuel types for road transportation.

This study therefore aims to examine the effect of the implementation of alternative fuels, such as compressed natural gas (CNG) and biofuels, on fuel consumption, CO_2 emissions and fuel subsidies for the road transportation sector. In addition, new energy efficient technologies such as electric vehicles and hybrid vehicles are also examined. It is expected that the results of this study can provide insight to what fuel mix can best be applied to the Indonesian road transport sector in such a way that features a favourable balance of reduced gasoline/diesel consumption and subsidies, more efficient energy usage, and low CO_2 emissions.

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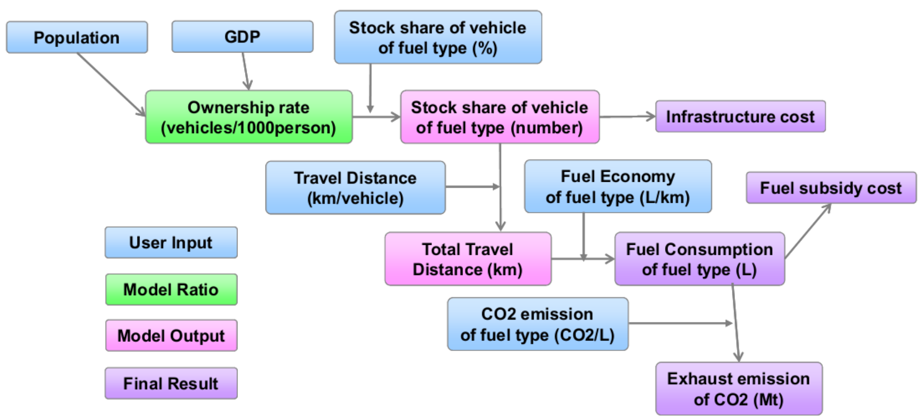
[2] Syahrial, *et al.* (2012).
[3] Fuerte Jr. (ed.), (2006).

A2-2: Predictive model

We have adopted a modified IEA/SMP Transport Spreadsheet Model to predict energy consumption, emissions and cost. The original IEA/SMP model calculates energy and CO_2/pollutant emissions based on fuel type using the IEA "ASIF" structure - Activity, Structure, Intensity and Fuel composition - and was designed to produce projections of vehicle stocks, travel, energy use and other indicators through 2050 for a reference case and for various policy cases and scenarios with incorporation of technological effects.[4] However, the model did not include cost structure and required modification to be able to examine the specific conditions of road transportation in Indonesia. We have therefore extensively modified the model for use with Indonesian provincial statistical data focusing only on road transport and have developed a cost prediction module incorporating subsidized fuel costs and infrastructure costs (Figure A2-1).

Due to the socio-economical and technological differences between the regions of Indonesia, this study grouped Indonesian provinces into six areas: Sumatra, Java & Bali, Kalimantan, Sulawesi, Nusa Tenggara, Papua and Maluku. This grouping also allows finer adjustment of scenarios such as the introduction of new technology or vehicles only within certain groups.

Figure A2-1: Model Algorithm



Calculation of vehicle ownership was based on vehicle sales obtained from the

[4] Center for Transportation and Logistics Studies of Gadjah Mada University, and South South North Project (2003).

Association of Indonesian Automotive Industries (GAIKINDO)[5] and the Indonesian Motorcycle Industries Association (AISI).[6] By correlating historical vehicle ownership to historical GDP per capita[7] for each study area, projections of ownership are predicted to 2030.

Annual travel distance was obtained from a study conducted by South South North and the Center for Transportation and Logistics Studies of Gadjah Mada University.[8] Average annual travel distance was calculated by estimating the number of the active days of the vehicle type within one year.

The majority of fuel economy data was adopted from an empirical research which investigated the fuel consumption of motorcycles, passenger cars (gasoline and diesel), buses and trucks in Indonesia, specifically the cities of Yogyakarta, Semarang and Surakarta.[9] The data was collected through field study which was then cross-validated with data from government institutions. Nevertheless, some data such as fuel-efficiency for CNG-vehicles (bus and truck) and electric-vehicles are not yet available in Indonesia so that those data are either obtained from manufacturers or assumed.[10]

Data on CO_2 emission collected through a literature survey on life-cycle assessment studies in Indonesia was utilized when available.[11] For cases where Indonesian data was not available, best estimates using other data was used.[12]

A2-3: Scenarios

We have developed five scenario types to examine the effect of the adoption of alternative fuels and fuel efficient technology on fuel and energy consumption, CO_2 emissions and fuel subsidies.

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5 Association of Indonesian Automotive Industries (GAIKINDO), (2013a), GAIKINDO, (2013b); GAIKINDO (2012).
6 Indonesian Motorcycle Industries Association (AISI), (2013).
7 Badan Pusat Statistik (BPS), (2013).
8 Center for Transportation and Logistics Studies of Gadjah Mada University, and South South North Project (2003)
9 Sandra (2012).
10 Sinaga, *et al.,* (2010).
11 Restianti and Gheewala (2012a).
12 Sevenster and Croezen (2006).

Scenario 0: Reference Scenario

In 2008, the Indonesian Ministry of Energy and Mineral Resources mandated that biofuel content within a biofuel blend reach 5 percent by 2015. Afterwards, biodiesel is expected to reach 20 percent content by 2025 while ethanol is expected to reach 5 percent. [13]

Due to limited stocks, production of a gasoline-ethanol blend was eventually suspended in 2009. However, biodiesel production met a good degree of success. In 2012, the biodiesel content was ahead of schedule and able to reach 5 percent with an increase to 7.5 percent beginning 2013. Therefore as a reference scenario, a constant biodiesel blend of 7.5 percent and ethanol blend of 0 percent was assumed until 2030.

Scenario 1: Biofuel Scenario

Two biofuel scenarios were added to simulate the effect of increased biofuel content towards energy consumption, carbon emissions and cost:

Scenario 1A: The current bioethanol blend of zero or E0 is increased gradually to an ethanol content of 10 percent or E10 by 2020. Likewise the biodiesel content is increased from the current 7.5 percent or B7.5 to 10 percent or B10 by 2020.

Scenario 1B: Similar to Scenario 1A up to 2020. Afterwards, from 2010, the bioethanol blend content is increased gradually to 20 percent or E20 by 2030.

Scenario 2: Natural Gas Scenario

In 2010, the Indonesian Ministry of Energy and Mineral Resources issued Regulation No. 19 Year 2010 concerning the Utilization of Natural Gas for Transportation Fuel which mandated the increase of natural gas resource allocation for the transportation sector from 10 percent to 25 percent by 2025[14]. Two gas scenarios were created to simulate the effect of CNG adoption:

Scenario 2A: CNG cars, buses and trucks are sold and old gasoline and diesel cars, buses and trucks are converted in islands which are adjacent or contain gas producing areas, namely Sumatera, Kalimantan, Sulawesi, Papua and Maluku. New CNG cars are produced and sold in the Indonesian market beginning 2016 beginning

[13] Indonesian Ministry of Energy and Mineral Resources (2008).
[14] Indonesian Ministry of Energy and Mineral Resources (2010).

at 10 percent of vehicles sold and reaching 100 percent by 2030. CNG conversion of older gasoline and diesel cars begins in 2015 at 0.2 percent of vehicles present and reaching 100 percent by 2030. Both are assumed to follow an exponential curve. This resulted in a final population of CNG passenger cars comprising 31 percent of the total car population.

Scenario 2B: Similar to Scenario 2A but with the addition of new cars, buses and trucks sold and old cars, buses and trucks converted to CNG operation in Java and Bali. In Java and Bali, it is assumed that CNG conversion begins in 2015 at 0.5 percent of old gasoline and diesel vehicles and CNG vehicle sales begins in 2016 at 10 percent of all vehicle sales. Both vehicles sales and conversion are assumed to reach 100 percent at 2030. The population of CNG passengers was found to reach 99.6 percent of the total car population by 2030.

Scenario 3: Electric vehicles

Scenario 3 introduces the sales of electrical passenger cars. Scenario 3 assumes sales of electric vehicles into the Indonesian market begin in 2016 with 0.5 percent of cars sold. In 2030, the ratio of sales of EVs to total passenger cars sales is 100 percent. A fuel economy of 45 km per litre gasoline equivalent was assumed in 2016. The final population of EV passenger cars by 2030 was 16 percent of the total passenger car population.

Scenario 4: Hybrid cars

Scenario 4 introduces the sales of hybrid cars. Similar to Scenario 3, sales of hybrid vehicles into the Indonesian market begin in 2016 with 0.5 percent of cars sold and reach 100 percent in 2030. Hybrid vehicles were modelled to be able to adopt to bioethanol and were assumed to have a fuel economy of 14 km per litre gasoline equivalent in 2016. Similar to Scenario 3, the final population of hybrid passenger cars by 2030 was 16 percent of the total passenger car population.

Scenario 5: Hybrid, CNG and biofuel Energy mix

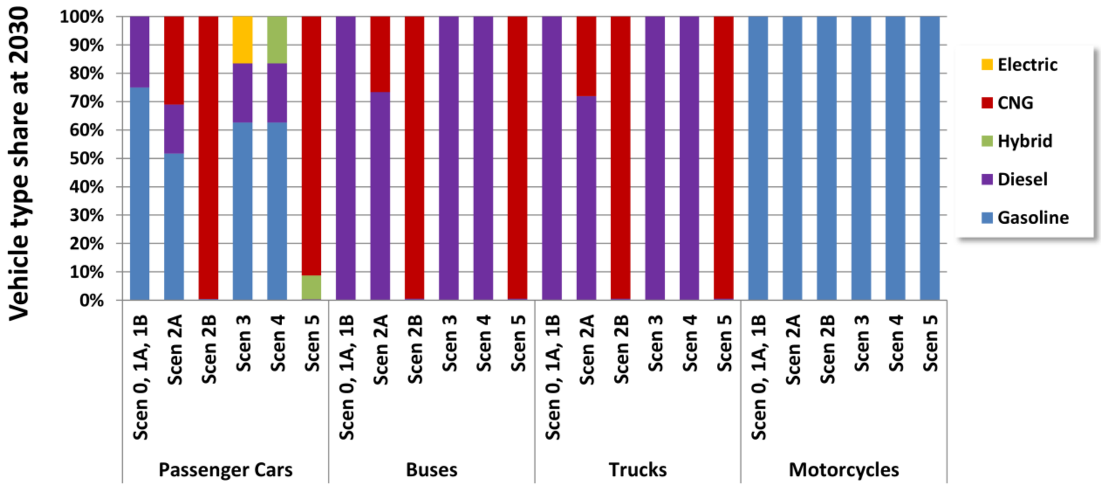
A fuel mix was proposed in Scenario 5. This scenario combines the use of hybrid vehicles and CNG vehicles. New hybrid passenger cars begin sale nationwide at 0.5 percent in 2016 and reaches 45 percent of total passenger cars sales by 2030. As in Scenario 2B, CNG cars are only sold and converted in Sumatra, Java, Bali, Kalimantan, Sulawesi, Papua and Maluku due to the presence or close proximity of natural gas production facilities and distribution infrastructure. New CNG cars begin sale at 10 percent in 2016 and reach 55 percent by 2030. Conversion of older cars to CNG operation begins at 0.5 percent of gasoline and diesel vehicle population for Java and Bali in 2015 and at 0.2 percent for other areas. Conversion reaches 100 percent of non-hybrid vehicle population in 2030. The final result of fuel type composition for passenger cars was 8 percent hybrid passenger cars and 91.3 percent CNG cars by 2030.

A2-4. Results and discussion

Vehicle Fuel type composition

As a result of new vehicles of different fuel types being sold and conversion of old vehicles to another fuel type (i.e. conversion of old cars to CNG), the vehicle populations of different fuel types (vehicle fuel type composition) will change. Figure A2-2 shows the final composition of vehicle fuel types by 2030. As can be seen, introduction of EV and hybrid technology (Scenario 3 and 4) that only relies on gradually increasing sales of new vehicles will result in a limited share (i.e. 16 percent) by 2030. To have a larger share, more aggressive adoption of these vehicles must be adopted or the older vehicles should be retired or converted to the new fuel type. For CNG (Scenario 2A and 2B), a larger share was obtained because older vehicles were converted to CNG.

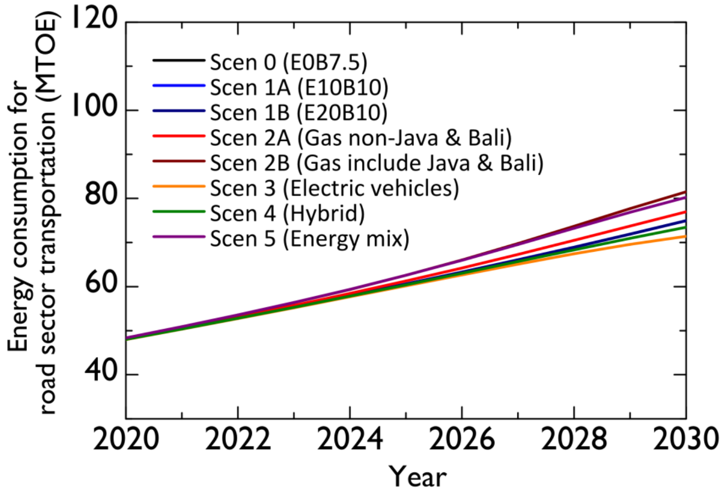
Figure A2-2: Vehicle Composition by Fuel Type in 2030



Energy consumption

The predicted energy consumption for each scenario is shown in Figure A2-3. As can be seen, low energy consumption occurs when high efficiency vehicles are introduced. The lowest energy consumption is for the electric vehicle scenario due to the highest efficiency of these vehicles. This is followed by the hybrid vehicle scenario. As it is assumed that CNG vehicles are not optimized and dedicated CNG vehicles but bi-fuel capable vehicles, these vehicles therefore have a lower efficiency than gasoline and diesel vehicles. Thus, the largest energy consumption occurs in Scenario 2B. Scenario 5 shows a slightly less energy consumption due to the mix of hybrid vehicles with CNG vehicles.

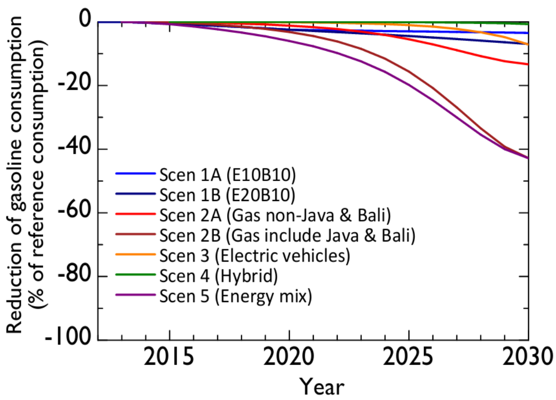
Figure A2-3: Energy Consumption



Reduction of gasoline and diesel usage

A main issue with transportation fuel in Indonesia is the heavy burden of gasoline and diesel subsidies that the Indonesian government allocates from its annual budget. Reduction of gasoline and diesel fuel usage will directly alleviate this burden. This will be an important consideration in deciding an action plan in regards to road sector energy planning.

Figure A2-4: Percentage reduction of gasoline (left) and diesel fuel consumption (right) compared to reference scenario consumption



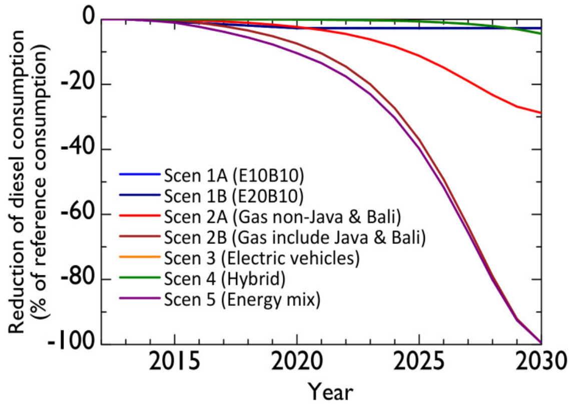
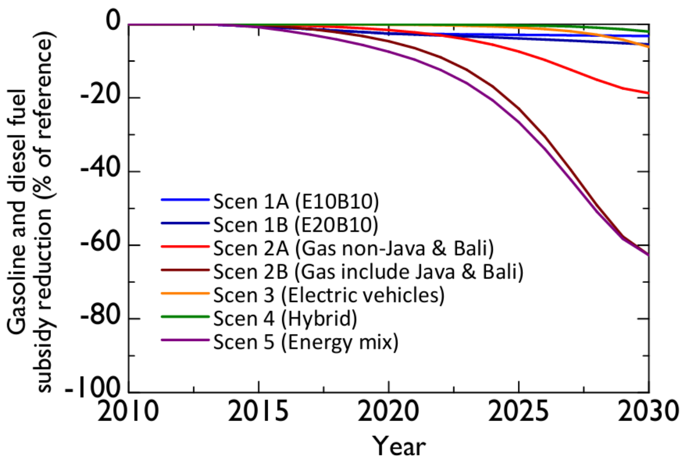


Figure A2-4 display the reduction of gasoline and diesel fuel usage respectively in regards to application of different energy mix scenarios. As can be seen, the largest reduction of gasoline and diesel fuels is obtained by Scenarios 2B and Scenario 5 which model a nationwide conversion of older gasoline and diesel vehicles and sales of new CNG vehicles. Introduction of new energy efficient technology such as hybrid vehicles and electric vehicles reduce the gasoline and diesel consumption at a milder rate since these technologies involve only newer vehicles sold without conversion of older vehicles. It is thus apparent that to significantly reduce gasoline and diesel consumption, an action plan must consider the presence and involve the existing population of gasoline and diesel vehicles. This is especially important considering the scarce retirement of old vehicles.

Reduction of gasoline and diesel fuel consumption will directly affect the amount of fuel subsidy. Figure A2-5 shows the reduction of annual fuel subsidy for each scenario. To better compare cost reduction between scenarios, a constant oil price and constant subsidy per litre gasoline and diesel was assumed. As expected, the largest amount of fuel subsidy reduction was achieved by scenarios with the largest gasoline and diesel fuel consumption reduction, Scenario 2B and Scenario 5 of which by 2030 achieved similar reduction of annual subsidies of 131.2 trillion IDR, a reduction of 62.7 percent. In addition, energy mix Scenario 5 which introduces sales of hybrid vehicles and includes distribution of E20 and E10 biofuels achieved a larger reduction earlier compared to Scenario 2B which only considers CNG usage.

The simulation results have shown that scenarios which have involved the conversion of old vehicles to CNG use have resulted in the most drastic reduction of consumption and managed to reduce gasoline and diesel fuel usage by 15.6 percent and 37.0 percent in 2025 respectively. This reduction reaches 42.8 percent for gasoline and 99.5 percent for diesel fuel consumption by 2030 and resulted in a subsidy reduction of 62.7 percent in 2030.

Figure A2-5: Percentage reduction of gasoline and diesel fuel subsidy reduction compared to reference scenario subsidies



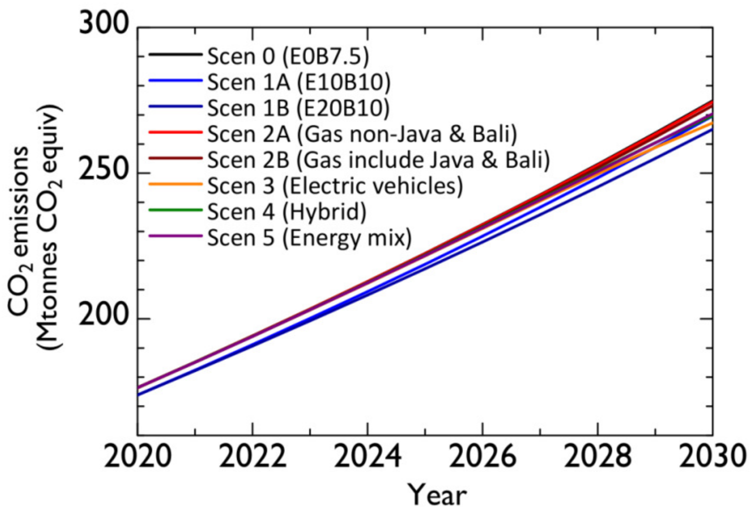
Results of Scenario 5 show that biofuel can well supplement other measures such as the introduction of hybrid vehicles and CNG conversion resulting in a larger reduction of gasoline and diesel fuel usage in short and mid-terms. Measures to increase the biofuel content further and implement biofuel usage to motorcycles will result in an even greater reduction of gasoline and diesel consumption.

The introduction of new fuel efficient vehicles have been shown to reduce gasoline consumption by 0.7 percent and diesel consumption by 4.4 percent for hybrid vehicles, resulting in a subsidy reduction of 2.0 percent in 2030. The reduction by electric vehicles was 7 percent and 4.4 percent gasoline and diesel fuel consumption respectively, resulting in a subsidy reduction of 6.2 percent. The relatively limited reduction of gasoline and diesel fuel consumption is due to the fact that at 2030 the population of these new vehicles will only account for 16 percent of the total passenger car population by 2030, assuming a 100 percent sales market share at that time. Competition with other fuel types, such as the with the sales of CNG cars as shown in Scenario 5, will result in a lower population count of the new technology cars. In Scenario 5, assuming 45 percent sales market share of hybrid vehicles in 2030, the final proportion of hybrid cars to total cars was 8 percent. Again, this highlights the importance of dealing with older gasoline and diesel vehicles already present in the vehicle population. Nevertheless, the eventual natural retirement of older vehicles will gradually increase the impact of these newer technology hybrid and electric vehicles in the long term and thus should not be ignored.

Carbon emissions

Carbon emissions were calculated based on fuel consumption and specific carbon emissions. Figure A2-6 shows that the road sector CO_2 emissions were not so different between the scenarios modelled. By 2030, reference Scenario 0 featured the largest annual CO_2 emissions, a value of 274 million tonnes CO_2 equivalent. CNG Scenario 2B was second largest, despite the low specific emissions of CNG, due to the lower fuel economy of bi-fuel CNG vehicles. Meanwhile the lowest CO_2 emissions of 267 million tonnes CO_2 equivalent were obtained by the EV scenario. Even though EVs had a good fuel economy of 45 kms per litre gasoline equivalent, the specific CO_2 emissions were quite high for Indonesian electric power as shown due to the dominance of coal fired power plants[15] thus reducing the impact of EVs in regards to CO_2 emissions.

Figure A2-6: CO_2 Emissions



15 Widiyanto, *et al.* (2003).

A2-5: Conclusion

The results have shown that to significantly reduce gasoline and diesel fuel usage and ultimately reduce fuel subsidies, the population of old gasoline and diesel vehicles must be put into consideration. The scarce retirement of older vehicles in Indonesia results in these vehicles still consuming a sizable amount of gasoline and diesel fuel despite introduction of newer, more efficient and alternative fuel capable vehicles. This resulted in a somewhat limited impact of introduction of high fuel economy vehicle like hybrid vehicles and electric vehicles due to the low population of these vehicles by 2030. If the portion of these high fuel economy vehicles is increased, either by the reduction of old vehicles or by accelerating the adoption of high fuel economy vehicles, the impact will be more pronounced.

The largest CO_2 emissions was obtained by the reference scenario at 274.8 million tonnes CO_2 by 2030, while the least was obtained by Scenario 3 (electric vehicles) with a value of 267.3 million tonnes CO_2 a difference of less than 3 percent due to the lower population size or due to increase of CO_2 by power generation for the electric vehicles. As such, CO_2 emissions were relatively similar between each scenario.

This conclusion is a result of the calculation under specific conditions. Based on the results, implementation of a fuel mix policy intended on reducing reliance on gasoline and diesel fuel consumption should consider the following:

- A plan to reduce the population of old gasoline and diesel vehicles must be considered, either by adopting a vehicle retirement scheme or by converting these vehicles to non-gasoline/diesel fuels.
- A recommended course of action is the implementation of a CNG conversion plan for older gasoline and diesel vehicles. While bi-fuel CNG vehicles are slightly less efficient, the end result is still only less than 6 percent rise in energy consumption, with the potential benefit of 60 percent reduction in fuel subsidies.
- Further development, production and adoption of biofuel blends with increasing biofuel content should be conducted in conjunction with other initiatives such as CNG conversion. In addition to being compatible with

a good portion of older vehicles, biofuel adoption will help reduce fuel subsidies earlier in the short term compared to adoption of CNG, EVs or hybrid technologies. A policy to mandate biofuel compatibility of motorcycles will further increase the impact of biofuel adoption.

- For the introduction of new fuel efficient technologies such as hybrid vehicles and electric vehicles to make a significant impact, the increase of the population portion of such vehicles must be accelerated, either by a more aggressive adoption plan or by retirement of older less efficient vehicles. A more aggressive adoption of new technologies may be promoted by the government by introducing policies such as subsidies or reduced taxes for high fuel efficiency vehicles.

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ANNEX 3 – RESULTS SUMMARY TABLES

EAS [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,635.4**	**4,078.6**	**5,142.3**	**6,003.0**	**6,856.8**	**7,716.1**	**8,536.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.7**	**3.9**	**2.4**	**3.0**
Coal	782.7	2,205.0	2,730.6	3,059.7	3,437.1	3,802.6	4,121.9	47.9	54.1	53.1	51.0	50.1	49.3	48.3	5.3	3.3	2.0	2.5
Oil	611.3	1,114.5	1,379.2	1,562.2	1,732.3	1,922.2	2,129.1	37.4	27.3	26.8	26.0	25.3	24.9	24.9	3.0	3.4	2.1	2.6
Natural gas	121.6	416.7	572.1	792.8	989.9	1,181.2	1,368.1	7.4	10.2	11.1	13.2	14.4	15.3	16.0	6.3	6.6	3.7	4.9
Nuclear	68.1	139.9	206.2	255.9	301.8	347.3	372.3	4.2	3.4	4.0	4.3	4.4	4.5	4.4	3.7	6.2	2.5	4.0
Hydro	31.7	89.2	111.8	139.9	157.9	175.3	191.9	1.9	2.2	2.2	2.3	2.3	2.3	2.2	5.3	4.6	2.1	3.1
Geothermal	8.7	26.5	32.7	45.6	56.5	67.0	76.6	0.5	0.6	0.6	0.8	0.8	0.9	0.9	5.8	5.6	3.5	4.3
Others	11.3	86.8	109.6	146.8	181.2	220.5	276.1	0.7	2.1	2.1	2.4	2.6	2.9	3.2	10.7	5.4	4.3	4.7

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,122.1**	**2,488.9**	**3,228.2**	**3,802.8**	**4,343.0**	**4,887.9**	**5,439.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**4.3**	**2.4**	**3.2**
Industry	474.9	1,112.4	1,471.5	1,699.5	1,905.5	2,100.9	2,300.1	42.3	44.7	44.7	45.6	44.7	43.9	42.3	4.3	4.3	2.0	2.9
Transportation	207.0	472.7	667.0	778.9	890.2	1,015.8	1,156.0	18.4	19.0	19.0	20.7	20.5	20.5	21.3	4.2	5.1	2.7	3.6
Others	326.9	607.5	729.4	896.8	1,066.9	1,234.5	1,388.9	29.1	24.4	24.4	22.6	23.6	24.6	25.5	3.1	4.0	3.0	3.4
Non-energy	113.3	296.3	360.3	427.5	480.5	536.8	594.0	10.1	11.9	11.9	11.2	11.2	11.1	10.9	4.9	3.7	2.2	2.8
Total	**1,122.3**	**2,488.9**	**3,228.2**	**3,802.8**	**4,343.0**	**4,887.9**	**5,439.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**4.3**	**2.4**	**3.2**
Coal	415.7	665.7	830.6	920.8	993.2	1,053.6	1,112.1	37.0	26.7	25.7	24.2	22.9	21.6	20.4	2.4	3.3	1.3	2.1
Oil	469.3	970.2	1,226.4	1,419.9	1,596.7	1,788.8	1,998.7	41.8	39.0	38.0	37.3	36.8	36.6	36.7	3.7	3.9	2.3	2.9
Natural gas	49.9	180.1	287.1	395.7	495.1	582.3	656.7	4.4	7.2	8.9	10.4	11.4	11.9	12.1	6.6	8.2	3.4	5.3
Electricity	154.4	556.2	731.5	884.9	1,050.1	1,228.4	1,408.8	13.8	22.3	22.7	23.3	24.2	25.1	25.9	6.6	4.8	3.1	3.8
Heat	13.4	69.2	92.2	106.4	117.9	127.1	133.7	1.2	2.8	2.9	2.8	2.7	2.6	2.5	8.6	4.4	1.5	2.7
Others	19.6	47.5	60.4	75.0	90.2	107.7	129.0	1.7	1.9	1.9	2.0	2.1	2.2	2.4	4.5	4.7	3.7	4.1

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2,194.3**	**7,739.6**	**10,052.3**	**12,116.1**	**14,323.8**	**16,670.4**	**19,011.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**4.6**	**3.0**	**3.7**
Coal	919.3	4,808.6	6,015.1	6,872.5	8,113.6	9,451.2	10,705.7	41.9	62.1	59.8	56.7	56.6	56.7	56.3	8.6	3.6	3.0	3.3
Oil	394.6	218.5	233.3	221.4	214.2	210.7	211.6	18.0	2.8	2.3	1.8	1.5	1.3	1.1	-2.9	0.1	-0.3	-0.1
Natural gas	235.2	981.1	1,353.5	1,849.4	2,273.0	2,739.8	3,280.8	10.7	12.7	13.5	15.3	15.9	16.4	17.3	7.4	6.5	3.9	4.9
Nuclear	261.3	537.0	791.3	981.8	1,158.2	1,332.5	1,428.5	11.9	6.9	7.9	8.1	8.1	8.0	7.5	3.7	6.2	2.5	4.0
Hydro	361.2	1,036.9	1,300.0	1,626.9	1,836.3	2,038.4	2,231.1	16.5	13.4	12.9	13.4	12.8	12.2	11.7	5.4	4.6	2.1	3.1
Geothermal	10.4	28.0	42.1	63.3	81.7	98.7	129.1	0.5	0.4	0.4	0.5	0.6	0.6	0.7	5.1	8.5	4.9	6.3
Others	12.2	129.6	316.9	500.7	646.8	799.1	1,025.0	0.6	1.7	3.2	4.1	4.5	4.8	5.4	12.5	14.5	4.9	8.6

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**396.7**	**1,448.8**	**1,782.0**	**2,048.4**	**2,381.8**	**2,735.3**	**3,072.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.7**	**3.5**	**2.7**	**3.1**
Coal	255.9	1,202.1	1,471.8	1,646.1	1,904.4	2,173.9	2,414.2	64.5	83.0	82.6	80.4	80.0	79.5	78.6	8.0	3.2	2.6	2.8
Oil	88.7	55.6	55.1	52.8	51.8	51.7	52.7	22.3	3.8	3.1	2.6	2.2	1.9	1.7	-2.3	-0.5	0.0	-0.2
Natural gas	52.1	191.2	255.1	349.6	425.5	509.6	605.1	13.1	13.2	14.3	17.1	17.9	18.6	19.7	6.7	6.2	3.7	4.7

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**33.6**	**35.7**	**36.7**	**37.5**	**38.3**	**39.0**	**39.7**								**0.3**	**0.5**	**0.4**	**0.4**
Coal	30.9	34.4	35.1	35.9	36.6	37.4	38.1								0.5	0.4	0.4	0.4
Oil	38.3	33.8	36.4	36.1	35.5	35.0	34.5								-0.6	0.7	-0.3	0.1
Natural gas	38.8	44.1	45.6	45.5	45.9	46.2	46.6								0.6	0.3	0.2	0.2

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,339.7**	**3,309.3**	**4,125.8**	**4,725.3**	**5,358.4**	**5,981.0**	**6,561.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**3.6**	**2.2**	**2.8**
Coal	826.2	2,340.4	2,903.8	3,255.9	3,659.2	4,046.9	4,381.6	61.7	70.7	70.4	68.9	68.3	67.7	66.8	5.3	3.4	2.0	2.5
Oil	439.5	743.5	895.8	1,013.4	1,127.4	1,252.3	1,390.2	32.8	22.5	21.7	21.4	21.0	20.9	21.2	2.7	3.1	2.1	2.5
Natural Gas	74.0	225.4	326.2	456.1	571.8	681.8	790.1	5.5	6.8	7.9	9.7	10.7	11.4	12.0	5.7	7.3	3.7	5.1

