Part II. Individual Country Reports

Chapter 2

Australia Country Report

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2009

This chapter should be cited as
Ford, M. (2009), 'Australia Country Report', in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.55-62.

Australia

Ms. Melanie Ford

1. Background

Australia is the sixth largest country in the world with a land area of approximately 7.7 million km^2, which is diverse in geography and climate. Australia's population in 2005 was around 20.3 million – most of the population is almost entirely concentrated in coastal cities and towns. The nations real gross domestic product (GDP) in 2005 was around US$468 billion (at constant 2000 US$ values[1]), which translates into a per capita income of around US$23,000.

Australia has an abundant supply of energy resources with significant deposits of petroleum, natural gas, coal and uranium (ABARE 2009). Australia is overwhelmingly a net energy exporter, with trade in energy dominated by coal, liquefied natural gas (LNG) and uranium. Australia accounts for approximately one-third of world black coal trade — almost 60 per cent of world metallurgical trade and 20 per cent of thermal coal trade (ABARE 2009). Since the late 1980s Australia has also emerged as one of the largest exporters of LNG. However, Australia is a net importer of crude oil and refined petroleum products (ABARE 2009).

At current rates of production, Australia's energy resources are expected to last for many more decades. The proportion of economic demonstrated reserves (EDR) to current production is estimated at 500 years for brown coal, 100 years for black coal and nearly 60 years for conventional gas (ABARE 2009).

In 2005 Australia's primary energy demand was around 122 Mtoe (million tons of oil equivalent). Coal and oil dominated primary energy demand accounting for about 45 percent and 31 percent respectively in 2005. Natural gas (19 percent), hydro (1 percent) and other (4 percent) – mainly biomass, wind and solar – accounted for the rest.

In 2005 Australia produced about 251 TWh (terawatt hours) of electricity. The majority of this was generated by coal (80 percent), natural gas (12 percent) and hydro (6 percent). Other renewable sources accounted for about 1 percent of total electricity generation in 2005.

2. Modelling Assumptions

2.1. Population and Gross Domestic Product

In this modelling exercise it is assumed that annual average growth in population will slow to about 0.9 percent between 2005 and 2030, which is slower than the average

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

annual growth of about 1.2 percent between 1990 and 2005.

Over the period 1990-2005, Australia's growth in gross domestic product (GDP) averaged about 3.5 percent yearly. Average annual growth in Australia's gross domestic product is assumed to remain fairly strong throughout the projection period averaging about 2.6 percent per year between 2005 and 2030. Average annual growth in GDP in Australia is assumed to gradually decline from about 3 percent between 2005 and 2010, to 2.8 percent between 2010 and 2020, and 2.3 percent between 2020 and 2030. The potential impacts of the current global economic crisis have not been accounted for.

2.2. Energy Consumption and Electricity Generation

Fossil fuels are projected to remain the dominant energy source in Australia's energy mix throughout the projection period given their relative abundance and cost effectiveness. In electricity generation, coal is projected to remain the dominant supplier of energy accounting for a projected 72 percent and 60 percent of total generation at 2030 in the BAU (business-as-usual) scenario and the APS (alternative policy scenario) respectively. However, there are projected to be increases through time in the share of natural gas and non-hydro renewables in both the BAU scenario and APS driven primarily by climate change concerns. The relative competitiveness of non-hydro renewable sources is also expected to increase driven by cost reductions as a result of learning by doing.

2.3. Energy and Climate Change Policies

Australia has implemented a range of policies at the state and Commonwealth levels to ensure reliable access to affordable energy while facilitating the efficient use of energy resources and managing environmental issues. Such policies include energy efficiency standards, renewable energy targets, research and development on cleaner technologies, financial incentives for energy efficient and renewable technologies and industry and government partnerships.

Australia has ratified the Kyoto Protocol and is expected to meet its emissions target of 108 percent of 1990 levels over the period 2008-2012 with domestic measures. Although not modelled in this exercise the Government has announced that a domestic emissions trading scheme – the Carbon Pollution Reduction Scheme (CPRS) will commence in 2011. The CPRS will assist Australia to reduce its' greenhouse gas emissions by between 5 and 25 percent below 2000 levels by 2020.

3. Outlook Results

3.1. Total Final Energy Consumption

Total final energy consumption in Australia grew at an average annual rate of about 1.9 percent between 1990 and 2005 from about 58 Mtoe in 1990 to 77 Mtoe in 2005. The transport and industry sectors were the largest users of final energy in 2005 accounting

for about 30 Mtoe and 26 Mtoe respectively.

Oil (51 percent) accounted for the largest share of final energy in 2005, followed by electricity (23 percent) and natural gas (16 percent). The fastest average annual growth in final energy consumption occurred in the electricity sector at about 3.2 percent over the period 1990 to 2005.

Business-as-Usual (BAU) Scenario

Total final energy consumption in Australia is expected to increase at an average annual rate of about 1.9 percent over the period 2005 to 2030 from about 77 Mtoe in 2005 to about 121 Mtoe in 2030. Growth in final energy consumption is projected to be slower than growth in Australia's GDP indicating improvements in the energy intensity of economic output.

In this scenario, strong average annual growth in final energy consumption over the period 2005 to 2030 is expected in electricity (2.3 percent) and natural gas (2.1 percent). Continued average annual growth is expected in oil (1.7 percent), others (1.8 percent), including renewables, and coal (0.3 percent) over the same period.

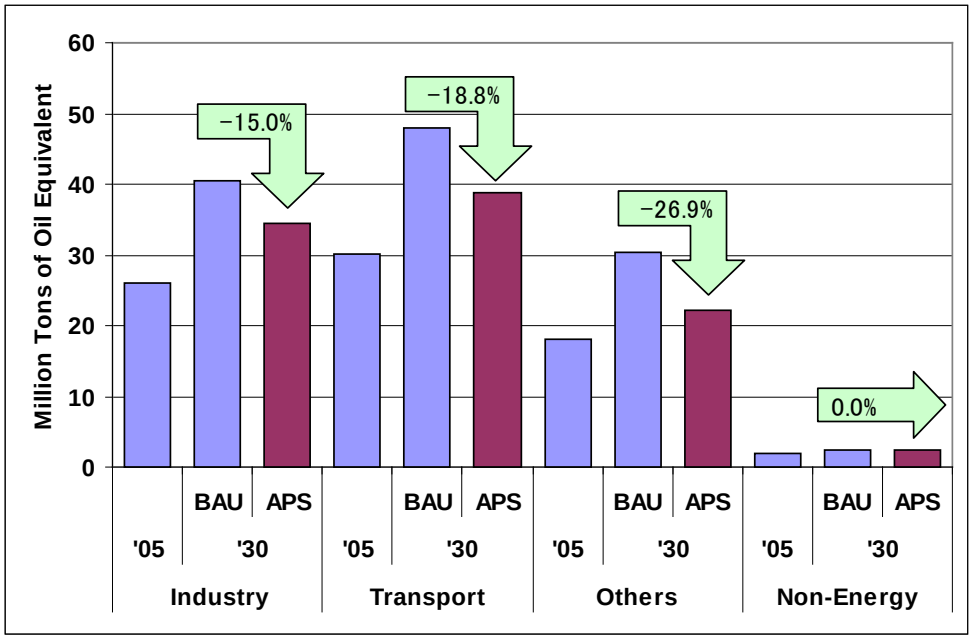
Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at an average annual rate of about 1 percent over the period 2005 to 2030, which is considerably lower than the expected 1.9 percent average annual growth in the BAU scenario. By 2030 final energy consumption in the APS is projected to reach about 98 Mtoe which is about 19 percent lower than in the BAU scenario.

The largest percentage decline in final energy consumption in the APS, relative to BAU, is expected to occur in "other" sectors driven by the uptake of more energy efficient technologies in the residential, commercial and agriculture sectors (Figure 1).

Considerable percentage reductions in the use of coal (23 percent), oil (26 percent), natural gas (15 percent) and electricity (26 percent) are expected in 2030 in the APS relative to the BAU scenario. However, final consumption of "other" fuels is projected to increase by about 62 percent in the APS, relative to the BAU scenario at 2030 as a result of increased uptake of non-hydro renewable energy sources.

Figure 1. Final Energy Consumption by Sector in Australia, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Australia grew at an average annual rate of about 2.2 percent between 1990 and 2005 from about 88 Mtoe in 1990 to about 122 Mtoe in 2005.

Coal (45 percent) accounted for the largest share of primary energy in 2005, followed by oil (31 percent) and natural gas (19 percent). Hydro and other renewable energy sources accounted for the remaining 5 percent of primary energy in Australia.

Business-as-Usual Scenario

In the BAU scenario Australia's primary energy demand is projected to increase at an average annual rate of about 1.6 percent increasing from about 122 Mtoe in 2005 to about 181 Mtoe in 2030.

Coal consumption is projected to increase at an average annual rate of about 0.8 percent over the period 2005 to 2030. However, the share of coal in primary energy demand is projected to decline from about 45 percent in 2005 to 36 percent in 2030. The share of natural gas in Australia's primary energy demand is projected to increase from about 19 percent in 2005 to about 24 percent in 2030. The strong growth in natural gas consumption (averaging about 2.6 percent per year over 2005-2030) is driven by increasing availability of natural gas and the assumed national and state policy initiatives designed to encourage the use of lower emission intensive fuels. The share of oil in Australia's primarily energy consumption mix is expected to increase modestly to about 33 percent in 2030.

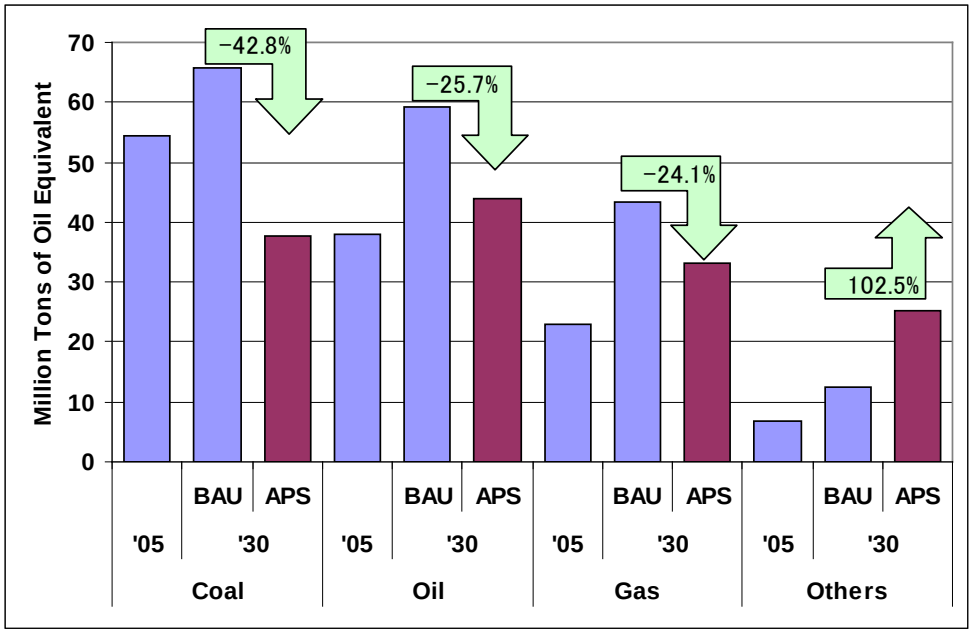
The strongest growth in primary energy demand is projected to occur in non-hydro renewables in response to national and state policies designed to drive increases in the use of renewables technologies and reductions in cost driven by learning by doing.