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	5,877	11,708	14,702	18,580	22,515	26,825	31,600	3.5	4.7	3.6	4.1
Population (millions of people)	2,611	3,301	3,453	3,583	3,691	3,779	3,850	1.2	0.8	0.5	0.6
GDP per capita (thousands of 2000 USD/person)	2.3	3.5	4.3	5.2	6.1	7.1	8.2	2.3	3.9	3.1	3.4
Primary energy consumption per capita (toe/person)	0.63	1.24	1.49	1.68	1.86	2.04	2.22	3.5	3.1	1.9	2.4
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	278	348	350	323	305	288	270	1.1	-0.8	-1.2	-1.0
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	228	283	281	254	238	223	208	1.1	-1.1	-1.3	-1.2
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.82	0.81	0.80	0.79	0.78	0.78	0.77	0.0	-0.3	-0.2	-0.2
Automobile ownership volume (millions of vehicles)	84	217	305	358	413	482	570	4.8	5.1	3.1	3.9
Automobile ownership volume per capita (vehicles per person)	0.03	0.07	0.09	0.10	0.11	0.13	0.15	3.6	4.3	2.7	3.3

EAS [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,635.4**	**4,078.6**	**4,954.8**	**5,553.2**	**6,091.0**	**6,563.8**	**6,954.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.7**	**3.1**	**1.5**	**2.2**
Coal	782.7	2,205.0	2,629.6	2,747.2	2,860.3	2,923.0	2,920.1	47.9	54.1	53.1	49.5	47.0	44.5	42.0	5.3	2.2	0.4	1.1
Oil	611.3	1,114.5	1,331.7	1,462.9	1,564.1	1,661.6	1,747.3	37.4	27.3	26.9	26.3	25.7	25.3	25.1	3.0	2.8	1.2	1.8
Natural gas	121.6	416.7	509.2	646.9	782.5	901.8	1,011.8	7.4	10.2	10.3	11.6	12.8	13.7	14.5	6.3	4.5	3.0	3.6
Nuclear	68.1	139.9	218.1	322.7	426.1	519.0	598.4	4.2	3.4	4.4	5.8	7.0	7.9	8.6	3.7	8.7	4.2	6.0
Hydro	31.7	89.2	117.0	161.0	183.1	204.5	228.2	1.9	2.2	2.4	2.9	3.0	3.1	3.3	5.3	6.1	2.4	3.8
Geothermal	8.7	26.5	31.5	42.7	55.3	73.8	86.2	0.5	0.6	0.6	0.8	0.9	1.1	1.2	5.8	4.9	4.8	4.8
Others	11.3	86.8	117.6	169.8	219.6	280.0	362.6	0.7	2.1	2.4	3.1	3.6	4.3	5.2	10.7	6.9	5.2	5.9

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,122.1**	**2,488.9**	**3,129.8**	**3,580.9**	**3,966.8**	**4,328.2**	**4,676.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**3.7**	**1.8**	**2.6**
Industry	474.9	1,112.4	1,423.5	1,590.2	1,729.7	1,850.3	1,969.0	42.3	44.7	44.7	45.5	44.4	43.6	42.1	4.3	3.6	1.4	2.3
Transportation	207.0	472.7	646.5	734.2	810.7	891.5	977.3	18.4	19.0	19.0	20.7	20.5	20.4	20.9	4.2	4.5	1.9	2.9
Others	326.9	607.5	703.6	838.5	961.6	1,070.5	1,163.5	29.1	24.4	24.4	22.5	23.4	24.2	24.9	3.1	3.3	2.2	2.6
Non-energy	113.3	296.3	356.1	417.9	464.9	515.9	567.1	10.1	11.9	11.9	11.4	11.7	11.7	12.1	4.9	3.5	2.1	2.6
Total	**1,122.3**	**2,488.9**	**3,129.8**	**3,580.9**	**3,966.9**	**4,328.2**	**4,676.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**3.7**	**1.8**	**2.6**
Coal	415.7	665.7	803.0	864.5	909.6	941.5	971.3	37.0	26.7	25.7	24.1	22.9	21.8	20.8	2.4	2.6	0.8	1.5
Oil	469.3	970.2	1,186.8	1,329.5	1,444.6	1,562.5	1,683.2	41.8	39.0	37.9	37.1	36.4	36.1	36.0	3.7	3.2	1.6	2.2
Natural gas	49.9	180.1	278.4	374.1	455.7	521.7	573.8	4.4	7.2	8.9	10.4	11.5	12.1	12.3	6.6	7.6	2.9	4.7
Electricity	154.4	556.2	709.3	832.7	954.7	1,078.3	1,198.2	13.8	22.3	22.7	23.3	24.1	24.9	25.6	6.6	4.1	2.5	3.1
Heat	13.4	69.2	90.4	100.1	105.3	107.5	107.2	1.2	2.8	2.9	2.8	2.7	2.5	2.3	8.6	3.8	0.5	1.8
Others	19.6	47.5	61.7	80.0	96.9	116.7	143.3	1.7	1.9	2.0	2.2	2.4	2.7	3.1	4.5	5.4	4.0	4.5

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2,194.3**	**7,739.6**	**9,727.9**	**11,353.2**	**12,888.0**	**14,357.4**	**15,700.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**3.9**	**2.2**	**2.9**
Coal	919.3	4,808.6	5,751.6	5,965.3	6,283.6	6,496.2	6,404.2	41.9	62.1	59.1	52.5	48.8	45.2	40.8	8.6	2.2	0.5	1.2
Oil	394.6	218.5	212.0	188.7	168.6	154.1	144.5	18.0	2.8	2.2	1.7	1.3	1.1	0.9	-2.9	-1.5	-1.8	-1.6
Natural gas	235.2	981.1	1,140.0	1,351.4	1,599.7	1,868.2	2,183.5	10.7	12.7	11.7	11.9	12.4	13.0	13.9	7.4	3.3	3.3	3.3
Nuclear	261.3	537.0	836.9	1,238.3	1,647.1	2,003.6	2,321.2	11.9	6.9	8.6	10.9	12.8	14.0	14.8	3.7	8.7	4.3	6.0
Hydro	361.2	1,036.9	1,360.7	1,871.6	2,128.5	2,377.6	2,653.2	16.5	13.4	14.0	16.5	16.5	16.6	16.9	5.4	6.1	2.4	3.8
Geothermal	10.4	28.0	40.0	57.9	76.0	102.1	135.9	0.5	0.4	0.4	0.5	0.6	0.7	0.9	5.1	7.5	5.9	6.5
Others	12.2	129.6	386.7	680.0	984.5	1,355.6	1,858.3	0.6	1.7	4.0	6.0	7.6	9.4	11.8	12.5	18.0	6.9	11.2

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**396.7**	**1,448.8**	**1,656.2**	**1,691.1**	**1,754.4**	**1,796.1**	**1,780.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.7**	**1.6**	**0.3**	**0.8**
Coal	255.9	1,202.1	1,398.0	1,403.9	1,433.3	1,436.2	1,373.0	64.5	83.0	84.4	83.0	81.7	80.0	77.1	8.0	1.6	-0.1	0.5
Oil	88.7	55.6	49.8	44.5	40.1	37.2	35.7	22.3	3.8	3.0	2.6	2.3	2.1	2.0	-2.3	-2.2	-1.5	-1.8
Natural gas	52.1	191.2	208.4	242.8	280.9	322.7	371.3	13.1	13.2	12.6	14.4	16.0	18.0	20.9	6.7	2.4	2.9	2.7

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**33.6**	**35.7**	**36.9**	**38.2**	**39.5**	**40.8**	**42.2**								**0.3**	**0.7**	**0.7**	**0.7**
Coal	30.9	34.4	35.4	36.5	37.7	38.9	40.1								0.5	0.6	0.6	0.6
Oil	38.3	33.8	36.6	36.5	36.1	35.6	34.8								-0.6	0.8	-0.3	0.1
Natural gas	38.8	44.1	47.0	47.9	49.0	49.8	50.6								0.6	0.8	0.4	0.5

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1,340.5**	**3,309.3**	**3,941.2**	**4,214.5**	**4,462.6**	**4,636.6**	**4,719.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**2.4**	**0.8**	**1.4**
Coal	826.2	2,340.4	2,793.9	2,917.8	3,032.4	3,092.1	3,079.8	61.6	70.7	70.9	69.2	68.0	66.7	65.3	5.3	2.2	0.4	1.1
Oil	439.5	743.5	860.6	933.2	989.5	1,038.5	1,073.8	32.8	22.5	21.8	22.1	22.2	22.4	22.8	2.7	2.3	0.9	1.5
Natural Gas	74.8	225.4	286.7	363.5	440.8	506.0	565.9	5.6	6.8	7.3	8.6	9.9	10.9	12.0	5.7	4.9	3.0	3.8

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	5,877	11,708	14,702	18,580	22,515	26,825	31,600	3.5	4.7	3.6	4.1
Population (millions of people)	2,611	3,301	3,453	3,583	3,691	3,779	3,850	1.2	0.8	0.5	0.6
GDP per capita (thousands of 2000 USD/person)	2.3	3.5	4.3	5.2	6.1	7.1	8.2	2.3	3.9	3.1	3.4
Primary energy consumption per capita (toe/person)	0.63	1.24	1.43	1.55	1.65	1.74	1.81	3.5	2.3	1.0	1.5
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	278	348	337	299	271	245	220	1.1	-1.5	-2.0	-1.8
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	228	283	268	227	198	173	149	1.1	-2.2	-2.7	-2.5
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.82	0.81	0.80	0.76	0.73	0.71	0.68	-0.1	-0.7	-0.7	-0.7
Automobile ownership volume (millions of vehicles)	84	217	305	358	413	482	570	4.8	5.1	3.1	3.9
Automobile ownership volume per capita (vehicles per person)	0.03	0.07	0.09	0.10	0.11	0.13	0.15	3.6	4.3	2.7	3.3

AUSTRALIA [BAU=APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**86.2**	**122.5**	**145.0**	**143.6**	**144.8**	**147.5**	**153.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.8**	**1.6**	**0.4**	**0.9**
Coal	35.0	50.0	45.0	34.8	28.9	24.1	20.1	40.6	40.9	31.0	24.2	20.0	16.3	13.1	1.8	-3.6	-3.6	-3.6
Oil	34.9	21.1	56.3	60.4	63.5	66.7	70.1	40.5	17.2	38.9	42.0	43.8	45.2	45.8	-2.5	11.1	1.0	4.9
Natural gas	14.8	26.2	37.1	40.6	43.3	46.2	49.2	17.1	21.4	25.6	28.2	29.9	31.3	32.1	2.9	4.5	1.3	2.6
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	1.2	1.2	1.5	1.5	1.5	1.5	1.5	1.4	0.9	1.0	1.0	1.0	1.0	1.0	-0.2	2.5	0.0	1.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.9	-	-100.0	-	37.9
Others	0.3	24.0	5.1	6.4	7.6	9.1	11.0	0.3	19.6	3.5	4.5	5.3	6.2	7.2	24.6	-12.4	3.6	-3.1

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**56.5**	**76.3**	**102.2**	**106.6**	**111.2**	**116.2**	**121.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.5**	**3.4**	**0.9**	**1.9**
Industry	19.2	22.6	36.5	37.9	39.3	41.0	42.7	34.0	29.7	29.7	35.8	35.5	35.4	35.2	0.8	5.3	0.8	2.6
Transportation	21.1	29.3	43.0	45.0	47.0	49.2	51.4	37.3	38.4	38.4	42.1	42.2	42.3	42.3	1.7	4.4	0.9	2.3
Others	12.3	19.5	22.6	23.7	24.9	26.1	27.3	21.7	25.5	25.5	22.2	22.3	22.4	22.5	2.3	2.0	1.0	1.4
Non-energy	4.0	4.9	0.0	0.0	0.0	0.0	0.0	7.0	6.4	6.4	0.0	0.0	0.0	0.0	1.1	-100.0	-	-100.0
Total	**56.5**	**76.3**	**102.2**	**106.6**	**111.2**	**116.2**	**121.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.5**	**3.4**	**0.9**	**1.9**
Coal	4.5	3.1	3.2	3.2	3.1	3.1	3.1	7.9	4.1	3.1	3.0	2.8	2.7	2.5	-1.8	0.1	-0.2	-0.1
Oil	29.0	38.7	53.2	56.2	59.4	62.7	66.2	51.3	50.7	52.1	52.7	53.4	54.0	54.5	1.5	3.8	1.1	2.2
Natural gas	8.6	12.8	21.8	22.1	22.5	22.8	23.2	15.3	16.8	21.4	20.8	20.2	19.6	19.1	2.0	5.6	0.3	2.4
Electricity	11.1	18.0	20.8	21.9	23.2	24.5	25.9	19.7	23.6	20.3	20.6	20.8	21.1	21.3	2.4	2.0	1.1	1.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	3.3	3.7	3.2	3.1	3.1	3.1	3.2	5.9	4.8	3.1	2.9	2.8	2.7	2.6	0.5	-1.6	0.2	-0.6

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**154.7**	**252.1**	**247.4**	**237.7**	**234.3**	**237.3**	**264.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.5**	**-0.6**	**0.7**	**0.2**
Coal	121.2	179.8	143.7	122.7	104.9	89.6	76.5	78.3	71.3	58.1	51.6	44.8	37.7	28.9	2.0	-3.7	-3.1	-3.4
Oil	3.6	3.1	3.3	2.1	1.4	0.9	0.6	2.3	1.2	1.4	0.9	0.6	0.4	0.2	-0.7	-3.7	-8.6	-6.7
Natural gas	14.4	44.6	64.6	71.7	79.6	88.3	97.9	9.3	17.7	26.1	30.2	34.0	37.2	37.0	5.8	4.9	2.1	3.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	14.9	13.5	17.0	17.0	17.0	17.0	17.0	9.6	5.4	6.9	7.2	7.3	7.2	6.4	-0.5	2.3	0.0	0.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	-	-	-	-
Others	0.8	11.1	18.8	24.2	31.5	41.6	55.9	0.5	4.4	7.6	10.2	13.4	17.5	21.1	14.4	8.1	5.8	6.7

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**35.6**	**58.3**	**53.6**	**45.7**	**41.6**	**38.8**	**36.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.5**	**-2.4**	**-1.4**	**-1.8**
Coal	29.6	46.9	40.6	30.7	25.0	20.4	16.5	83.2	80.4	75.8	67.1	60.2	52.6	44.9	2.3	-4.2	-4.0	-4.1
Oil	1.3	1.1	1.2	0.7	0.5	0.3	0.2	3.5	1.9	2.2	1.6	1.2	0.8	0.6	-0.7	-3.9	-8.0	-6.4
Natural gas	4.7	10.3	11.8	14.3	16.1	18.1	20.1	13.3	17.7	22.1	31.3	38.6	46.6	54.6	4.0	3.3	2.3	2.7

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**33.6**	**33.5**	**34.0**	**37.0**	**38.4**	**39.6**	**40.9**								**0.0**	**1.0**	**0.7**	**0.8**
Coal	35.2	33.0	30.4	34.4	36.0	37.8	39.9								-0.3	0.4	1.0	0.8
Oil	24.3	24.3	24.6	24.7	23.6	23.4	22.4								0.0	0.2	-0.6	-0.3
Natural gas	26.0	37.1	47.1	43.2	42.6	42.0	42.0								1.8	1.5	-0.2	0.5

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**54.9**	**82.1**	**89.2**	**82.8**	**80.2**	**78.7**	**78.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.0**	**0.1**	**-0.4**	**-0.2**
Coal	32.7	48.9	42.8	33.1	27.5	22.9	19.1	59.5	59.6	48.0	40.0	34.3	29.1	24.5	2.0	-3.8	-3.6	-3.7
Oil	13.4	21.1	29.4	31.1	32.9	34.7	36.6	24.4	25.7	33.0	37.6	41.0	44.0	46.8	2.3	4.0	1.1	2.2
Natural Gas	8.8	12.1	17.0	18.6	19.8	21.1	22.5	16.0	14.7	19.0	22.4	24.7	26.8	28.7	1.6	4.4	1.3	2.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	299.6	561.8	678.7	838.5	1,021.5	1,226.8	1,447.4	3.2	4.1	3.7	3.9
Population (millions of people)	17.2	22.2	23.9	25.7	27.4	29.2	31.2	1.3	1.5	1.3	1.4
GDP per capita (thousands of 2000 USD/person)	17.4	25.3	28.4	32.6	37.3	42.0	46.4	1.9	2.6	2.4	2.5
Primary energy consumption per capita (toe/person)	5.02	5.52	6.07	5.59	5.29	5.05	4.91	0.5	0.1	-0.9	-0.5
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	288	218	214	171	142	120	106	-1.4	-2.4	-3.2	-2.8
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	183	146	131	99	78	64	54	-1.1	-3.8	-3.9	-3.9
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.64	0.67	0.62	0.58	0.55	0.53	0.51	0.3	-1.5	-0.8	-1.1
Automobile ownership volume (millions of vehicles)	10.91	16.37	16.60	17.93	19.07	20.13	21.08	2.0	0.9	1.1	1.0
Automobile ownership volume per capita (vehicles per person)	0.64	0.74	0.70	0.70	0.70	0.69	0.68	0.8	-0.6	-0.2	-0.4

BRUNEI DARUSSALAM [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.8**	**3.1**	**3.6**	**3.7**	**3.9**	**4.0**	**4.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.9**	**1.7**	**1.1**	**1.3**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.1	0.5	0.8	0.8	0.9	1.0	1.1	4.7	14.7	21.2	22.7	23.6	24.6	24.5	9.0	6.2	1.7	3.4
Natural gas	1.7	2.7	2.8	2.9	3.0	3.0	3.3	95.3	85.3	78.8	77.3	76.4	75.4	75.5	2.4	0.7	1.0	0.9
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	0.0	-

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.3**	**1.7**	**1.8**	**2.0**	**2.2**	**2.4**	**2.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.2**	**1.7**	**1.9**	**1.8**
Industry	0.1	1.0	1.0	1.1	1.2	1.3	1.4	17.5	59.4	59.4	57.0	55.6	54.8	54.3	15.1	1.0	1.7	1.4
Transportation	0.2	0.4	0.5	0.5	0.6	0.6	0.7	53.9	23.2	23.2	24.5	25.4	25.8	26.0	3.8	2.6	2.0	2.3
Others	0.1	0.3	0.3	0.4	0.4	0.5	0.5	23.8	16.3	16.3	17.4	18.0	18.4	18.8	6.2	2.7	2.2	2.4
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	1.1	1.1	1.0	1.0	1.0	0.9	0.3	1.3	1.2	1.3
Total	**0.3**	**1.7**	**1.8**	**2.0**	**2.2**	**2.4**	**2.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.3**	**1.7**	**1.9**	**1.8**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.3	0.6	0.6	0.7	0.8	0.9	0.9	75.0	33.9	34.8	35.3	35.5	35.5	35.4	4.0	2.1	1.9	2.0
Natural gas	0.0	0.8	0.9	0.9	1.0	1.1	1.2	0.0	49.3	47.2	45.5	44.5	43.7	43.3	-	0.9	1.5	1.3
Electricity	0.1	0.3	0.3	0.4	0.4	0.5	0.6	25.0	16.9	18.0	19.2	20.1	20.8	21.4	6.1	3.0	2.6	2.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.2**	**3.9**	**4.5**	**5.2**	**6.0**	**6.8**	**7.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**3.0**	**2.6**	**2.8**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	1.2	3.9	4.5	5.2	6.0	6.8	7.7	99.1	100.0	100.0	100.0	100.0	100.0	100.0	6.2	3.0	2.6	2.8
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	0.0	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.8**	**0.8**	**1.0**	**0.9**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	0.5	1.2	1.3	1.3	1.3	1.3	1.5	99.4	100.0	100.0	100.0	100.0	100.0	100.0	4.8	0.8	1.0	0.9

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**21.8**	**28.4**	**30.1**	**35.3**	**39.5**	**45.0**	**45.0**								**1.3**	**2.2**	**1.6**	**1.9**
Coal	-	-	-	-	-	-	-								-	-	-	-
Oil	31.5	-	-	-	-	-	-								-	-	-	-
Natural gas	21.8	28.4	30.1	35.3	39.5	45.0	45.0								1.3	2.2	1.6	1.9

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.9**	**1.8**	**2.0**	**2.1**	**2.2**	**2.3**	**2.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.6**	**1.2**	**1.4**	**1.3**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.2	0.5	0.6	0.7	0.7	0.8	0.9	25.1	29.8	30.2	32.0	33.0	34.1	33.6	4.4	1.9	1.7	1.8
Natural Gas	0.7	1.3	1.4	1.4	1.5	1.5	1.7	74.9	70.2	69.8	68.0	67.0	65.9	66.4	3.2	0.8	1.2	1.1

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	4.8	6.9	7.9	9.1	10.4	11.8	13.5	1.8	2.9	2.6	2.7
Population (millions of people)	0.3	0.4	0.4	0.5	0.5	0.6	0.6	2.3	2.0	1.6	1.8
GDP per capita (thousands of 2000 USD/person)	19.1	17.2	17.8	18.8	19.7	20.7	21.9	-0.5	0.9	1.0	1.0
Primary energy consumption per capita (toe/person)	6.98	7.86	8.05	7.60	7.35	7.05	7.10	0.6	-0.3	-0.5	-0.4
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	366	456	452	405	372	340	324	1.1	-1.2	-1.5	-1.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	191	268	250	227	211	194	188	1.7	-1.7	-1.2	-1.4
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.52	0.59	0.55	0.56	0.57	0.57	0.58	0.6	-0.5	0.2	-0.1
Automobile ownership volume (millions of vehicles)	0.12	0.32	0.35	0.39	0.42	0.46	0.49	5.0	2.0	1.6	1.8
Automobile ownership volume per capita (vehicles per person)	0.48	0.80	0.80	0.80	0.80	0.80	0.80	2.6	0.0	0.0	0.0

BRUNEI DARUSSALAM [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.8**	**3.1**	**3.4**	**3.3**	**3.3**	**3.1**	**3.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.9**	**0.6**	**-0.4**	**0.0**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.1	0.5	0.7	0.7	0.7	0.7	0.7	4.7	14.7	20.7	21.9	22.7	23.9	23.7	9.0	4.7	0.1	1.9
Natural gas	1.7	2.7	2.7	2.6	2.5	2.3	2.4	95.3	85.3	79.3	77.8	76.6	74.9	75.0	2.4	-0.3	-0.6	-0.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	1.3	1.3	-	-	8.5	-

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.3**	**1.7**	**1.7**	**1.8**	**1.8**	**1.8**	**1.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.2**	**0.4**	**0.3**	**0.3**
Industry	0.1	1.0	1.0	1.0	1.0	1.1	1.1	17.5	59.4	59.4	57.8	57.3	57.6	59.9	15.1	0.0	0.6	0.4
Transportation	0.2	0.4	0.4	0.4	0.4	0.4	0.4	53.9	23.2	23.2	24.1	24.4	24.3	23.1	3.8	0.9	-0.1	0.3
Others	0.1	0.3	0.3	0.3	0.3	0.3	0.3	23.8	16.3	16.3	17.0	17.1	16.9	15.7	6.2	0.9	-0.3	0.2
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	1.1	1.1	1.1	1.1	1.2	1.2	0.3	1.1	0.9	1.0
Total	**0.3**	**1.7**	**1.7**	**1.8**	**1.8**	**1.8**	**1.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.3**	**0.4**	**0.3**	**0.3**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.3	0.6	0.6	0.6	0.6	0.6	0.6	75.0	33.9	34.6	34.9	34.8	34.5	34.0	4.0	0.7	0.1	0.4
Natural gas	0.0	0.8	0.8	0.8	0.8	0.9	0.9	0.0	49.3	47.9	47.1	47.0	47.4	48.2	-	-0.1	0.5	0.3
Electricity	0.1	0.3	0.3	0.3	0.3	0.3	0.3	25.0	16.9	17.5	18.1	18.2	18.1	17.8	6.1	1.1	0.2	0.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.2**	**3.9**	**4.1**	**4.3**	**4.4**	**4.5**	**4.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**1.1**	**0.2**	**0.6**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	1.2	3.9	4.1	4.2	4.3	4.3	4.2	99.1	100.0	100.0	98.2	97.3	95.6	95.1	6.2	0.9	0.0	0.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.0	0.0	0.0	1.8	2.7	4.4	4.9	-	-	7.2	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.2**	**1.2**	**1.1**	**1.0**	**0.8**	**0.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.8**	**-0.6**	**-2.0**	**-1.5**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	0.5	1.2	1.2	1.1	1.0	0.8	0.8	99.4	100.0	100.0	100.0	100.0	100.0	100.0	4.8	-0.6	-2.0	-1.5

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**21.8**	**28.4**	**28.9**	**33.2**	**37.6**	**45.0**	**45.0**								**1.3**	**1.6**	**2.0**	**1.9**
Coal	-	-	-	-	-	-	-								-	-	-	-
Oil	31.5	-	-	-	-	-	-								-	-	-	-
Natural gas	21.8	28.4	28.9	33.2	37.6	45.0	45.0								1.3	1.6	2.0	1.9

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.9**	**1.8**	**1.9**	**1.8**	**1.8**	**1.7**	**1.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.6**	**-0.1**	**-0.5**	**-0.4**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.2	0.5	0.6	0.6	0.6	0.6	0.6	25.1	29.8	29.8	31.6	33.0	35.0	34.7	4.4	0.4	0.1	0.2
Natural Gas	0.7	1.3	1.3	1.2	1.2	1.1	1.1	74.9	70.2	70.2	68.4	67.0	65.0	65.3	3.2	-0.4	-0.8	-0.7

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	4.8	6.9	7.9	9.1	10.4	11.8	13.5	1.8	2.9	2.6	2.7
Population (millions of people)	0.3	0.4	0.4	0.5	0.5	0.6	0.6	2.3	2.0	1.6	1.8
GDP per capita (thousands of 2000 USD/person)	19.1	17.2	17.8	18.8	19.7	20.7	21.9	-0.5	0.9	1.0	1.0
Primary energy consumption per capita (toe/person)	6.98	7.86	7.69	6.86	6.19	5.48	5.09	0.6	-1.3	-2.0	-1.7
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	366	456	432	365	313	264	233	1.1	-2.2	-3.0	-2.7
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	191	268	237	199	170	142	125	1.7	-2.9	-3.1	-3.0
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.52	0.59	0.55	0.55	0.54	0.54	0.54	0.6	-0.8	-0.1	-0.4
Automobile ownership volume (millions of vehicles)	0.12	0.32	0.35	0.39	0.42	0.46	0.49	5.0	2.0	1.6	1.8
Automobile ownership volume per capita (vehicles per person)	0.48	0.80	0.80	0.80	0.80	0.80	0.80	2.6	0.0	0.0	0.0

CAMBODIA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.4**	**1.9**	**2.7**	**3.5**	**4.3**	**5.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.8**	**6.8**	**4.6**	**5.4**
Coal	0.0	0.0	0.4	1.0	1.5	1.6	1.8	0.0	0.6	23.3	36.8	41.9	37.4	34.2	-	61.6	4.0	24.1
Oil	0.5	1.2	1.4	1.6	2.0	2.5	3.1	100.0	90.4	72.1	61.3	56.2	58.1	58.9	6.1	2.7	4.3	3.6
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.3	0.7	1.0	1.1	1.3	0.0	0.2	18.0	26.1	28.2	26.0	24.7	-	77.5	4.2	28.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.1	-0.3	-0.6	-0.9	-0.9	-0.9	0.0	8.9	-13.3	-24.3	-26.2	-21.5	-17.8	-	-	2.4	-208.4

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.2**	**1.4**	**1.8**	**2.3**	**2.9**	**3.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**4.3**	**5.0**	**4.7**
Industry	0.0	0.2	0.3	0.4	0.5	0.7	0.9	2.2	20.5	20.5	22.0	22.5	23.1	24.2	23.5	5.3	5.5	5.4
Transportation	0.4	0.6	0.8	1.0	1.2	1.5	1.9	84.9	54.3	54.3	55.6	54.4	53.4	52.5	3.4	4.3	4.7	4.6
Others	0.1	0.3	0.3	0.4	0.5	0.6	0.8	11.3	23.6	23.6	20.8	21.5	22.1	21.9	11.9	3.3	5.1	4.4
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.6	1.6	1.6	1.6	1.6	1.5	1.4	6.9	3.8	4.3	4.1
Total	**0.4**	**1.2**	**1.4**	**1.8**	**2.3**	**2.9**	**3.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**4.3**	**5.0**	**4.7**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.4	1.0	1.2	1.5	1.9	2.3	2.9	97.8	84.9	86.7	84.9	83.0	81.5	80.4	5.5	4.3	4.6	4.5
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Electricity	0.0	0.2	0.2	0.3	0.4	0.5	0.7	2.2	15.1	13.3	15.1	17.0	18.5	19.6	21.0	4.3	6.8	5.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**1.0**	**6.1**	**12.3**	**17.7**	**19.6**	**22.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**11.4**	**28.6**	**4.0**	**13.2**
Coal	0.0	0.0	1.7	3.8	5.7	6.1	6.8	0.0	3.1	27.3	30.5	32.1	31.3	30.8	-	61.6	4.0	24.1
Oil	0.2	0.9	0.5	0.5	0.4	0.5	0.4	100.0	92.0	8.4	3.8	2.3	2.5	1.7	10.7	-6.6	-1.2	-3.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	3.9	8.1	11.6	12.9	14.9	0.0	2.6	64.0	65.6	65.4	66.1	67.4	-	77.5	4.2	28.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.4	0.2	0.1	0.1	0.1	-	0.2	0.0	0.1

Power generation Input	MTOE							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.1**	**0.3**	**0.6**	**1.1**	**1.6**	**1.7**	**1.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**11.8**	**15.2**	**3.6**	**8.1**
Coal	0.0	0.0	0.4	1.0	1.5	1.6	1.8	0.0	3.0	74.8	88.1	92.6	91.9	94.1	-	61.6	4.0	24.1
Oil	0.1	0.3	0.1	0.1	0.1	0.1	0.1	100.0	97.0	25.2	11.9	7.4	8.1	5.9	11.5	-6.6	-1.2	-3.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Thermal Efficiency	%														AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**33.4**	**30.1**	**32.3**	**32.6**	**32.8**	**32.8**	**32.8**								**-0.7**	**0.8**	**0.0**	**0.3**
Coal	-	33.0	33.0	33.0	33.0	33.0	33.0								-	0.0	0.0	0.0
Oil	33.4	30.0	30.0	30.0	30.0	30.0	30.0								-0.7	0.0	0.0	0.0
Natural gas	-	-	-	-	-	-	-								-	-	-	-

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.4**	**1.0**	**1.6**	**2.4**	**3.3**	**3.8**	**4.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**8.8**	**4.2**	**6.0**
Coal	0.0	0.0	0.5	1.1	1.6	1.8	1.9	0.0	0.9	30.1	44.5	49.9	46.3	43.8	-	61.6	4.0	24.1
Oil	0.4	1.0	1.1	1.3	1.6	2.0	2.5	100.0	99.1	69.9	55.5	50.1	53.7	56.2	6.6	2.7	4.3	3.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Energy and economic indicators								AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	2.6	7.9	10.1	13.0	16.6	21.3	27.4	7.8	5.1	5.1	5.1
Population (millions of people)	11.2	14.1	15.5	16.9	18.5	20.2	22.1	1.6	1.8	1.8	1.8
GDP per capita (thousands of 2000 USD/person)	0.2	0.6	0.7	0.8	0.9	1.1	1.2	6.1	3.2	3.2	3.2
Primary energy consumption per capita (toe/person)	0.05	0.10	0.12	0.16	0.19	0.21	0.23	5.2	4.9	2.7	3.6
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	199	175	186	205	212	200	190	-0.9	1.6	-0.5	0.3
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	155	132	158	186	195	178	163	-1.1	3.5	-0.9	0.9
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.78	0.75	0.85	0.91	0.92	0.89	0.86	-0.2	1.9	-0.4	0.5
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

CAMBODIA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.4**	**1.7**	**2.4**	**3.2**	**3.9**	**4.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.8**	**5.9**	**4.4**	**5.0**
Coal	0.0	0.0	0.4	0.9	1.3	1.6	1.7	0.0	0.6	24.0	37.9	42.0	40.0	35.9	-	60.7	4.1	23.8
Oil	0.5	1.2	1.2	1.5	1.8	2.2	2.7	100.0	90.4	71.1	60.5	56.2	56.7	58.6	6.1	1.7	4.2	3.2
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.3	0.7	1.0	1.1	1.2	0.0	0.2	19.4	28.2	30.7	27.0	25.0	-	77.4	3.6	28.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.1	-0.3	-0.7	-0.9	-0.9	-0.9	0.0	8.9	-14.5	-26.6	-28.9	-23.7	-19.6	-	-	2.3	-208.4

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**1.2**	**1.3**	**1.6**	**2.0**	**2.6**	**3.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**3.3**	**4.7**	**4.2**
Industry	0.0	0.2	0.3	0.4	0.5	0.6	0.8	2.2	20.5	20.5	21.4	22.0	22.4	23.4	23.5	4.0	5.2	4.7
Transportation	0.4	0.6	0.7	0.9	1.1	1.3	1.7	84.9	54.3	54.3	55.4	54.1	53.1	52.3	3.4	3.3	4.5	4.0
Others	0.1	0.3	0.3	0.4	0.5	0.6	0.7	11.3	23.6	23.6	21.5	22.4	23.0	22.9	11.9	2.8	4.9	4.0
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	1.5	1.5	1.4	6.9	2.6	4.0	3.4
Total	**0.4**	**1.2**	**1.3**	**1.6**	**2.0**	**2.6**	**3.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**3.3**	**4.7**	**4.2**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	0.4	1.0	1.1	1.4	1.7	2.1	2.6	97.8	84.9	87.0	85.3	83.5	82.0	81.0	5.5	3.4	4.4	4.0
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Electricity	0.0	0.2	0.2	0.2	0.3	0.5	0.6	2.2	15.1	13.0	14.7	16.5	18.0	19.0	21.0	3.0	6.5	5.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**1.0**	**5.9**	**12.0**	**17.1**	**18.7**	**20.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**11.4**	**28.3**	**3.7**	**12.9**
Coal	0.0	0.0	1.6	3.6	5.2	6.0	6.5	0.0	3.1	27.0	29.7	30.3	32.1	31.4	-	60.7	4.1	23.8
Oil	0.2	0.9	0.4	0.4	0.4	0.4	0.5	100.0	92.0	6.6	3.2	2.3	2.2	2.4	10.7	-8.3	1.7	-2.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	3.9	8.0	11.5	12.3	13.6	0.0	2.6	66.0	66.9	67.2	65.6	66.1	-	77.4	3.6	28.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.4	0.2	0.1	0.1	0.1	-	0.2	0.0	0.1

Power generation Input	MTOE							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.1**	**0.3**	**0.5**	**1.0**	**1.5**	**1.7**	**1.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**11.8**	**14.4**	**3.8**	**7.9**
Coal	0.0	0.0	0.4	0.9	1.3	1.6	1.7	0.0	3.0	78.9	89.4	92.4	93.0	92.3	-	60.7	4.1	23.8
Oil	0.1	0.3	0.1	0.1	0.1	0.1	0.1	100.0	97.0	21.1	10.6	7.6	7.0	7.7	11.5	-8.3	1.7	-2.4
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Thermal Efficiency	%														AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**33.4**	**30.1**	**32.4**	**32.7**	**32.8**	**32.8**	**32.8**								**-0.7**	**0.8**	**0.0**	**0.3**
Coal	-	33.0	33.0	33.0	33.0	33.0	33.0								-	0.0	0.0	0.0
Oil	33.4	30.0	30.0	30.0	30.0	30.0	30.0								-0.7	0.0	0.0	0.0
Natural gas	-	-	-	-	-	-	-								-	-	-	-

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
Total	**0.4**	**1.0**	**1.5**	**2.2**	**3.0**	**3.5**	**4.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**8.0**	**4.1**	**5.7**
Coal	0.0	0.0	0.5	1.0	1.5	1.7	1.8	0.0	0.9	31.1	45.6	50.0	48.6	45.0	-	60.7	4.1	23.8
Oil	0.4	1.0	1.0	1.2	1.5	1.8	2.3	100.0	99.1	68.9	54.4	50.0	51.4	55.0	6.6	1.7	4.2	3.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Energy and economic indicators								AAGR(%)			
	1995	2010	2015	2020	2025	2030	2035	1995-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	2.6	7.9	10.1	13.0	16.6	21.3	27.4	7.8	5.1	5.1	5.1
Population (millions of people)	11.2	14.1	15.5	16.9	18.5	20.2	22.1	1.6	1.8	1.8	1.8
GDP per capita (thousands of 2000 USD/person)	0.2	0.6	0.7	0.8	0.9	1.1	1.2	6.1	3.2	3.2	3.2
Primary energy consumption per capita (toe/person)	0.05	0.10	0.11	0.14	0.17	0.19	0.21	5.2	4.0	2.6	3.2
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	199	175	171	189	193	183	171	-0.9	0.8	-0.6	-0.1
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	155	132	145	172	178	166	150	-1.1	2.7	-0.9	0.5
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.78	0.75	0.85	0.91	0.92	0.90	0.88	-0.2	2.0	-0.3	0.6
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

CHINA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**671.7**	**2,212.5**	**2,987.6**	**3,474.3**	**3,925.5**	**4,316.3**	**4,585.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**4.6**	**1.9**	**3.0**
Coal	528.3	1,595.1	1,995.0	2,174.5	2,384.2	2,553.4	2,632.4	78.7	72.1	66.8	62.6	60.7	59.2	57.4	5.7	3.1	1.3	2.0
Oil	119.5	431.3	593.4	673.4	734.6	788.4	832.0	17.8	19.5	19.9	19.4	18.7	18.3	18.1	6.6	4.6	1.4	2.7
Natural gas	12.8	88.6	205.5	360.4	479.8	584.1	661.1	1.9	4.0	6.9	10.4	12.2	13.5	14.4	10.2	15.1	4.1	8.4
Nuclear	0.0	19.3	78.3	111.8	145.2	178.6	211.9	0.0	0.9	2.6	3.2	3.7	4.1	4.6	-	19.2	4.4	10.1
Hydro	10.9	62.1	77.2	100.0	112.6	126.1	138.3	1.6	2.8	2.6	2.9	2.9	2.9	3.0	9.1	4.9	2.2	3.3
Geothermal	0.0	3.7	4.0	4.4	4.7	5.1	5.4	0.0	0.2	0.1	0.1	0.1	0.1	0.1	-	1.6	1.5	1.5
Others	0.2	12.4	34.2	50.0	64.3	80.9	104.3	0.0	0.6	1.1	1.4	1.6	1.9	2.3	23.2	15.0	5.0	8.9

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**466.2**	**1,312.7**	**1,830.8**	**2,159.6**	**2,431.5**	**2,660.8**	**2,828.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**5.1**	**1.8**	**3.1**
Industry	243.5	711.9	977.3	1,109.7	1,210.0	1,279.6	1,322.1	52.2	54.2	54.2	53.4	51.4	49.8	46.7	5.5	4.5	1.2	2.5
Transportation	33.9	182.4	311.6	366.2	409.5	451.2	487.4	7.3	13.9	13.9	17.0	17.0	16.8	17.2	8.8	7.2	1.9	4.0
Others	144.3	286.9	364.5	470.6	572.7	662.5	724.0	31.0	21.9	21.9	19.9	21.8	23.6	25.6	3.5	5.1	2.9	3.8
Non-energy	44.4	131.5	177.4	213.1	239.3	267.5	295.1	9.5	10.0	10.0	9.7	9.9	9.8	10.4	5.6	4.9	2.2	3.3
Total	**466.2**	**1,312.7**	**1,830.8**	**2,159.6**	**2,431.5**	**2,660.8**	**2,828.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**5.1**	**1.8**	**3.1**
Coal	319.9	512.1	637.7	694.2	731.3	747.0	748.9	68.6	39.0	34.8	32.1	30.1	28.1	26.5	2.4	3.1	0.5	1.5
Oil	85.1	369.0	548.1	636.2	700.1	757.2	804.9	18.3	28.1	29.9	29.5	28.8	28.5	28.5	7.6	5.6	1.6	3.2
Natural gas	8.9	57.2	124.7	211.1	284.1	341.9	381.1	1.9	4.4	6.8	9.8	11.7	12.9	13.5	9.8	13.9	4.0	7.9
Electricity	39.0	296.8	418.9	499.0	582.4	666.4	731.9	8.4	22.6	22.9	23.1	24.0	25.0	25.9	10.7	5.3	2.6	3.7
Heat	13.2	64.3	84.7	97.1	106.9	114.8	120.2	2.8	4.9	4.6	4.5	4.4	4.3	4.2	8.2	4.2	1.4	2.5
Others	0.0	13.2	16.8	22.1	26.7	33.5	41.7	0.0	1.0	0.9	1.0	1.1	1.3	1.5	35.1	5.3	4.3	4.7

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**621.2**	**4,208.3**	**5,822.9**	**6,896.7**	**8,021.5**	**9,145.7**	**10,009.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.0**	**5.1**	**2.5**	**3.5**
Coal	443.1	3,272.8	4,145.6	4,469.3	5,085.6	5,679.4	6,012.4	71.3	77.8	71.2	64.8	63.4	62.1	60.1	10.5	3.2	2.0	2.5
Oil	48.6	13.3	16.0	15.8	15.7	15.5	15.4	7.8	0.3	0.3	0.2	0.2	0.2	0.2	-6.3	1.8	-0.2	0.6
Natural gas	2.8	69.0	291.6	558.7	710.8	876.0	1,011.3	0.4	1.6	5.0	8.1	8.9	9.6	10.1	17.5	23.3	4.0	11.3
Nuclear	0.0	73.9	300.4	429.0	557.1	685.1	813.2	0.0	1.8	5.2	6.2	6.9	7.5	8.1	-	19.2	4.4	10.1
Hydro	126.7	722.2	897.9	1,162.2	1,309.6	1,465.8	1,608.3	20.4	17.2	15.4	16.9	16.3	16.0	16.1	9.1	4.9	2.2	3.3
Geothermal	0.0	0.2	0.3	0.5	0.6	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	11.3	5.1	7.5
Others	0.0	57.0	171.0	261.2	342.1	423.0	547.8	0.0	1.4	2.9	3.8	4.3	4.6	5.5	61.3	16.4	5.1	9.5

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**144.7**	**814.9**	**1,045.0**	**1,157.7**	**1,312.7**	**1,463.5**	**1,549.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**9.0**	**3.6**	**2.0**	**2.6**
Coal	131.7	794.7	980.0	1,039.9	1,166.5	1,286.5	1,346.7	91.1	97.5	93.8	89.8	88.9	87.9	86.9	9.4	2.7	1.7	2.1
Oil	12.3	5.0	3.6	3.5	3.4	3.3	3.2	8.5	0.6	0.3	0.3	0.3	0.2	0.2	-4.4	-3.4	-0.6	-1.7
Natural gas	0.6	15.3	61.4	114.3	142.7	173.8	199.4	0.4	1.9	5.9	9.9	10.9	11.9	12.9	17.5	22.3	3.8	10.8

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**29.4**	**35.4**	**36.6**	**37.5**	**38.1**	**38.6**	**39.1**								**0.9**	**0.6**	**0.3**	**0.4**
Coal	28.9	35.4	36.4	37.0	37.5	38.0	38.4								1.0	0.4	0.3	0.3
Oil	34.0	22.9	37.8	38.8	39.5	40.2	41.0								-2.0	5.4	0.4	2.4
Natural gas	38.9	38.9	40.9	42.0	42.8	43.4	43.6								0.0	0.8	0.2	0.5

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**637.3**	**2,024.9**	**2,625.1**	**2,956.7**	**3,285.9**	**3,551.7**	**3,692.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**3.9**	**1.5**	**2.4**
Coal	547.5	1,689.7	2,114.5	2,302.0	2,521.1	2,695.2	2,770.6	85.9	83.4	80.6	77.9	76.7	75.9	75.0	5.8	3.1	1.2	2.0
Oil	84.6	284.3	391.2	443.6	482.0	513.0	534.2	13.3	14.0	14.9	15.0	14.7	14.4	14.5	6.3	4.5	1.2	2.6
Natural Gas	5.3	50.8	119.4	211.1	282.8	343.5	387.9	0.8	2.5	4.5	7.1	8.6	9.7	10.5	12.0	15.3	4.1	8.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	445	3,246	4,821	6,791	8,664	10,675	12,736	10.5	7.7	4.3	5.6
Population (millions of people)	1,135	1,338	1,370	1,388	1,395	1,393	1,382	0.8	0.4	0.0	0.1
GDP per capita (thousands of 2000 USD/person)	0.4	2.4	3.5	4.9	6.2	7.7	9.2	9.5	7.3	4.3	5.5
Primary energy consumption per capita (toe/person)	0.59	1.65	2.18	2.50	2.81	3.10	3.32	5.3	4.2	1.9	2.8
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	1,511	682	620	512	453	404	360	-3.9	-2.8	-2.3	-2.5
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	1,433	624	544	435	379	333	290	-4.1	-3.5	-2.7	-3.0
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.95	0.92	0.88	0.85	0.84	0.82	0.81	-0.2	-0.7	-0.4	-0.5
Automobile ownership volume (millions of vehicles)	5.5	78.0	152.9	186.0	215.6	249.9	289.8	14.2	9.1	3.0	5.4
Automobile ownership volume per capita (vehicles per person)	0.00	0.06	0.11	0.13	0.15	0.18	0.21	13.2	8.7	3.0	5.3

CHINA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**671.7**	**2,212.5**	**2,897.9**	**3,227.2**	**3,500.0**	**3,669.6**	**3,699.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**3.8**	**0.9**	**2.1**
Coal	528.3	1,595.1	1,947.4	1,998.6	2,052.0	2,038.8	1,927.6	78.7	72.1	67.2	61.9	58.6	55.6	52.1	5.7	2.3	-0.2	0.8
Oil	119.5	431.3	580.9	643.0	677.9	696.1	680.4	17.8	19.5	20.0	19.9	19.4	19.0	18.4	6.6	4.1	0.4	1.8
Natural gas	12.8	88.6	162.5	256.0	343.2	406.1	441.2	1.9	4.0	5.6	7.9	9.8	11.1	11.9	10.2	11.2	3.7	6.6
Nuclear	0.0	19.3	79.7	137.2	194.4	251.6	308.8	0.0	0.9	2.7	4.3	5.6	6.9	8.3	-	21.7	5.6	11.7
Hydro	10.9	62.1	81.9	119.6	135.2	151.6	170.0	1.6	2.8	2.8	3.7	3.9	4.1	4.6	9.1	6.8	2.4	4.1
Geothermal	0.0	3.7	4.2	4.7	5.2	5.7	6.2	0.0	0.2	0.1	0.1	0.1	0.2	0.2	-	2.2	1.9	2.1
Others	0.2	12.4	41.5	68.2	92.2	119.8	164.7	0.0	0.6	1.4	2.1	2.6	3.3	4.5	23.2	18.6	6.1	10.9

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**466.2**	**1,312.7**	**1,787.2**	**2,050.2**	**2,241.7**	**2,377.2**	**2,446.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**4.6**	**1.2**	**2.5**
Industry	243.5	711.9	947.8	1,038.4	1,096.2	1,120.2	1,117.6	52.2	54.2	54.2	53.0	50.6	48.9	45.7	5.5	3.8	0.5	1.8
Transportation	33.9	182.4	309.0	358.6	393.4	424.7	445.9	7.3	13.9	13.9	17.3	17.5	17.6	18.2	8.8	7.0	1.5	3.6
Others	144.3	286.9	353.8	442.5	516.4	569.6	594.1	31.0	21.9	21.9	19.8	21.6	23.0	24.3	3.5	4.4	2.0	3.0
Non-energy	44.4	131.5	176.5	210.7	235.6	262.7	289.0	9.5	10.0	10.0	9.9	10.3	10.5	11.8	5.6	4.8	2.1	3.2
Total	**466.2**	**1,312.7**	**1,787.2**	**2,050.2**	**2,241.7**	**2,377.2**	**2,446.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**4.6**	**1.2**	**2.5**
Coal	319.9	512.1	616.7	651.2	669.6	667.5	653.4	68.6	39.0	34.5	31.8	29.9	28.1	26.7	2.4	2.4	0.0	1.0
Oil	85.1	369.0	540.4	611.2	655.1	688.3	702.8	18.3	28.1	30.2	29.8	29.2	29.0	28.7	7.6	5.2	0.9	2.6
Natural gas	8.9	57.2	120.7	199.5	261.6	305.8	331.5	1.9	4.4	6.8	9.7	11.7	12.9	13.5	9.8	13.3	3.4	7.3
Electricity	39.0	296.8	409.2	472.0	528.4	577.4	606.3	8.4	22.6	22.9	23.0	23.6	24.3	24.8	10.7	4.7	1.7	2.9
Heat	13.2	64.3	82.5	90.4	94.2	94.9	93.5	2.8	4.9	4.6	4.4	4.2	4.0	3.8	8.2	3.5	0.2	1.5
Others	0.0	13.2	17.6	25.9	32.8	43.3	59.1	0.0	1.0	1.0	1.3	1.5	1.8	2.4	35.1	7.0	5.7	6.2

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**621.2**	**4,208.3**	**5,679.0**	**6,501.3**	**7,207.3**	**7,775.8**	**8,030.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.0**	**4.4**	**1.4**	**2.6**
Coal	443.1	3,272.8	4,033.9	3,976.7	4,050.4	3,984.2	3,492.8	71.3	77.8	71.0	61.2	56.2	51.2	43.5	10.5	2.0	-0.9	0.3
Oil	48.6	13.3	16.0	15.8	15.7	15.5	15.4	7.8	0.3	0.3	0.2	0.2	0.2	0.2	-6.3	1.8	-0.2	0.6
Natural gas	2.8	69.0	139.2	192.3	262.0	322.9	349.9	0.4	1.6	2.5	3.0	3.6	4.2	4.4	17.5	10.8	4.1	6.7
Nuclear	0.0	73.9	305.7	526.4	745.9	965.3	1,184.8	0.0	1.8	5.4	8.1	10.3	12.4	14.8	-	21.7	5.6	11.7
Hydro	126.7	722.2	951.8	1,390.9	1,571.5	1,763.2	1,976.9	20.4	17.2	16.8	21.4	21.8	22.7	24.6	9.1	6.8	2.4	4.1
Geothermal	0.0	0.2	0.5	0.8	1.2	1.6	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	17.6	5.8	10.4
Others	0.0	57.0	232.0	398.3	560.7	723.0	1,009.2	0.0	1.4	4.1	6.1	7.8	9.3	12.6	61.3	21.5	6.4	12.2

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**144.7**	**814.9**	**985.1**	**961.7**	**973.5**	**946.3**	**825.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**9.0**	**1.7**	**-1.0**	**0.1**
Coal	131.7	794.7	952.5	919.4	918.6	881.2	755.8	91.1	97.5	96.7	95.6	94.4	93.1	91.6	9.4	1.5	-1.3	-0.2
Oil	12.3	5.0	3.4	3.2	3.1	3.0	2.8	8.5	0.6	0.3	0.3	0.3	0.3	0.3	-4.4	-4.3	-0.8	-2.2
Natural gas	0.6	15.3	29.3	39.2	51.8	62.2	66.6	0.4	1.9	3.0	4.1	5.3	6.6	8.1	17.5	9.9	3.6	6.1

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**29.4**	**35.4**	**36.6**	**37.4**	**38.2**	**39.3**	**40.2**								**0.9**	**0.6**	**0.5**	**0.5**
Coal	28.9	35.4	36.4	37.2	37.9	38.9	39.7								1.0	0.5	0.4	0.5
Oil	34.0	22.9	40.7	42.5	43.8	45.1	46.5								-2.0	6.4	0.6	2.9
Natural gas	38.9	38.9	40.9	42.2	43.5	44.7	45.2								0.0	0.8	0.4	0.6

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**637.3**	**2,024.9**	**2,539.5**	**2,676.5**	**2,793.3**	**2,801.9**	**2,654.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**2.8**	**-0.1**	**1.1**
Coal	547.5	1,689.7	2,063.2	2,112.0	2,162.3	2,139.4	2,009.5	85.9	83.4	81.2	78.9	77.4	76.4	75.7	5.8	2.3	-0.3	0.7
Oil	84.6	284.3	384.6	420.3	435.7	433.0	397.9	13.3	14.0	15.1	15.7	15.6	15.5	15.0	6.3	4.0	-0.4	1.4
Natural Gas	5.3	50.8	91.8	144.2	195.2	229.4	247.0	0.8	2.5	3.6	5.4	7.0	8.2	9.3	12.0	11.0	3.7	6.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	445	3,246	4,821	6,791	8,664	10,675	12,736	10.5	7.7	4.3	5.6
Population (millions of people)	1,135	1,338	1,370	1,388	1,395	1,393	1,382	0.8	0.4	0.0	0.1
GDP per capita (thousands of 2000 USD/person)	0.4	2.4	3.5	4.9	6.2	7.7	9.2	9.5	7.3	4.3	5.5
Primary energy consumption per capita (toe/person)	0.59	1.65	2.12	2.33	2.51	2.63	2.68	5.3	3.5	0.9	1.9
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	1,511	682	601	475	404	344	290	-3.9	-3.5	-3.2	-3.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	1,433	624	527	394	322	262	208	-4.1	-4.5	-4.2	-4.3
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.95	0.92	0.88	0.83	0.80	0.76	0.72	-0.2	-1.0	-1.0	-1.0
Automobile ownership volume (millions of vehicles)	5.5	78.0	152.9	186.0	215.6	249.9	289.8	14.2	9.1	3.0	5.4
Automobile ownership volume per capita (vehicles per person)	0.00	0.06	0.11	0.13	0.15	0.18	0.21	13.2	8.7	3.0	5.3

INDIA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**183.3**	**523.9**	**662.4**	**857.9**	**1,068.6**	**1,313.4**	**1,607.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.4**	**5.1**	**4.3**	**4.6**
Coal	103.4	288.4	380.8	475.6	587.8	712.7	866.0	56.4	55.0	57.5	55.4	55.0	54.3	53.9	5.3	5.1	4.1	4.5
Oil	61.4	162.3	188.0	245.4	305.4	375.7	459.2	33.5	31.0	28.4	28.6	28.6	28.6	28.6	5.0	4.2	4.3	4.2
Natural gas	10.6	52.7	62.3	82.7	106.5	135.6	175.9	5.8	10.1	9.4	9.6	10.0	10.3	10.9	8.4	4.6	5.2	4.9
Nuclear	1.6	6.8	13.0	28.1	37.6	51.5	60.1	0.9	1.3	2.0	3.3	3.5	3.9	3.7	7.5	15.2	5.2	9.1
Hydro	6.2	9.8	11.7	14.0	15.8	17.9	20.3	3.4	1.9	1.8	1.6	1.5	1.4	1.3	2.4	3.6	2.5	2.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.1	3.8	6.6	12.1	15.5	20.0	25.9	0.1	0.7	1.0	1.4	1.5	1.5	1.6	18.5	12.1	5.2	7.9

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**118.2**	**288.7**	**373.4**	**490.6**	**616.9**	**770.7**	**961.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**5.4**	**4.6**	**4.9**
Industry	47.8	122.9	150.6	195.2	242.5	301.6	377.8	40.4	42.6	42.6	40.3	39.8	39.3	39.3	4.8	4.7	4.5	4.6
Transportation	27.1	55.5	76.8	103.0	134.2	173.0	222.3	22.9	19.2	19.2	20.6	21.0	21.7	23.1	3.6	6.4	5.3	5.7
Others	31.7	72.4	96.6	131.6	169.0	212.7	265.8	26.8	25.1	25.1	25.9	26.8	27.4	27.6	4.2	6.2	4.8	5.3
Non-energy	11.7	37.9	49.3	60.7	71.3	83.4	95.8	9.9	13.1	13.1	13.2	12.4	11.6	10.0	6.1	4.8	3.1	3.8
Total	**118.2**	**288.7**	**373.4**	**490.6**	**616.9**	**770.7**	**961.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**5.4**	**4.6**	**4.9**
Coal	41.8	75.8	104.1	122.4	140.4	163.9	194.6	35.4	26.3	27.9	25.0	22.8	21.3	20.2	3.0	4.9	3.1	3.8
Oil	52.6	128.3	156.2	211.6	268.9	336.3	416.3	44.5	44.5	41.8	43.1	43.6	43.6	43.3	4.6	5.1	4.6	4.8
Natural gas	5.6	22.9	27.1	32.4	38.8	46.5	55.9	4.8	7.9	7.3	6.6	6.3	6.0	5.8	7.3	3.5	3.7	3.6
Electricity	18.2	61.1	85.4	123.3	167.5	222.2	291.9	15.4	21.2	22.9	25.1	27.2	28.8	30.3	6.2	7.3	5.9	6.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.5	0.6	0.9	1.3	1.9	3.1	0.0	0.2	0.2	0.2	0.2	0.2	0.3	22.9	6.6	8.5	7.8

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**289.4**	**959.9**	**1,315.4**	**1,860.5**	**2,476.6**	**3,216.2**	**4,134.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**6.8**	**5.5**	**6.0**
Coal	191.6	653.0	891.2	1,219.9	1,652.1	2,156.6	2,798.2	66.2	68.0	67.8	65.6	66.7	67.1	67.7	6.3	6.4	5.7	6.0
Oil	10.0	26.4	24.1	28.1	34.2	40.7	48.7	3.5	2.8	1.8	1.5	1.4	1.3	1.2	5.0	0.6	3.7	2.5
Natural gas	10.0	117.8	168.3	247.4	341.7	459.8	632.5	3.4	12.3	12.8	13.3	13.8	14.3	15.3	13.1	7.7	6.5	7.0
Nuclear	6.1	26.3	49.8	108.0	144.3	197.6	230.7	2.1	2.7	3.8	5.8	5.8	6.1	5.6	7.5	15.2	5.2	9.1
Hydro	71.7	114.4	136.4	162.7	184.0	208.2	235.6	24.8	11.9	10.4	8.7	7.4	6.5	5.7	2.4	3.6	2.5	2.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	22.0	45.4	94.4	120.3	153.3	188.9	0.0	2.3	3.5	5.1	4.9	4.8	4.6	38.6	15.7	4.7	9.0

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**62.6**	**238.8**	**301.3**	**388.9**	**497.1**	**615.9**	**764.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.9**	**5.0**	**4.6**	**4.8**
Coal	55.6	201.5	260.8	333.7	424.1	521.5	639.7	88.7	84.4	86.6	85.8	85.3	84.7	83.7	6.7	5.2	4.4	4.7
Oil	3.6	11.3	10.0	11.4	13.5	15.7	18.3	5.7	4.7	3.3	2.9	2.7	2.5	2.4	5.9	0.1	3.2	2.0
Natural gas	3.5	26.0	30.4	43.9	59.5	78.7	106.3	5.5	10.9	10.1	11.3	12.0	12.8	13.9	10.6	5.4	6.1	5.8

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**29.1**	**28.7**	**30.9**	**33.1**	**35.1**	**37.1**	**39.2**								**-0.1**	**1.4**	**1.1**	**1.2**
Coal	29.6	27.9	29.4	31.4	33.5	35.6	37.6								-0.3	1.2	1.2	1.2
Oil	24.1	20.2	20.7	21.2	21.8	22.3	22.9								-0.9	0.5	0.5	0.5
Natural gas	24.7	38.9	47.6	48.5	49.4	50.3	51.2								2.3	2.2	0.4	1.1

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**161.1**	**451.9**	**570.1**	**724.4**	**902.5**	**1,105.2**	**1,356.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**4.8**	**4.3**	**4.5**
Coal	111.7	311.4	411.3	513.7	634.8	769.7	935.3	69.3	68.9	72.1	70.9	70.3	69.6	69.0	5.3	5.1	4.1	4.5
Oil	46.1	115.0	128.0	167.8	210.8	261.1	322.4	28.6	25.4	22.4	23.2	23.4	23.6	23.8	4.7	3.9	4.4	4.2
Natural Gas	3.4	25.5	30.8	42.9	56.9	74.3	98.8	2.1	5.6	5.4	5.9	6.3	6.7	7.3	10.6	5.3	5.7	5.6

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	275.0	995.5	1,450.5	2,175.1	2,992.6	4,021.9	5,369.5	6.6	8.1	6.2	7.0
Population (millions of people)	849.5	1,170.9	1,250.9	1,326.1	1,395.0	1,456.7	1,510.6	1.6	1.3	0.9	1.0
GDP per capita (thousands of 2000 USD/person)	0.3	0.9	1.2	1.6	2.1	2.8	3.6	4.9	6.8	5.3	5.9
Primary energy consumption per capita (toe/person)	0.22	0.45	0.53	0.65	0.77	0.90	1.06	3.7	3.8	3.4	3.5
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	667	526	457	394	357	327	299	-1.2	-2.8	-1.8	-2.2
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	586	454	393	333	302	275	253	-1.3	-3.0	-1.8	-2.3
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.88	0.86	0.86	0.84	0.84	0.84	0.84	-0.1	-0.2	0.0	-0.1
Automobile ownership volume (millions of vehicles)	4.32	21.38	32.23	48.81	71.49	103.38	148.49	8.3	8.6	7.7	8.1
Automobile ownership volume per capita (vehicles per person)	0.01	0.02	0.03	0.04	0.05	0.07	0.10	6.6	7.3	6.8	7.0

INDIA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**183.3**	**523.9**	**625.5**	**775.7**	**921.2**	**1,080.0**	**1,262.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.4**	**4.0**	**3.3**	**3.6**
Coal	103.4	288.4	352.3	398.1	441.6	486.8	552.2	56.4	55.0	56.3	51.3	47.9	45.1	43.7	5.3	3.3	2.2	2.6
Oil	61.4	162.3	179.1	224.2	265.3	309.3	358.3	33.5	31.0	28.6	28.9	28.8	28.6	28.4	5.0	3.3	3.2	3.2
Natural gas	10.6	52.7	61.7	82.4	105.9	134.1	168.7	5.8	10.1	9.9	10.6	11.5	12.4	13.4	8.4	4.6	4.9	4.8
Nuclear	1.6	6.8	13.0	41.1	69.2	97.3	115.6	0.9	1.3	2.1	5.3	7.5	9.0	9.2	7.5	19.6	7.1	12.0
Hydro	6.2	9.8	11.7	14.0	15.8	17.9	20.3	3.4	1.9	1.9	1.8	1.7	1.7	1.6	2.4	3.6	2.5	2.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.1	3.8	7.6	16.0	23.4	34.6	47.6	0.1	0.7	1.2	2.1	2.5	3.2	3.8	18.5	15.3	7.6	10.6

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**118.2**	**288.7**	**359.2**	**459.1**	**557.8**	**672.5**	**808.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**4.7**	**3.8**	**4.2**
Industry	47.8	122.9	145.1	184.3	223.6	271.6	332.1	40.4	42.6	42.6	40.4	40.1	40.1	41.1	4.8	4.1	4.0	4.1
Transportation	27.1	55.5	73.4	93.9	114.4	137.4	163.1	22.9	19.2	19.2	20.4	20.4	20.5	20.2	3.6	5.4	3.8	4.4
Others	31.7	72.4	92.7	122.6	152.2	185.6	225.0	26.8	25.1	25.1	25.8	26.7	27.3	27.8	4.2	5.4	4.1	4.6
Non-energy	11.7	37.9	48.0	58.4	67.5	77.9	88.3	9.9	13.1	13.1	13.4	12.7	12.1	10.9	6.1	4.4	2.8	3.4
Total	**118.2**	**288.7**	**359.2**	**459.1**	**557.8**	**672.5**	**808.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**4.7**	**3.8**	**4.2**
Coal	41.8	75.8	101.8	117.6	132.0	150.3	174.0	35.4	26.3	28.3	25.6	23.7	22.4	21.5	3.0	4.5	2.6	3.4
Oil	52.6	128.3	148.3	192.7	232.9	275.9	323.5	44.5	44.5	41.3	42.0	41.8	41.0	40.0	4.6	4.1	3.5	3.8
Natural gas	5.6	22.9	26.3	30.9	36.1	42.2	49.5	4.8	7.9	7.3	6.7	6.5	6.3	6.1	7.3	3.0	3.2	3.1
Electricity	18.2	61.1	82.1	116.4	154.4	200.1	256.9	15.4	21.2	22.9	25.4	27.7	29.8	31.8	6.2	6.7	5.4	5.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.5	0.8	1.5	2.4	3.9	4.7	0.0	0.2	0.2	0.3	0.4	0.6	0.6	22.9	12.4	7.8	9.6