Alternative Policy Scenario

As a result of the enhanced development and deployment of more energy efficient technologies, average annual growth in Australia's primary energy demand in the APS is expected to be reduced by one percentage point, relative to BAU, to 0.6 percent over the period 2005-2030.

In the APS, the absolute level of coal consumed is projected to decline significantly falling from about 54 Mtoe in 2005 to about 38 Mtoe in 2030. This is primarily driven by considerable improvements in the efficiency of coal fired electricity generation and improvements in industry coal use efficiency in the APS, relative to the BAU scenario (Figure 2).

Figure 2. Primary Energy Demand by Source in Australia, BAU and APS



Average annual growth in the consumption of oil is expected to more than halve in the APS, relative to the BAU scenario, to about 0.6 percent over the period 2005-2030. Reduction in the growth of oil consumption in the APS is driven primarily by the enhanced uptake of more fuel efficient vehicles in transport, improved industry efficiency and increased biofuels use in transport.

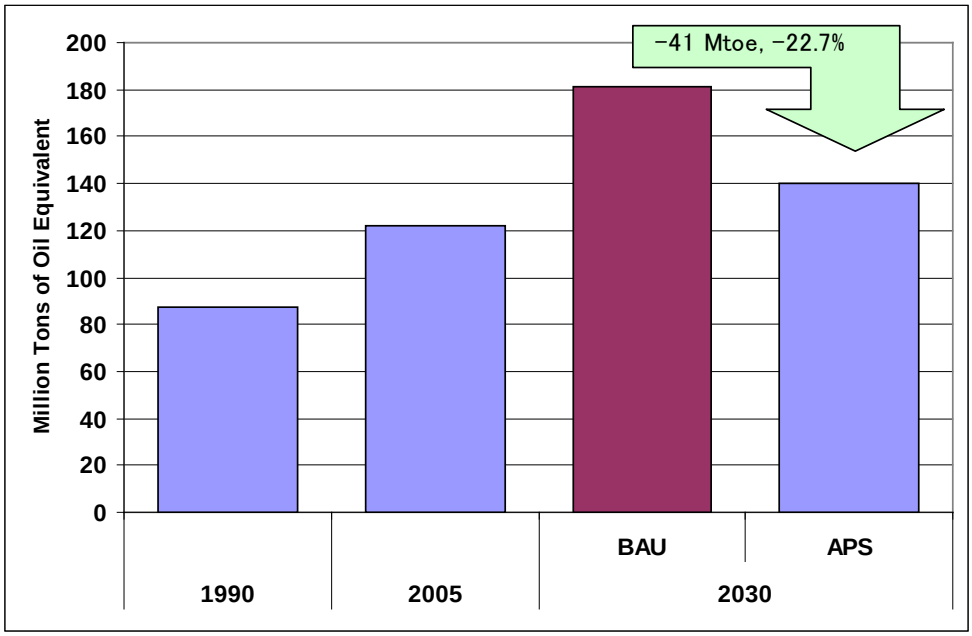
Growth in consumption of natural gas is also projected to be slower in the APS, relative to the BAU as a result of increased electricity generation efficiency and increased efficiency in the residential and industry sectors in particular.

The fastest growth (averaging about 6.1 percent per year over 2005-2030) in primary energy demand in the APS is expected to occur in non-hydro renewables (others) with its contribution to primary energy demand increasing to about 17 percent in 2030. This is driven by the assumed implementation of additional policies designed to increase the uptake of these technologies and fuels, with a particular focus on wind, solar and biomass in electricity generation and biofuels in transport. Although the uptake of geothermal in Australia was not modelled in this exercise it is important to note that Australia has considerable geothermal reserves that may be utilised in the future.

3.3. Projected Energy Savings

As a result of the enhanced deployment of more energy efficient technologies across the economy, primary energy demand in Australia in 2030 is projected to be reduced by about 41 Mtoe or 23 percent in the APS, relative to the BAU scenario (Figure 3). The projected reductions in energy consumption by fuel in the APS at 2030, relative to the BAU scenario are: coal -28 Mtoe or 43 percent; oil -15 Mtoe or 26 percent and gas -11 Mtoe or 24 percent. As discussed previously, consumption of other non-hydro renewables (others) is projected to increase in the APS, relative to the BAU scenario as a result of the implementation of policies to increase the use of lower emission fuels across the economy.

Figure 3. Total Primary Energy Demand in Australia, BAU and APS

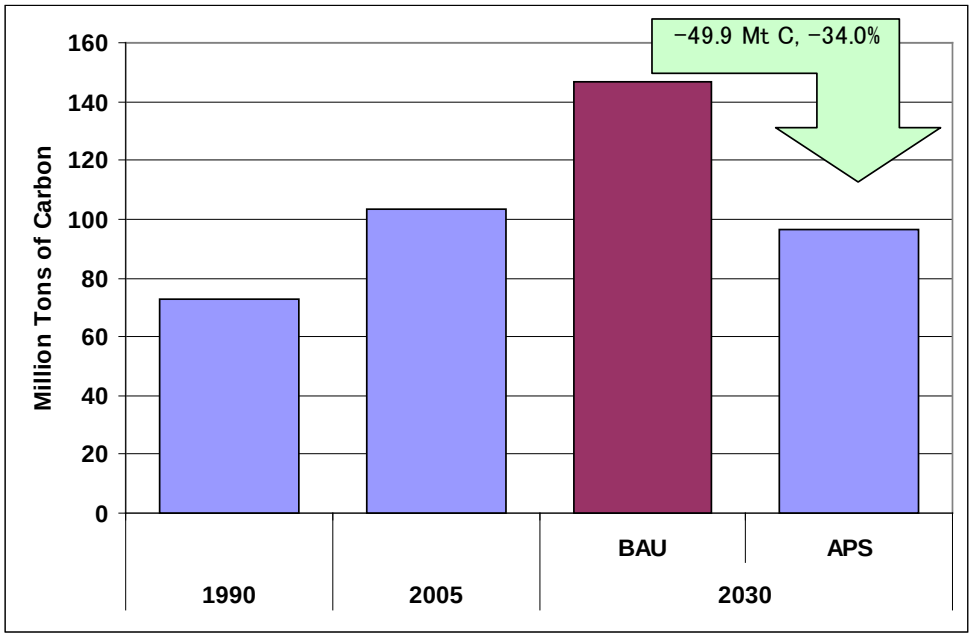


3.4. CO_2 Emissions from Energy Consumption

In the APS, the enhanced uptake of more energy efficient and lower emissions technologies across the Australian economy is projected to reduce growth in CO_2 emissions from energy consumption. At 2030 in the APS, CO_2 emissions from energy

consumption in Australia are projected to reach about 97 million tons of carbon (Mt-C) which is about 34 percent below BAU levels and about 7 percent below 2005 levels (Figure 4). Technologies which are projected to contribute to reducing growth in Australia's CO_2 emissions include energy efficient appliances, enhanced generation efficiencies in electricity generation, non fossil fuel electricity generation, energy efficient vehicles such as hybrid vehicles, solar heating systems, biofuels, fluidised bed combustion technologies and a range of fugitive emission abatement measures and technologies. It is important to note that the potential impacts of Australia's CPRS are not modelled here.

Figure 4. CO_2 Emission from Energy Consumption in Australia, BAU and APS



4. Implications and Policy Recommendations.

Australia's economy is more emission intensive than most developed countries because of the strong reliance on the abundant supply of coal as an energy source. Projected increases in population and economic activity are projected to lead to increased demand for energy services. Continued reliance on fossil fuels to meet the demand for energy is projected to lead to considerable increases in greenhouse gas emissions in the BAU scenario.

To achieve large reductions in Australia's emissions, relative to the BAU scenario, a portfolio of abatement opportunities across all sectors of the economy must be used. Encouraging the uptake of currently available energy efficient technologies in the short term is particularly important as it will reduce both current annual emissions and the requirement for new emission intensive energy infrastructure, which will potentially have a significant impact on the long term emissions pathway (Gurney et al. 2007).

Australia will implement an emissions trading scheme in 2011 that will cover as many sectors and gases as practical. However, given the varying nature of market barriers that limit the uptake of energy efficient and low emission technologies across sectors, a range of complementary policies will be needed. These include education and training initiatives, performance and emission standards, the development of financial instruments to encourage uptake of advanced and economic technologies and the use of renewable energy targets in the short term.

Governments must also play a key role in creating policy environments that are conducive to increased levels of research and development in industry and in providing funding for basic research and development in mitigation and adaptation measures and technologies.

Accelerating the development and global deployment of advanced future generation energy efficient and low emission technologies is also important. Australia can play a key role in developing and demonstrating some of these key advanced technologies such as carbon capture and storage and solar technologies. Australia must remain actively engaged in regional and global technology partnerships to encourage global uptake of advanced technologies (Ford et al. 2007; Matysek et al. 2006).

Given that some degree of climate change is inevitable as a result of historical emissions, adaptation strategies (as well as mitigation) will need to play an important role in any policy mix aimed at addressing climate change in a cost effective manner.

5. References

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Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D. (2007) *Technology: towards a low emissions future*, ABARE research report 07.16, Canberra.

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Chapter 3

Brunei Darussalam Country Report

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2009

This chapter should be cited as
Noor Dina Zharina Haji Yahya (2009), 'Brunei Darussalam Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.63-68.

Brunei Darussalam

Ms. Noor Dina Zharina Haji Yahya

1. Background

Brunei Darussalam (referred to here as 'Brunei') covers the northeast coast of Borneo Island in Southeast Asia. Brunei has an area of 5,765 square kilometres – the majority of which is still covered with pristine tropical forests. Brunei was home to about 373,800 people in 2005 and has one of the highest gross domestic product (GDP) per capita in the region at about US$12,900 in 2005. Brunei's GDP in 2005 was about US$4.8 billion. About 66 percent of the total was contributed by the oil and gas sector.

Brunei exports about 90 percent of its crude oil and natural gas production and keeps the remaining fraction for domestic purposes making Brunei's energy self-sufficiency one of the highest in the region. In 2005, Brunei's total final energy consumption (TFEC) was about 0.7 million tons of oil equivalent (Mtoe)[2]. Transport was the largest energy consuming sector accounting for almost 0.4 Mtoe of final energy consumption.

Brunei's total primary energy demand in 2005 was about 2.4 Mtoe. Oil and natural gas are the only forms of primary energy used in Brunei. The share of natural gas is about 76 percent while oil contributes about 24 percent. Natural gas is mainly used for generating electricity and town gas whereas oil is used primarily for petroleum products.

Brunei generated about 2,907 gigawatt hours (GWh) of electricity in 2005, using a total installed generating capacity of about 690.5 megawatts (MW). About 99 percent of the electricity in Brunei is generated by natural gas, while oil (diesel) supplies the remainder.

2. Modelling Assumptions

In this report assumptions on future GDP growth in Brunei were developed primarily by the Institute of Energy Economics, Japan (IEEJ). GDP in Brunei is assumed to increase at an average annual rate of 4.8 percent from 2005 to 2030. Growth in GDP between 2005 and 2010 is assumed to average about 5.2 percent per year, before declining to 4.8 percent per year and 4.5 percent per year for the periods 2010 to 2020 and 2020 to 2030 respectively. Brunei's population is assumed to grow at an average annual rate of 2.6 percent from 2005 to 2030.

As pledged by APEC Leaders at the 2007 Sydney Declaration on Climate Change, Brunei aims to contribute to the achievement of a regional 25 percent improvement in energy efficiency by 2030, relative to 2005 levels.

[2] Note: Historical and projected figures used in this document are obtained from IEEJ and are not national figures.