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**289.4**	**959.9**	**1,249.4**	**1,713.2**	**2,196.5**	**2,747.2**	**3,400.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**6.0**	**4.7**	**5.2**
Coal	191.6	653.0	818.2	988.8	1,173.4	1,363.0	1,630.5	66.2	68.0	65.5	57.7	53.4	49.6	48.0	6.3	4.2	3.4	3.7
Oil	10.0	26.4	22.1	23.0	24.8	26.8	29.9	3.5	2.8	1.8	1.3	1.1	1.0	0.9	5.0	-1.4	1.8	0.5
Natural gas	10.0	117.8	171.1	258.4	362.0	491.0	655.1	3.4	12.3	13.7	15.1	16.5	17.9	19.3	13.1	8.2	6.4	7.1
Nuclear	6.1	26.3	49.8	157.6	265.4	373.2	443.6	2.1	2.7	4.0	9.2	12.1	13.6	13.0	7.5	19.6	7.1	12.0
Hydro	71.7	114.4	136.4	162.7	184.0	208.2	235.6	24.8	11.9	10.9	9.5	8.4	7.6	6.9	2.4	3.6	2.5	2.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	22.0	51.8	122.7	186.9	284.9	405.3	0.0	2.3	4.1	7.2	8.5	10.4	11.9	38.6	18.8	8.3	12.4

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**62.6**	**238.8**	**275.8**	**317.6**	**361.3**	**406.1**	**469.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.9**	**2.9**	**2.6**	**2.7**
Coal	55.6	201.5	236.0	263.2	289.9	314.3	352.4	88.7	84.4	85.6	82.9	80.2	77.4	75.0	6.7	2.7	2.0	2.3
Oil	3.6	11.3	9.2	9.3	9.8	10.3	11.3	5.7	4.7	3.3	2.9	2.7	2.5	2.4	5.9	-1.9	1.3	0.0
Natural gas	3.5	26.0	30.7	45.1	61.6	81.5	106.1	5.5	10.9	11.1	14.2	17.0	20.1	22.6	10.6	5.6	5.9	5.8

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**29.1**	**28.7**	**31.5**	**34.4**	**37.1**	**39.8**	**42.4**								**-0.1**	**1.8**	**1.4**	**1.6**
Coal	29.6	27.9	29.8	32.3	34.8	37.3	39.8								-0.3	1.5	1.4	1.4
Oil	24.1	20.2	20.7	21.2	21.8	22.3	22.9								-0.9	0.5	0.5	0.5
Natural gas	24.7	38.9	48.0	49.3	50.5	51.8	53.1								2.3	2.4	0.5	1.3

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**161.1**	**451.9**	**532.5**	**624.4**	**713.5**	**808.8**	**934.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**3.3**	**2.7**	**2.9**
Coal	111.7	311.4	380.5	429.9	477.0	525.7	596.4	69.3	68.9	71.5	68.9	66.8	65.0	63.8	5.3	3.3	2.2	2.6
Oil	46.1	115.0	121.1	151.2	179.1	208.4	241.8	28.6	25.4	22.7	24.2	25.1	25.8	25.9	4.7	2.8	3.2	3.0
Natural Gas	3.4	25.5	30.9	43.3	57.5	74.7	96.0	2.1	5.6	5.8	6.9	8.1	9.2	10.3	10.6	5.5	5.4	5.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	275.0	995.5	1,450.5	2,175.1	2,992.6	4,021.9	5,369.5	6.6	8.1	6.2	7.0
Population (millions of people)	849.5	1,170.9	1,250.9	1,326.1	1,395.0	1,456.7	1,510.6	1.6	1.3	0.9	1.0
GDP per capita (thousands of 2000 USD/person)	0.3	0.9	1.2	1.6	2.1	2.8	3.6	4.9	6.8	5.3	5.9
Primary energy consumption per capita (toe/person)	0.22	0.45	0.50	0.58	0.66	0.74	0.84	3.7	2.7	2.4	2.5
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	667	526	431	357	308	269	235	-1.2	-3.8	-2.7	-3.2
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	586	454	367	287	238	201	174	-1.3	-4.5	-3.3	-3.8
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.88	0.86	0.85	0.81	0.77	0.75	0.74	-0.1	-0.7	-0.6	-0.6
Automobile ownership volume (millions of vehicles)	4.32	21.38	32.23	48.81	71.49	103.38	148.49	8.3	8.6	7.7	8.1
Automobile ownership volume per capita (vehicles per person)	0.01	0.02	0.03	0.04	0.05	0.07	0.10	6.6	7.3	6.8	7.0

INDONESIA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**58.1**	**158.6**	**198.3**	**257.2**	**327.1**	**417.8**	**530.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.2**	**5.0**	**4.9**	**4.9**
Coal	3.9	30.1	44.2	59.4	78.4	105.4	141.4	6.7	19.0	22.3	23.1	24.0	25.2	26.7	10.8	7.0	6.0	6.4
Oil	34.2	72.8	92.5	106.6	125.3	155.9	195.5	58.9	45.9	46.6	41.5	38.3	37.3	36.9	3.8	3.9	4.1	4.0
Natural gas	18.5	39.8	36.1	50.4	67.5	87.9	110.7	31.8	25.1	18.2	19.6	20.6	21.0	20.9	3.9	2.4	5.4	4.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.6	1.5	2.4	3.4	4.9	6.4	7.9	1.0	1.0	1.2	1.3	1.5	1.5	1.5	4.8	8.4	5.8	6.8
Geothermal	0.9	8.0	10.0	18.8	26.4	32.8	37.0	1.5	5.1	5.1	7.3	8.1	7.8	7.0	11.6	8.9	4.6	6.3
Others	0.0	6.4	13.1	18.6	24.6	29.5	37.8	0.0	4.0	6.6	7.2	7.5	7.0	7.1	-	11.3	4.9	7.4

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**45.3**	**107.6**	**142.8**	**185.8**	**241.3**	**308.9**	**394.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.4**	**5.6**	**5.1**	**5.3**
Industry	16.7	45.8	61.7	80.3	104.2	133.2	170.2	36.9	42.5	42.5	43.2	43.2	43.2	43.2	5.2	5.8	5.1	5.4
Transportation	11.0	36.0	50.1	65.8	86.1	111.0	142.0	24.3	33.4	33.4	35.1	35.4	35.7	36.0	6.1	6.2	5.3	5.6
Others	9.8	18.7	23.7	30.3	39.0	49.7	63.1	21.6	17.4	17.4	16.6	16.3	16.2	16.0	3.3	4.9	5.0	5.0
Non-energy	7.8	7.2	7.3	9.3	11.9	15.0	19.0	17.2	6.7	6.7	5.1	5.0	4.9	4.8	-0.4	2.7	4.8	4.0
Total	**45.4**	**107.6**	**142.8**	**185.8**	**241.3**	**308.9**	**394.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.4**	**5.6**	**5.1**	**5.3**
Coal	0.6	12.8	18.1	24.8	33.6	44.3	57.9	1.3	11.9	12.7	13.3	13.9	14.3	14.7	16.5	6.8	5.8	6.2
Oil	28.4	60.0	74.6	92.4	116.1	147.4	186.9	62.6	55.7	52.2	49.7	48.1	47.7	47.4	3.8	4.4	4.8	4.7
Natural gas	7.4	15.8	20.0	27.1	36.2	47.1	60.9	16.3	14.7	14.0	14.6	15.0	15.2	15.5	3.9	5.5	5.6	5.5
Electricity	2.3	12.7	19.3	26.3	34.7	44.6	56.8	5.1	11.8	13.5	14.2	14.4	14.4	14.4	8.9	7.5	5.3	6.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	6.7	6.3	10.9	15.3	20.7	25.6	31.6	14.8	5.9	7.6	8.2	8.6	8.3	8.0	-0.3	9.2	5.0	6.6

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**33.3**	**169.8**	**252.4**	**341.6**	**448.1**	**576.0**	**733.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.5**	**7.2**	**5.2**	**6.0**
Coal	10.5	68.1	96.3	127.8	165.5	225.5	308.2	31.5	40.1	38.2	37.4	36.9	39.2	42.0	9.8	6.5	6.0	6.2
Oil	14.2	33.7	36.9	33.4	32.3	30.9	30.9	42.6	19.9	14.6	9.8	7.2	5.4	4.2	4.4	-0.1	-0.5	-0.3
Natural gas	0.8	40.8	67.3	97.6	130.7	170.8	208.1	2.4	24.1	26.7	28.6	29.2	29.6	28.4	21.7	9.1	5.2	6.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	6.7	17.7	27.6	39.4	56.5	74.2	92.0	20.1	10.4	10.9	11.5	12.6	12.9	12.5	5.0	8.4	5.8	6.8
Geothermal	1.1	9.4	17.5	32.8	46.1	57.1	64.6	3.3	5.5	6.9	9.6	10.3	9.9	8.8	11.3	13.4	4.6	8.0
Others	0.0	0.1	6.7	10.7	16.9	17.4	29.3	0.0	0.1	2.6	3.1	3.8	3.0	4.0	-	60.1	7.0	25.7

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**6.8**	**37.1**	**51.9**	**66.8**	**84.6**	**110.1**	**141.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.9**	**6.0**	**5.1**	**5.5**
Coal	2.7	18.5	26.1	34.6	44.8	61.1	83.5	39.7	49.7	50.3	51.8	53.0	55.5	59.0	10.1	6.5	6.0	6.2
Oil	3.8	8.9	9.7	8.8	8.5	8.1	8.1	55.9	23.9	18.7	13.2	10.1	7.4	5.8	4.3	-0.1	-0.5	-0.3
Natural gas	0.3	9.8	16.1	23.4	31.3	40.9	49.8	4.4	26.3	31.0	35.0	37.0	37.1	35.2	19.0	9.1	5.2	6.7

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.3**	**33.1**	**33.2**	**33.3**	**33.4**	**33.4**	**33.3**								**0.1**	**0.1**	**0.0**	**0.0**
Coal	33.4	31.7	31.7	31.7	31.7	31.7	31.7								-0.3	0.0	0.0	0.0
Oil	32.1	32.6	32.6	32.6	32.6	32.6	32.6								0.1	0.0	0.0	0.0
Natural gas	22.9	35.9	35.9	35.9	35.9	35.9	35.9								2.3	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**40.9**	**99.6**	**132.5**	**169.6**	**217.1**	**281.0**	**362.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**5.5**	**5.2**	**5.3**
Coal	5.3	33.2	47.0	63.2	83.5	112.2	150.5	12.9	33.4	35.5	37.3	38.4	39.9	41.6	9.6	6.6	6.0	6.2
Oil	27.2	54.5	67.4	80.6	98.9	123.3	154.4	66.6	54.7	50.9	47.5	45.6	43.9	42.6	3.5	4.0	4.4	4.3
Natural Gas	8.4	11.9	18.1	25.8	34.7	45.6	57.2	20.5	11.9	13.6	15.2	16.0	16.2	15.8	1.8	8.0	5.5	6.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	109.2	274.7	370.9	484.7	630.5	804.8	1,027.1	4.7	5.8	5.1	5.4
Population (millions of people)	178.2	237.6	253.3	268.0	281.0	291.1	301.6	1.4	1.2	0.8	1.0
GDP per capita (thousands of 2000 USD/person)	0.6	1.2	1.5	1.8	2.2	2.8	3.4	3.2	4.6	4.3	4.4
Primary energy consumption per capita (toe/person)	0.33	0.67	0.78	0.96	1.16	1.44	1.76	3.6	3.7	4.1	4.0
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	532	577	535	531	519	519	516	0.4	-0.8	-0.2	-0.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	374	363	357	350	344	349	353	-0.2	-0.4	0.1	-0.1
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.70	0.63	0.67	0.66	0.66	0.67	0.68	-0.6	0.5	0.2	0.3
Automobile ownership volume (millions of vehicles)		-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

INDONESIA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**58.1**	**158.6**	**180.1**	**215.3**	**256.6**	**310.7**	**388.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.2**	**3.1**	**4.0**	**3.7**
Coal	3.9	30.1	37.8	44.2	51.8	65.6	85.4	6.7	19.0	21.0	20.6	20.2	21.1	22.0	10.8	3.9	4.5	4.3
Oil	34.2	72.8	87.1	95.5	108.0	124.4	151.8	58.9	45.9	48.3	44.3	42.1	40.0	39.0	3.8	2.7	3.1	3.0
Natural gas	18.5	39.8	31.9	40.5	50.3	63.4	79.4	31.8	25.1	17.7	18.8	19.6	20.4	20.4	3.9	0.2	4.6	2.8
Nuclear	0.0	0.0	0.0	0.0	1.6	1.6	3.2	0.0	0.0	0.0	0.0	0.6	0.5	0.8	-	-	-	-
Hydro	0.6	1.5	2.4	3.4	4.9	6.4	7.9	1.0	1.0	1.3	1.6	1.9	2.1	2.0	4.8	8.4	5.8	6.8
Geothermal	0.9	8.0	9.0	15.9	20.1	26.7	32.0	1.5	5.1	5.0	7.4	7.8	8.6	8.2	11.6	7.0	4.8	5.7
Others	0.0	6.4	12.0	15.9	20.0	22.6	29.2	0.0	4.0	6.7	7.4	7.8	7.3	7.5	-	9.6	4.2	6.3

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**45.3**	**107.6**	**130.8**	**159.5**	**199.8**	**246.2**	**313.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.4**	**4.0**	**4.6**	**4.4**
Industry	16.7	45.8	56.0	69.2	87.4	108.7	138.9	36.9	42.5	42.5	42.8	43.4	43.8	44.2	5.2	4.2	4.8	4.5
Transportation	11.0	36.0	45.6	54.1	66.8	80.9	103.2	24.3	33.4	33.4	34.9	33.9	33.4	32.9	6.1	4.2	4.4	4.3
Others	9.8	18.7	21.9	26.9	33.6	41.6	52.8	21.6	17.4	17.4	16.7	16.8	16.8	16.8	3.3	3.7	4.6	4.2
Non-energy	7.8	7.2	7.3	9.3	11.9	15.0	19.0	17.2	6.7	6.7	5.6	5.9	6.0	6.0	-0.4	2.7	4.8	4.0
Total	**45.4**	**107.6**	**130.8**	**159.5**	**199.8**	**246.2**	**313.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.4**	**4.0**	**4.6**	**4.4**
Coal	0.6	12.8	16.3	21.1	27.7	35.4	46.3	1.3	11.9	12.4	13.2	13.9	14.4	14.8	16.5	5.1	5.4	5.3
Oil	28.4	60.0	68.3	78.2	94.1	114.1	144.3	62.6	55.7	52.2	49.1	47.1	46.3	46.0	3.8	2.7	4.2	3.6
Natural gas	7.4	15.8	18.9	24.7	32.4	41.4	53.5	16.3	14.7	14.4	15.5	16.2	16.8	17.1	3.9	4.5	5.3	5.0
Electricity	2.3	12.7	17.6	22.9	29.4	36.6	46.6	5.1	11.8	13.5	14.4	14.7	14.9	14.9	8.9	6.1	4.8	5.3
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	6.7	6.3	9.8	12.6	16.1	18.7	23.1	14.8	5.9	7.5	7.9	8.1	7.6	7.3	-0.3	7.1	4.1	5.3

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**33.3**	**169.8**	**230.0**	**296.2**	**377.1**	**467.9**	**595.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.5**	**5.7**	**4.8**	**5.1**
Coal	10.5	68.1	86.5	107.9	126.0	158.0	204.3	31.5	40.1	37.6	36.4	33.4	33.8	34.3	9.8	4.7	4.3	4.5
Oil	14.2	33.7	33.1	28.2	24.6	25.2	26.8	42.6	19.9	14.4	9.5	6.5	5.4	4.5	4.4	-1.8	-0.3	-0.9
Natural gas	0.8	40.8	60.4	82.4	99.5	128.1	150.5	2.4	24.1	26.3	27.8	26.4	27.4	25.3	21.7	7.3	4.1	5.4
Nuclear	0.0	0.0	0.0	0.0	18.4	18.4	36.8	0.0	0.0	0.0	0.0	4.9	3.9	6.2	-	-	-	-
Hydro	6.7	17.7	27.6	39.4	56.5	74.2	92.0	20.1	10.4	12.0	13.3	15.0	15.9	15.4	5.0	8.4	5.8	6.8
Geothermal	1.1	9.4	15.7	27.7	35.1	46.5	55.9	3.3	5.5	6.8	9.3	9.3	9.9	9.4	11.3	11.5	4.8	7.4
Others	0.0	0.1	6.7	10.7	16.9	17.4	29.3	0.0	0.1	2.9	3.6	4.5	3.7	4.9	-	60.1	7.0	25.7

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**6.8**	**37.1**	**43.2**	**46.4**	**48.4**	**58.9**	**72.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.9**	**2.3**	**3.0**	**2.7**
Coal	2.7	18.5	21.5	23.2	24.1	30.2	39.0	39.7	49.7	49.7	50.0	49.8	51.3	54.2	10.1	2.3	3.5	3.0
Oil	3.8	8.9	8.7	7.4	6.5	6.6	7.0	55.9	23.9	20.2	16.0	13.4	11.3	9.8	4.3	-1.8	-0.3	-0.9
Natural gas	0.3	9.8	13.0	15.7	17.8	22.0	25.9	4.4	26.3	30.1	34.0	36.8	37.4	36.0	19.0	4.9	3.4	4.0

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.3**	**33.1**	**35.8**	**40.5**	**44.5**	**45.5**	**45.6**								**0.1**	**2.1**	**0.8**	**1.3**
Coal	33.4	31.7	34.6	40.0	45.0	45.0	45.0								-0.3	2.3	0.8	1.4
Oil	32.1	32.6	32.6	32.6	32.6	32.6	32.6								0.1	0.0	0.0	0.0
Natural gas	22.9	35.9	40.0	45.0	48.0	50.0	50.0								2.3	2.3	0.7	1.3

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**41.6**	**99.6**	**116.8**	**134.1**	**157.8**	**194.0**	**246.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.5**	**3.0**	**4.1**	**3.7**
Coal	5.3	33.2	40.2	47.1	55.1	69.9	90.9	12.7	33.4	34.4	35.1	34.9	36.0	36.9	9.6	3.5	4.5	4.1
Oil	27.2	54.5	61.3	67.7	79.1	94.4	118.2	65.4	54.7	52.5	50.5	50.1	48.7	48.1	3.5	2.2	3.8	3.1
Natural Gas	9.1	11.9	15.3	19.3	23.6	29.7	36.9	21.9	11.9	13.1	14.4	15.0	15.3	15.0	1.3	4.9	4.4	4.6

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	109.2	274.7	370.9	484.7	630.5	804.8	1,027.1	4.7	5.8	5.1	5.4
Population (millions of people)	178.2	237.6	253.3	268.0	281.0	291.1	301.6	1.4	1.2	0.8	1.0
GDP per capita (thousands of 2000 USD/person)	0.6	1.2	1.5	1.8	2.2	2.8	3.4	3.2	4.6	4.3	4.4
Primary energy consumption per capita (toe/person)	0.33	0.67	0.71	0.80	0.91	1.07	1.29	3.6	1.9	3.2	2.7
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	532	577	486	444	407	386	379	0.4	-2.6	-1.1	-1.7
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	381	363	315	277	250	241	240	-0.2	-2.7	-1.0	-1.6
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.72	0.63	0.65	0.62	0.62	0.62	0.63	-0.7	-0.1	0.1	0.0
Automobile ownership volume (millions of vehicles)		-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

JAPAN [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**436.6**	**494.0**	**487.1**	**484.9**	**481.3**	**471.8**	**458.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.6**	**-0.2**	**-0.4**	**-0.3**
Coal	76.6	115.0	112.3	117.2	118.6	121.2	123.7	17.5	23.3	23.1	24.2	24.6	25.7	27.0	2.0	0.2	0.4	0.3
Oil	250.4	203.0	188.6	175.5	164.8	154.5	145.2	57.4	41.1	38.7	36.2	34.2	32.7	31.7	-1.0	-1.4	-1.3	-1.3
Natural gas	44.2	86.0	98.8	105.2	112.3	119.9	129.0	10.1	17.4	20.3	21.7	23.3	25.4	28.2	3.4	2.0	1.4	1.6
Nuclear	52.7	75.1	67.8	62.2	57.6	44.1	23.8	12.1	15.2	13.9	12.8	12.0	9.3	5.2	1.8	-1.9	-6.2	-4.5
Hydro	7.7	7.1	7.4	7.4	7.4	7.5	7.5	1.8	1.4	1.5	1.5	1.5	1.6	1.6	-0.4	0.4	0.1	0.2
Geothermal	1.6	2.5	3.8	6.8	8.9	11.6	14.1	0.4	0.5	0.8	1.4	1.8	2.5	3.1	2.3	10.7	5.0	7.2
Others	3.4	5.3	8.4	10.6	11.8	13.1	14.9	0.8	1.1	1.7	2.2	2.4	2.8	3.3	2.2	7.1	2.3	4.2

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**300.1**	**324.6**	**321.3**	**315.5**	**309.4**	**301.5**	**293.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-0.3**	**-0.5**	**-0.4**
Industry	102.8	90.0	98.5	98.0	96.6	94.9	93.5	34.3	27.7	27.7	30.7	31.1	31.2	31.9	-0.7	0.9	-0.3	0.2
Transportation	71.8	76.9	71.4	66.2	61.5	57.2	53.3	23.9	23.7	23.7	22.2	21.0	19.9	18.1	0.4	-1.5	-1.4	-1.5
Others	90.9	117.7	116.0	116.5	117.0	116.0	114.1	30.3	36.3	36.3	36.1	36.9	37.8	38.9	1.3	-0.1	-0.1	-0.1
Non-energy	34.5	39.9	35.4	34.7	34.3	33.5	32.7	11.5	12.3	12.3	11.0	11.0	11.1	11.1	0.7	-1.4	-0.4	-0.8
Total	**300.1**	**324.6**	**321.3**	**315.5**	**309.4**	**301.5**	**293.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-0.3**	**-0.5**	**-0.4**
Coal	32.3	28.7	28.9	29.0	27.9	26.8	25.5	10.8	8.8	9.0	9.2	9.0	8.9	8.7	-0.6	0.1	-0.8	-0.5
Oil	184.0	171.4	153.8	142.5	133.0	123.6	115.0	61.3	52.8	47.9	45.2	43.0	41.0	39.2	-0.4	-1.8	-1.4	-1.6
Natural gas	15.2	34.5	44.8	44.5	44.8	44.5	44.1	5.1	10.6	13.9	14.1	14.5	14.7	15.0	4.2	2.6	-0.1	1.0
Electricity	64.5	86.2	87.1	91.3	94.6	96.6	98.0	21.5	26.5	27.1	29.0	30.6	32.1	33.4	1.5	0.6	0.5	0.5
Heat	0.2	0.6	2.2	3.3	4.4	5.4	6.3	0.1	0.2	0.7	1.1	1.4	1.8	2.2	5.5	19.0	4.4	10.0
Others	3.9	3.3	4.6	4.9	4.8	4.6	4.5	1.3	1.0	1.4	1.6	1.5	1.5	1.5	-0.7	3.9	-0.5	1.2

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**835.5**	**1,110.8**	**1,126.5**	**1,182.3**	**1,225.0**	**1,252.0**	**1,269.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.4**	**0.6**	**0.5**	**0.5**
Coal	116.7	304.5	293.5	319.0	334.1	356.1	382.0	14.0	27.4	26.0	27.0	27.3	28.4	30.1	4.9	0.5	1.2	0.9
Oil	247.9	97.5	114.8	105.1	98.6	93.3	89.4	29.7	8.8	10.2	8.9	8.1	7.5	7.0	-4.6	0.8	-1.1	-0.3
Natural gas	167.1	304.5	318.5	356.2	394.0	439.2	492.5	20.0	27.4	28.3	30.1	32.2	35.1	38.8	3.0	1.6	2.2	1.9
Nuclear	202.3	288.2	260.0	238.7	220.9	169.1	91.4	24.2	25.9	23.1	20.2	18.0	13.5	7.2	1.8	-1.9	-6.2	-4.5
Hydro	89.3	82.2	86.0	85.9	86.3	86.8	86.8	10.7	7.4	7.6	7.3	7.0	6.9	6.8	-0.4	0.4	0.1	0.2
Geothermal	1.7	2.6	4.2	7.7	10.1	13.3	16.1	0.2	0.2	0.4	0.7	0.8	1.1	1.3	2.1	11.3	5.1	7.5
Others	10.5	31.2	49.5	69.8	80.8	94.1	111.2	1.3	2.8	4.4	5.9	6.6	7.5	8.8	5.6	8.4	3.1	5.2

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**109.3**	**133.6**	**137.1**	**147.1**	**155.6**	**166.8**	**180.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.0**	**1.0**	**1.4**	**1.2**
Coal	25.4	61.6	59.4	64.6	67.6	71.8	76.7	23.2	46.1	43.3	43.9	43.4	43.0	42.5	4.5	0.5	1.2	0.9
Oil	50.6	18.0	21.2	19.4	18.2	17.3	16.5	46.3	13.5	15.5	13.2	11.7	10.3	9.2	-5.0	0.8	-1.1	-0.3
Natural gas	33.3	54.0	56.4	63.1	69.8	77.8	87.3	30.5	40.4	41.2	42.9	44.9	46.6	48.3	2.4	1.6	2.2	1.9

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**41.9**	**45.5**	**45.6**	**45.6**	**45.7**	**45.8**	**45.9**								**0.4**	**0.0**	**0.0**	**0.0**
Coal	39.5	42.5	42.5	42.5	42.5	42.7	42.8								0.4	0.0	0.1	0.0
Oil	42.1	46.5	46.5	46.5	46.5	46.5	46.5								0.5	0.0	0.0	0.0
Natural gas	43.2	48.5	48.5	48.5	48.5	48.5	48.5								0.6	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**291.7**	**315.8**	**312.9**	**311.8**	**309.3**	**309.0**	**310.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-0.1**	**0.0**	**-0.1**
Coal	82.3	123.8	120.9	126.2	127.7	130.5	133.2	28.2	39.2	38.7	40.5	41.3	42.2	42.9	2.1	0.2	0.4	0.3
Oil	181.3	137.1	128.9	118.5	109.9	101.9	94.8	62.1	43.4	41.2	38.0	35.5	33.0	30.5	-1.4	-1.4	-1.5	-1.5
Natural Gas	28.1	54.9	63.1	67.2	71.7	76.6	82.4	9.6	17.4	20.2	21.5	23.2	24.8	26.6	3.4	2.0	1.4	1.6

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	4,150.3	5,029.3	5,372.8	5,782.3	6,189.4	6,537.4	6,853.9	1.0	1.4	1.1	1.2
Population (millions of people)	123.9	127.2	125.5	122.8	119.3	115.2	110.7	0.1	-0.4	-0.7	-0.6
GDP per capita (thousands of 2000 USD/person)	33.5	39.5	42.8	47.1	51.9	56.7	61.9	0.8	1.8	1.8	1.8
Primary energy consumption per capita (toe/person)	3.52	3.88	3.88	3.95	4.04	4.09	4.14	0.5	0.2	0.3	0.3
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	105	98	91	84	78	72	67	-0.3	-1.6	-1.5	-1.5
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	70	63	58	54	50	47	45	-0.6	-1.5	-1.2	-1.3
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.67	0.64	0.64	0.64	0.64	0.65	0.68	-0.2	0.1	0.3	0.2
Automobile ownership volume (millions of vehicles)	56.49	75.36	74.17	72.57	70.80	68.84	66.69	1.5	-0.4	-0.6	-0.5
Automobile ownership volume per capita (vehicles per person)	0.46	0.59	0.59	0.59	0.59	0.60	0.60	1.3	0.0	0.1	0.1

JAPAN [APS]

Primary energy consumption	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**436.6**	**494.0**	**472.8**	**460.4**	**443.1**	**420.9**	**400.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.6**	**-0.7**	**-0.9**	**-0.8**
Coal	76.6	115.0	106.3	103.1	98.4	91.7	85.2	17.5	23.3	22.5	22.4	22.2	21.8	21.3	2.0	-1.1	-1.3	-1.2
Oil	250.4	203.0	183.0	164.4	148.3	132.7	119.0	57.4	41.1	38.7	35.7	33.5	31.5	29.7	-1.0	-2.1	-2.1	-2.1
Natural gas	44.2	86.0	92.3	90.1	88.2	84.0	80.0	10.1	17.4	19.5	19.6	19.9	20.0	20.0	3.4	0.5	-0.8	-0.3
Nuclear	52.7	75.1	71.9	77.5	73.6	62.2	57.6	12.1	15.2	15.2	16.8	16.6	14.8	14.4	1.8	0.3	-2.0	-1.1
Hydro	7.7	7.1	7.8	8.5	9.3	10.0	10.6	1.8	1.4	1.7	1.9	2.1	2.4	2.7	-0.4	1.9	1.5	1.6
Geothermal	1.6	2.5	3.7	6.4	11.0	19.0	23.0	0.4	0.5	0.8	1.4	2.5	4.5	5.7	2.3	10.0	8.9	9.3
Others	3.4	5.3	7.7	10.4	14.4	21.1	24.7	0.8	1.1	1.6	2.3	3.3	5.0	6.2	2.2	6.9	5.9	6.3

Final energy demand Sector	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**300.1**	**324.6**	**312.9**	**299.5**	**285.6**	**270.3**	**255.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-0.8**	**-1.1**	**-1.0**
Industry	102.8	90.0	98.0	96.8	94.9	92.6	89.9	34.3	27.7	27.7	31.3	32.3	33.2	35.2	-0.7	0.7	-0.5	0.0
Transportation	71.8	76.9	69.8	62.1	54.7	48.2	42.6	23.9	23.7	23.7	22.3	20.8	19.2	16.7	0.4	-2.1	-2.5	-2.3
Others	90.9	117.7	109.7	105.8	101.6	96.0	90.3	30.3	36.3	36.3	35.1	35.3	35.6	35.3	1.3	-1.1	-1.0	-1.1
Non-energy	34.5	39.9	35.4	34.7	34.3	33.5	32.7	11.5	12.3	12.3	11.3	11.6	12.0	12.8	0.7	-1.4	-0.4	-0.8
Total	**300.1**	**324.6**	**312.9**	**299.5**	**285.6**	**270.3**	**255.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-0.8**	**-1.1**	**-1.0**
Coal	32.3	28.7	29.0	29.2	28.4	27.5	26.3	10.8	8.8	9.3	9.8	9.9	10.2	10.3	-0.6	0.2	-0.7	-0.3
Oil	184.0	171.4	149.7	134.3	120.6	107.5	95.9	61.3	52.8	47.8	44.9	42.2	39.8	37.5	-0.4	-2.4	-2.2	-2.3
Natural gas	15.2	34.5	43.1	41.3	40.0	37.8	35.8	5.1	10.6	13.8	13.8	14.0	14.0	14.0	4.2	1.8	-1.0	0.1
Electricity	64.5	86.2	83.5	85.1	85.8	85.5	84.9	21.5	26.5	26.7	28.4	30.0	31.6	33.2	1.5	-0.1	0.0	-0.1
Heat	0.2	0.6	2.7	3.8	4.7	5.9	7.0	0.1	0.2	0.8	1.3	1.7	2.2	2.7	5.5	20.6	4.1	10.4
Others	3.9	3.3	5.0	5.7	6.1	6.1	5.7	1.3	1.0	1.6	1.9	2.1	2.2	2.2	-0.7	5.5	0.0	2.2

Power generation Output	TWh 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**835.5**	**1,110.8**	**1,079.1**	**1,100.6**	**1,109.7**	**1,106.0**	**1,099.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.4**	**-0.1**	**0.0**	**0.0**
Coal	116.7	304.5	263.5	249.7	234.5	209.0	190.5	14.0	27.4	24.4	22.7	21.1	18.9	17.3	4.9	-2.0	-1.8	-1.9
Oil	247.9	97.5	106.6	88.5	76.1	62.5	50.9	29.7	8.8	9.9	8.0	6.9	5.7	4.6	-4.6	-1.0	-3.6	-2.6
Natural gas	167.1	304.5	294.6	295.7	295.8	284.7	274.9	20.0	27.4	27.3	26.9	26.7	25.7	25.0	3.0	-0.3	-0.5	-0.4
Nuclear	202.3	288.2	276.0	297.2	282.3	238.7	220.9	24.2	25.9	25.6	27.0	25.4	21.6	20.1	1.8	0.3	-2.0	-1.1
Hydro	89.3	82.2	91.0	99.2	107.9	116.7	123.4	10.7	7.4	8.4	9.0	9.7	10.6	11.2	-0.4	1.9	1.5	1.6
Geothermal	1.7	2.6	4.1	7.2	12.5	21.9	26.5	0.2	0.2	0.4	0.7	1.1	2.0	2.4	2.1	10.6	9.1	9.7
Others	10.5	31.2	43.2	63.1	100.4	172.5	211.9	1.3	2.8	4.0	5.7	9.1	15.6	19.3	5.6	7.3	8.4	8.0

Power generation Input	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**109.3**	**133.6**	**124.6**	**117.9**	**111.6**	**101.8**	**93.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.0**	**-1.2**	**-1.5**	**-1.4**
Coal	25.4	61.6	53.3	50.2	46.9	41.6	37.5	23.2	46.1	42.8	42.6	42.0	40.9	40.0	4.5	-2.0	-1.9	-2.0
Oil	50.6	18.0	19.7	16.4	14.2	11.6	9.5	46.3	13.5	15.8	13.9	12.7	11.4	10.1	-5.0	-0.9	-3.6	-2.5
Natural gas	33.3	54.0	51.6	51.3	50.6	48.6	46.6	30.5	40.4	41.4	43.5	45.3	47.7	49.8	2.4	-0.5	-0.6	-0.6

Thermal Efficiency	% 1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**41.9**	**45.5**	**45.9**	**46.2**	**46.7**	**47.0**	**47.4**								**0.4**	**0.2**	**0.2**	**0.2**
Coal	39.5	42.5	42.5	42.7	43.0	43.2	43.7								0.4	0.1	0.1	0.1
Oil	42.1	46.5	46.4	46.4	46.2	46.2	46.2								0.5	0.0	0.0	0.0
Natural gas	43.2	48.5	49.1	49.6	50.3	50.4	50.7								0.6	0.2	0.1	0.2

CO_2 emissions	Mt-C 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**291.7**	**315.8**	**297.6**	**277.7**	**258.2**	**236.0**	**215.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0.4**	**-1.3**	**-1.7**	**-1.5**
Coal	82.3	123.8	114.4	111.0	105.9	98.7	91.7	28.2	39.2	38.5	40.0	41.0	41.8	42.5	2.1	-1.1	-1.3	-1.2
Oil	181.3	137.1	124.2	109.2	96.1	83.7	72.9	62.1	43.4	41.7	39.3	37.2	35.5	33.8	-1.4	-2.3	-2.7	-2.5
Natural Gas	28.1	54.9	58.9	57.5	56.2	53.6	51.0	9.6	17.4	19.8	20.7	21.8	22.7	23.7	3.4	0.5	-0.8	-0.3

Energy and economic indicators	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	4,150.3	5,029.3	5,372.8	5,782.3	6,189.4	6,537.4	6,853.9	1.0	1.4	1.1	1.2
Population (millions of people)	123.9	127.2	125.5	122.8	119.3	115.2	110.7	0.1	-0.4	-0.7	-0.6
GDP per capita (thousands of 2000 USD/person)	33.5	39.5	42.8	47.1	51.9	56.7	61.9	0.8	1.8	1.8	1.8
Primary energy consumption per capita (toe/person)	3.52	3.88	3.77	3.75	3.72	3.65	3.61	0.5	-0.3	-0.2	-0.3
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	105	98	88	80	72	64	58	-0.3	-2.1	-2.0	-2.1
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	70	63	55	48	42	36	31	-0.6	-2.6	-2.8	-2.7
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.67	0.64	0.63	0.60	0.58	0.56	0.54	-0.2	-0.6	-0.7	-0.7
Automobile ownership volume (millions of vehicles)	56.49	75.36	74.17	72.57	70.80	68.84	66.69	1.5	-0.4	-0.6	-0.5
Automobile ownership volume per capita (vehicles per person)	0.46	0.59	0.59	0.59	0.59	0.60	0.60	1.3	0.0	0.1	0.1

KOREA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**92.4**	**247.3**	**271.9**	**301.9**	**331.3**	**352.7**	**367.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.0**	**2.0**	**1.3**	**1.6**
Coal	25.6	73.4	79.4	90.1	100.8	109.0	114.2	27.7	29.7	29.2	29.8	30.4	30.9	31.0	5.4	2.1	1.6	1.8
Oil	49.7	95.1	97.5	103.8	110.5	114.9	117.2	53.9	38.5	35.8	34.4	33.4	32.6	31.9	3.3	0.9	0.8	0.8
Natural gas	2.7	38.7	44.9	51.6	57.2	61.5	63.9	2.9	15.6	16.5	17.1	17.3	17.4	17.4	14.2	2.9	1.4	2.0
Nuclear	13.8	38.7	47.2	52.4	57.6	61.0	64.3	14.9	15.7	17.4	17.4	17.4	17.3	17.5	5.3	3.1	1.4	2.1
Hydro	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.1	0.1	0.1	0.1	0.1	0.1	-2.7	-2.0	0.0	-0.8
Geothermal	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	8.2	4.1	5.7
Others	0.0	1.0	2.6	3.7	4.8	6.0	7.8	0.0	0.4	0.9	1.2	1.5	1.7	2.1	25.9	14.0	5.1	8.6

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**64.9**	**157.4**	**173.0**	**190.8**	**208.1**	**220.9**	**229.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.5**	**1.9**	**1.2**	**1.5**
Industry	19.3	44.8	50.7	57.2	64.1	69.2	72.5	29.7	28.4	28.4	29.3	30.0	30.8	31.6	4.3	2.5	1.6	1.9
Transportation	14.6	29.9	31.4	32.7	33.0	32.8	32.1	22.5	19.0	19.0	18.2	17.1	15.9	14.0	3.7	0.9	-0.1	0.3
Others	24.3	44.4	48.4	52.1	55.5	58.4	60.8	37.5	28.2	28.2	28.0	27.3	26.7	26.4	3.1	1.6	1.0	1.3
Non-energy	6.7	38.4	42.3	48.9	55.5	60.5	64.4	10.4	24.4	24.4	24.5	25.6	26.7	28.0	9.1	2.5	1.9	2.1
Total	**64.9**	**157.4**	**173.0**	**190.8**	**208.1**	**220.9**	**229.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.5**	**1.9**	**1.2**	**1.5**
Coal	11.7	9.5	9.8	9.7	9.5	9.2	8.8	18.1	6.1	5.7	5.1	4.6	4.2	3.8	-1.0	0.1	-0.7	-0.3
Oil	43.7	81.9	84.3	90.1	95.9	99.9	102.4	67.3	52.0	48.8	47.2	46.1	45.2	44.6	3.2	1.0	0.9	0.9
Natural gas	0.7	20.4	25.3	29.0	32.3	35.1	37.2	1.0	12.9	14.6	15.2	15.5	15.9	16.2	18.6	3.6	1.7	2.4
Electricity	8.1	38.6	45.0	52.4	59.7	65.2	69.6	12.5	24.5	26.0	27.5	28.7	29.5	30.3	8.1	3.1	1.9	2.4
Heat	0.0	4.3	5.3	6.0	6.6	7.0	7.2	0.0	2.8	3.1	3.1	3.2	3.2	3.1	-	3.3	1.2	2.0
Others	0.7	2.7	3.2	3.6	4.0	4.4	4.7	1.1	1.7	1.8	1.9	1.9	2.0	2.0	6.7	2.9	1.8	2.2

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**105.4**	**496.7**	**570.1**	**663.0**	**754.7**	**824.2**	**879.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**2.9**	**1.9**	**2.3**
Coal	17.7	219.3	246.7	296.6	348.0	390.5	420.9	16.8	44.1	43.3	44.7	46.1	47.4	47.9	13.4	3.1	2.4	2.6
Oil	18.9	18.9	17.1	15.6	15.4	14.2	12.0	17.9	3.8	3.0	2.4	2.0	1.7	1.4	0.0	-1.9	-1.7	-1.8
Natural gas	9.6	103.2	111.6	128.9	142.9	151.4	153.9	9.1	20.8	19.6	19.4	18.9	18.4	17.5	12.6	2.3	1.2	1.6
Nuclear	52.9	148.6	181.1	201.0	220.9	233.9	246.9	50.2	29.9	31.8	30.3	29.3	28.4	28.1	5.3	3.1	1.4	2.1
Hydro	6.4	3.7	3.0	3.0	3.0	3.0	3.0	6.0	0.7	0.5	0.5	0.4	0.4	0.3	-2.7	-2.0	0.0	-0.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	3.0	10.6	17.7	24.6	31.4	42.4	0.0	0.6	1.9	2.7	3.3	3.8	4.8	49.3	19.3	6.0	11.1

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.5**	**74.8**	**81.6**	**95.0**	**108.2**	**117.9**	**123.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**9.4**	**2.4**	**1.8**	**2.0**
Coal	6.0	52.3	58.0	68.8	79.6	88.2	93.8	47.7	69.8	71.1	72.4	73.6	74.8	76.0	11.5	2.8	2.1	2.4
Oil	4.5	4.7	4.2	3.9	3.8	3.5	3.0	36.0	6.3	5.2	4.1	3.5	3.0	2.4	0.2	-1.9	-1.7	-1.8
Natural gas	2.0	17.9	19.3	22.3	24.7	26.2	26.6	16.3	23.9	23.7	23.5	22.9	22.2	21.6	11.5	2.3	1.2	1.6

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**31.7**	**39.2**	**39.6**	**39.9**	**40.2**	**40.5**	**40.9**								**1.1**	**0.2**	**0.2**	**0.2**
Coal	25.4	36.1	36.6	37.1	37.6	38.1	38.6								1.8	0.3	0.3	0.3
Oil	35.9	34.6	34.6	34.6	34.6	34.6	34.6								-0.2	0.0	0.0	0.0
Natural gas	40.6	49.7	49.7	49.7	49.7	49.7	49.7								1.0	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**65.3**	**151.5**	**160.6**	**176.2**	**191.5**	**202.6**	**208.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.3**	**1.5**	**1.1**	**1.3**
Coal	27.6	78.9	85.3	96.8	108.4	117.3	122.9	42.2	52.1	53.1	55.0	56.6	57.9	59.0	5.4	2.1	1.6	1.8
Oil	36.0	47.8	46.5	46.3	46.4	45.9	44.5	55.1	31.6	28.9	26.3	24.2	22.6	21.4	1.4	-0.3	-0.3	-0.3
Natural Gas	1.7	24.8	28.8	33.1	36.7	39.4	41.0	2.7	16.4	17.9	18.8	19.2	19.4	19.7	14.2	2.9	1.4	2.0

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	295.6	801.3	980.0	1,188.9	1,393.6	1,565.1	1,724.3	5.1	4.0	2.5	3.1
Population (millions of people)	42.9	49.4	50.6	51.4	52.0	52.2	51.9	0.7	0.4	0.1	0.2
GDP per capita (thousands of 2000 USD/person)	6.9	16.2	19.4	23.1	26.8	30.0	33.2	4.4	3.6	2.4	2.9
Primary energy consumption per capita (toe/person)	2.15	5.00	5.37	5.87	6.37	6.76	7.09	4.3	1.6	1.3	1.4
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	312	309	277	254	238	225	213	-0.1	-1.9	-1.2	-1.5
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	221	189	164	148	137	129	121	-0.8	-2.4	-1.4	-1.8
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.71	0.61	0.59	0.58	0.58	0.57	0.57	-0.7	-0.5	-0.2	-0.3
Automobile ownership volume (millions of vehicles)	3.40	17.93	19.86	22.20	24.08	25.41	26.05	8.7	2.2	1.1	1.5
Automobile ownership volume per capita (vehicles per person)	0.08	0.36	0.39	0.43	0.46	0.49	0.50	7.9	1.8	1.0	1.3

KOREA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**92.4**	**247.3**	**267.9**	**292.2**	**314.6**	**328.1**	**334.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.0**	**1.7**	**0.9**	**1.2**
Coal	25.6	73.4	72.4	74.2	75.8	76.7	73.5	27.7	29.7	27.0	25.4	24.1	23.4	22.0	5.4	0.1	-0.1	0.0
Oil	49.7	95.1	95.9	100.6	104.7	106.6	107.0	53.9	38.5	35.8	34.4	33.3	32.5	32.0	3.3	0.6	0.4	0.5
Natural gas	2.7	38.7	42.7	46.6	49.2	50.9	50.7	2.9	15.6	16.0	15.9	15.6	15.5	15.2	14.2	1.9	0.6	1.1
Nuclear	13.8	38.7	53.5	65.7	78.3	85.5	92.7	14.9	15.7	20.0	22.5	24.9	26.1	27.7	5.3	5.4	2.3	3.6
Hydro	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.1	0.1	0.1	0.1	0.1	0.1	-2.7	-2.0	0.0	-0.8
Geothermal	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	8.2	4.1	5.7
Others	0.0	1.0	3.1	4.7	6.4	8.0	10.0	0.0	0.4	1.1	1.6	2.0	2.4	3.0	25.9	16.9	5.1	9.6

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**64.9**	**157.4**	**170.7**	**185.4**	**198.3**	**206.3**	**210.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.5**	**1.7**	**0.9**	**1.2**
Industry	19.3	44.8	49.7	54.5	59.2	61.8	62.7	29.7	28.4	28.4	29.1	29.4	29.8	29.7	4.3	2.0	0.9	1.4
Transportation	14.6	29.9	31.0	31.8	30.9	29.6	27.9	22.5	19.0	19.0	18.1	17.1	15.6	13.2	3.7	0.6	-0.9	-0.3
Others	24.3	44.4	47.7	50.3	52.7	54.4	55.7	37.5	28.2	28.2	27.9	27.1	26.6	26.4	3.1	1.3	0.7	0.9
Non-energy	6.7	38.4	42.3	48.9	55.5	60.5	64.4	10.4	24.4	24.4	24.8	26.4	28.0	30.6	9.1	2.5	1.9	2.1
Total	**64.9**	**157.4**	**170.7**	**185.4**	**198.3**	**206.3**	**210.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.5**	**1.7**	**0.9**	**1.2**
Coal	11.7	9.5	9.6	9.2	8.8	8.2	7.6	18.1	6.1	5.6	4.9	4.4	4.0	3.6	-1.0	-0.4	-1.3	-0.9
Oil	43.7	81.9	83.4	88.1	91.9	94.0	94.8	67.3	52.0	48.8	47.5	46.4	45.6	45.0	3.2	0.7	0.5	0.6
Natural gas	0.7	20.4	25.1	28.4	31.0	33.0	34.2	1.0	12.9	14.7	15.3	15.6	16.0	16.2	18.6	3.4	1.2	2.1
Electricity	8.1	38.6	44.0	49.9	55.7	59.4	61.9	12.5	24.5	25.8	26.9	28.1	28.8	29.4	8.1	2.6	1.4	1.9
Heat	0.0	4.3	5.3	5.9	6.4	6.7	6.8	0.0	2.8	3.1	3.2	3.2	3.2	3.2	-	3.1	1.0	1.8
Others	0.7	2.7	3.4	3.9	4.5	5.0	5.4	1.1	1.7	2.0	2.1	2.3	2.4	2.6	6.7	3.9	2.1	2.8

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**105.4**	**496.7**	**557.4**	**631.8**	**703.8**	**751.3**	**782.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**2.4**	**1.4**	**1.8**
Coal	17.7	219.3	221.2	238.4	252.8	264.9	262.8	16.8	44.1	39.7	37.7	35.9	35.3	33.6	13.4	0.8	0.7	0.7
Oil	18.9	18.9	15.3	12.6	11.2	9.6	7.5	17.9	3.8	2.7	2.0	1.6	1.3	1.0	0.0	-4.0	-3.4	-3.6
Natural gas	9.6	103.2	100.1	103.6	103.8	102.7	96.1	9.1	20.8	17.9	16.4	14.7	13.7	12.3	12.6	0.0	-0.5	-0.3
Nuclear	52.9	148.6	205.3	252.0	300.4	328.0	355.6	50.2	29.9	36.8	39.9	42.7	43.7	45.4	5.3	5.4	2.3	3.6
Hydro	6.4	3.7	3.0	3.0	3.0	3.0	3.0	6.0	0.7	0.5	0.5	0.4	0.4	0.4	-2.7	-2.0	0.0	-0.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	3.0	12.5	22.1	32.6	43.0	57.7	0.0	0.6	2.2	3.5	4.6	5.7	7.4	49.3	21.9	6.6	12.5

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.5**	**74.8**	**72.3**	**74.5**	**76.2**	**77.0**	**72.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**9.4**	**0.0**	**-0.2**	**-0.1**
Coal	6.0	52.3	51.2	53.4	55.4	56.9	54.3	47.7	69.8	70.8	71.7	72.7	73.9	74.8	11.5	0.2	0.1	0.2
Oil	4.5	4.7	3.8	3.1	2.8	2.4	1.9	36.0	6.3	5.3	4.2	3.7	3.1	2.6	0.2	-4.0	-3.4	-3.6
Natural gas	2.0	17.9	17.3	17.9	18.0	17.7	16.4	16.3	23.9	24.0	24.1	23.6	23.0	22.6	11.5	0.0	-0.6	-0.3

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**31.7**	**39.2**	**40.0**	**40.9**	**41.5**	**42.1**	**43.4**								**1.1**	**0.4**	**0.4**	**0.4**
Coal	25.4	36.1	37.2	38.4	39.2	40.0	41.6								1.8	0.6	0.5	0.6
Oil	35.9	34.6	34.6	34.6	34.6	34.6	34.6								-0.2	0.0	0.0	0.0
Natural gas	40.6	49.7	49.7	49.7	49.7	49.8	50.3								1.0	0.0	0.1	0.1

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**65.3**	**151.5**	**150.2**	**153.2**	**154.4**	**154.0**	**147.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.3**	**0.1**	**-0.3**	**-0.1**
Coal	27.6	78.9	77.7	79.7	81.4	82.4	78.9	42.2	52.1	51.7	52.0	52.7	53.5	53.5	5.4	0.1	-0.1	0.0
Oil	36.0	47.8	45.1	43.6	41.5	39.0	36.0	55.1	31.6	30.0	28.5	26.9	25.3	24.4	1.4	-0.9	-1.3	-1.1
Natural Gas	1.7	24.8	27.4	29.8	31.5	32.6	32.5	2.7	16.4	18.2	19.5	20.4	21.2	22.1	14.2	1.9	0.6	1.1

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	295.6	801.3	980.0	1,188.9	1,393.6	1,565.1	1,724.3	5.1	4.0	2.5	3.1
Population (millions of people)	42.9	49.4	50.6	51.4	52.0	52.2	51.9	0.7	0.4	0.1	0.2
GDP per capita (thousands of 2000 USD/person)	6.9	16.2	19.4	23.1	26.8	30.0	33.2	4.4	3.6	2.4	2.9
Primary energy consumption per capita (toe/person)	2.15	5.00	5.29	5.68	6.05	6.28	6.44	4.3	1.3	0.8	1.0
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	312	309	273	246	226	210	194	-0.1	-2.3	-1.6	-1.8
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	221	189	153	129	111	98	85	-0.8	-3.8	-2.7	-3.1
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.71	0.61	0.56	0.52	0.49	0.47	0.44	-0.7	-1.5	-1.1	-1.3
Automobile ownership volume (millions of vehicles)	3.40	17.93	19.86	22.20	24.08	25.41	26.05	8.7	2.2	1.1	1.5
Automobile ownership volume per capita (vehicles per person)	0.08	0.36	0.39	0.43	0.46	0.49	0.50	7.9	1.8	1.0	1.3

LAO PDR [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.3**	**0.9**	**1.3**	**4.2**	**4.9**	**5.7**	**6.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**16.8**	**3.3**	**8.5**
Coal	0.0	0.1	0.2	3.8	3.9	3.9	4.0	0.0	11.9	11.8	90.6	79.1	68.7	58.5	-	43.1	0.3	15.6
Oil	0.2	0.5	0.8	1.0	1.4	1.8	2.4	72.8	60.0	56.4	24.1	27.7	31.4	34.8	5.5	6.6	5.8	6.1
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.1	0.7	1.9	3.1	4.4	4.5	4.7	28.1	81.3	145.6	74.6	88.9	78.6	68.2	12.4	15.8	2.6	7.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	-0.5	-1.5	-3.8	-4.7	-4.5	-4.2	-1.0	-53.2	-113.8	-89.3	-95.7	-78.6	-61.5	30.3	23.0	0.7	9.1

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**0.9**	**1.2**	**1.7**	**2.3**	**3.2**	**4.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.3**	**7.3**	**6.2**	**6.6**
Industry	0.0	0.2	0.3	0.4	0.5	0.7	0.9	1.3	20.3	20.3	22.0	22.4	22.4	21.9	24.0	8.4	6.0	6.9
Transportation	0.1	0.5	0.7	1.0	1.3	1.7	2.3	57.8	59.7	59.7	57.7	56.4	55.5	54.2	8.5	6.7	5.9	6.2
Others	0.1	0.2	0.2	0.4	0.5	0.7	1.0	40.8	19.7	19.7	20.0	21.0	21.9	23.8	4.4	8.0	7.1	7.4
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.2	0.2	0.1	-	3.3	2.9	3.1
Total	**0.2**	**0.9**	**1.2**	**1.7**	**2.3**	**3.2**	**4.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**7.6**	**7.3**	**6.2**	**6.6**
Coal	0.0	0.1	0.2	0.2	0.3	0.3	0.4	0.0	12.4	12.7	12.2	11.3	10.2	8.9	-	7.1	4.0	5.2
Oil	0.2	0.5	0.8	1.0	1.4	1.8	2.4	92.8	62.9	60.7	59.0	57.8	56.9	56.2	5.5	6.6	5.8	6.1
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Electricity	0.0	0.2	0.3	0.5	0.7	1.0	1.5	7.2	24.6	26.6	28.8	30.9	32.9	34.9	14.4	9.0	7.5	8.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.8**	**8.4**	**22.5**	**51.3**	**65.4**	**67.1**	**68.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.4**	**19.8**	**2.0**	**8.8**
Coal	0.0	0.0	0.0	14.7	14.7	14.7	14.7	0.0	0.0	0.0	28.7	22.5	21.9	21.4	-	-	0.0	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.8	8.4	22.5	36.6	50.7	52.4	54.1	100.0	100.0	100.0	71.3	77.5	78.1	78.6	12.4	15.8	2.6	7.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	0.0	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.0**	**0.0**	**0.0**	**3.6**	**3.6**	**3.6**	**3.6**	**-**	**-**	**-**	**100**	**100**	**100**	**100**	**-**	**-**	**0.0**	**-**
Coal	0.0	0.0	0.0	3.6	3.6	3.6	3.6	-	-	-	100.0	100.0	100.0	100.0	-	-	0.0	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	-	-	-	-
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	-	-	-	-

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**-**	**-**	**-**	**35.0**	**35.0**	**35.0**	**35.0**								**-**	**-**	**0.0**	**-**
Coal	-	-	-	35.0	35.0	35.0	35.0								-	-	0.0	-
Oil	-	-	-	-	-	-	-								-	-	-	-
Natural gas	-	-	-	-	-	-	-								-	-	-	-

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**0.6**	**0.8**	**5.3**	**5.6**	**6.0**	**6.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**25.1**	**1.5**	**10.3**
Coal	0.0	0.1	0.2	4.4	4.5	4.5	4.6	0.0	20.7	21.7	83.9	79.9	75.2	69.9	-	43.8	0.3	15.8
Oil	0.2	0.4	0.6	0.8	1.1	1.5	2.0	100.0	79.3	78.3	16.1	20.1	24.8	30.1	4.1	6.6	5.8	6.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Energy and economic indicators	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	0.9	3.4	4.9	6.8	9.6	13.4	18.9	6.9	7.1	7.0	7.0
Population (millions of people)	4.1	6.2	6.7	7.2	7.8	8.4	9.0	2.1	1.5	1.5	1.5
GDP per capita (thousands of 2000 USD/person)	0.2	0.6	0.7	0.9	1.2	1.6	2.1	4.8	5.5	5.4	5.5
Primary energy consumption per capita (toe/person)	0.06	0.14	0.20	0.59	0.63	0.68	0.76	4.4	15.1	1.7	6.9
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	279	260	274	618	512	427	362	-0.4	9.1	-3.5	1.3
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	222	163	164	769	584	448	348	-1.5	16.8	-5.1	3.1
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.80	0.63	0.60	1.24	1.14	1.05	0.96	-1.2	7.1	-1.7	1.7
Automobile ownership volume (millions of vehicles)	0.12	0.32	0.35	0.39	0.42	0.46	0.49	5.0	2.0	1.6	1.8
Automobile ownership volume per capita (vehicles per person)	0.03	0.05	0.05	0.05	0.05	0.05	0.05	2.8	0.5	0.1	0.3

LAO PDR [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.3**	**0.9**	**1.2**	**4.1**	**4.7**	**5.4**	**6.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**16.3**	**3.1**	**8.2**
Coal	0.0	0.1	0.1	3.8	3.9	3.9	4.0	0.0	11.9	11.7	93.9	82.5	72.1	61.8	-	43.0	0.3	15.6
Oil	0.2	0.5	0.7	0.9	1.2	1.6	2.1	72.8	60.0	56.2	22.7	26.3	30.0	33.5	5.5	5.5	5.8	5.7
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.1	0.7	1.9	3.1	4.4	4.5	4.7	28.1	81.3	160.3	77.7	93.4	83.2	72.7	12.4	15.8	2.6	7.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	-0.5	-1.5	-3.8	-4.8	-4.6	-4.4	-1.0	-53.2	-128.1	-94.3	-102.2	-85.2	-68.0	30.3	23.2	0.9	9.3

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**0.9**	**1.1**	**1.6**	**2.1**	**2.9**	**3.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.3**	**6.2**	**6.2**	**6.2**
Industry	0.0	0.2	0.2	0.3	0.5	0.6	0.8	1.3	20.3	20.3	21.9	22.3	22.4	21.9	24.0	7.2	6.0	6.5
Transportation	0.1	0.5	0.6	0.9	1.2	1.6	2.1	57.8	59.7	59.7	57.6	56.3	55.4	54.2	8.5	5.6	5.9	5.8
Others	0.1	0.2	0.2	0.3	0.5	0.7	0.9	40.8	19.7	19.7	20.2	21.1	22.0	23.8	4.4	6.9	7.0	7.0
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.2	0.2	0.1	-	2.7	2.9	2.8
Total	**0.2**	**0.9**	**1.1**	**1.6**	**2.1**	**2.9**	**3.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**7.6**	**6.2**	**6.2**	**6.2**
Coal	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.0	12.4	12.7	12.2	11.3	10.2	8.9	-	5.9	4.0	4.8
Oil	0.2	0.5	0.7	0.9	1.2	1.6	2.1	92.8	62.9	60.8	59.1	57.9	57.0	56.3	5.5	5.5	5.8	5.7
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Electricity	0.0	0.2	0.3	0.4	0.7	0.9	1.3	7.2	24.6	26.6	28.8	30.8	32.8	34.8	14.4	7.9	7.5	7.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.8**	**8.4**	**22.5**	**51.3**	**65.4**	**67.1**	**68.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.4**	**19.8**	**2.0**	**8.8**
Coal	0.0	0.0	0.0	14.7	14.7	14.7	14.7	0.0	0.0	0.0	28.7	22.5	21.9	21.4	-	-	0.0	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.8	8.4	22.5	36.6	50.7	52.4	54.1	100.0	100.0	100.0	71.3	77.5	78.1	78.6	12.4	15.8	2.6	7.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.0**	**0.0**	**0.0**	**3.6**	**3.6**	**3.6**	**3.6**	**-**	**-**	**-**	**100**	**100**	**100**	**100**	**-**	**-**	**0.0**	**-**
Coal	0.0	0.0	0.0	3.6	3.6	3.6	3.6	-	-	-	100.0	100.0	100.0	100.0	-	-	0.0	-
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	-	-	-	-
Natural gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	0.0	-	-	-	-

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**-**	**-**	**-**	**35.0**	**35.0**	**35.0**	**35.0**								**-**	**-**	**0.0**	**-**
Coal	-	-	-	35.0	35.0	35.0	35.0								-	-	0.0	-
Oil	-	-	-	-	-	-	-								-	-	-	-
Natural gas	-	-	-	-	-	-	-								-	-	-	-

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.2**	**0.6**	**0.7**	**5.1**	**5.5**	**5.8**	**6.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.3**	**24.8**	**1.4**	**10.2**
Coal	0.0	0.1	0.2	4.4	4.4	4.5	4.6	0.0	20.7	21.6	85.2	81.3	76.9	71.8	-	43.7	0.2	15.8
Oil	0.2	0.4	0.6	0.8	1.0	1.4	1.8	100.0	79.3	78.4	14.8	18.7	23.1	28.2	4.1	5.5	5.8	5.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Energy and economic indicators	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	0.9	3.4	4.9	6.8	9.6	13.4	18.9	6.9	7.1	7.0	7.0
Population (millions of people)	4.1	6.2	6.7	7.2	7.8	8.4	9.0	2.1	1.5	1.5	1.5
GDP per capita (thousands of 2000 USD/person)	0.2	0.6	0.7	0.9	1.2	1.6	2.1	4.8	5.5	5.4	5.5
Primary energy consumption per capita (toe/person)	0.06	0.14	0.18	0.56	0.60	0.65	0.71	4.4	14.6	1.6	6.6
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	279	260	249	593	487	403	339	-0.4	8.6	-3.6	1.1
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	222	163	148	753	570	435	336	-1.5	16.5	-5.2	2.9
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.80	0.63	0.59	1.27	1.17	1.08	0.99	-1.2	7.3	-1.7	1.8
Automobile ownership volume (millions of vehicles)	0.12	0.32	0.35	0.39	0.42	0.46	0.49	5.0	2.0	1.6	1.8
Automobile ownership volume per capita (vehicles per person)	0.03	0.05	0.05	0.05	0.05	0.05	0.05	2.8	0.5	0.1	0.3

MALAYSIA [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**19.5**	**69.2**	**75.5**	**93.0**	**111.3**	**134.1**	**160.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**3.0**	**3.7**	**3.4**
Coal	1.4	14.6	16.8	20.8	24.6	30.1	37.3	7.0	21.1	22.3	22.4	22.1	22.4	23.2	12.6	3.6	4.0	3.8
Oil	11.4	26.0	36.8	45.1	53.3	62.7	73.4	58.2	37.6	48.7	48.5	47.9	46.8	45.7	4.2	5.7	3.3	4.2
Natural gas	6.1	28.1	20.3	25.5	31.8	39.7	48.2	31.4	40.5	26.9	27.4	28.6	29.6	30.0	7.9	-1.0	4.3	2.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.3	0.6	1.6	1.6	1.6	1.6	1.6	1.8	0.8	2.1	1.7	1.4	1.2	1.0	2.4	11.1	0.0	4.3
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.3	0.0	0.0	0.0	0.0	0.0	0.1	1.7	0.0	0.0	0.0	0.0	0.0	0.1	-100.0	-	-	-