Brunei currently has a range of sectoral-based energy efficiency and conservation programmes in place, with a key focus on raising awareness through campaigns, publications, media and other means. Brunei is still in the process of formulating sectoral energy efficiency and conservation targets. In addition Brunei's first Solar Power Plant with a capacity of 1.2 MW is expected to be commissioned in the second quarter of 2010.

This report illustrates the potential impacts on Brunei's energy profile if the following targets as outlined in table 1 were applied.

Table 1. Potential Sectoral Targets in Brunei: Improvements in Energy Efficiency

Sectors	APS		
	2010	2020	2030
Industrial Sector	5% lower than BAU	10% lower than BAU	10% lower than BAU
Residential Sector	5% lower than BAU	10% lower than BAU	10% lower than BAU
Commercial Sector	5% lower than BAU	10% lower than BAU	10% lower than BAU
Transport Sector	5% lower than BAU	10% lower than BAU	10% lower than BAU

3. Outlook Results

3.1. Total Final Energy Consumption

Total final energy consumption in Brunei increased at an average annual rate of 4.2 percent from 0.4 Mtoe in 1990 to 0.7 Mtoe in 2005. From 1990 to 2005, the residential/commercial (other) sector had the highest growth rate of 5.8 percent per year followed by the transportation sector with 3.9 percent per year and the industrial sector with 1.9 percent per year. The transportation sector was the largest energy consuming sector accounting for about 58 percent of final energy consumption in 1990. There was a slight decrease in its share to about 56 percent in 2005. Oil was the largest provider of final energy over the period 1990-2005. However, electricity had the highest average annual growth per year over the same period.

Business-as-Usual (BAU) Scenario

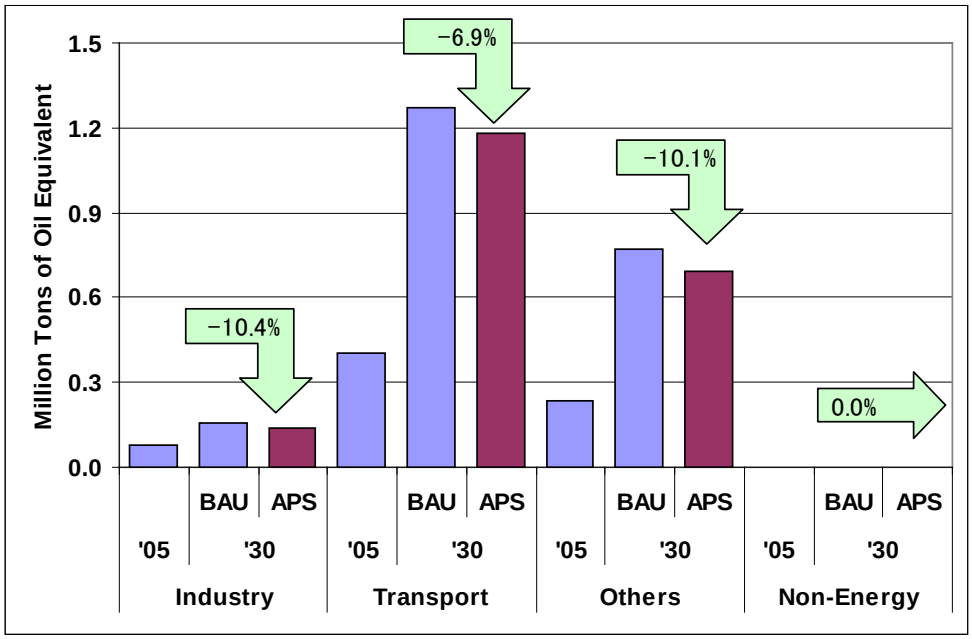
From 2005 to 2030, Brunei's total final energy consumption is projected to grow at an average rate of 4.6 percent per year driven in part by the assumed growth in GDP and population. There is expected to be a significant increase in energy demand in the residential/commercial (other) sector and transportation with projected average annual growth rates of 4.9 percent and 4.7 percent, respectively from 2005 to 2030 in the BAU scenario. Emerging industrial activities are expected to drive growth of 2.7 percent per year from 2005 to 2030 in the industry sector.

In final energy consumption, oil and electricity are projected to grow at an average annual rate of 4.3 percent and 5.0 percent, respectively between 2005 and 2030. Oil is expected to continue to account for the largest share of fuel for energy consumption.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a slower rate than in the BAU scenario at an average of 4.2 percent per annum from 2005 to 2030. That is, from 0.7 Mtoe in 2005 to 2.0 Mtoe in 2030. The transportation sector consumption is projected to increase at a slower pace of 4.4 percent per annum as compared to its growth rate in the BAU. In the APS, the annual growth of all sectors is projected to be lower as compared with the BAU scenario. The industry and other sectors will have more than 10 percent reduction in energy consumption with respect to BAU (Figure 5).

Figure 5. Final Energy Consumption by Sector in Brunei, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Brunei grew at an average annual rate of about 2.0 percent from about 1.8 Mtoe in 1990 to 2.4 Mtoe in 2005. Oil and natural gas were the only energy sources during that period. Natural gas accounted for the highest percentage share which was about 76 percent in 2005. Oil consumption, on the other hand, increased at a much faster rate of 11.1 percent per year from 1990 to 2005.

Business-as-Usual Scenario

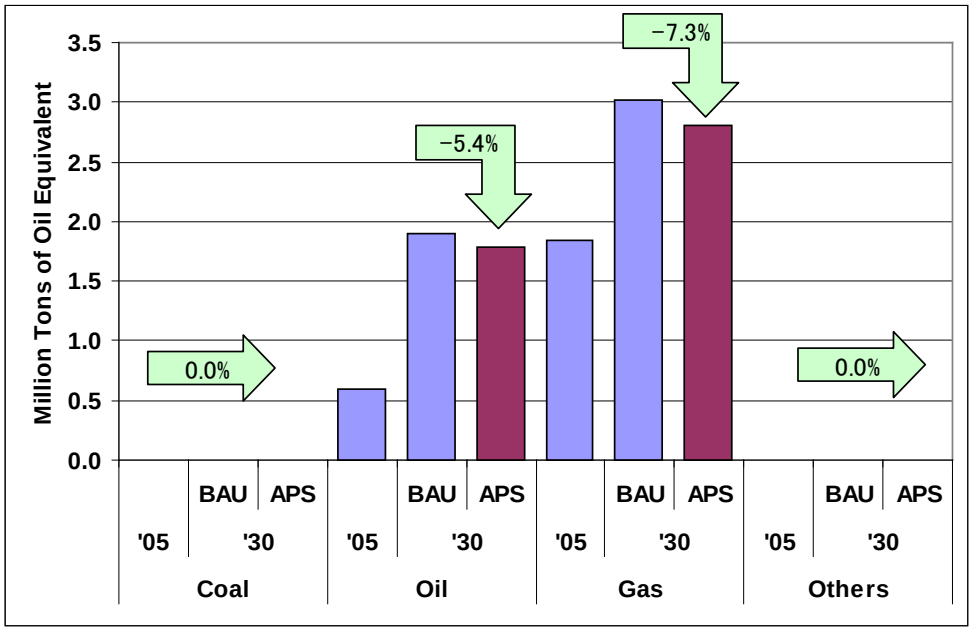
From 2005 to 2030, oil and natural gas are projected to remain Brunei's only primary energy sources. Primary energy demand is projected to increase to 4.9 Mtoe in 2030 at

an average rate of 2.9 percent per year between 2005 and 2030. Oil consumption is projected to grow at a rate of about 4.7 percent per year while natural gas consumption is projected to grow at a slower rate of about 2.0 percent per year from 2005 to 2030. The share of oil in primary energy demand is expected to increase from 24.4 percent in 2005 to 38.5 percent in 2030 as a result of the increase in oil consumption mainly for transportation purposes during this period.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate, relative to the BAU scenario, of 2.6 percent per annum over the period of 2005-2030 to 4.6 Mtoe in 2030. Both natural gas and oil will grow at a much slower rate in the APS, relative to the BAU scenario, mainly due to energy efficiency and conservation improvements (Figure 6).

Figure 6. Primary Energy Demand by Source in Brunei, BAU and APS

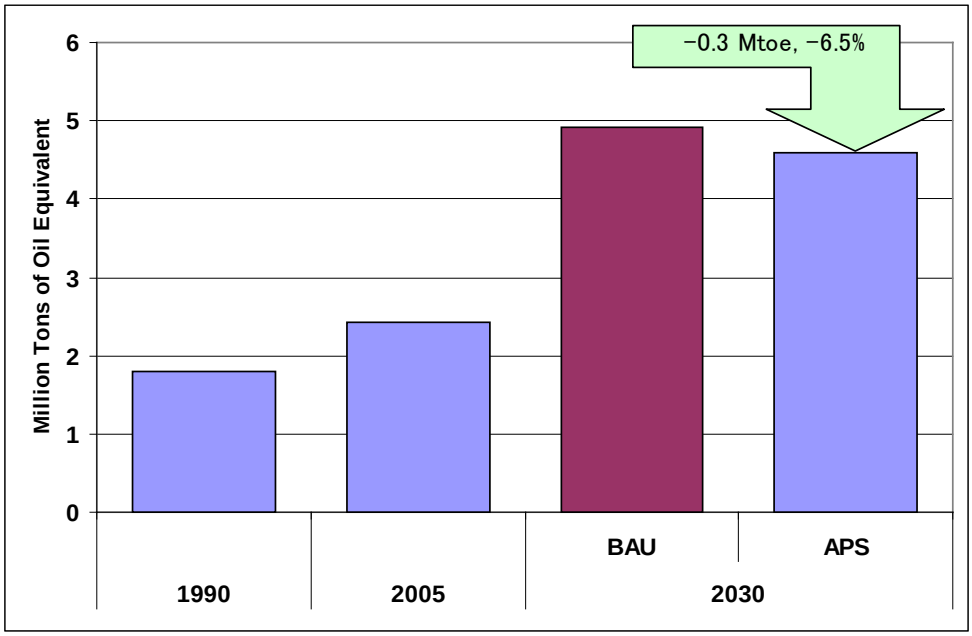


3.3 Projected Energy Savings

The energy savings that could be achieved in Brunei from applying the potential EEC sectoral goals and implementing the EEC goals and action plans that are already in place is projected to be around 322 ktoe or 6.5 percent lower than that of the BAU in 2030. This is the difference between primary energy demand in the BAU scenario and the APS (Figure 7).

In terms of final energy consumption savings, there is estimated to be a saving of 88 ktoe in the transportation sector, 78 ktoe in the residential/commercial sector, and 16 ktoe in the industrial sector in 2030.