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.7**	**41.6**	**57.9**	**72.2**	**87.3**	**104.7**	**125.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**5.7**	**3.7**	**4.5**
Industry	5.6	13.0	18.3	23.1	28.3	34.2	41.3	43.7	31.3	31.3	31.6	32.0	32.4	33.0	4.4	5.9	3.9	4.7
Transportation	4.8	14.4	24.7	31.3	37.7	45.0	53.4	37.4	34.7	34.7	42.7	43.4	43.2	42.7	5.7	8.1	3.6	5.4
Others	1.6	8.0	9.2	11.8	14.7	18.0	21.6	12.8	19.3	19.3	15.9	16.3	16.8	17.3	8.3	3.9	4.1	4.0
Non-energy	0.8	6.1	5.7	6.0	6.6	7.5	8.7	6.1	14.7	14.7	9.8	8.3	7.6	7.0	10.9	-0.2	2.5	1.4
Total	**12.7**	**41.6**	**57.9**	**72.2**	**87.3**	**104.7**	**125.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**5.7**	**3.7**	**4.5**
Coal	0.5	1.8	1.9	2.4	2.8	3.4	4.0	4.0	4.4	3.3	3.3	3.2	3.2	3.2	6.6	2.8	3.5	3.2
Oil	9.2	24.6	35.9	43.9	52.0	61.2	71.8	72.2	59.2	62.0	60.8	59.6	58.5	57.4	5.1	5.9	3.3	4.4
Natural gas	1.0	5.6	7.5	9.7	12.4	15.6	19.7	7.7	13.5	13.0	13.4	14.2	14.9	15.8	9.1	5.6	4.8	5.1
Electricity	1.7	9.5	12.4	15.9	19.8	24.1	29.1	13.5	22.9	21.4	22.0	22.7	23.0	23.3	9.0	5.2	4.1	4.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.3	0.0	0.2	0.3	0.3	0.4	0.4	2.6	0.0	0.3	0.4	0.3	0.4	0.3	-100.0	-	1.9	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**23.0**	**124.1**	**161.2**	**205.1**	**254.0**	**309.1**	**371.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.8**	**5.2**	**4.0**	**4.5**
Coal	2.9	43.1	69.7	92.2	119.6	151.4	186.2	12.7	34.7	43.2	45.0	47.1	49.0	50.1	14.4	7.9	4.8	6.0
Oil	11.1	3.7	0.9	1.0	1.0	1.0	1.0	48.3	3.0	0.6	0.5	0.4	0.3	0.3	-5.3	-12.3	0.0	-5.1
Natural gas	5.0	70.8	71.9	93.2	114.7	138.0	165.9	21.7	57.1	44.6	45.4	45.2	44.6	44.6	14.2	2.8	3.9	3.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	4.0	6.5	18.4	18.4	18.4	18.4	18.4	17.3	5.2	11.4	9.0	7.2	6.0	4.9	2.5	11.0	0.0	4.3
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.2	0.1	0.1	0.1	0.1	-	-	0.0	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**5.0**	**26.8**	**29.5**	**38.0**	**46.9**	**56.6**	**67.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.7**	**3.6**	**3.9**	**3.8**
Coal	0.8	10.6	16.9	22.0	27.8	33.8	40.0	16.2	39.6	57.3	57.9	59.3	59.7	59.4	13.7	7.6	4.1	5.5
Oil	3.0	1.0	0.2	0.2	0.2	0.2	0.2	59.5	3.7	0.7	0.5	0.4	0.4	0.3	-5.3	-14.9	0.0	-6.2
Natural gas	1.2	15.2	12.4	15.8	18.9	22.6	27.1	24.4	56.7	42.0	41.6	40.3	39.9	40.3	13.4	0.4	3.7	2.3

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.6**	**37.7**	**41.5**	**42.2**	**43.1**	**44.1**	**45.1**								**0.7**	**1.1**	**0.4**	**0.7**
Coal	31.0	35.0	35.5	36.0	37.0	38.5	40.0								0.6	0.3	0.7	0.5
Oil	32.0	31.8	38.7	43.0	43.0	43.0	43.0								0.0	3.1	0.0	1.2
Natural gas	35.0	40.1	49.9	50.7	52.2	52.5	52.6								0.7	2.4	0.2	1.1

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**13.6**	**42.8**	**57.1**	**73.0**	**89.3**	**107.5**	**127.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.9**	**5.5**	**3.8**	**4.5**
Coal	1.4	13.1	19.9	25.8	32.4	39.4	46.6	10.3	30.6	34.9	35.3	36.3	36.7	36.4	11.8	7.0	4.0	5.2
Oil	10.3	17.4	25.9	32.7	39.1	46.3	54.6	75.7	40.7	45.4	44.8	43.8	43.1	42.7	2.7	6.5	3.5	4.7
Natural Gas	1.9	12.3	11.3	14.5	17.8	21.8	26.7	14.0	28.7	19.8	19.9	19.9	20.3	20.9	9.8	1.7	4.2	3.1

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	47.2	147.3	183.6	226.6	269.1	319.6	375.9	5.9	4.4	3.4	3.8
Population (millions of people)	18.2	28.4	30.7	32.9	35.0	37.0	38.9	2.2	1.5	1.1	1.3
GDP per capita (thousands of 2000 USD/person)	2.6	5.2	6.0	6.9	7.7	8.6	9.7	3.5	2.9	2.3	2.5
Primary energy consumption per capita (toe/person)	1.07	2.44	2.46	2.83	3.18	3.62	4.13	4.2	1.5	2.6	2.1
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	413	470	411	410	414	420	427	0.7	-1.4	0.3	-0.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	288	291	311	322	332	336	340	0.0	1.0	0.4	0.6
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.70	0.62	0.76	0.78	0.80	0.80	0.80	-0.6	2.4	0.1	1.0
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

MALAYSIA [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**19.5**	**69.2**	**69.3**	**82.7**	**97.3**	**114.0**	**131.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.5**	**1.8**	**3.2**	**2.6**
Coal	1.4	14.6	16.2	17.6	19.3	22.9	27.2	7.0	21.1	23.4	21.3	19.8	20.1	20.7	12.6	1.9	2.9	2.5
Oil	11.4	26.0	30.1	36.0	42.1	49.0	56.6	58.2	37.6	43.4	43.5	43.3	43.0	43.0	4.2	3.3	3.1	3.2
Natural gas	6.1	28.1	20.0	25.0	29.4	34.5	40.1	31.4	40.5	28.9	30.2	30.2	30.3	30.4	7.9	-1.2	3.2	1.4
Nuclear	0.0	0.0	0.0	0.0	1.2	1.2	1.1	0.0	0.0	0.0	0.0	1.2	1.1	0.8	-	-	-	-
Hydro	0.3	0.6	1.6	1.7	1.7	1.8	1.8	1.8	0.8	2.3	2.1	1.7	1.6	1.4	2.4	11.8	0.4	4.8
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.3	0.0	1.4	2.4	3.6	4.6	4.9	1.7	0.0	2.0	2.9	3.7	4.0	3.7	-100.0	-	4.9	-

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.7**	**41.6**	**51.6**	**62.4**	**73.9**	**86.6**	**100.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**4.1**	**3.2**	**3.6**
Industry	5.6	13.0	17.9	21.5	25.0	28.8	32.8	43.7	31.3	31.3	34.7	34.5	33.8	32.6	4.4	5.1	2.9	3.8
Transportation	4.8	14.4	18.9	23.6	28.6	34.2	40.7	37.4	34.7	34.7	36.6	37.8	38.7	40.4	5.7	5.0	3.7	4.2
Others	1.6	8.0	9.1	11.3	13.6	15.9	18.4	12.8	19.3	19.3	17.6	18.1	18.4	18.3	8.3	3.5	3.3	3.4
Non-energy	0.8	6.1	5.7	6.0	6.7	7.7	8.8	6.1	14.7	14.7	11.0	9.6	9.1	8.7	10.9	-0.2	2.6	1.5
Total	**12.7**	**41.6**	**51.6**	**62.4**	**73.9**	**86.6**	**100.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.1**	**4.1**	**3.2**	**3.6**
Coal	0.5	1.8	1.9	2.2	2.5	2.9	3.2	4.0	4.4	3.7	3.5	3.4	3.3	3.2	6.6	1.9	2.5	2.3
Oil	9.2	24.6	29.1	34.8	40.6	47.3	54.8	72.2	59.2	56.4	55.8	54.9	54.6	54.4	5.1	3.5	3.1	3.3
Natural gas	1.0	5.6	7.5	9.4	11.6	14.2	17.2	7.7	13.5	14.5	15.1	15.7	16.4	17.1	9.1	5.3	4.1	4.6
Electricity	1.7	9.5	12.3	15.0	17.9	20.7	23.7	13.5	22.9	23.8	24.0	24.2	23.9	23.5	9.0	4.6	3.1	3.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.3	0.0	0.8	1.0	1.3	1.5	1.8	2.6	0.0	1.6	1.6	1.8	1.7	1.8	-100.0	-	4.0	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**23.0**	**124.1**	**160.8**	**196.5**	**233.2**	**270.7**	**308.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.8**	**4.7**	**3.1**	**3.7**
Coal	2.9	43.1	67.2	82.8	99.7	117.2	139.5	12.7	34.7	41.8	42.1	42.8	43.3	45.2	14.4	6.7	3.5	4.8
Oil	11.1	3.7	0.9	1.0	1.0	1.0	1.0	48.3	3.0	0.6	0.5	0.4	0.4	0.3	-5.3	-12.3	0.0	-5.1
Natural gas	5.0	70.8	69.9	85.8	96.9	112.8	128.6	21.7	57.1	43.5	43.7	41.6	41.7	41.6	14.2	1.9	2.7	2.4
Nuclear	0.0	0.0	0.0	0.0	4.5	4.4	4.4	0.0	0.0	0.0	0.0	1.9	1.6	1.4	-	-	-	-
Hydro	4.0	6.5	18.9	19.4	19.9	20.4	20.4	17.3	5.2	11.8	9.9	8.5	7.5	6.6	2.5	11.6	0.3	4.7
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	3.9	7.5	11.2	14.9	14.9	0.0	0.0	2.4	3.8	4.8	5.5	4.8	-	-	4.7	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**5.0**	**26.8**	**27.9**	**33.0**	**35.0**	**40.8**	**47.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.7**	**2.1**	**2.5**	**2.3**
Coal	0.8	10.6	15.6	18.2	18.7	22.0	26.2	16.2	39.6	55.9	55.2	53.4	53.9	55.2	13.7	5.6	2.5	3.7
Oil	3.0	1.0	0.2	0.2	0.2	0.2	0.2	59.5	3.7	0.7	0.6	0.6	0.5	0.4	-5.3	-14.9	0.0	-6.2
Natural gas	1.2	15.2	12.1	14.6	16.1	18.6	21.1	24.4	56.7	43.4	44.2	46.0	45.6	44.4	13.4	-0.4	2.5	1.3

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.6**	**37.7**	**42.5**	**44.2**	**48.6**	**48.7**	**48.7**								**0.7**	**1.6**	**0.7**	**1.0**
Coal	31.0	35.0	37.0	39.1	45.9	45.8	45.8								0.6	1.1	1.1	1.1
Oil	32.0	31.8	38.7	43.0	43.0	43.0	43.0								0.0	3.1	0.0	1.2
Natural gas	35.0	40.1	49.7	50.5	51.8	52.2	52.4								0.7	2.4	0.2	1.1

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**13.6**	**42.8**	**50.4**	**60.9**	**68.5**	**80.3**	**94.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.9**	**3.6**	**3.0**	**3.2**
Coal	1.4	13.1	18.5	21.6	22.5	26.3	31.1	10.3	30.6	36.7	35.5	32.8	32.8	33.0	11.8	5.1	2.5	3.5
Oil	10.3	17.4	20.9	25.8	30.6	35.8	41.8	75.7	40.7	41.5	42.4	44.7	44.6	44.4	2.7	4.0	3.3	3.6
Natural Gas	1.9	12.3	11.0	13.5	15.4	18.2	21.3	14.0	28.7	21.8	22.2	22.5	22.7	22.6	9.8	0.9	3.1	2.2

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	47.2	147.3	183.6	226.6	269.1	319.6	375.9	5.9	4.4	3.4	3.8
Population (millions of people)	18.2	28.4	30.7	32.9	35.0	37.0	38.9	2.2	1.5	1.1	1.3
GDP per capita (thousands of 2000 USD/person)	2.6	5.2	6.0	6.9	7.7	8.6	9.7	3.5	2.9	2.3	2.5
Primary energy consumption per capita (toe/person)	1.07	2.44	2.26	2.51	2.78	3.08	3.39	4.2	0.3	2.0	1.3
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	413	470	377	365	362	357	350	0.7	-2.5	-0.3	-1.2
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	288	291	275	269	255	251	251	0.0	-0.8	-0.5	-0.6
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.70	0.62	0.73	0.74	0.70	0.70	0.72	-0.6	1.8	-0.2	0.6
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

MYANMAR [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.7**	**6.0**	**7.8**	**10.1**	**13.6**	**17.8**	**23.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.7**	**5.3**	**5.9**	**5.7**
Coal	0.1	0.4	0.5	1.0	2.1	2.2	2.4	4.0	6.8	7.0	10.3	15.3	12.1	9.9	9.5	9.7	5.6	7.2
Oil	0.7	1.8	2.6	3.6	5.1	7.2	10.1	44.0	29.2	33.1	35.7	37.6	40.3	42.4	4.5	7.5	7.1	7.2
Natural gas	0.8	1.4	2.0	2.8	3.5	5.4	8.0	45.8	23.4	26.4	27.6	26.1	30.3	33.6	3.1	7.1	7.3	7.2
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.1	0.4	0.6	0.6	0.7	0.8	0.9	6.2	7.3	7.5	6.2	4.9	4.4	3.9	7.5	3.6	2.8	3.1
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	2.0	2.0	2.1	2.2	2.3	2.4	0.0	33.3	26.0	20.3	16.1	12.9	10.1	-	0.2	1.1	0.7

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.0**	**3.2**	**4.5**	**6.2**	**8.5**	**11.7**	**16.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**6.7**	**6.6**	**6.6**
Industry	0.4	0.9	1.3	1.7	2.3	3.1	4.2	39.0	29.2	29.2	29.0	27.8	26.9	25.8	4.5	6.2	6.0	6.1
Transportation	0.4	1.7	2.4	3.3	4.7	6.6	9.2	44.0	51.5	51.5	52.1	53.7	55.0	57.1	6.9	7.1	7.0	7.1
Others	0.1	0.5	0.7	1.0	1.4	1.9	2.6	7.8	16.0	16.0	16.2	16.4	16.5	16.2	9.9	7.0	6.5	6.7
Non-energy	0.1	0.1	0.1	0.1	0.1	0.1	0.1	9.2	3.3	3.3	2.7	2.1	1.6	0.9	0.7	2.0	0.8	1.3
Total	**1.0**	**3.2**	**4.5**	**6.2**	**8.5**	**11.7**	**16.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**6.7**	**6.6**	**6.6**
Coal	0.1	0.2	0.3	0.5	0.6	0.8	1.1	5.0	7.2	7.7	7.3	7.0	6.8	6.6	7.9	6.8	5.9	6.3
Oil	0.6	1.7	2.3	3.3	4.6	6.4	9.1	58.0	51.0	51.1	52.3	53.6	54.9	56.1	5.3	7.0	7.1	7.0
Natural gas	0.2	0.8	1.0	1.3	1.7	2.2	2.8	22.3	25.3	23.1	21.4	19.9	18.6	17.5	6.7	4.9	5.1	5.1
Electricity	0.1	0.5	0.8	1.2	1.7	2.3	3.2	14.7	16.5	18.1	19.0	19.5	19.7	19.8	6.6	8.2	6.9	7.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2.5**	**7.5**	**11.4**	**16.4**	**23.2**	**32.2**	**44.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.7**	**8.1**	**6.9**	**7.4**
Coal	0.0	0.7	0.7	2.2	5.5	5.1	4.8	1.6	8.9	6.5	13.5	24.0	15.9	10.9	15.1	12.7	5.4	8.2
Oil	0.3	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.4	0.0	0.0	0.0	0.0	0.0	-10.0	-100.0	-	-100.0
Natural gas	1.0	1.7	3.9	6.5	8.0	14.9	24.3	39.3	23.0	34.1	39.3	34.5	46.1	54.5	2.9	14.1	9.2	11.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	1.2	5.1	6.8	7.3	7.8	9.1	11.0	48.1	67.7	59.2	44.3	33.7	28.3	24.6	7.5	3.6	2.8	3.1
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.5	1.8	3.1	4.5	0.0	0.0	0.3	3.0	7.8	9.8	10.0	-	-	15.9	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**0.7**	**1.1**	**1.9**	**3.0**	**4.2**	**5.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.8**	**10.0**	**8.0**	**8.8**
Coal	0.0	0.2	0.2	0.6	1.5	1.4	1.3	2.4	24.7	18.5	31.6	48.6	32.5	21.8	14.5	12.7	5.4	8.2
Oil	0.1	0.0	0.0	0.0	0.0	0.0	0.0	12.5	1.1	0.0	0.0	0.0	0.0	0.0	-9.9	-100.0	-	-100.0
Natural gas	0.4	0.5	0.9	1.3	1.6	2.8	4.6	85.1	74.2	81.5	68.4	51.4	67.5	78.2	1.1	9.1	9.0	9.0

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**21.7**	**28.9**	**37.5**	**39.8**	**38.2**	**40.9**	**42.2**								**1.5**	**3.3**	**0.4**	**1.5**
Coal	28.7	32.2	32.2	32.2	32.2	32.2	32.2								0.6	0.0	0.0	0.0
Oil	36.4	35.5	-	-	-	-	-								-0.1	-	-	-
Natural gas	19.3	27.7	38.6	43.3	43.9	45.0	45.0								1.8	4.6	0.3	2.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.1**	**2.7**	**3.9**	**5.8**	**8.5**	**11.5**	**15.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**7.7**	**6.9**	**7.3**
Coal	0.1	0.4	0.6	1.1	2.3	2.4	2.6	7.4	16.5	15.2	19.8	26.6	20.6	16.4	8.8	9.7	5.6	7.2
Oil	0.6	1.4	2.0	2.8	4.0	5.7	8.0	50.4	51.3	51.8	49.5	47.2	49.5	51.1	4.7	7.4	7.1	7.2
Natural Gas	0.5	0.9	1.3	1.8	2.2	3.4	5.1	42.2	32.3	33.0	30.7	26.2	29.9	32.5	3.2	7.2	7.3	7.3

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	3.7	20.3	28.5	40.0	56.0	78.6	110.2	8.9	7.0	7.0	7.0
Population (millions of people)	39.3	48.0	50.4	52.9	55.5	58.3	61.2	1.0	1.0	1.0	1.0
GDP per capita (thousands of 2000 USD/person)	0.1	0.4	0.6	0.8	1.0	1.3	1.8	7.8	6.0	6.0	6.0
Primary energy consumption per capita (toe/person)	0.04	0.13	0.15	0.19	0.24	0.31	0.39	5.6	4.3	4.8	4.6
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	451	297	272	254	242	227	217	-2.1	-1.6	-1.1	-1.3
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	301	134	137	144	152	146	142	-4.0	0.7	-0.1	0.2
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.67	0.45	0.50	0.57	0.63	0.64	0.66	-1.9	2.3	1.0	1.5
Automobile ownership volume (millions of vehicles)	0.07	0.36	0.43	0.55	0.73	1.07	1.76	8.6	4.2	8.1	6.5
Automobile ownership volume per capita (vehicles per person)	0.00	0.01	0.01	0.01	0.01	0.02	0.03	7.5	3.2	7.1	5.5

MYANMAR [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.7**	**6.0**	**7.6**	**9.9**	**12.6**	**16.0**	**21.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.7**	**5.1**	**5.3**	**5.2**
Coal	0.1	0.4	0.5	1.1	1.9	1.8	2.1	4.0	6.9	7.0	10.9	15.0	11.3	9.7	9.5	10.0	4.4	6.6
Oil	0.7	1.8	2.5	3.5	4.8	6.7	9.4	44.0	29.2	32.9	35.0	38.2	41.7	44.1	4.5	7.0	6.9	6.9
Natural gas	0.8	1.4	2.0	2.7	2.9	4.1	6.0	45.8	23.4	26.3	27.2	23.1	25.9	28.3	3.1	6.7	5.5	6.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.1	0.4	0.6	0.6	0.7	0.8	1.0	6.2	7.3	7.3	6.0	5.3	5.2	4.9	7.5	3.0	3.8	3.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	2.0	2.0	2.1	2.3	2.6	2.8	0.0	33.2	26.4	20.9	18.4	16.0	13.1	-	0.3	2.1	1.3

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.0**	**3.2**	**4.4**	**5.9**	**8.0**	**10.8**	**14.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**6.2**	**6.3**	**6.3**
Industry	0.4	0.9	1.3	1.6	2.1	2.8	3.8	39.0	29.2	29.2	28.9	27.7	26.7	25.6	4.5	5.7	5.8	5.7
Transportation	0.4	1.7	2.3	3.2	4.4	6.1	8.5	44.0	51.5	51.5	52.1	53.6	55.1	57.4	6.9	6.6	6.8	6.7
Others	0.1	0.5	0.7	1.0	1.3	1.8	2.4	7.8	16.0	16.0	16.2	16.5	16.5	16.0	9.9	6.5	6.1	6.3
Non-energy	0.1	0.1	0.1	0.1	0.1	0.1	0.1	9.2	3.3	3.3	2.8	2.2	1.7	1.0	0.7	2.0	0.8	1.3
Total	**1.0**	**3.2**	**4.4**	**5.9**	**8.0**	**10.8**	**14.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.0**	**6.2**	**6.3**	**6.3**
Coal	0.1	0.2	0.3	0.4	0.6	0.7	1.0	5.0	7.2	7.7	7.2	7.0	6.8	6.6	7.9	6.3	5.7	5.9
Oil	0.6	1.7	2.3	3.1	4.3	6.0	8.4	58.0	51.0	51.2	52.4	53.9	55.3	56.5	5.3	6.5	6.8	6.7
Natural gas	0.2	0.8	1.0	1.3	1.6	2.0	2.6	22.3	25.3	23.2	21.4	20.0	18.7	17.5	6.7	4.5	4.9	4.7
Electricity	0.1	0.5	0.8	1.1	1.5	2.1	2.9	14.7	16.5	18.0	18.9	19.2	19.3	19.3	6.6	7.7	6.5	7.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2.5**	**7.5**	**11.1**	**15.6**	**21.4**	**29.0**	**40.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.7**	**7.5**	**6.5**	**6.9**
Coal	0.0	0.7	0.7	2.4	5.0	4.0	4.0	1.6	8.9	6.6	15.5	23.3	13.9	10.0	15.1	13.7	3.4	7.4
Oil	0.3	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.4	0.0	0.0	0.0	0.0	0.0	-10.0	-100.0	-	-100.0
Natural gas	1.0	1.7	3.9	5.8	5.4	9.2	15.2	39.3	23.0	34.8	37.2	25.4	31.8	37.9	2.9	12.9	6.6	9.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	1.2	5.1	6.5	6.9	7.7	9.6	12.0	48.1	67.7	58.3	44.1	35.8	33.2	29.9	7.5	3.0	3.8	3.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.5	3.3	6.1	8.9	0.0	0.0	0.3	3.2	15.4	21.0	22.2	-	-	21.1	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**0.5**	**0.7**	**1.1**	**1.9**	**2.4**	**2.8**	**4.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.8**	**10.0**	**5.1**	**7.0**
Coal	0.0	0.2	0.2	0.6	1.3	1.1	1.1	2.4	24.7	18.7	34.2	55.9	37.9	26.8	14.5	13.7	3.4	7.4
Oil	0.1	0.0	0.0	0.0	0.0	0.0	0.0	12.5	1.1	0.0	0.0	0.0	0.0	0.0	-9.9	-100.0	-	-100.0
Natural gas	0.4	0.5	0.9	1.2	1.0	1.8	2.9	85.1	74.2	81.3	65.8	44.1	62.1	73.2	1.1	8.7	5.9	7.0

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**21.7**	**28.9**	**37.5**	**37.6**	**37.7**	**40.2**	**41.6**								**1.5**	**2.7**	**0.7**	**1.5**
Coal	28.7	32.2	32.2	32.2	32.2	32.2	32.2								0.6	0.0	0.0	0.0
Oil	36.4	35.5	-	-	-	-	-								-0.1	-	-	-
Natural gas	19.3	27.7	38.8	40.4	44.7	45.0	45.0								1.8	3.8	0.7	2.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.1**	**2.7**	**3.8**	**5.6**	**7.7**	**9.9**	**13.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.6**	**7.4**	**6.1**	**6.6**
Coal	0.1	0.4	0.6	1.2	2.1	2.0	2.2	7.4	16.5	15.3	21.0	26.9	20.0	16.6	8.8	10.1	4.4	6.6
Oil	0.6	1.4	2.0	2.7	3.8	5.3	7.4	50.4	51.3	51.7	48.7	49.3	53.4	55.0	4.7	6.9	6.9	6.9
Natural Gas	0.5	0.9	1.3	1.7	1.8	2.6	3.8	42.2	32.3	33.0	30.3	23.8	26.6	28.4	3.2	6.8	5.6	6.1

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	3.7	20.3	28.5	40.0	56.0	78.6	110.2	8.9	7.0	7.0	7.0
Population (millions of people)	39.3	48.0	50.4	52.9	55.5	58.3	61.2	1.0	1.0	1.0	1.0
GDP per capita (thousands of 2000 USD/person)	0.1	0.4	0.6	0.8	1.0	1.3	1.8	7.8	6.0	6.0	6.0
Primary energy consumption per capita (toe/person)	0.04	0.13	0.15	0.19	0.23	0.27	0.35	5.6	4.0	4.2	4.2
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	451	297	268	247	224	203	193	-2.1	-1.8	-1.6	-1.7
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	301	134	134	140	137	125	122	-4.0	0.4	-0.9	-0.4
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.67	0.45	0.50	0.57	0.61	0.62	0.63	-1.9	2.3	0.8	1.4
Automobile ownership volume (millions of vehicles)	0.07	0.36	0.43	0.55	0.73	1.07	1.76	8.6	4.2	8.1	6.5
Automobile ownership volume per capita (vehicles per person)	0.00	0.01	0.01	0.01	0.01	0.02	0.03	7.5	3.2	7.1	5.5

NEW ZEALAND [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.9**	**18.2**	**18.7**	**19.7**	**20.8**	**21.9**	**23.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.7**	**0.8**	**1.0**	**1.0**
Coal	1.2	1.3	1.2	1.1	1.0	0.9	0.9	9.2	7.2	6.4	5.7	4.8	4.2	4.0	0.5	-1.6	-1.3	-1.4
Oil	3.6	6.0	5.8	5.8	5.8	5.9	6.0	27.6	33.2	31.2	29.4	28.0	26.9	25.8	2.7	-0.4	0.2	-0.1
Natural gas	3.9	3.7	3.8	4.0	4.0	3.9	3.4	30.1	20.5	20.3	20.2	19.4	17.7	14.7	-0.2	0.7	-1.1	-0.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	2.0	2.1	2.2	2.2	2.2	2.3	2.3	15.5	11.7	11.5	11.1	10.7	10.3	9.9	0.3	0.3	0.3	0.3
Geothermal	1.5	3.6	4.2	4.9	5.8	6.8	8.0	11.5	20.0	22.3	25.0	27.8	31.0	34.5	4.6	3.1	3.2	3.2
Others	0.8	1.4	1.5	1.7	1.9	2.2	2.5	6.2	7.5	8.2	8.7	9.2	10.0	11.0	2.7	2.4	2.7	2.5

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**10.0**	**12.8**	**12.9**	**13.2**	**13.5**	**13.9**	**14.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**0.3**	**0.5**	**0.4**
Industry	3.8	3.9	3.9	4.0	4.1	4.2	4.3	38.6	30.5	30.5	30.4	30.5	30.5	30.3	0.1	0.3	0.5	0.4
Transportation	3.0	4.6	4.5	4.5	4.6	4.6	4.7	29.7	36.1	36.1	35.3	34.5	33.9	32.8	2.2	-0.1	0.2	0.1
Others	2.5	3.4	3.5	3.7	3.9	4.1	4.2	25.5	26.3	26.3	27.1	27.8	28.6	29.8	1.4	0.9	1.0	0.9
Non-energy	0.6	0.9	0.9	0.9	1.0	1.0	1.0	6.2	7.1	7.1	7.1	7.1	7.1	7.1	2.0	0.3	0.5	0.4
Total	**10.0**	**12.8**	**12.9**	**13.2**	**13.5**	**13.9**	**14.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**0.3**	**0.5**	**0.4**
Coal	0.9	0.6	0.6	0.7	0.7	0.7	0.7	9.3	4.7	4.8	5.0	5.0	5.0	5.0	-2.1	1.0	0.5	0.7
Oil	4.0	5.9	5.7	5.6	5.7	5.7	5.8	40.4	46.0	44.2	42.8	41.9	41.2	40.7	1.9	-0.4	0.2	-0.1
Natural gas	1.8	1.7	1.6	1.6	1.6	1.5	1.5	18.0	13.0	12.4	12.0	11.5	11.1	10.7	-0.4	-0.5	-0.2	-0.3
Electricity	2.4	3.4	3.6	3.9	4.2	4.4	4.6	24.3	26.5	28.0	29.5	30.7	31.7	32.6	1.7	1.4	1.2	1.3
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.8	1.3	1.4	1.4	1.5	1.5	1.6	7.9	9.8	10.6	10.8	10.9	11.0	11.1	2.3	1.2	0.7	0.9

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.2**	**44.8**	**47.4**	**51.0**	**54.5**	**57.9**	**60.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.7**	**1.3**	**1.2**	**1.2**
Coal	0.7	2.1	1.5	1.0	0.5	0.0	0.0	2.1	4.6	3.3	2.0	0.9	0.0	0.0	5.8	-6.8	-100.0	-100.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	-100.0	-	-100.0
Natural gas	5.7	9.9	10.7	11.7	12.1	11.3	8.7	17.7	22.0	22.5	23.0	22.3	19.6	14.4	2.8	1.8	-2.0	-0.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	23.2	24.7	25.1	25.5	25.8	26.2	26.6	72.0	55.2	52.9	49.9	47.4	45.3	43.8	0.3	0.3	0.3	0.3
Geothermal	2.1	5.9	6.8	8.0	9.5	11.2	13.1	6.6	13.1	14.3	15.8	17.4	19.3	21.6	5.2	3.2	3.3	3.3
Others	0.5	2.2	3.3	4.7	6.6	9.2	12.3	1.6	5.0	7.0	9.3	12.0	15.8	20.3	7.8	7.7	6.6	7.0

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.4**	**2.2**	**2.3**	**2.3**	**2.3**	**2.0**	**1.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.3**	**0.4**	**-2.7**	**-1.5**
Coal	0.2	0.5	0.4	0.2	0.1	0.0	0.0	11.9	22.1	16.3	10.5	5.2	0.0	0.0	5.5	-6.8	-100.0	-100.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	1.2	1.7	1.9	2.1	2.2	2.0	1.5	87.7	77.9	83.7	89.5	94.8	100.0	100.0	1.7	1.8	-2.0	-0.5

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**38.8**	**45.8**	**46.5**	**47.2**	**47.9**	**48.5**	**48.5**								**0.8**	**0.3**	**0.2**	**0.2**
Coal	33.9	36.0	36.0	36.0	36.0	-	-								0.3	0.0	-	-
Oil	11.3	-	-	-	-	-	-								-	-	-	-
Natural gas	39.6	48.5	48.5	48.5	48.5	48.5	48.5								1.0	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**6.3**	**8.2**	**8.0**	**7.9**	**7.9**	**7.7**	**7.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**-0.3**	**-0.4**	**-0.4**
Coal	1.3	1.4	1.3	1.2	1.1	1.0	1.0	20.4	17.2	16.3	15.2	13.9	12.8	13.4	0.5	-1.6	-1.3	-1.4
Oil	2.7	4.8	4.6	4.5	4.6	4.6	4.6	43.1	58.0	57.5	57.2	58.0	59.9	62.6	2.9	-0.5	0.2	-0.1
Natural Gas	2.3	2.0	2.1	2.2	2.2	2.1	1.8	36.5	24.9	26.1	27.6	28.2	27.4	24.0	-0.6	0.7	-1.4	-0.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	40.1	68.3	77.3	88.7	97.9	108.1	116.5	2.7	2.6	1.8	2.2
Population (millions of people)	3.4	4.4	4.6	4.8	5.0	5.2	5.4	1.3	1.0	0.7	0.8
GDP per capita (thousands of 2000 USD/person)	11.8	15.6	16.8	18.4	19.5	20.8	21.7	1.4	1.6	1.1	1.3
Primary energy consumption per capita (toe/person)	3.79	4.17	4.07	4.09	4.13	4.20	4.30	0.5	-0.2	0.3	0.1
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	321	266	242	223	212	203	198	-0.9	-1.8	-0.8	-1.2
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	156	120	103	89	80	71	64	-1.3	-2.9	-2.2	-2.5
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.49	0.45	0.43	0.40	0.38	0.35	0.32	-0.4	-1.1	-1.5	-1.3
Automobile ownership volume (millions of vehicles)	1.8	3.1	3.0	3.3	3.6	3.8	4.0	2.8	0.7	1.2	1.0
Automobile ownership volume per capita (vehicles per person)	0.53	0.71	0.65	0.69	0.71	0.73	0.74	1.5	-0.3	0.5	0.2

NEW ZEALAND [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**12.9**	**18.2**	**18.2**	**18.5**	**18.8**	**19.1**	**19.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.7**	**0.1**	**0.3**	**0.2**
Coal	1.2	1.3	1.2	1.1	0.9	0.8	0.8	9.2	7.2	6.5	5.8	5.0	4.3	4.2	0.5	-1.9	-1.9	-1.9
Oil	3.6	6.0	5.7	5.5	5.3	5.1	4.9	27.6	33.2	31.4	30.0	28.2	26.8	25.7	2.7	-0.9	-0.7	-0.8
Natural gas	3.9	3.7	3.5	3.3	3.3	3.1	2.5	30.1	20.5	19.5	17.7	17.5	16.4	13.1	-0.2	-1.3	-1.7	-1.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	2.0	2.1	2.2	2.2	2.2	2.3	2.3	15.5	11.7	11.9	11.9	11.8	11.8	11.9	0.3	0.3	0.3	0.3
Geothermal	1.5	3.6	4.0	4.4	4.8	5.2	5.6	11.5	20.0	21.7	23.7	25.3	27.1	29.0	4.6	1.8	1.7	1.7
Others	0.8	1.4	1.6	2.0	2.3	2.6	3.1	6.2	7.5	8.9	11.0	12.1	13.6	16.1	2.7	4.1	2.9	3.4

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**10.0**	**12.8**	**12.6**	**12.7**	**12.7**	**12.8**	**12.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**-0.1**	**0.1**	**0.0**
Industry	3.8	3.9	3.9	3.9	4.0	4.0	4.1	38.6	30.5	30.5	30.7	31.0	31.2	31.8	0.1	0.1	0.3	0.2
Transportation	3.0	4.6	4.5	4.4	4.3	4.1	4.0	29.7	36.1	36.1	35.4	34.6	33.5	31.3	2.2	-0.5	-0.6	-0.6
Others	2.5	3.4	3.4	3.5	3.6	3.7	3.8	25.5	26.3	26.3	26.8	27.3	28.2	29.8	1.4	0.3	0.6	0.5
Non-energy	0.6	0.9	0.9	0.9	0.9	0.9	0.9	6.2	7.1	7.1	7.1	7.1	7.1	7.1	2.0	-0.1	0.1	0.0
Total	**10.0**	**12.8**	**12.6**	**12.7**	**12.7**	**12.8**	**12.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**-0.1**	**0.1**	**0.0**
Coal	0.9	0.6	0.6	0.6	0.6	0.6	0.6	9.3	4.7	4.8	4.9	4.8	4.8	4.7	-2.1	0.3	-0.2	0.0
Oil	4.0	5.9	5.6	5.4	5.2	5.0	4.8	40.4	46.0	44.0	42.3	40.5	38.8	37.3	1.9	-0.9	-0.8	-0.8
Natural gas	1.8	1.7	1.6	1.5	1.4	1.4	1.3	18.0	13.0	12.3	11.9	11.4	10.9	10.4	-0.4	-1.0	-0.8	-0.9
Electricity	2.4	3.4	3.5	3.8	4.0	4.3	4.5	24.3	26.5	28.1	29.8	31.7	33.5	35.2	1.7	1.1	1.2	1.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.8	1.3	1.4	1.4	1.5	1.5	1.6	7.9	9.8	10.8	11.2	11.6	11.9	12.4	2.3	1.2	0.7	0.9

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**32.2**	**44.8**	**46.6**	**49.7**	**53.0**	**56.3**	**59.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.7**	**1.0**	**1.2**	**1.1**
Coal	0.7	2.1	1.5	1.0	0.5	0.0	0.0	2.1	4.6	3.3	2.1	0.9	0.0	0.0	5.8	-6.8	-100.0	-100.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	-100.0	-	-100.0
Natural gas	5.7	9.9	9.4	8.1	8.6	8.1	4.9	17.7	22.0	20.2	16.3	16.2	14.4	8.3	2.8	-1.9	-3.3	-2.7
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	23.2	24.7	25.1	25.5	25.8	26.2	26.6	72.0	55.2	53.8	51.3	48.7	46.6	45.0	0.3	0.3	0.3	0.3
Geothermal	2.1	5.9	6.4	7.1	7.7	8.4	9.0	6.6	13.1	13.7	14.2	14.5	14.9	15.2	5.2	1.8	1.6	1.7
Others	0.5	2.2	4.2	8.0	10.4	13.6	18.6	1.6	5.0	9.0	16.2	19.7	24.1	31.4	7.8	13.6	5.7	8.8

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.4**	**2.2**	**2.0**	**1.7**	**1.6**	**1.4**	**0.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.3**	**-2.8**	**-4.4**	**-3.8**
Coal	0.2	0.5	0.4	0.2	0.1	0.0	0.0	11.9	22.1	18.1	14.5	7.3	0.0	0.0	5.5	-6.8	-100.0	-100.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	-100.0	-	-	-
Natural gas	1.2	1.7	1.7	1.4	1.5	1.4	0.9	87.7	77.9	81.9	85.5	92.7	100.0	100.0	1.7	-1.9	-3.4	-2.8

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**38.8**	**45.8**	**46.3**	**46.7**	**47.8**	**49.3**	**49.3**								**0.8**	**0.2**	**0.4**	**0.3**
Coal	33.9	36.0	36.0	36.0	36.0	-	-								0.3	0.0	-	-
Oil	11.3	-	-	-	-	-	-								-	-	-	-
Natural gas	39.6	48.5	48.5	48.6	48.8	49.3	49.3								1.0	0.0	0.1	0.1

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**6.3**	**8.2**	**7.7**	**7.2**	**6.9**	**6.5**	**6.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.3**	**-1.3**	**-1.3**	**-1.3**
Coal	1.3	1.4	1.3	1.2	1.0	0.9	0.9	20.4	17.2	16.6	16.0	14.7	13.6	14.6	0.5	-1.9	-1.9	-1.9
Oil	2.7	4.8	4.5	4.3	4.1	4.0	3.8	43.1	58.0	58.3	59.8	59.9	61.0	64.2	2.9	-0.9	-0.8	-0.9
Natural Gas	2.3	2.0	1.9	1.7	1.8	1.7	1.3	36.5	24.9	25.1	24.1	25.4	25.4	21.2	-0.6	-1.5	-2.1	-1.9

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	40.1	68.3	77.3	88.7	97.9	108.1	116.5	2.7	2.6	1.8	2.2
Population (millions of people)	3.4	4.4	4.6	4.8	5.0	5.2	5.4	1.3	1.0	0.7	0.8
GDP per capita (thousands of 2000 USD/person)	11.8	15.6	16.8	18.4	19.5	20.8	21.7	1.4	1.6	1.1	1.3
Primary energy consumption per capita (toe/person)	3.79	4.17	3.95	3.82	3.74	3.67	3.59	0.5	-0.9	-0.4	-0.6
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	321	266	235	208	192	177	165	-0.9	-2.4	-1.5	-1.9
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	156	120	99	82	71	60	51	-1.3	-3.8	-3.0	-3.3
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.49	0.45	0.42	0.39	0.37	0.34	0.31	-0.4	-1.4	-1.5	-1.5
Automobile ownership volume (millions of vehicles)	1.79	3.10	3.01	3.33	3.57	3.80	3.98	2.8	0.7	1.2	1.0
Automobile ownership volume per capita (vehicles per person)	0.53	0.71	0.65	0.69	0.71	0.73	0.74	1.5	-0.3	0.5	0.2

PHILIPPINES [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**18.4**	**34.9**	**42.7**	**50.1**	**58.5**	**67.8**	**78.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.2**	**3.7**	**3.1**	**3.3**
Coal	1.4	7.8	12.3	16.8	22.1	27.4	33.8	7.8	22.3	28.7	33.6	37.8	40.5	43.0	8.8	8.0	4.8	6.1
Oil	10.8	13.4	14.7	16.5	18.8	21.6	24.9	58.9	38.5	34.5	33.0	32.1	31.8	31.7	1.1	2.1	2.8	2.5
Natural gas	0.0	2.8	2.1	2.9	3.4	4.2	5.0	0.0	8.1	5.0	5.7	5.9	6.2	6.4	-	0.2	3.8	2.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.5	0.7	0.7	0.7	0.7	0.7	0.7	2.8	1.9	1.7	1.4	1.2	1.1	0.9	1.3	0.6	0.0	0.3
Geothermal	4.7	8.5	10.6	10.6	10.6	10.6	10.6	25.5	24.5	24.8	21.1	18.1	15.6	13.5	3.0	2.2	0.0	0.9
Others	0.9	1.6	2.3	2.6	2.9	3.2	3.7	4.9	4.7	5.3	5.1	5.0	4.8	4.6	3.0	4.6	2.4	3.2

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**11.6**	**19.9**	**23.4**	**27.8**	**32.9**	**38.8**	**45.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.7**	**3.4**	**3.4**	**3.4**
Industry	4.6	6.4	7.2	8.7	10.2	11.8	13.6	39.8	32.1	32.1	31.0	31.3	30.9	29.7	1.6	3.1	3.0	3.1
Transportation	4.5	8.0	9.4	10.9	12.8	15.1	18.0	38.8	40.4	40.4	40.4	39.1	38.7	39.3	2.9	3.1	3.4	3.3
Others	2.1	5.2	6.5	8.0	9.8	11.7	14.0	17.9	26.3	26.3	27.6	28.8	29.6	30.5	4.7	4.3	3.8	4.0
Non-energy	0.4	0.2	0.2	0.2	0.2	0.2	0.2	3.4	1.1	1.1	1.0	0.8	0.7	0.5	-2.9	0.6	-0.1	0.2
Total	**11.6**	**19.9**	**23.4**	**27.8**	**32.9**	**38.8**	**45.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.7**	**3.4**	**3.4**	**3.4**
Coal	0.8	2.0	1.9	2.3	2.8	3.2	3.7	6.5	10.0	8.3	8.4	8.4	8.3	8.1	4.9	1.6	3.1	2.5
Oil	8.1	11.5	13.4	15.3	17.7	20.6	24.1	70.0	57.5	57.2	55.0	53.8	53.1	52.6	1.7	2.9	3.1	3.0
Natural gas	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.0	0.4	0.4	0.4	0.4	0.4	0.4	-	3.7	3.3	3.4
Electricity	1.8	4.8	6.1	7.9	9.8	12.0	14.5	15.7	23.9	26.0	28.2	29.7	30.8	31.8	4.9	5.1	4.2	4.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.9	1.7	1.9	2.2	2.6	2.9	3.3	7.8	8.3	8.2	8.0	7.8	7.5	7.2	3.1	3.1	2.7	2.8

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**26.3**	**67.7**	**84.6**	**106.8**	**130.5**	**156.0**	**185.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.8**	**4.7**	**3.8**	**4.1**
Coal	1.9	23.3	43.6	61.2	81.8	102.5	127.3	7.3	34.4	51.5	57.3	62.6	65.7	68.5	13.3	10.1	5.0	7.0
Oil	12.4	7.1	4.8	4.3	3.6	3.0	2.5	47.2	10.5	5.7	4.0	2.8	1.9	1.3	-2.8	-5.0	-3.6	-4.2
Natural gas	0.0	19.5	14.5	19.6	23.5	28.8	34.5	0.0	28.8	17.2	18.4	18.0	18.4	18.5	-	0.1	3.8	2.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	6.1	7.8	8.3	8.3	8.3	8.3	8.3	23.0	11.5	9.8	7.8	6.4	5.3	4.5	1.3	0.6	0.0	0.3
Geothermal	5.5	9.9	12.3	12.3	12.3	12.3	12.3	20.8	14.7	14.5	11.5	9.4	7.9	6.6	3.0	2.2	0.0	0.9
Others	0.4	0.1	1.1	1.1	1.1	1.1	1.1	1.6	0.1	1.3	1.0	0.8	0.7	0.6	-7.5	28.1	0.0	10.4

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2.7**	**9.7**	**13.4**	**18.1**	**23.4**	**28.9**	**35.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**6.4**	**4.6**	**5.3**
Coal	0.5	5.5	10.3	14.5	19.3	24.2	30.1	18.9	56.6	77.2	79.8	82.7	83.8	84.9	12.7	10.1	5.0	7.0
Oil	2.2	1.5	1.0	0.9	0.7	0.6	0.5	81.1	15.2	7.5	4.9	3.2	2.2	1.4	-1.9	-5.0	-3.6	-4.2
Natural gas	0.0	2.7	2.0	2.8	3.3	4.1	4.9	0.0	28.2	15.3	15.2	14.1	14.0	13.7	-	0.1	3.8	2.3

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**45.9**	**44.1**	**40.5**	**40.4**	**40.0**	**39.9**	**39.8**								**-0.2**	**-0.9**	**-0.1**	**-0.4**
Coal	32.7	36.4	36.4	36.4	36.4	36.4	36.4								0.5	0.0	0.0	0.0
Oil	49.0	41.3	41.3	41.3	41.3	41.3	41.3								-0.9	0.0	0.0	0.0
Natural gas	-	61.1	61.1	61.1	61.1	61.1	61.1								-	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**10.2**	**20.6**	**26.4**	**33.3**	**41.2**	**49.8**	**59.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.6**	**4.9**	**4.0**	**4.4**
Coal	1.4	8.1	13.2	18.1	23.9	29.7	36.6	13.4	39.1	49.8	54.4	57.9	59.6	61.1	9.3	8.4	4.8	6.2
Oil	8.8	10.7	11.9	13.4	15.2	17.4	20.1	86.6	52.1	45.0	40.1	36.8	35.0	33.5	1.0	2.2	2.8	2.5
Natural Gas	0.0	1.8	1.4	1.8	2.2	2.7	3.2	0.0	8.8	5.2	5.5	5.3	5.4	5.4	-	0.2	3.8	2.3

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	61.1	129.0	174.9	245.3	313.8	401.4	513.6	3.8	6.6	5.1	5.7
Population (millions of people)	61.6	93.3	104.0	112.6	121.3	129.4	138.0	2.1	1.9	1.4	1.6
GDP per capita (thousands of 2000 USD/person)	1.0	1.4	1.7	2.2	2.6	3.1	3.7	1.7	4.6	3.6	4.0
Primary energy consumption per capita (toe/person)	0.30	0.37	0.41	0.44	0.48	0.52	0.57	1.1	1.8	1.7	1.7
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	301	270	244	204	186	169	153	-0.5	-2.8	-1.9	-2.2
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	166	159	151	136	131	124	117	-0.2	-1.6	-1.0	-1.2
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.55	0.59	0.62	0.67	0.70	0.73	0.76	0.3	1.2	0.9	1.0
Automobile ownership volume (millions of vehicles)	1.22	3.12	3.84	4.78	6.04	7.67	9.80	4.8	4.4	4.9	4.7
Automobile ownership volume per capita (vehicles per person)	0.02	0.03	0.04	0.04	0.05	0.06	0.07	2.7	2.4	3.5	3.1

PHILIPPINES [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**18.4**	**34.9**	**40.0**	**47.2**	**56.5**	**66.4**	**76.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.2**	**3.1**	**3.3**	**3.2**
Coal	1.4	7.8	11.9	14.6	17.8	21.1	26.3	7.8	22.3	29.7	30.8	31.5	31.8	34.4	8.8	6.5	4.0	5.0
Oil	10.8	13.4	12.8	14.3	15.5	17.4	20.2	58.9	38.5	32.1	30.2	27.5	26.3	26.4	1.1	0.6	2.3	1.6
Natural gas	0.0	2.8	1.7	2.7	3.2	4.2	4.6	0.0	8.1	4.1	5.8	5.7	6.4	6.0	-	-0.4	3.6	2.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.5	0.7	0.7	0.7	1.0	1.2	1.5	2.8	1.9	1.8	1.5	1.8	1.8	2.0	1.3	0.6	5.2	3.3
Geothermal	4.7	8.5	10.6	11.3	14.2	17.1	17.8	25.5	24.5	26.5	24.0	25.1	25.8	23.3	3.0	2.9	3.1	3.0
Others	0.9	1.6	2.3	3.6	4.7	5.2	6.0	4.9	4.7	5.8	7.7	8.4	7.9	7.8	3.0	8.2	3.4	5.3

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**11.6**	**19.9**	**21.7**	**25.7**	**30.3**	**35.6**	**42.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.7**	**2.6**	**3.3**	**3.0**
Industry	4.6	6.4	6.9	8.2	9.6	11.0	12.7	39.8	32.1	32.1	31.7	32.0	31.7	30.3	1.6	2.5	3.0	2.8
Transportation	4.5	8.0	8.5	9.7	11.4	13.4	16.0	38.8	40.4	40.4	39.4	38.0	37.6	38.2	2.9	1.9	3.4	2.8
Others	2.1	5.2	6.0	7.5	9.1	10.9	13.0	17.9	26.3	26.3	27.8	29.1	30.0	30.9	4.7	3.6	3.8	3.7
Non-energy	0.4	0.2	0.2	0.2	0.2	0.2	0.2	3.4	1.1	1.1	1.1	0.9	0.8	0.6	-2.9	0.6	-0.1	0.2
Total	**11.6**	**19.9**	**21.7**	**25.7**	**30.3**	**35.6**	**42.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**2.7**	**2.6**	**3.3**	**3.0**
Coal	0.8	2.0	1.8	2.1	2.5	2.9	3.3	6.5	10.0	8.1	8.3	8.2	8.2	8.0	4.9	0.7	3.1	2.1
Oil	8.1	11.5	12.3	13.0	14.4	16.4	19.3	70.0	57.5	56.6	50.6	47.5	46.1	45.9	1.7	1.3	2.7	2.1
Natural gas	0.0	0.1	0.1	0.5	0.7	1.1	1.1	0.0	0.4	0.7	2.1	2.4	3.1	2.7	-	22.8	5.0	11.8
Electricity	1.8	4.8	5.5	7.1	8.9	10.8	13.2	15.7	23.9	25.4	27.7	29.3	30.4	31.3	4.9	4.1	4.2	4.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.9	1.7	2.0	2.9	3.8	4.4	5.1	7.8	8.3	9.2	11.3	12.7	12.2	12.1	3.1	5.8	3.8	4.6

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**26.3**	**67.7**	**76.6**	**96.6**	**118.0**	**141.1**	**168.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.8**	**3.6**	**3.8**	**3.7**
Coal	1.9	23.3	42.8	52.6	64.7	77.0	97.2	7.3	34.4	55.9	54.5	54.8	54.5	57.8	13.3	8.5	4.2	5.9
Oil	12.4	7.1	1.3	4.7	3.9	3.4	2.8	47.2	10.5	1.6	4.9	3.3	2.4	1.7	-2.8	-4.1	-3.4	-3.6
Natural gas	0.0	19.5	10.7	15.4	17.9	22.2	24.8	0.0	28.8	14.0	16.0	15.2	15.7	14.7	-	-2.3	3.2	1.0
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	6.1	7.8	8.3	8.3	11.8	14.2	17.7	23.0	11.5	10.9	8.6	10.0	10.1	10.5	1.3	0.6	5.2	3.3
Geothermal	5.5	9.9	12.3	13.1	16.4	19.7	20.5	20.8	14.7	16.1	13.6	13.9	14.0	12.2	3.0	2.8	3.0	2.9
Others	0.4	0.1	1.1	2.4	3.2	4.6	5.2	1.6	0.1	1.5	2.5	2.8	3.3	3.1	-7.5	38.7	5.3	17.6

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**2.7**	**9.7**	**11.9**	**15.6**	**18.6**	**22.0**	**27.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.6**	**4.8**	**3.7**	**4.2**
Coal	0.5	5.5	10.1	12.4	15.3	18.2	23.0	18.9	56.6	85.1	79.8	82.1	82.6	84.9	12.7	8.5	4.2	5.9
Oil	2.2	1.5	0.3	1.0	0.8	0.7	0.6	81.1	15.2	2.2	6.3	4.4	3.3	2.2	-1.9	-4.1	-3.4	-3.6
Natural gas	0.0	2.7	1.5	2.2	2.5	3.1	3.5	0.0	28.2	12.7	13.9	13.5	14.2	12.9	-	-2.3	3.2	1.0

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**45.9**	**44.1**	**39.6**	**40.1**	**39.9**	**40.0**	**39.7**								**-0.2**	**-0.9**	**-0.1**	**-0.4**
Coal	32.7	36.4	36.4	36.4	36.4	36.4	36.4								0.5	0.0	0.0	0.0
Oil	49.0	41.3	41.3	41.3	41.3	41.3	41.3								-0.9	0.0	0.0	0.0
Natural gas	-	61.1	61.1	61.1	61.1	61.1	61.1								-	0.0	0.0	0.0

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**10.2**	**20.6**	**24.2**	**29.0**	**33.7**	**39.5**	**47.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.6**	**3.5**	**3.4**	**3.4**
Coal	1.4	8.1	12.8	15.7	19.2	22.8	28.5	13.4	39.1	52.8	54.1	56.9	57.7	59.8	9.3	6.9	4.1	5.2
Oil	8.8	10.7	10.3	11.5	12.5	14.0	16.2	86.6	52.1	42.8	39.8	37.0	35.4	34.0	1.0	0.7	2.3	1.7
Natural Gas	0.0	1.8	1.1	1.7	2.1	2.7	3.0	0.0	8.8	4.4	6.0	6.2	6.9	6.2	-	-0.4	3.6	2.0

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	61.1	129.0	174.9	245.3	313.8	401.4	513.6	3.8	6.6	5.1	5.7
Population (millions of people)	61.6	93.3	104.0	112.6	121.3	129.4	138.0	2.1	1.9	1.4	1.6
GDP per capita (thousands of 2000 USD/person)	1.0	1.4	1.7	2.2	2.6	3.1	3.7	1.7	4.6	3.6	4.0
Primary energy consumption per capita (toe/person)	0.30	0.37	0.39	0.42	0.47	0.51	0.55	1.1	1.2	1.9	1.6
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	301	270	229	193	180	165	149	-0.5	-3.3	-1.7	-2.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	166	159	138	118	108	98	93	-0.2	-3.0	-1.6	-2.1
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.55	0.59	0.60	0.61	0.60	0.60	0.62	0.3	0.4	0.1	0.2
Automobile ownership volume (millions of vehicles)	1.22	3.12	3.84	4.78	6.04	7.67	9.80	4.8	4.4	4.9	4.7
Automobile ownership volume per capita (vehicles per person)	0.02	0.03	0.04	0.04	0.05	0.06	0.07	2.7	2.4	3.5	3.1

SINGAPORE [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**11.4**	**33.1**	**42.4**	**50.8**	**53.2**	**55.8**	**58.3**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.5**	**4.4**	**0.9**	**2.3**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	11.4	25.5	33.4	40.6	41.8	43.1	44.2	100.0	77.0	78.8	79.9	78.6	77.2	75.8	4.1	4.8	0.6	2.2
Natural gas	0.0	7.2	8.5	9.6	10.7	11.9	13.2	0.0	21.8	20.0	18.9	20.1	21.3	22.6	-	2.9	2.1	2.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.4	0.5	0.6	0.7	0.8	0.9	0.0	1.2	1.2	1.2	1.3	1.4	1.5	-	4.0	2.7	3.3

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**5.0**	**23.7**	**32.6**	**40.8**	**43.0**	**45.4**	**47.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**5.6**	**1.1**	**2.8**
Industry	0.6	7.5	9.9	11.8	13.8	15.9	18.1	12.0	31.5	31.5	30.5	29.0	32.1	37.8	13.4	4.7	2.9	3.6
Transportation	1.4	2.8	3.0	3.1	3.2	3.4	3.5	28.0	11.9	11.9	9.2	7.7	7.5	7.3	3.6	1.0	0.7	0.8
Others	0.7	2.4	2.7	2.9	3.1	3.2	3.3	14.0	10.1	10.1	8.3	7.1	7.1	6.9	6.3	2.0	0.9	1.3
Non-energy	2.3	11.0	17.0	22.9	22.9	22.9	23.0	46.0	46.5	46.5	52.1	56.2	53.3	48.0	8.1	7.6	0.0	3.0
Total	**5.0**	**23.7**	**32.6**	**40.8**	**43.0**	**45.4**	**47.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**5.6**	**1.1**	**2.8**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	3.8	19.1	27.1	34.4	35.7	37.0	38.2	76.0	80.8	83.3	84.4	82.9	81.4	79.9	8.4	6.0	0.7	2.8
Natural gas	0.1	0.9	1.4	1.9	2.6	3.4	4.4	2.0	3.9	4.1	4.7	6.0	7.5	9.1	11.8	7.5	5.7	6.4
Electricity	1.1	3.6	4.1	4.4	4.7	5.0	5.3	22.0	15.3	12.6	10.9	11.0	11.1	11.0	6.1	2.1	1.1	1.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**15.7**	**45.4**	**51.2**	**55.6**	**59.4**	**61.9**	**65.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.5**	**2.1**	**1.1**	**1.5**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	15.7	8.5	8.4	8.6	8.6	8.4	8.2	100.0	18.7	16.4	15.4	14.4	13.6	12.4	-3.0	0.1	-0.3	-0.2
Natural gas	0.0	35.7	41.0	44.5	47.5	50.2	52.6	0.0	78.7	80.0	80.0	80.0	81.2	80.0	-	2.2	1.1	1.6
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	1.2	1.8	2.5	3.3	3.2	5.0	0.0	2.6	3.6	4.6	5.6	5.2	7.6	-	8.1	4.6	6.0

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**4.4**	**8.5**	**9.2**	**9.8**	**10.2**	**10.5**	**10.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.3**	**1.4**	**0.6**	**1.0**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	4.4	2.2	2.1	2.1	2.0	2.0	1.9	100.0	26.1	22.9	21.5	20.1	18.7	17.5	-3.4	-0.5	-0.7	-0.7
Natural gas	0.0	6.3	7.1	7.7	8.1	8.5	8.9	0.0	73.9	77.1	78.5	79.9	81.3	82.5	-	2.1	1.0	1.4

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**30.7**	**44.8**	**45.9**	**46.7**	**47.4**	**48.0**	**48.6**								**1.9**	**0.4**	**0.3**	**0.3**
Coal	-	-	-	-	-	-	-								-	-	-	-
Oil	30.7	32.9	34.1	35.1	36.0	36.8	37.4								0.4	0.6	0.4	0.5
Natural gas	-	49.0	49.4	49.8	50.2	50.6	51.0								-	0.2	0.2	0.2

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**7.7**	**17.0**	**20.5**	**23.3**	**25.1**	**26.9**	**28.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**3.2**	**1.4**	**2.1**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	6.9	12.4	15.1	17.2	18.2	19.3	20.2	89.1	72.9	73.5	73.7	72.6	71.6	70.5	3.0	3.3	1.1	2.0
Natural Gas	0.8	4.6	5.4	6.1	6.9	7.7	8.5	10.9	27.1	26.5	26.3	27.4	28.4	29.5	8.9	2.9	2.2	2.5

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	48.1	165.7	219.7	275.1	329.1	383.0	436.9	6.4	5.2	3.1	4.0
Population (millions of people)	3.0	5.1	5.5	5.8	6.0	6.2	6.4	2.6	1.3	0.7	0.9
GDP per capita (thousands of 2000 USD/person)	15.8	32.6	40.0	47.6	54.5	61.3	68.1	3.7	3.8	2.4	3.0
Primary energy consumption per capita (toe/person)	3.74	6.52	7.73	8.79	8.82	8.94	9.09	2.8	3.0	0.2	1.3
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	237	200	193	185	162	146	133	-0.9	-0.8	-2.1	-1.6
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	160	103	93	85	76	70	66	-2.2	-1.9	-1.7	-1.8
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.68	0.52	0.48	0.46	0.47	0.48	0.49	-1.3	-1.1	0.5	-0.2
Automobile ownership volume (millions of vehicles)	0.43	0.80	0.86	0.91	0.95	0.98	1.01	3.2	1.3	0.7	0.9
Automobile ownership volume per capita (vehicles per person)	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.6	0.0	0.0	0.0

SINGAPORE [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**11.4**	**33.1**	**42.0**	**50.1**	**52.1**	**54.2**	**56.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.5**	**4.2**	**0.8**	**2.2**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	11.4	25.5	33.2	40.3	41.4	42.4	43.4	100.0	77.0	79.1	80.5	79.4	78.3	76.9	4.1	4.7	0.5	2.2
Natural gas	0.0	7.2	8.3	9.2	10.1	11.0	12.2	0.0	21.8	19.7	18.3	19.3	20.3	21.6	-	2.5	1.9	2.1
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.4	0.5	0.6	0.7	0.7	0.8	0.0	1.2	1.2	1.2	1.3	1.4	1.5	-	3.7	2.4	2.9

Final energy demand	MTOE							Share, %							AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**5.0**	**23.7**	**32.5**	**40.5**	**42.5**	**44.6**	**46.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**5.5**	**1.0**	**2.8**
Industry	0.6	7.5	9.8	11.6	13.4	15.2	17.1	12.0	31.5	31.5	30.3	28.7	31.4	36.6	13.4	4.5	2.6	3.4
Transportation	1.4	2.8	3.0	3.1	3.2	3.4	3.5	28.0	11.9	11.9	9.2	7.7	7.6	7.4	3.6	1.0	0.7	0.8
Others	0.7	2.4	2.7	2.9	3.0	3.1	3.2	14.0	10.1	10.1	8.2	7.1	7.0	6.8	6.3	1.8	0.8	1.2
Non-energy	2.3	11.0	17.0	22.9	22.9	22.9	23.0	46.0	46.5	46.5	52.2	56.6	53.9	49.1	8.1	7.6	0.0	3.0
Total	**5.0**	**23.7**	**32.5**	**40.5**	**42.5**	**44.6**	**46.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**8.1**	**5.5**	**1.0**	**2.8**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	3.8	19.1	27.1	34.2	35.4	36.5	37.6	76.0	80.8	83.4	84.6	83.2	81.8	80.3	8.4	6.0	0.6	2.7
Natural gas	0.1	0.9	1.3	1.9	2.5	3.3	4.1	2.0	3.9	4.1	4.6	5.9	7.3	8.9	11.8	7.2	5.4	6.1
Electricity	1.1	3.6	4.1	4.4	4.6	4.9	5.1	22.0	15.3	12.5	10.8	10.9	10.9	10.8	6.1	1.9	1.0	1.3
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**15.7**	**45.4**	**50.8**	**54.7**	**58.0**	**60.7**	**63.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.5**	**1.9**	**1.0**	**1.3**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	15.7	8.5	8.3	8.4	8.4	8.1	7.8	100.0	18.7	16.4	15.4	14.4	13.4	12.4	-3.0	-0.1	-0.5	-0.3
Natural gas	0.0	35.7	40.6	43.8	46.4	48.6	50.6	0.0	78.7	80.0	80.0	80.0	80.0	80.0	-	2.1	1.0	1.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Hydro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	1.2	1.8	2.5	3.2	4.0	4.8	0.0	2.6	3.6	4.6	5.6	6.6	7.6	-	7.9	4.4	5.8

Power generation Input	MTOE							Share, %							AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**4.4**	**8.5**	**9.0**	**9.3**	**9.4**	**9.5**	**9.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**3.3**	**0.9**	**0.3**	**0.6**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	4.4	2.2	2.1	2.0	1.9	1.8	1.7	100.0	26.1	22.8	21.4	20.0	18.8	17.8	-3.4	-1.1	-0.9	-1.0
Natural gas	0.0	6.3	7.0	7.3	7.6	7.7	8.0	0.0	73.9	77.2	78.6	80.0	81.2	82.2	-	1.6	0.6	1.0