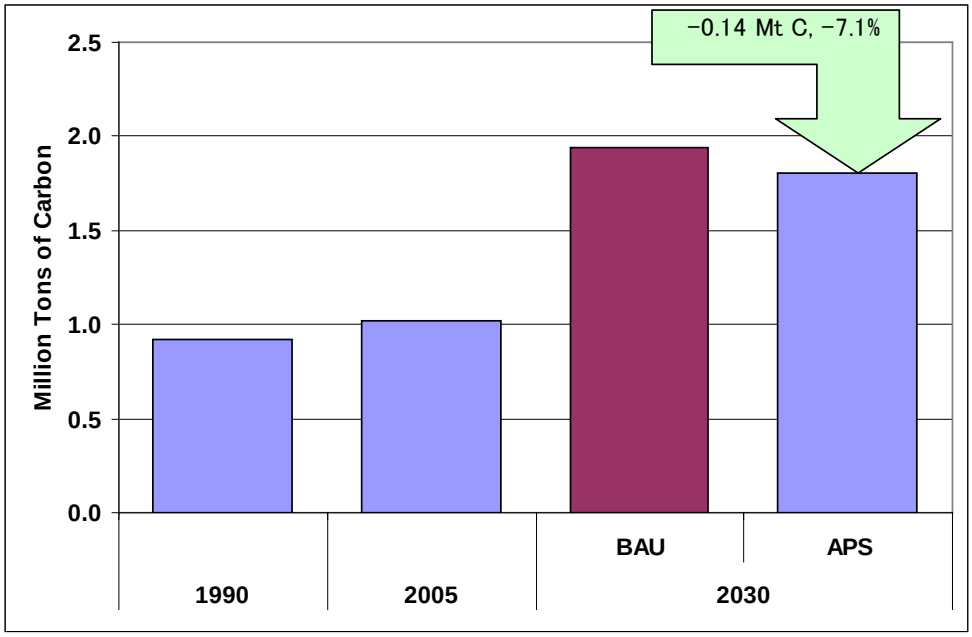
Figure 7. Primary Energy Demand in Brunei, BAU and APS



3.3. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 3.2 percent per annum from 1.4 million tons of carbon equivalent (Mt C) in 2005 to 3.1 Mt C in 2030 in the BAU scenario (Figure 8). This increase is driven by increases in consumption of gas for electricity generation and oil for transportation.

Figure 8. CO_2 Emissions from Energy Consumption in Brunei, BAU and APS



In the APS, the annual average growth in CO_2 emissions from 2005 to 2030 is expected to be lower than in the BAU scenario at 2.9 percent. This is achieved by reductions in the growth of final energy consumption and primary energy demand. This indicates that the energy saving goals and plans in place could reduce Brunei's CO_2 emissions by 7.1 percent in 2030, relative to the BAU scenario.

4. Implications and Policy Recommendations

Energy consumption has increased significantly since 1980 and as projected, energy demand will continue to rise. Given this trend and the dominance of oil and gas in the energy mix, it is of utmost priority for Brunei to improve its energy efficiency and conservation as the main driver in the pursuit of national energy security.

As declared in the *Sydney Declaration on Climate Change* Brunei will contribute to the achievement of the 25 percent improvement in regional energy efficiency in 2030, relative to 2000 levels. In moving towards this vision, Brunei has set out several sectoral goals and action plans.

It is also recommended that Brunei adopt a sectoral quantitative target to help assist in the achievement of overall energy savings.

Chapter 4

Cambodia Country Report

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This chapter should be cited as
Malik, C. L. (2009), 'Cambodia Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.69-72.

Cambodia

Ms. Cecilya Laksmiwati Malik

1. Background

Cambodia has a total land area of 181 thousand square kilometres[3] inhabited by 14.1 million people in 2005[4]. It has a tropical climate with wet and dry seasons. It shares borders with Vietnam to the East, Lao PDR to the north, and Thailand to the west and the South China Sea at its southern part. The country's gross domestic product (GDP) in 2005 is about US$ 5.7 billion at 2000 constant prices with a substantial agriculture share of 34 percent.

Cambodia's conventional primary energy demand in 2005 stood at 1.3 million tons of oil equivalent (Mtoe) while its final energy consumption stood at 1.0 Mtoe[5]. It is dependent on imports of petroleum products having no crude oil production or oil refining facilities. Its electricity supply is dominated by oil at 91.5 percent with hydro accounting for the rest.

Cambodia has 10,000 megawatts (GW) of hydropower potential; however, only 20 megawatts (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

In forecasting energy demand to 2030, it is assumed that the GDP of Cambodia will grow at an annual rate of 7.6 percent. Its population on the other hand is projected to grow at 0.9 percent per annum resulting in a growth rate of GDP per capita of 6.5 percent per year to 2030.

With regards to future electricity supply, hydro is expected to continue to dominate Cambodia's fuel mix. However, coal is expected to enter Cambodia's energy fuel mix before 2020. Remote communities will continue to rely on oil to meet their energy needs. Cambodia has not yet quantified the potential energy savings that could be achieved via its current energy efficiency and conservation programs. Given this, projections are only provided for a Business-as-Usual (BAU) scenario.

[3] Governmetn of Cambodia, 2009, Cambodia e-Gov Homepage, Available: http://www.cambodia.gov.kh/unisql1/egov/english/country.land&resource.html
[4] World Bank, 2008, World Development Indicators 2008.
[5] International Energy Agency, 2008, Energy Balances of Non-OECD Countries 2008.

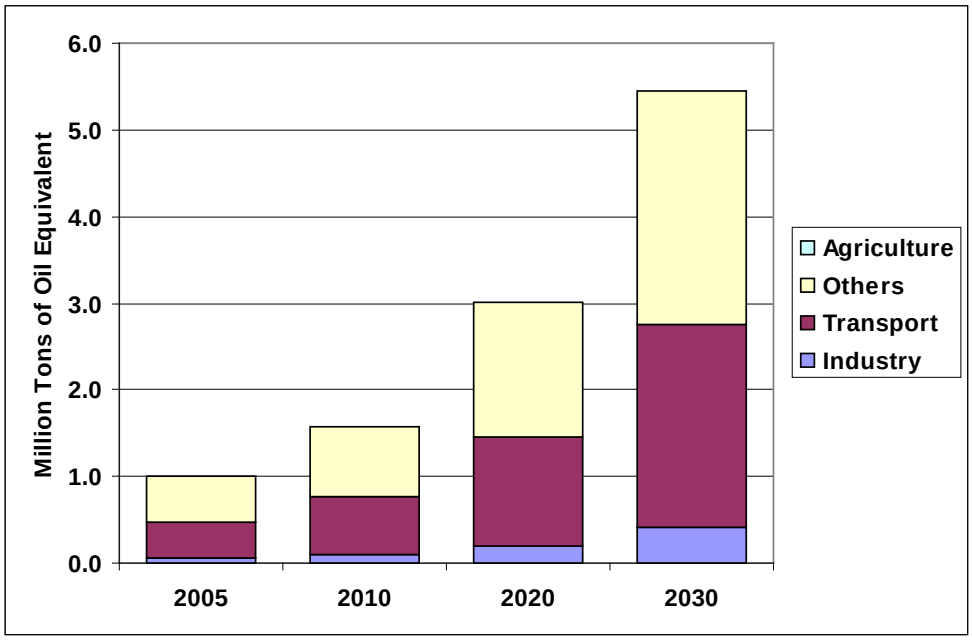
3. Outlook Results

3.1. Total Final Energy Consumption

Cambodia's final energy consumption grew at an average annual rate of 10.2 percent from 1995 to 2005. This growth was driven by the industrial sector which grew at a rapid rate of 30.7 percent during the ten-year period. The other sector which comprises the residential and commercial sectors grew at 18.9 percent annually while the transportation sector had more modest annual growth of 4.2 percent. In terms of energy, petroleum products comprise more than 90 percent of total final energy consumption with electricity supplying the rest.

From 2005 to 2030, Cambodia's final energy consumption is projected to grow at an average annual rate of 7.0 percent (Figure 9). The industrial sector is expected to have the highest growth rate of 8.7 percent per annum followed by the transportation sector at 7.0 percent and the residential/commercial sector at 6.9 percent over the period 2005 to 2030. Electricity demand is expected to increase on average by 9.1 percent per year while demand for petroleum products will grow by 6.9 percent per year to 2020.

Figure 9. Final Energy Consumption by Sector in Cambodia



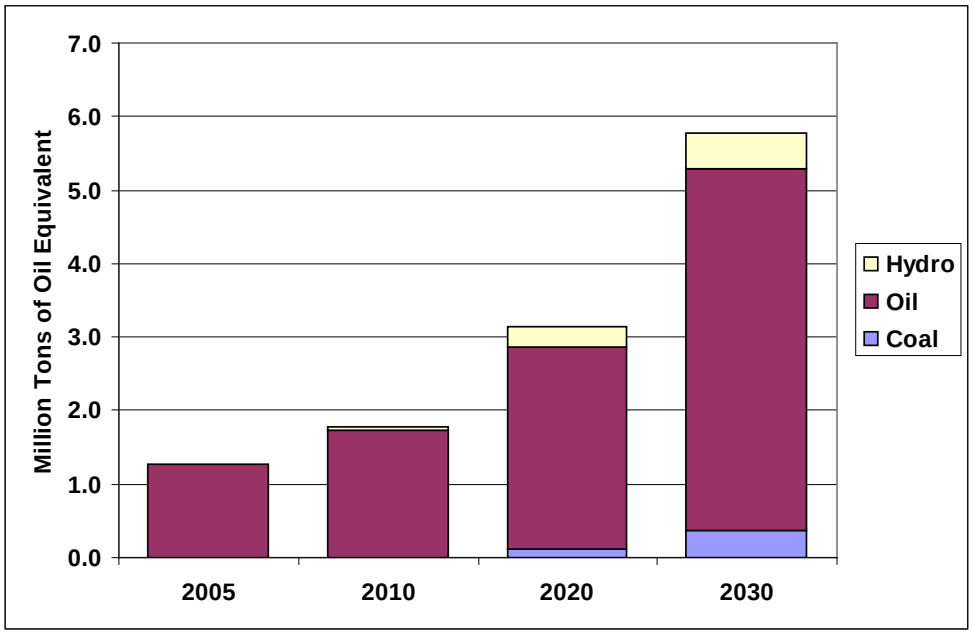
3.2 Primary Energy Demand

Cambodia's primary energy demand grew at an average annual rate of 10.2 percent from 1995 to 2005. Petroleum products were the only source of conventional energy supply in the country in 1995. By 2005, a small hydropower plant was built but only contributed 0.3 percent to the total primary energy demand.

From 2005 to 2030, the country's primary energy demand is projected to grow at an

average annual rate of 6.2 percent. Given the rapid growth in electricity demand of 9.1 percent annually, hydroelectricity production will increase on average by 21.3 percent per annum to 2030. This high growth in hydroelectricity is projected given that options for using other fuels in Cambodia are still very uncertain. Specifically the uptake of natural gas will require huge investments in infrastructure. Coal may be developed by about 2020. By 2030 the share of coal in the primary energy demand mix is projected to be about 6.5 percent (Figure 10).

Figure 10. Primary Energy Demand by Source in Cambodia



3.3 Projected Energy Savings

Although Cambodia has energy efficiency and conservation plans, the country has not yet quantified the energy savings that would be induced by these plans. Given this, no alternative policy scenario (APS) was modelled here and energy savings were not estimated.

Cambodia's energy efficiency and conservation programs aims to achieve an integrated and sustainable program that would facilitate energy efficiency improvements in the major energy consuming sectors and help prevent increased and wasteful fuel consumption. To achieve these aims, the country realises 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:

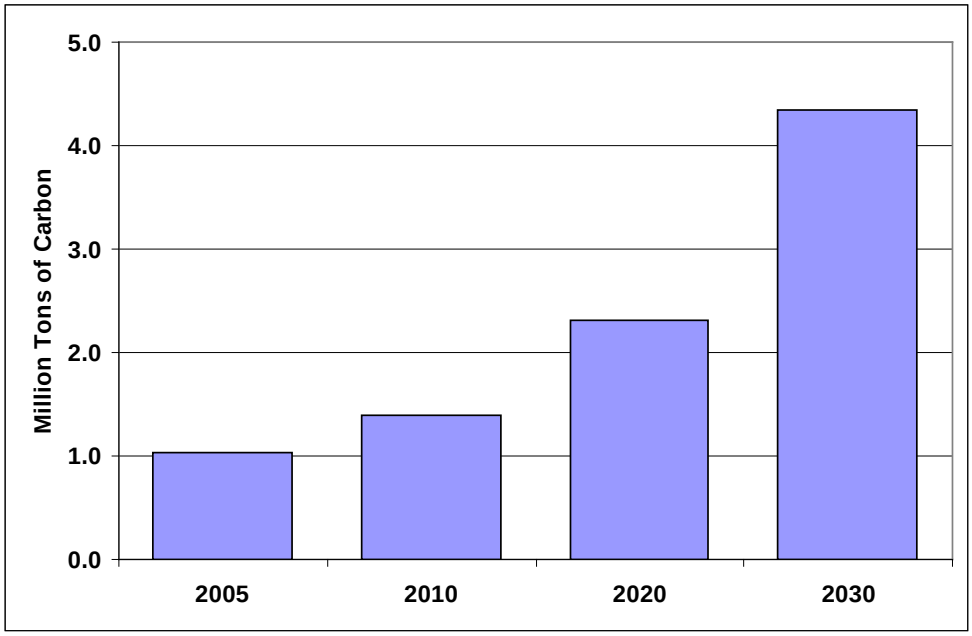
- Improving the efficiency of the overall supply chain for home lighting in rural areas by the provision of decentralized rural energy services through a new generation of rural energy entrepreneurs.

- 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.

3.4 CO_2 Emissions from Energy Consumption

Based on the above projections, CO_2 emissions in Cambodia will increase from 1.0 million tons of carbon (Mt C) in 2005 to 4.3 Mt C in 2030 at an average annual rate of 5.9 percent. This growth rate is lower than that of primary energy demand in view of the rapid growth for hydroelectricity which does not emit CO_2 (Figure 11).

Figure 11. CO_2 Emission from Energy Consumption in Cambodia



Chapter 5

China Country Report

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2009

This chapter should be cited as
Bai Quan (2009), 'China Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.73-81.

China

Dr. BAI Quan, Ms. TONG Qing

1. Background

1.1 Natural Condition and History

The People's Republic of China is situated in eastern Asia on the western shore of the Pacific Ocean, with an area of 9.6 million square kilometres. China's continental coastline extends for about 18,000 kilometres, and its vast sea surface is studded with more than 5,000 islands. Due to its size, China's climate is obviously very diverse, ranging from an unbearable 48ºC in the northwest during summer to an equally unbearable -40ºC in the far north in winter.

China is a country with a long history and ancient civilization. The People's Republic of China was founded on October 1st, 1949. Today, China is implementing reforms and opening up its economy, and has established a socialist market economy, thereby charting the course for socialist modernization with Chinese characteristics.

1.2 Economy and Population

China's real gross domestic product (GDP) in 2005 was around US$1,890 billion (at constant 2000 US$ values), which translates into a per capita income of around US$1,400.

China is the world's most populous country. It has a population exceeding 1.3 billion, which makes up 22 percent of the world total. To bring population growth under control, the country has followed a family planning policy since the 1970s. China is experiencing a fast urbanization process. About 46 percent of people lived in urban areas in 2008.

1.3 Energy Situation

In terms of energy resources, China is endowed with coal, oil and gas reserves and hydropower. China is the world's top coal producer and has the third largest coal reserves with recoverable reserves of 114.5 billion tonnes. In 2008 China produced 2.79 billion tons of coal and is self sufficient in coal. China is still a major crude oil producer, and produces about 190 million tons of crude oil per year. However, driven by very fast increases in China's oil demand, China became an oil importer in the 1990s. About 50 percent of China's oil consumption is met by imported oil.

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 50 percent of the world's average, while the per-capita average of both oil and natural gas reserves is only about 1/15th of the world's average. The per-capita average of arable land is less than 30 percent of the world's average, which has hindered the development of biomass energy.

In 2005 China's primary energy demand was about 1,494 million tons of oil equivalent (Mtoe). Coal dominated primary energy demand accounting for about 73 percent in 2005. Oil is the second largest contributor accounting for 21.3 percent in 2005. Natural gas (2.7 percent), hydro (2.3 percent) and nuclear (0.9 percent) and others, mainly biomass, wind and solar, accounted for the rest.

In 2005 China produced about 2,497 TWh of electricity. The majority of this was generated by coal (79 percent), hydro (15.9 percent), oil (2.4 percent) and natural gas (2.1 percent). Other renewable sources accounted for about 0.1 percent of total electricity generation in 2005.

2. Modelling Assumptions

2.1.Population and Gross Domestic Product

China had a population of 1.1 billion in 1990 and reached 1.3 billion in 2005. This is an average annual growth of 0.9 percent over those 15 years. From 2005 onward, growth in population is expected to be slower due to the implementation of the one child per family policy. China's population is projected to increase on average by about 0.4 percent per year reaching 1.45 billion people by 2030.

China's economy grew at an average annual rate of 10.1 percent between 1990 and 2005. That is, from US$ 445 billion in 1990 to almost US$ 1890 billion in 2005. Future growth in GDP is expected to be slower. In this report it has been assumed to grow at an average rate of 6.3 percent per annum reaching US$ 8644 billion by 2030. Given future expected GDP and population levels, GDP per capita in China is projected to improve from US$ 1445 per person in 2005 to almost US$ 6000 per person in 2030.

2.2. Energy Consumption and Electricity Generation

Based on China's primary energy mix for 1990, coal accounted for 79.7 percent while oil was 16.7 percent, natural gas almost 2 percent and hydro 1.6 percent. In 2005, coal still played a major role in the primary energy mix, but had a lower share of 73 percent. The share of other energy sources increased from their 1990 levels to 21 percent for oil, 3 percent for gas and 2 percent for hydro. In 2005, nuclear had a 1 percent share in the total primary energy mix of China. Overall, primary energy demand in China increased at an average annual rate of 5.6 percent from 663 Mtoe in 1990 to 1494 Mtoe in 2005. Energy intensity (primary energy demand per unit of GDP) decreased from 1491 tons of oil equivalent per million US$ (toe/million US$) in 1990 to 790 toe/million US$ in 2005.

Final energy consumption in China increased at a slower annual average growth rate of 4.5 percent from 463 Mtoe in 1990 to 890 Mtoe in 2005. Coal accounted for the majority of final energy consumption amounting to 68 percent in 1990 and 42 percent in 2005. In 1990 oil accounted for 18 percent of total final energy consumption in China.

Growth in oil consumption has increased rapidly at 8.2 percent per annum leading to a significant increase in its share to 30.4 percent in 2005. Electricity is also increasing in importance in China and it has had a rapid annual growth rate of 9.9 percent between 1990 and 2005 which is faster than any of the other final energy sources. Its share in final energy consumption has increased from 9 percent in 1990 to 19 percent in 2005. The remaining fuels, natural gas and heat, constituted less than 9 percent of total final energy consumption in 2005 and grew at a fast rate of 8.2 percent per annum between 1990 and 2005.

Industry is the major energy consuming sector in China followed by the residential/commercial ("other") sector. The share of industry's consumption in total final energy consumption has increased from 56 percent in 1990 to 58 percent in 2005. The shares of energy consumed by the residential and commercial sector, on the other hand, has declined from 30.7 percent in 1990 to 23.4 percent in 2005. This was due to faster growth in the industry and transport sectors, which grew respectively at 7.2 and 11.9 percent per annum between 1990 and 2005.

In China, coal fired power generation accounted for around 71.3 percent of total electricity generation in 1990. By 2005 this share had increased to 79 percent. The share of hydro in the total generation mix was around 20.4 percent in 1990 and this share was reduced to about 16 percent in 2005. Gas and oil, together accounted for about 3 per cent of total generation in 2005. The share of oil in total generation declined to 2 percent in 2005 while the share of nuclear power increased to about 2 percent.

2.3. Energy and Climate Change Policies

Although China is still a developing country and has a GDP per capita less than 1/10th of that in the United States, the Chinese government has developed aggressive goals to reduce energy intensity and address climate change challenges.

The Chinese government announced a goal of reducing its national energy intensity by 20 per cent in 2010 as part of its socio-economic development plan. In order to realize this goal, the Chinese government implemented administrative, market and legal measures simultaneously to promote energy conservation. Energy intensity reduction goals are assigned to provincial leaders and progress is announced publicly every year.

In addition, the top 1000 energy intensive enterprises in China are required to take measures to save energy. Many polluting and inefficient factories and equipment have shut down as a result. New vehicle fuel standards have also been established. New buildings are required to meet the 50 percent energy saving standard to improve building energy efficiency. Efficient fluorescent lamps are widely promoted to enterprises and citizens. Energy audits of many factories are subsidized. Energy consumption statistical and dynamic monitoring systems for industrial enterprises have also been developed. Furthermore, a number of energy efficiency standards on industrial devices and household appliances have been issued and enforced. With all these measures, the energy intensity of China decreased by 1.79 percent in 2006, 4.04 percent in 2007 and 4.59 percent in 2008. Energy intensity was reduced by 10.1% in the last

three years. As a result of all of these activities, 203 million tons of energy was saved from 2005 to 2008.

The development of renewable energy was also accelerated. The People's Congress of China passed the Renewable Energy Development Law of China in 2005, which is used to support developing renewable energy in China. In the National Renewable Energy medium- and long-term plans developed in 2007, the Chinese government announced a goal of raising the proportion of renewable energy in total primary energy demand from the current 7 percent to 15 percent by 2020. Other subsidization policies have also been developed to encourage the development of wind power, solar photovoltaic and biomass.

China has also announced that it will increase forest coverage to 20 percent and will increase carbon sinks by 50 million tons between 2005 and 2010. Measures in this regard include: continuously carrying out the policies and measures on afforestation, returning farmland to forest and grassland, and natural forest protection.

3. Outlook Results

3.1. Total Final Energy Consumption

Between 2005 and 2030 China's final energy consumption is still expected to grow but at a slower rate than between 1990 and 2005 since GDP and population growth is also expected to slow.

Business-as-Usual (BAU) Scenario

Final energy consumption from 2005 to 2030 is projected to increase at an average rate of 3.0 percent per annum. Consumption in the transportation sector is projected to grow the fastest with an annual average growth rate of 4.5 percent, followed by the residential/commercial sector at 4.3 percent over the period 2005 and 2030. Consumption in the industry sector is projected to grow at an average annual rate of 2.0 percent over the period 2005 and 2030 (Figure 12).