Thermal Efficiency	%														AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**30.7**	**44.8**	**46.7**	**48.3**	**49.8**	**51.2**	**51.3**								**1.9**	**0.8**	**0.4**	**0.5**
Coal	-	-	-	-	-	-	-								-	-	-	-
Oil	30.7	32.9	34.8	36.5	38.0	39.2	38.7								0.4	1.0	0.4	0.7
Natural gas	-	49.0	50.3	51.5	52.8	54.0	54.0								-	0.5	0.3	0.4

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
															1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035				
Total	**7.7**	**17.0**	**20.3**	**22.8**	**24.3**	**25.8**	**27.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**4.1**	**3.0**	**1.2**	**1.9**
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Oil	6.9	12.4	15.0	16.9	17.8	18.7	19.6	89.1	72.9	73.8	74.2	73.4	72.6	71.5	3.0	3.2	1.0	1.8
Natural Gas	0.8	4.6	5.3	5.9	6.5	7.1	7.8	10.9	27.1	26.2	25.8	26.6	27.4	28.5	8.9	2.5	1.9	2.1

Energy and economic indicators								AAGR(%)			
								1990-2010	2010-2020	2020-2035	2010-2035
	1990	2010	2015	2020	2025	2030	2035				
GDP (billions of 2000 US dollars)	48.1	165.7	219.7	275.1	329.1	383.0	436.9	6.4	5.2	3.1	4.0
Population (millions of people)	3.0	5.1	5.5	5.8	6.0	6.2	6.4	2.6	1.3	0.7	0.9
GDP per capita (thousands of 2000 USD/person)	15.8	32.6	40.0	47.6	54.5	61.3	68.1	3.7	3.8	2.4	3.0
Primary energy consumption per capita (toe/person)	3.74	6.52	7.66	8.67	8.64	8.67	8.81	2.8	2.9	0.1	1.2
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	237	200	191	182	158	141	129	-0.9	-0.9	-2.3	-1.7
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	160	103	92	83	74	67	63	-2.2	-2.1	-1.9	-2.0
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.68	0.52	0.48	0.46	0.47	0.48	0.49	-1.3	-1.2	0.4	-0.2
Automobile ownership volume (millions of vehicles)	0.43	0.80	0.86	0.91	0.95	0.98	1.01	3.2	1.3	0.7	0.9
Automobile ownership volume per capita (vehicles per person)	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.6	0.0	0.0	0.0

THAILAND [BAU]

Primary energy consumption	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**35.4**	**112.2**	**136.8**	**163.6**	**194.6**	**231.0**	**269.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.9**	**3.8**	**3.4**	**3.6**
Coal	3.7	14.9	19.0	24.9	30.8	36.0	42.3	10.6	13.3	13.9	15.2	15.8	15.6	15.7	7.2	5.3	3.6	4.3
Oil	19.7	37.7	45.9	54.5	62.8	72.7	83.6	55.6	33.6	33.5	33.3	32.3	31.5	31.0	3.3	3.8	2.9	3.2
Natural gas	5.7	30.9	37.6	41.9	51.3	59.8	70.6	16.0	27.5	27.5	25.6	26.4	25.9	26.2	8.8	3.1	3.5	3.4
Nuclear	0.0	0.0	0.0	0.0	0.0	4.6	4.6	0.0	0.0	0.0	0.0	0.0	2.0	1.7	-	-	-	-
Hydro	1.1	0.3	0.3	0.3	0.3	0.3	0.3	3.1	0.2	0.2	0.2	0.2	0.1	0.1	-6.9	2.0	0.3	1.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	5.2	28.4	34.1	41.9	49.3	57.6	68.4	14.7	25.3	24.9	25.6	25.3	24.9	25.3	8.9	4.0	3.3	3.6

Final energy demand Sector	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**25.4**	**84.6**	**103.6**	**125.8**	**150.9**	**179.2**	**210.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**4.1**	**3.5**	**3.7**
Industry	8.7	26.5	33.0	41.3	50.8	61.8	74.5	34.4	31.3	31.3	31.8	32.8	33.7	35.4	5.7	4.5	4.0	4.2
Transportation	11.4	19.5	23.1	26.3	29.6	32.7	35.6	45.0	23.0	23.0	22.3	20.9	19.6	16.9	2.7	3.0	2.0	2.4
Others	5.2	20.4	23.0	27.8	33.3	39.6	46.8	20.6	24.2	24.2	22.2	22.1	22.1	22.2	7.1	3.1	3.5	3.4
Non-energy	0.0	18.2	24.6	30.5	37.2	45.0	53.9	0.0	21.5	21.5	23.7	24.2	24.7	25.6	-	5.3	3.9	4.4
Total	**25.4**	**84.6**	**103.6**	**125.8**	**150.9**	**179.2**	**210.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**4.1**	**3.5**	**3.7**
Coal	1.3	9.2	11.3	14.9	19.4	24.7	30.7	5.3	10.9	10.9	11.9	12.9	13.8	14.6	10.1	4.9	4.9	4.9
Oil	17.6	41.7	49.7	59.0	69.4	80.8	93.1	69.2	49.3	48.0	46.9	46.0	45.1	44.2	4.4	3.5	3.1	3.3
Natural gas	0.3	6.0	10.2	12.7	15.1	17.8	20.8	1.2	7.1	9.8	10.1	10.0	9.9	9.9	16.2	7.7	3.3	5.1
Electricity	3.3	12.8	14.8	18.0	21.9	26.3	31.3	12.9	15.2	14.2	14.3	14.5	14.7	14.8	7.0	3.4	3.7	3.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	2.9	14.8	17.7	21.2	25.2	29.7	34.9	11.4	17.5	17.0	16.8	16.7	16.6	16.6	8.5	3.6	3.4	3.5

Power generation Output	TWh 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**44.2**	**147.0**	**180.4**	**210.9**	**257.5**	**309.6**	**355.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**3.7**	**3.5**	**3.6**
Coal	11.1	25.0	32.6	44.3	52.9	53.3	54.8	25.0	17.0	18.1	21.0	20.6	17.2	15.4	4.2	5.9	1.4	3.2
Oil	10.4	0.8	4.8	6.4	2.7	2.0	2.6	23.5	0.5	2.7	3.0	1.1	0.6	0.7	-12.2	23.4	-5.9	4.9
Natural gas	17.8	116.6	130.5	141.1	177.9	207.8	245.5	40.2	79.3	72.4	66.9	69.1	67.1	69.2	9.9	1.9	3.8	3.0
Nuclear	0.0	0.0	0.0	0.0	0.0	17.5	17.5	0.0	0.0	0.0	0.0	0.0	5.7	4.9	-	-	-	-
Hydro	5.0	3.0	3.1	3.7	3.7	3.8	3.8	11.3	2.0	1.7	1.7	1.4	1.2	1.1	-2.5	2.0	0.3	1.0
Geothermal	0.0	0.0	1.0	2.0	3.0	4.0	5.0	0.0	0.0	0.6	0.9	1.2	1.3	1.4	-	-	6.3	-
Others	0.0	1.6	8.3	13.4	17.3	21.1	25.8	0.0	1.1	4.6	6.3	6.7	6.8	7.3	-	23.4	4.5	11.7

Power generation Input	MTOE 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**9.4**	**28.7**	**33.6**	**37.9**	**44.5**	**49.3**	**56.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.7**	**2.8**	**2.7**	**2.8**
Coal	2.5	5.7	7.6	10.0	11.4	11.3	11.6	27.0	20.0	22.7	26.4	25.7	22.9	20.5	4.1	5.8	1.0	2.9
Oil	2.5	0.2	1.2	1.5	0.7	0.5	0.6	26.9	0.7	3.5	4.1	1.5	1.0	1.1	-12.2	23.4	-5.9	4.9
Natural gas	4.3	22.8	24.8	26.3	32.4	37.5	44.3	46.0	79.4	73.8	69.5	72.8	76.1	78.4	8.6	1.5	3.5	2.7

Thermal Efficiency	% 1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**35.8**	**42.7**	**43.0**	**43.6**	**45.1**	**45.9**	**46.1**								**0.9**	**0.2**	**0.4**	**0.3**
Coal	37.3	37.5	36.8	38.1	39.8	40.6	40.7								0.0	0.1	0.4	0.3
Oil	35.1	35.5	35.5	35.5	35.5	35.5	35.5								0.1	0.0	0.0	0.0
Natural gas	35.2	44.0	45.3	46.1	47.2	47.6	47.6								1.1	0.5	0.2	0.3

CO_2 emissions	Mt-C 1990	2010	2015	2020	2025	2030	2035	Share, % 1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
Total	**43.5**	**54.5**	**65.4**	**77.7**	**92.1**	**105.8**	**122.2**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.1**	**3.6**	**3.1**	**3.3**
Coal	12.6	15.8	20.1	26.4	32.6	38.1	44.8	29.0	29.0	30.7	34.0	35.4	36.0	36.7	1.1	5.3	3.6	4.3
Oil	18.7	21.9	26.3	30.5	34.0	38.4	43.0	43.1	40.3	40.2	39.2	37.0	36.3	35.2	0.8	3.3	2.3	2.7
Natural Gas	12.1	16.7	19.0	20.9	25.4	29.3	34.4	27.9	30.7	29.1	26.8	27.6	27.7	28.2	1.6	2.2	3.4	2.9

Energy and economic indicators	1990	2010	2015	2020	2025	2030	2035	AAGR(%) 1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	79.4	187.5	233.7	291.2	345.0	408.8	484.3	4.4	4.5	3.5	3.9
Population (millions of people)	57.1	69.1	70.3	71.5	72.7	73.9	75.2	1.0	0.3	0.3	0.3
GDP per capita (thousands of 2000 USD/person)	1.4	2.7	3.3	4.1	4.7	5.5	6.4	3.4	4.2	3.1	3.5
Primary energy consumption per capita (toe/person)	0.62	1.62	1.95	2.29	2.68	3.12	3.59	4.9	3.5	3.0	3.2
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	446	598	586	562	564	565	557	1.5	-0.6	-0.1	-0.3
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	548	291	280	267	267	259	252	-3.1	-0.8	-0.4	-0.6
CO_2 emissions per unit of primary energy consumption (t-C/toe)	1.23	0.49	0.48	0.48	0.47	0.46	0.45	-4.5	-0.2	-0.3	-0.3
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

THAILAND [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**35.4**	**112.2**	**127.3**	**142.6**	**157.6**	**182.6**	**210.5**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.9**	**2.4**	**2.6**	**2.5**
Coal	3.7	14.9	17.9	22.0	25.3	28.5	33.1	10.6	13.3	14.0	15.4	16.1	15.6	15.7	7.2	3.9	2.8	3.2
Oil	19.7	37.7	42.1	45.9	48.9	55.0	62.1	55.6	33.6	33.1	32.2	31.0	30.1	29.5	3.3	2.0	2.0	2.0
Natural gas	5.7	30.9	33.8	34.6	38.2	42.9	51.3	16.0	27.5	26.6	24.3	24.2	23.5	24.4	8.8	1.1	2.7	2.1
Nuclear	0.0	0.0	0.0	0.0	0.0	4.6	4.6	0.0	0.0	0.0	0.0	0.0	2.5	2.2	-	-	-	-
Hydro	1.1	0.3	0.3	0.3	0.3	0.3	0.3	3.1	0.2	0.2	0.2	0.2	0.2	0.2	-6.9	2.0	0.3	1.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	5.2	28.4	33.2	39.8	44.9	51.2	59.0	14.7	25.3	26.1	27.9	28.5	28.1	28.0	8.9	3.4	2.7	3.0

Final energy demand Sector	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**25.4**	**84.6**	**97.1**	**110.3**	**123.3**	**142.6**	**164.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**2.7**	**2.7**	**2.7**
Industry	8.7	26.5	30.3	34.8	39.7	47.2	56.0	34.4	31.3	31.3	31.3	31.6	32.2	34.0	5.7	2.8	3.2	3.0
Transportation	11.4	19.5	22.2	24.6	25.7	27.3	28.6	45.0	23.0	23.0	22.9	22.4	20.8	17.4	2.7	2.4	1.0	1.6
Others	5.2	20.4	21.9	25.1	28.9	33.8	39.4	20.6	24.2	24.2	22.5	22.8	23.4	24.0	7.1	2.1	3.1	2.7
Non-energy	0.0	18.2	22.6	25.7	29.1	34.3	40.5	0.0	21.5	21.5	23.3	23.3	23.6	24.6	-	3.5	3.1	3.3
Total	**25.4**	**84.6**	**97.1**	**110.3**	**123.3**	**142.6**	**164.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**2.7**	**2.7**	**2.7**
Coal	1.3	9.2	10.4	12.6	15.1	18.8	23.1	5.3	10.9	10.7	11.4	12.3	13.2	14.0	10.1	3.2	4.1	3.7
Oil	17.6	41.7	46.0	50.2	54.5	61.6	69.5	69.2	49.3	47.4	45.5	44.2	43.2	42.2	4.4	1.9	2.2	2.1
Natural gas	0.3	6.0	9.3	10.7	11.7	13.3	15.3	1.2	7.1	9.6	9.7	9.5	9.4	9.3	16.2	5.8	2.4	3.8
Electricity	3.3	12.8	13.7	15.4	17.4	20.6	24.2	12.9	15.2	14.1	14.0	14.1	14.4	14.7	7.0	1.8	3.1	2.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	2.9	14.8	17.6	21.5	24.5	28.3	32.5	11.4	17.5	18.1	19.5	19.9	19.8	19.7	8.5	3.8	2.8	3.2

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**44.2**	**147.0**	**170.4**	**191.4**	**221.6**	**262.8**	**306.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**6.2**	**2.7**	**3.2**	**3.0**
Coal	11.1	25.0	32.0	42.4	48.4	47.3	49.2	25.0	17.0	18.8	22.1	21.8	18.0	16.0	4.2	5.4	1.0	2.7
Oil	10.4	0.8	3.2	3.6	0.9	0.6	1.3	23.5	0.5	1.9	1.9	0.4	0.2	0.4	-12.2	16.6	-6.7	2.0
Natural gas	17.8	116.6	122.8	126.4	148.3	168.4	203.8	40.2	79.3	72.1	66.0	66.9	64.1	66.5	9.9	0.8	3.2	2.3
Nuclear	0.0	0.0	0.0	0.0	0.0	17.5	17.5	0.0	0.0	0.0	0.0	0.0	6.7	5.7	-	-	-	-
Hydro	5.0	3.0	3.1	3.7	3.7	3.8	3.8	11.3	2.0	1.8	1.9	1.7	1.5	1.3	-2.5	2.0	0.3	1.0
Geothermal	0.0	0.0	1.0	2.0	3.0	4.0	5.0	0.0	0.0	0.6	1.0	1.4	1.5	1.6	-	-	6.3	-
Others	0.0	1.6	8.3	13.4	17.3	21.1	25.8	0.0	1.1	4.8	7.0	7.8	8.0	8.4	-	23.4	4.5	11.7

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**9.4**	**28.7**	**30.4**	**32.1**	**34.4**	**36.7**	**42.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**5.7**	**1.1**	**1.9**	**1.6**
Coal	2.5	5.7	7.4	9.4	10.1	9.7	10.0	27.0	20.0	24.5	29.4	29.5	26.5	23.4	4.1	5.1	0.4	2.3
Oil	2.5	0.2	0.8	0.9	0.2	0.1	0.3	26.9	0.7	2.5	2.7	0.6	0.4	0.7	-12.2	16.6	-6.6	2.0
Natural gas	4.3	22.8	22.2	21.8	24.1	26.8	32.5	46.0	79.4	73.0	67.9	69.9	73.1	75.9	8.6	-0.4	2.7	1.4

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**35.8**	**42.7**	**44.7**	**46.2**	**49.3**	**50.7**	**51.1**								**0.9**	**0.8**	**0.7**	**0.7**
Coal	37.3	37.5	37.0	38.7	41.0	42.0	42.2								0.0	0.3	0.6	0.5
Oil	35.1	35.5	35.5	35.5	35.5	35.6	35.5								0.1	0.0	0.0	0.0
Natural gas	35.2	44.0	47.6	49.9	53.0	54.0	54.0								1.1	1.3	0.5	0.8

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**43.5**	**54.5**	**60.2**	**66.3**	**72.4**	**80.3**	**92.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.1**	**2.0**	**2.2**	**2.1**
Coal	12.6	15.8	18.9	23.3	26.8	30.2	35.1	29.0	29.0	31.4	35.1	37.0	37.6	38.1	1.1	3.9	2.8	3.2
Oil	18.7	21.9	24.2	25.7	26.6	29.1	31.8	43.1	40.3	40.2	38.8	36.8	36.2	34.6	0.8	1.6	1.4	1.5
Natural Gas	12.1	16.7	17.1	17.3	19.0	21.1	25.1	27.9	30.7	28.4	26.1	26.2	26.3	27.3	1.6	0.3	2.5	1.6

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	79.4	187.5	233.7	291.2	345.0	408.8	484.3	4.4	4.5	3.5	3.9
Population (millions of people)	57.1	69.1	70.3	71.5	72.7	73.9	75.2	1.0	0.3	0.3	0.3
GDP per capita (thousands of 2000 USD/person)	1.4	2.7	3.3	4.1	4.7	5.5	6.4	3.4	4.2	3.1	3.5
Primary energy consumption per capita (toe/person)	0.62	1.62	1.81	1.99	2.17	2.47	2.80	4.9	2.1	2.3	2.2
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	446	598	545	490	457	447	435	1.5	-2.0	-0.8	-1.3
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	548	291	258	228	210	197	190	-3.1	-2.4	-1.2	-1.7
CO_2 emissions per unit of primary energy consumption (t-C/toe)	1.23	0.49	0.47	0.47	0.46	0.44	0.44	-4.5	-0.4	-0.4	-0.4
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

VIETNAM [BAU]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**5.4**	**40.9**	**59.3**	**85.2**	**113.9**	**154.0**	**202.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.6**	**7.6**	**6.0**	**6.6**
Coal	2.2	13.9	23.6	38.7	52.3	74.8	101.7	41.0	33.9	39.8	45.4	46.0	48.5	50.1	9.6	10.8	6.7	8.3
Oil	2.7	16.3	20.9	27.6	36.3	47.7	61.2	50.5	39.7	35.2	32.4	31.9	31.0	30.2	9.3	5.4	5.5	5.4
Natural gas	0.0	8.0	10.1	12.4	15.5	18.1	26.6	0.1	19.5	17.1	14.6	13.6	11.8	13.1	48.3	4.5	5.2	4.9
Nuclear	0.0	0.0	0.0	1.3	3.9	7.6	7.5	0.0	0.0	0.0	1.6	3.4	4.9	3.7	-	-	12.3	-
Hydro	0.5	2.4	3.8	4.2	4.6	4.5	4.4	8.5	5.8	6.4	4.9	4.0	2.9	2.2	8.5	5.9	0.3	2.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.4	0.9	1.0	1.2	1.4	1.6	0.0	1.0	1.5	1.2	1.1	0.9	0.8	-	9.7	2.9	5.6

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**4.2**	**32.0**	**45.4**	**62.3**	**81.5**	**106.7**	**139.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.7**	**6.9**	**5.5**	**6.1**
Industry	1.7	14.7	20.7	28.6	37.0	47.9	62.0	41.4	46.0	46.0	45.6	45.8	45.4	44.5	11.2	6.9	5.3	5.9
Transportation	1.4	10.1	13.6	18.1	23.4	30.1	38.2	33.5	31.7	31.7	30.0	29.1	28.7	27.4	10.4	6.0	5.1	5.4
Others	1.1	7.2	11.1	15.6	21.2	28.7	39.0	25.1	22.3	22.3	24.4	25.1	26.0	28.0	10.0	8.1	6.3	7.0
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Total	**4.2**	**32.0**	**45.4**	**62.3**	**81.5**	**106.7**	**139.1**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.7**	**6.9**	**5.5**	**6.1**
Coal	1.3	9.7	12.6	16.7	20.9	26.3	32.8	31.5	30.3	27.8	26.8	25.7	24.6	23.5	10.4	5.6	4.6	5.0
Oil	2.4	14.4	19.5	26.2	34.3	45.0	58.6	55.9	44.8	43.0	42.1	42.1	42.2	42.1	9.5	6.2	5.5	5.8
Natural gas	0.0	0.5	0.8	1.3	1.9	2.7	3.8	0.0	1.5	1.9	2.0	2.3	2.5	2.7	-	10.0	7.6	8.6
Electricity	0.5	7.5	12.4	18.2	24.4	32.8	44.0	12.6	23.3	27.4	29.1	29.9	30.7	31.6	14.1	9.3	6.1	7.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**8.7**	**92.2**	**148.4**	**219.6**	**295.4**	**398.8**	**538.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.5**	**9.1**	**6.2**	**7.3**
Coal	2.0	17.0	48.2	97.8	142.7	220.3	312.9	23.1	18.5	32.5	44.6	48.3	55.2	58.1	11.3	19.1	8.1	12.4
Oil	1.3	4.6	1.5	0.5	0.3	0.3	0.0	15.0	4.9	1.0	0.2	0.1	0.1	0.0	6.4	-19.5	-100.0	-100.0
Natural gas	0.0	43.1	54.6	67.1	83.7	96.6	145.5	0.1	46.7	36.8	30.5	28.3	24.2	27.0	55.9	4.5	5.3	5.0
Nuclear	0.0	0.0	0.0	5.1	15.0	29.2	28.7	0.0	0.0	0.0	2.3	5.1	7.3	5.3	-	-	12.3	-
Hydro	5.4	27.6	43.9	48.9	53.4	52.1	51.2	61.8	29.9	29.6	22.3	18.1	13.1	9.5	8.5	5.9	0.3	2.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.0	0.0	0.1	0.1	0.1	0.1	0.1	-	-	5.2	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.3**	**13.2**	**20.7**	**33.3**	**45.2**	**64.0**	**91.7**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.4**	**9.7**	**7.0**	**8.1**
Coal	0.9	4.2	11.0	22.0	31.4	48.5	68.9	69.8	31.8	53.2	66.0	69.6	75.8	75.2	8.1	18.0	7.9	11.9
Oil	0.4	1.5	0.4	0.1	0.1	0.1	0.0	30.0	11.2	2.0	0.4	0.2	0.1	0.0	7.0	-21.0	-100.0	-100.0
Natural gas	0.0	7.5	9.3	11.2	13.6	15.4	22.8	0.2	57.0	44.8	33.5	30.2	24.1	24.8	47.9	4.0	4.9	4.5

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**22.4**	**42.2**	**43.3**	**42.8**	**43.2**	**42.6**	**43.0**								**3.2**	**0.1**	**0.0**	**0.1**
Coal	19.4	35.0	37.6	38.3	39.0	39.0	39.0								3.0	0.9	0.1	0.4
Oil	29.4	26.4	31.9	31.9	31.2	31.2	-								-0.5	1.9	-	-
Natural gas	17.2	49.4	50.6	51.7	52.8	53.9	55.0								5.4	0.5	0.4	0.4

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**4.7**	**34.2**	**49.8**	**73.0**	**96.7**	**131.6**	**178.0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.5**	**7.9**	**6.1**	**6.8**
Coal	2.5	15.5	26.2	42.7	57.8	82.2	111.7	52.5	45.2	52.7	58.5	59.7	62.5	62.8	9.6	10.7	6.6	8.2
Oil	2.2	13.0	16.3	21.5	28.0	36.6	47.4	47.4	38.1	32.7	29.4	28.9	27.8	26.6	9.3	5.1	5.4	5.3
Natural Gas	0.0	5.7	7.2	8.9	11.0	12.8	18.9	0.0	16.7	14.5	12.1	11.4	9.7	10.6	49.2	4.5	5.2	4.9

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	15.0	62.8	88.0	123.4	174.8	247.7	344.2	7.4	7.0	7.1	7.0
Population (millions of people)	66.2	86.9	91.4	96.0	99.2	102.5	105.8	1.4	1.0	0.7	0.8
GDP per capita (thousands of 2000 USD/person)	0.2	0.7	1.0	1.3	1.8	2.4	3.3	6.0	5.9	6.4	6.2
Primary energy consumption per capita (toe/person)	0.08	0.47	0.65	0.89	1.15	1.50	1.92	9.1	6.5	5.3	5.8
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	361	651	674	690	652	622	589	3.0	0.6	-1.0	-0.4
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	312	545	565	592	553	531	517	2.8	0.8	-0.9	-0.2
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.86	0.84	0.84	0.86	0.85	0.85	0.88	-0.2	0.2	0.2	0.2
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-

VIETNAM [APS]

Primary energy consumption	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**5.4**	**40.9**	**54.8**	**78.0**	**104.6**	**142.2**	**186.6**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.6**	**6.7**	**6.0**	**6.3**
Coal	2.2	13.9	20.2	33.2	41.3	58.7	80.9	41.0	33.9	36.8	42.5	39.5	41.3	43.4	9.6	9.1	6.1	7.3
Oil	2.7	16.3	20.2	26.4	34.7	45.5	58.4	50.5	39.7	36.9	33.8	33.2	32.0	31.3	9.3	5.0	5.4	5.3
Natural gas	0.0	8.0	9.0	10.8	13.0	14.8	23.4	0.1	19.5	16.5	13.8	12.4	10.4	12.5	48.3	3.0	5.3	4.4
Nuclear	0.0	0.0	0.0	1.3	7.9	15.1	15.0	0.0	0.0	0.0	1.7	7.5	10.6	8.0	-	-	17.6	-
Hydro	0.5	2.4	3.9	4.4	4.9	4.8	4.9	8.5	5.8	7.2	5.6	4.7	3.4	2.6	8.5	6.4	0.7	2.9
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.4	1.4	2.0	2.9	3.3	4.0	0.0	1.0	2.6	2.6	2.7	2.3	2.2	-	17.7	4.6	9.7

Final energy demand	MTOE							Share, %							AAGR(%)			
Sector	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**4.2**	**32.0**	**42.8**	**58.2**	**75.9**	**99.2**	**129.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.7**	**6.2**	**5.5**	**5.7**
Industry	1.7	14.7	18.7	25.7	33.3	43.1	55.8	41.4	46.0	46.0	43.8	44.2	43.8	43.1	11.2	5.7	5.3	5.5
Transportation	1.4	10.1	13.5	18.0	23.1	29.7	37.6	33.5	31.7	31.7	31.6	30.8	30.4	29.0	10.4	5.9	5.0	5.4
Others	1.1	7.2	10.5	14.6	19.5	26.5	36.1	25.1	22.3	22.3	24.6	25.0	25.7	27.9	10.0	7.4	6.2	6.7
Non-energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Total	**4.2**	**32.0**	**42.8**	**58.2**	**75.9**	**99.2**	**129.4**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.7**	**6.2**	**5.5**	**5.7**
Coal	1.3	9.7	11.4	14.8	18.5	23.2	29.0	31.5	30.3	26.6	25.5	24.4	23.4	22.4	10.4	4.3	4.6	4.5
Oil	2.4	14.4	18.9	25.1	32.7	42.8	55.8	55.9	44.8	44.1	43.1	43.1	43.2	43.1	9.5	5.7	5.5	5.6
Natural gas	0.0	0.5	0.8	1.2	1.7	2.5	3.5	0.0	1.5	1.8	2.0	2.3	2.5	2.7	-	9.0	7.6	8.2
Electricity	0.5	7.5	11.5	16.6	22.2	29.8	40.0	12.6	23.3	26.9	28.5	29.2	30.0	30.9	14.1	8.3	6.0	6.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	0.3	0.5	0.8	1.0	1.2	0.0	0.0	0.6	0.9	1.0	1.0	0.9	-	-	5.6	-

Power generation Output	TWh							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**8.7**	**92.2**	**136.7**	**200.2**	**267.3**	**361.1**	**487.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.5**	**8.1**	**6.1**	**6.9**
Coal	2.0	17.0	38.6	81.6	103.5	161.3	235.7	23.1	18.5	28.3	40.8	38.7	44.7	48.3	11.3	17.0	7.3	11.1
Oil	1.3	4.6	1.5	0.3	0.3	0.0	0.0	15.0	4.9	1.1	0.2	0.1	0.0	0.0	6.4	-23.3	-100.0	-100.0
Natural gas	0.0	43.1	48.6	57.7	69.2	77.0	127.0	0.1	46.7	35.6	28.8	25.9	21.3	26.0	55.9	3.0	5.4	4.4
Nuclear	0.0	0.0	0.0	5.0	30.2	58.0	57.5	0.0	0.0	0.0	2.5	11.3	16.1	11.8	-	-	17.6	-
Hydro	5.4	27.6	45.5	51.1	57.4	56.3	57.0	61.8	29.9	33.3	25.5	21.5	15.6	11.7	8.5	6.4	0.7	3.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Others	0.0	0.0	2.4	4.5	6.7	8.6	10.6	0.0	0.0	1.7	2.2	2.5	2.4	2.2	-	-	5.9	-

Power generation Input	MTOE							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**1.3**	**13.2**	**17.5**	**28.0**	**34.2**	**47.8**	**71.8**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**12.4**	**7.8**	**6.5**	**7.0**
Coal	0.9	4.2	8.8	18.3	22.8	35.5	51.9	69.8	31.8	50.5	65.4	66.8	74.3	72.3	8.1	15.9	7.2	10.6
Oil	0.4	1.5	0.4	0.1	0.1	0.0	0.0	30.0	11.2	2.3	0.3	0.2	0.0	0.0	7.0	-24.4	-100.0	-100.0
Natural gas	0.0	7.5	8.3	9.6	11.3	12.3	19.9	0.2	57.0	47.2	34.3	33.0	25.7	27.7	47.9	2.5	5.0	4.0

Thermal Efficiency	%														AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**22.4**	**42.2**	**43.6**	**42.9**	**43.6**	**42.9**	**43.5**								**3.2**	**0.2**	**0.1**	**0.1**
Coal	19.4	35.0	37.6	38.3	39.0	39.0	39.0								3.0	0.9	0.1	0.4
Oil	29.4	26.4	31.9	30.6	31.2	-	-								-0.5	1.5	-	-
Natural gas	17.2	49.4	50.6	51.7	52.8	53.9	55.0								5.4	0.5	0.4	0.4

CO_2 emissions	Mt-C							Share, %							AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
Total	**4.7**	**34.2**	**44.7**	**64.8**	**81.6**	**109.9**	**150.9**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**10.5**	**6.6**	**5.8**	**6.1**
Coal	2.5	15.5	22.4	36.6	45.7	64.7	89.2	52.5	45.2	50.2	56.5	56.0	58.9	59.1	9.6	9.0	6.1	7.3
Oil	2.2	13.0	15.8	20.5	26.6	34.7	45.2	47.4	38.1	35.3	31.6	32.7	31.6	29.9	9.3	4.6	5.4	5.1
Natural Gas	0.0	5.7	6.5	7.7	9.2	10.4	16.6	0.0	16.7	14.4	11.8	11.3	9.5	11.0	49.2	3.0	5.3	4.3

Energy and economic indicators								AAGR(%)			
	1990	2010	2015	2020	2025	2030	2035	1990-2010	2010-2020	2020-2035	2010-2035
GDP (billions of 2000 US dollars)	15.0	62.8	88.0	123.4	174.8	247.7	344.2	7.4	7.0	7.1	7.0
Population (millions of people)	66.2	86.9	91.4	96.0	99.2	102.5	105.8	1.4	1.0	0.7	0.8
GDP per capita (thousands of 2000 USD/person)	0.2	0.7	1.0	1.3	1.8	2.4	3.3	6.0	5.9	6.4	6.2
Primary energy consumption per capita (toe/person)	0.08	0.47	0.60	0.81	1.05	1.39	1.76	9.1	5.6	5.3	5.4
Primary energy consumption per unit of GDP (toe/million 2000 US Dollars)	361	651	623	632	599	574	542	3.0	-0.3	-1.0	-0.7
CO_2 emissions per unit of GDP (t-C/million 2000 US Dollars)	312	545	508	525	467	444	438	2.8	-0.4	-1.2	-0.9
CO_2 emissions per unit of primary energy consumption (t-C/toe)	0.86	0.84	0.81	0.83	0.78	0.77	0.81	-0.2	-0.1	-0.2	-0.1
Automobile ownership volume (millions of vehicles)	-	-	-	-	-	-	-	-	-	-	-
Automobile ownership volume per capita (vehicles per person)	-	-	-	-	-	-	-	-	-	-	-