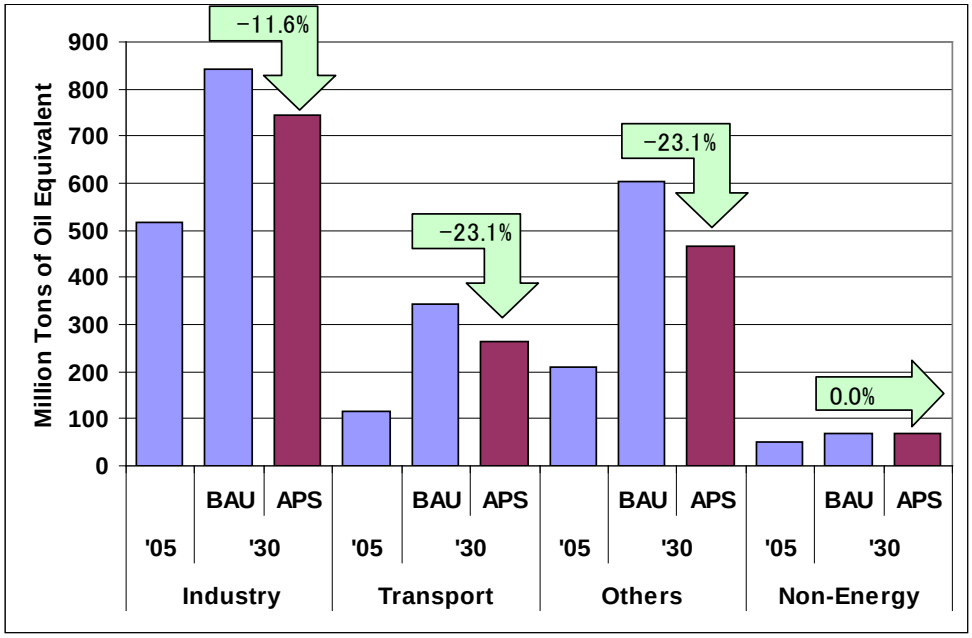
By fuel, natural gas is projected to grow the fastest at 7.4 percent per annum over the period 2005 and 2030. Consumption of electricity and heat are both projected to increase at an average annual rate of 4.0 over the period 2005 and 2030. Oil is projected to have the fourth highest growth rate of 3.5 percent per annum over the same period.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a slower rate than in the BAU scenario at 2.2 percent per annum, from 890 Mtoe in 2005 to 1545 Mtoe in 2030 due to energy efficiency and conservation programs. The decline in energy consumption growth is expected to occur across all sectors, particularly in the commercial/residential and transportation sectors due to improvement in end-use technologies and the introduction of energy management systems. Final consumption of coal is expected to

decline at an average rate of 0.2 percent per annum, reducing its share in the total primary energy mix in 2030 in the APS. Figure 12 shows the final energy consumption in china in 2005 and 2030 in both BAU and APS.

Figure 12. Final Energy Consumption in China, BAU and APS



2.1. Primary Energy Demand

Primary energy demand in China is expected to continue growing but at a slower rate than it has in the past. It is also expected that growth in primary energy demand will be lower than that of final energy consumption due to higher efficiency in energy transformation.

Business-as-Usual Scenario

In the BAU scenario, China's primary energy demand is projected to increase at an annual average rate of 2.9 percent per annum to 3,075 Mtoe in 2030. Coal will still constitute the largest share in the total primary energy mix of China, but is expected to grow slower than other fuels at an annual average rate of 1.9 percent. Consequently, the share of coal in the total primary energy mix is projected to decrease from 73 percent in 2005 to about 56 percent in 2030.

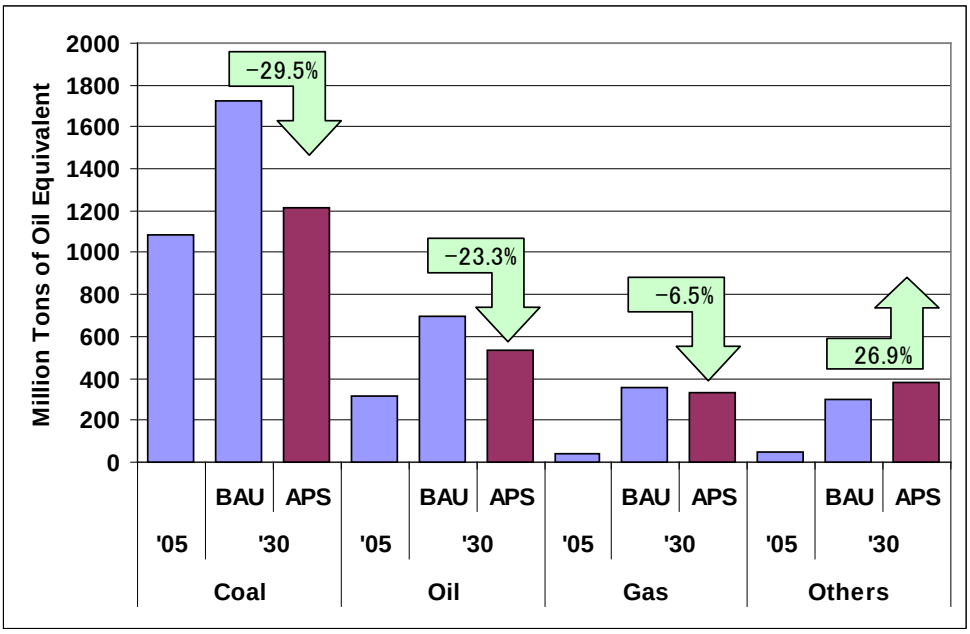
Natural gas is expected to increase the fastest over the 2005 to 2030 period at an annual average rate of 9.1 percent followed by nuclear at 7.8 percent. Oil and hydro are projected to grow at a slower rate of 3.2 and 3.3 percent per annum respectively over the period 2005 to 2030. The shares of these energy sources are expected to increase over the 2005 and 2030 period. The share of natural gas is projected to increase from 2.7 percent in 2005 to 11.6 percent in 2030 whereas the share of nuclear will increase from 0.9 percent to 3.0 percent. The shares of oil and hydro are projected to increase

from 21.3 percent in 2005 to 22.6 percent in 2030 and from 2.3 percent to 2.5 percent, respectively.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate than in the BAU scenario at 2.0 percent per annum between 2005 and 2030. By 2030 primary energy demand is expected to reach 2,462 Mtoe. The demand for coal, oil and gas is projected to continue increasing over the 2005-2030 period but at a slower rate than in the BAU scenario (Figure 13). These energy sources are projected to grow at an annual average rate of 0.4 percent (coal), 2.1 percent (oil) and 8.9 percent (natural gas) between 2005 and 2030. These decreases in consumption growth rates, relative to the BAU scenario, are mainly due to energy efficiency and conservation measures on the demand side. For nuclear, the annual average growth rate will be higher than in the BAU scenario at 9.3 percent between 2005 and 2030 while for hydro, the growth rate in the APS is expected to be the same as in the BAU scenario.

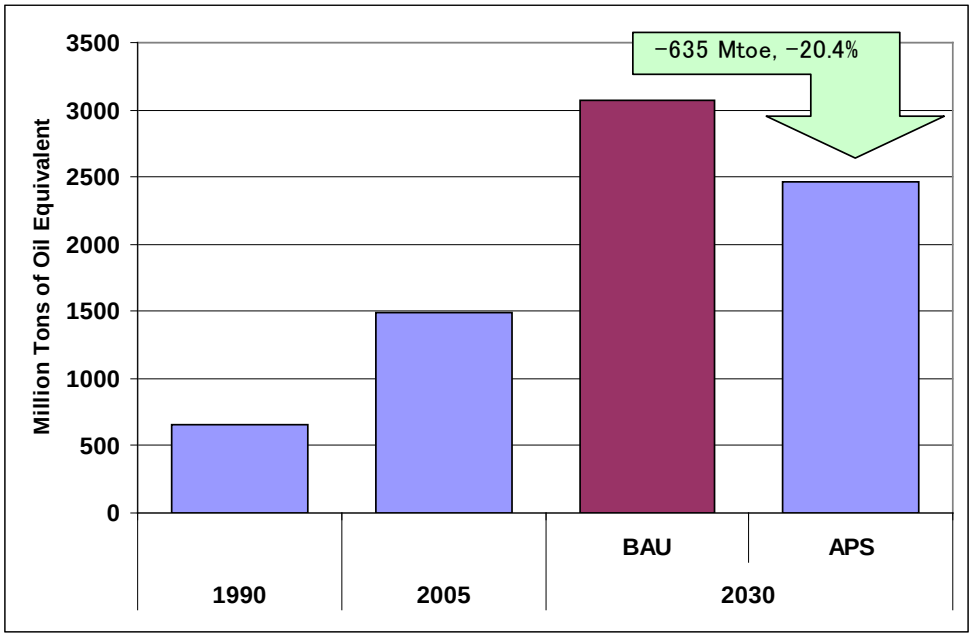
Figure 13. Primary Energy Demand by Source in China, BAU and APS



2.2. Projected Energy Savings

It is estimated that the adoption of energy efficiency and conservation goals and action plans in China could reduce primary energy demand in 2030 by about 613 Mtoe in the APS relative to the BAU scenario. In the APS China's primary energy demand is about 20 percent lower in the APS than in the BAU scenario (Figure 14).

Figure 14. Total Primary Energy Demand in China, BAU and APS



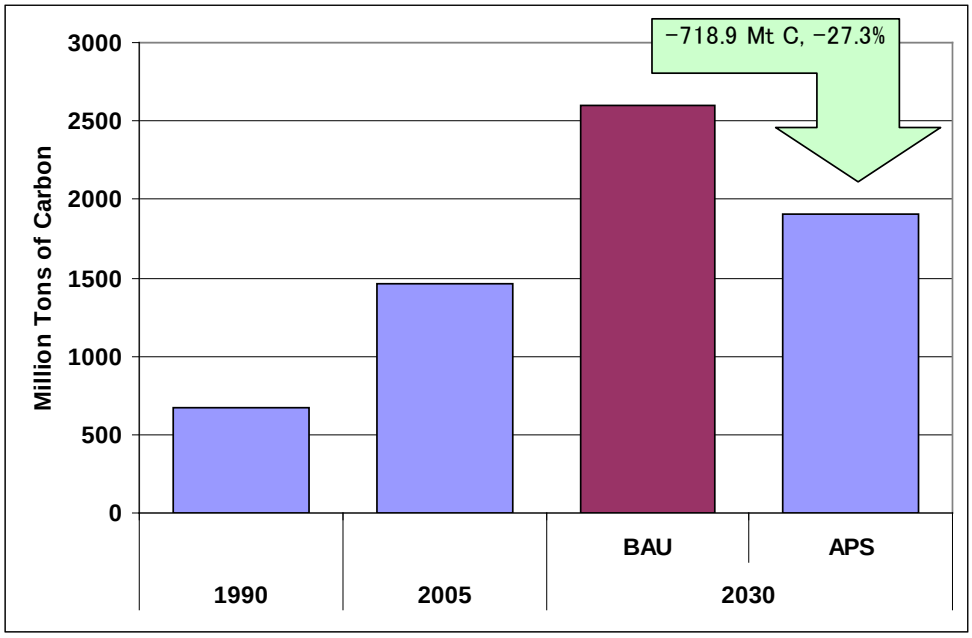
In terms of savings in final energy consumption, there is an estimated saving of 98 Mtoe in the industry sector, 79 Mtoe in the transportation sector and 140 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

2.3. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 2.3 percent per annum from 1467 million tons of carbon (Mt C) in 2005 to 2605 Mt C in 2030 in the BAU scenario. This percentage increase is lower than the percentage increase in primary energy demand of 2.9 percent per annum over the same period indicating an improvement in the emissions intensity of primary energy demand.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 1.0 percent. This rate is also lower than the average annual growth rate in primary energy demand of 2.0 percent over the same period. The reduction in the growth rate of CO_2 between the APS and the BAU scenario indicates that the energy saving goals and action plans of China are effective in reducing CO_2 (Figure 15).

Figure 15. CO_2 Emission from Energy Consumption in China, BAU and APS



3. Implications and Policy Recommendations.

As the world's largest developing economy, reducing poverty and leading a better life has become a widely recognized target of Chinese people. China is still in the fast growth period of development, and there is a long way to go in its industrialization and urbanization. The increase in China's energy demand in the long run is the undoubted result of socio-economic development. Consequently, CO_2 emissions will also increase.

There are challenges in transferring the national energy conservation goal to the province and enterprise level. A more detailed method for assigning responsibility is required to make the procedure of task allocation more fair and reasonable.

The role of government is crucial in realizing the energy conservation goal. Without strong government political willingness and powerful measures, the energy conservation goals will not be easily realized. However, more market-based measures should be used to stimulate enterprises to take actions voluntarily.

Establishment of the Energy Conservation Law will provide a sound legal basis for meeting the energy conservation target. Government should act according to the terms required by the Energy Conservation Law, including establishing energy conservation funds to support energy conservation activities.

About 70 percent of energy intensity improvements have been attributed to structural change. The requirement to reduce energy intensity strongly encouraged the development of tertiary industry and restructuring of the secondary industry. In addition, compulsory shutdown of small inefficient power plants, coal mines and small energy

intensive enterprises such as cement and steel plants is contributing to industry-wide improvements in energy efficiency.

The Clean Development Mechanism (CDM) under the Kyoto Protocol can also promote energy conservation in developing countries because it improves the economic feasibility of energy conservation projects.

Chapter 6

India Country Report

Cecilya Laksmiwati Malik
Agency for the Assessment and Application of Technology (BPPT)

2009

This chapter should be cited as
Malik, C. L. (2009), 'India Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.83-88.

India

Ms. Cecilya Laksmiwati Malik

1. Background

India is a country in South Asia with a land area of 2,973 thousand square kilometres. It had a population of 849.5 million in 1990 which grew at an annual average rate of 1.7 percent per annum reaching 1,095 million in 2005. Its gross domestic product (GDP) in 1990 was US$274 billion which grew at an average annual rate of 6.0 percent to reach US$655 billion in 2005. India's GDP components are: 55 percent services, 27 percent industrial and 18 percent agricultural. GDP per capita stood at about US$600 per person in 2005.

India's total primary energy demand was 379 million tons of oil equivalent (Mtoe) in 2005. Demand grew at an average rate of 4.8 percent per annum since 1990. By fuel in 2005, coal represented the largest share at 54.8 percent, followed by oil at 33.9 percent. Coal is mainly consumed for power generation and industry. The remaining shares were: natural gas (7.6 percent), hydro (2.3 percent), nuclear (1.2 percent) and others (0.2 percent). Compared to 1990, the share of coal lessened marginally. Similarly, the share of hydro also declined from 3.3 percent in 1990. Conversely there were increases in the share of natural gas and nuclear energy.

India generated almost 700 terawatthours (TWh) of electricity in 2005. The annual average growth rate of electricity production has been growing at almost the same rate as GDP (6.1 percent) over the period 1990-2005. The share of generation from coal in 2005 amounted to 68.7 percent while the remaining shares are: hydro (14.3 percent), natural gas (8.9 percent), oil (4.5 percent), nuclear (2.5 percent) and others (1.2 percent).

2. Modelling Assumptions

In this report, India's gross domestic product (GDP) is assumed to grow at an average annual rate of 8.0 percent from 2005 to 2030. Population growth, on the other hand, is projected to increase by 1.2 percent per annum from 2005 to 2030.

With regards to future electricity supply, the shares of electricity from natural gas fired and nuclear power plants are projected to increase to 2030 whereas the shares of coal, oil, hydro and others are expected to decrease. The share of natural gas in 2030 in total electricity generation will double from its share in 2005, which was 8.9 percent.

India's energy saving goals could be attained through the implementation of energy efficiency programs in power generation and the final energy consuming sectors. For the industry sector, energy savings are expected from improvements in the highly energy-intensive industries and in inefficient small plants. In the residential and commercial sector, efficient end use technologies and energy management systems are projected to induce significant savings. In the transport sector, efficiency improvements

will not only be achieved by improved mileage but also through more effective traffic management.

3. Outlook Results

3.1. Total Final Energy Consumption

India's final energy consumption experienced a growth of 3.6 percent per annum from 117 Mtoe in 1990 to 199 Mtoe in 2005. The transport sector grew at 4.1 percent per annum followed by the residential/commercial (other) sector at 4.0 percent per annum between 1990 and 2005. The industrial sector was the slowest growing consumer at 2.7 percent per annum over the same period. The non-energy sector grew the fastest over the 1990-2005 period at 9.2 percent per annum, but its share in the total final energy consumption of the country was less than 7 percent.

Oil was the most consumed product having a share of 44.2 percent in total final energy consumption in 1990, which increased to 53.4 percent in 2005. Coal was the second most consumed product at 35.4 percent of total final energy consumption in 1990 and this decreased to 18.9 percent in 2005. The share of electricity, which was 15.6 percent in 1990 increased to 20.6 percent in 2005. Similarly, the share of natural gas also experienced an increase from 4.8 percent in 1990 to 7.0 percent in 2005.

Business-as-Usual (BAU) Scenario

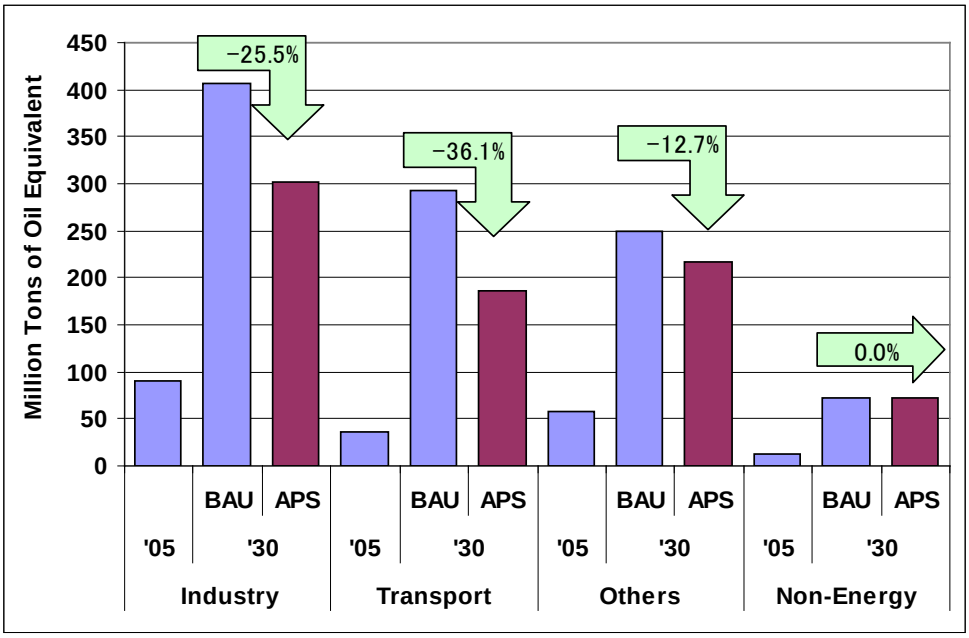
With the projected strong economic growth and population increase, final energy consumption from 2005 to 2030 is projected to increase at an average rate of 6.8 percent per annum from 199 Mtoe in 2005 to 1,020 Mtoe in 2030. The consumption of the transportation sector is projected to grow the fastest with annual growth of 8.6 percent per annum followed by the industry and the residential/commercial (other) sector, at 6.2 and 6.0 percent per annum respectively over the period 2005-2030.

By fuel type, electricity is projected to grow the fastest at 7.5 percent per annum over the period 2005-2030. Oil is projected to have the second highest growth rate of 6.8 percent per annum over the same period. Consumption of natural gas and coal are projected to increase at an average annual rate of 6.0 and 5.9 percent, respectively over the period 2005-2030.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a slower rate than in the BAU scenario at 5.6 percent per annum from 199 Mtoe in 2005 to 780 Mtoe in 2030 due to energy efficiency and conservation programs. The decrease in the consumption growth rate is expected to occur across all sectors, especially in the industrial and transportation sectors due to improvements in end-use technologies and the introduction of energy management systems (Figure 16).

Figure 16. Final Energy Consumption by Sector in India, BAU and APS



3.1. Primary Energy Demand

Primary energy demand in India grew at a higher rate than final energy consumption at 4.8 percent per annum from 186 Mtoe in 1990 to 379 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas and nuclear. Natural gas demand grew at an average annual rate of 7.4 percent while nuclear grew at 7.2 percent per annum over the period 1990-2005. Oil, coal and hydro demand increased but at a slower annual average rate of 4.9 percent, 4.6 percent and 2.2 percent respectively. Other energy sources had a high growth rate of 13.2 percent per annum during the period but its share in total primary energy consumption remained small at 0.2 percent in 2005.

Business-as-Usual Scenario

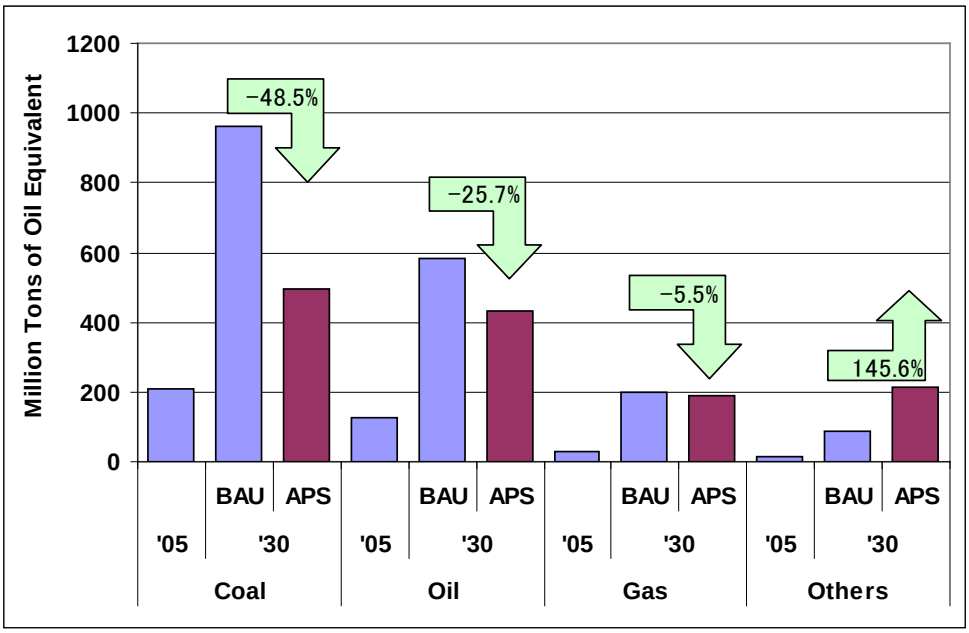
In the BAU scenario, India's primary energy demand is projected to increase at an annual rate of 6.5 percent per annum to 1,832 Mtoe in 2030. Nuclear energy is expected to grow the fastest at an annual average rate of 9.4 percent followed by natural gas at 8.1 percent over the period 2005-2030. The share of oil, coal and hydro is projected to increase at an annual average rate of 6.2, 6.3 and 6.7 percent respectively over the same period.

Alternative Policy Scenario

In the APS, India's primary energy demand is projected to increase at a slower rate than in the BAU scenario at 5.1 percent per year from 379 Mtoe in 2005 to 1,330 Mtoe in 2030. Nuclear will be the fastest growing fuel at 14.8 percent per annum followed by natural gas at 7.8 percent per annum. Oil, coal and hydro will grow at slower annual

rates of 5.0 percent, 3.5 percent and 6.7 percent, respectively. Other energy will also make its mark in the primary energy demand mix and will grow at an average annual rate of 15.2 percent. Consequently, its share will increase from 0.2 percent in 2005 to 2.0 percent in 2030. Figure 17 shows the future primary energy demand mix in both the BAU scenario and APS in 2005 and 2030.

Figure 17. Primary Energy Demand by Source in India, BAU and APS

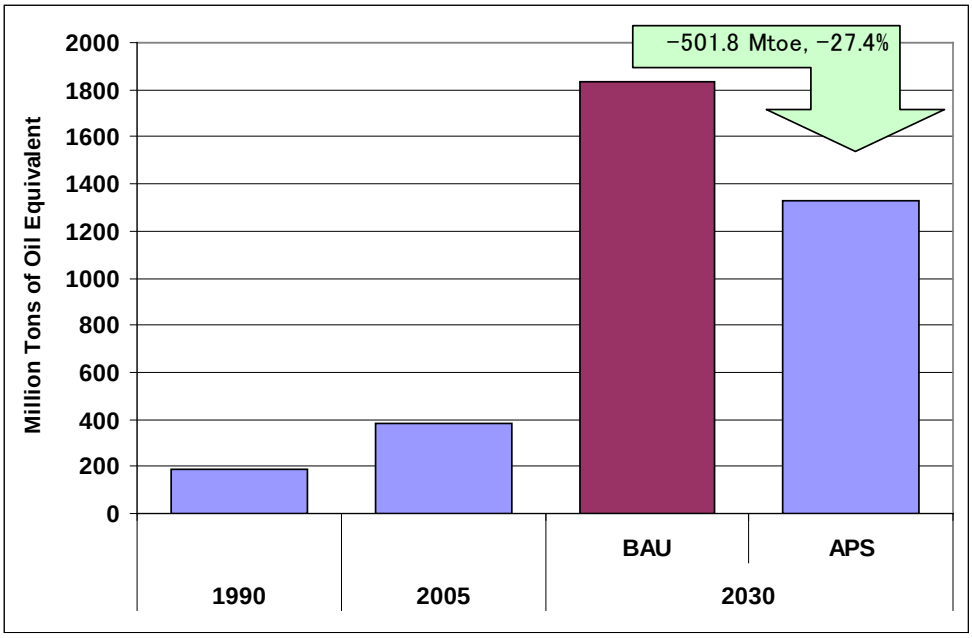


3.2. Projected Energy Saving

In 2030, the total energy savings that could be derived from the EEC goals and action plans of India would amount to 502 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 27.4 percent of India's primary energy demand in 2030 (Figure 18). This is also higher than the primary energy demand of India in 2005 (379 Mtoe).

In terms of savings in final energy consumption, there is an estimated saving of 104 Mtoe in the industry sector, 105 Mtoe in the transportation sector and 31.5 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

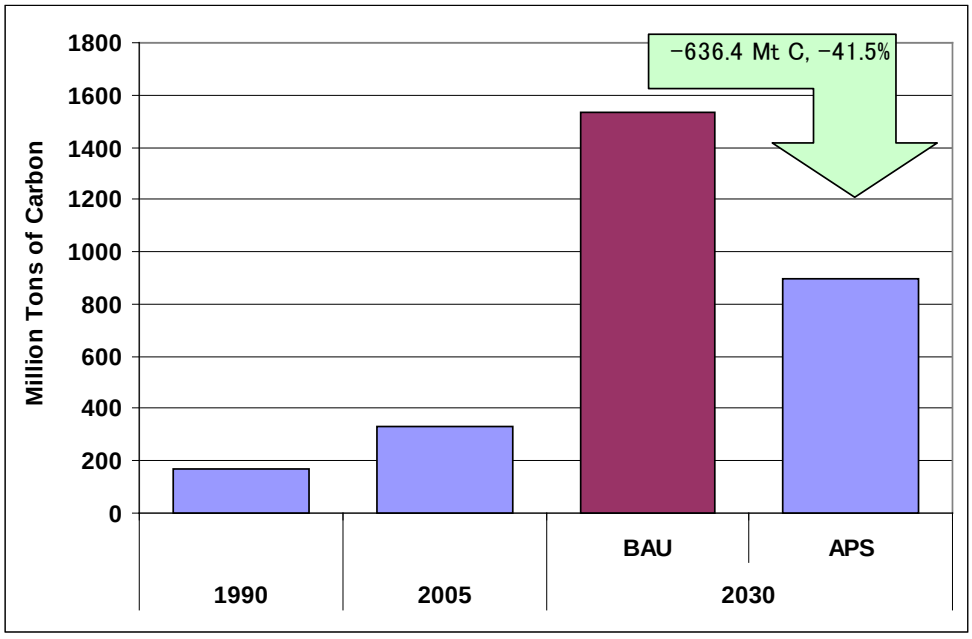
Figure 18. Total Primary Energy Demand in India, BAU and APS



3.3. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 6.3 percent per annum from 329 Mt C in 2005 to 1,532 Mt C in 2030 in the BAU scenario. This percentage increase is lower than the percentage increase in primary energy demand reflecting the expected increasing use of less carbon intensive fuels in India.

Figure 19. CO_2 Emission from Energy Combustion in India, BAU and APS



In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 4.1 percent. The reduction in the growth rate of CO_2 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 19)

Chapter 7

Indonesia Country Report

Cecilya Laksmiwati Malik
Agency for the Assessment and Application of Technology (BPPT)

2009

This chapter should be cited as
Malik, C. L. (2009), 'Indonesia Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.89-96.

Indonesia

Ms. Cecilya Laksmiwati Malik

1. Background

Indonesia is the world's largest archipelagic state in Southeast Asia comprising of 17,508 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 territory of the Andaman and Nicobar Islands.

Indonesia covers an area of 1,919,440 square kilometres and is the world's 16th largest country in terms of land area. With a population of over 234 million people, it is the world's fourth most populous country. Its average population density is 134 people per square kilometre.

Indonesia's real gross domestic product (GDP) in 2005 was almost US$221 billion. From 1990, it has grown at an average rate of 4.4 percent per year to 2005. GDP per capita in 2005 was around US$900 dollars while in 1990 it was only US$600.

Despite its large population and densely populated regions, Indonesia has vast areas of wilderness that support the world's second highest level of biodiversity. The country is richly endowed with natural resources. Indonesia is particularly important to the world's energy markets because of its OPEC membership and substantial, but declining, oil production. Indonesian crude oil proven reserves were 9 billion barrels in 1986 but this has since declined to 5 billion barrels in 1996 and currently, 4.3 billion barrels.

Indonesia is also the world's largest liquefied natural gas (LNG) exporter. Its natural gas proven reserves were 2.27 trillion cubic metres (TCM) in 1986 and these declined slightly in 1996 to 2.05 TCM. In 2005, the proven reserves increased to 2.48 TCM and 2.63 TCM (around 94 trillion cubic feet) in 2006. Indonesia is also a coal exporter with proven coal reserves of around 4.6 billion tonnes.

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 gigawatts (GW) while for geothermal its potential is 27 GW.

Indonesia's total primary energy demand was 135.1 Mtoe in 2005. By fuel, oil represented the largest share at 49.0 percent, followed by natural gas at 22.6 percent and coal at 18.8 percent. The remaining share of about 5.2 percent represents hydro, geothermal and others.

Indonesia has 28.9 GW of installed electricity generating capacity and generated about 127.4 terawatthours (TWh) of electricity in 2005. The state electricity company of

Indonesia, PT PLN PERSERO, owns and operates generation plants of about 23.9 GW composed of: 42 percent oil, 20 percent coal, 22 percent gas, 14 percent hydro and 2 percent geothermal.

2. Modelling Assumptions

In this report, Indonesia's GDP is assumed to grow at an average annual rate of 6.2 percent from 2005 to 2030. This rate is lower than the projected growth used in the National Energy Planning Blueprint of 6.5 percent per year. A lower growth rate was used in this report given the current global economic crisis which is also affecting economic growth in the East Asia Summit (EAS) region.

The GDP growth rate used in this report primarily reflects historical growth rates to 2008 and incorporates projections from the World Bank which account for the potential impacts of the global economic crisis. Indonesia's GDP growth rate was 6.3 percent in 2007 and this slowed down 6.1 percent in 2008. In 2009, the International Monetary Fund expects annual growth in GDP to slow further to 2.5 percent. However, the World Bank expects a higher growth rate of 4.4 percent in 2009 which is projected to increase further to 5.5 percent in 2010. In this report it is assumed that annual GDP growth will reach 6 percent by 2015 and increase to 6.5 percent until 2030. Thus, on average the assumed annual growth in Indonesia's GDP from 2005 to 2030 is around 6.2 percent.

Population growth is assumed to increase at an average of 1.1 percent per year from 2005 to 2030. Growth is assumed to be slightly faster from 2005 to 2010 at 1.2 percent per year, tapering off to 1.1 percent per year from 2010-2020 and to 1.0 percent per year from 2020-2030. These projections are in line with the projections of the Central Bureau of Statistics (BPS) of Indonesia.

In regard to future electricity supply, Indonesia will increase its usage of coal as part of the Government Crash Program for power generation. On the First Phase of the program an additional of 10,000 megawatts (MW) of coal fired electricity capacity will be built by 2010. In addition the Government is also embarking on the Second Phase on which additional capacities will be mainly coming from geothermal energy and other renewable energy sources. This is in line with the projected increasing share of renewables 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 are assumed to decrease significantly. Beyond 2028, nuclear is also assumed to be a part of the future electricity supply mix in Indonesia. This is deferred from the original plan in 2017. As a result of this deferral nuclear power plants are only assumed to be available in the APS in this study.

The National Energy Policy 2005-2025 stated that the goal for energy savings is to achieve GDP energy elasticity of less than 1 by 2025. This means that energy demand

growth should be less than the corresponding GDP growth. The following energy Demand-Side Management (DSM) programs are in place in order to achieve this energy saving goal:

- Industries (both primary and secondary) - applying energy saving technologies and energy management;
- Households and the commercial sector - promoting the use of energy saving equipment (applying standards and labels for efficient energy saving equipment);
- Transportation - applying fuel efficiency standards; and
- Electricity generators - applying energy saving technologies and energy management

The energy saving goals used in the study were based on the conservation potential indicated in the Government's Blueprint for Energy Efficiency and Conservation published in 2006 (RIKEN 2006) as shown below in Table 2.

Table 2. Energy Conservation Potential to 2020

Sector	Energy Conservation Potential (%)	Total Consumption (MMBOE)	Energy Conservation potential (MMBOE)
Industry	15-30	213.7	30.1-64.1
Transportation	25	199.6	49.9
Household and commercial	10-30	112.8	11.3-33.8

MMBOE = million barrels of oil equivalent

3. Outlook Results

3.1. Total Final Energy Consumption

Indonesia's final energy consumption increased at an average annual rate of 4.9 percent over the 1990 to 2005 period from 44 Mtoe to 90 Mtoe. The transport sector had the highest growth rate during this period at 5.9 percent per year. Final energy consumption in the industry and other (mainly consisting of the residential and commercial) sectors, grew at slower rates of 5.0 percent and 4.9 percent per year respectively over the period 1990-2005. Oil still plays a major role in the country's final energy consumption. Its share in total final energy consumption however, shows a decreasing trend, from 63.3 percent in 1990 to 57.9 percent in 2005. Natural gas was the second most consumed product in 2005 followed by coal and electricity.

Business-as-Usual (BAU) Scenario

Given the projected economic and population growth, final energy consumption from 2005 to 2030 is projected to grow at an average rate of 6.2 percent per year in the BAU scenario. This is mainly due to the rapid increase in the consumption of the

transportation sector which is still heavily dependent on oil. Consumption by the industry and residential/commercial (other) sectors is projected to grow at slower annual rates of 6.6 percent and 5.2 percent respectively. The use of natural gas as a feedstock is included in industry sector demand.

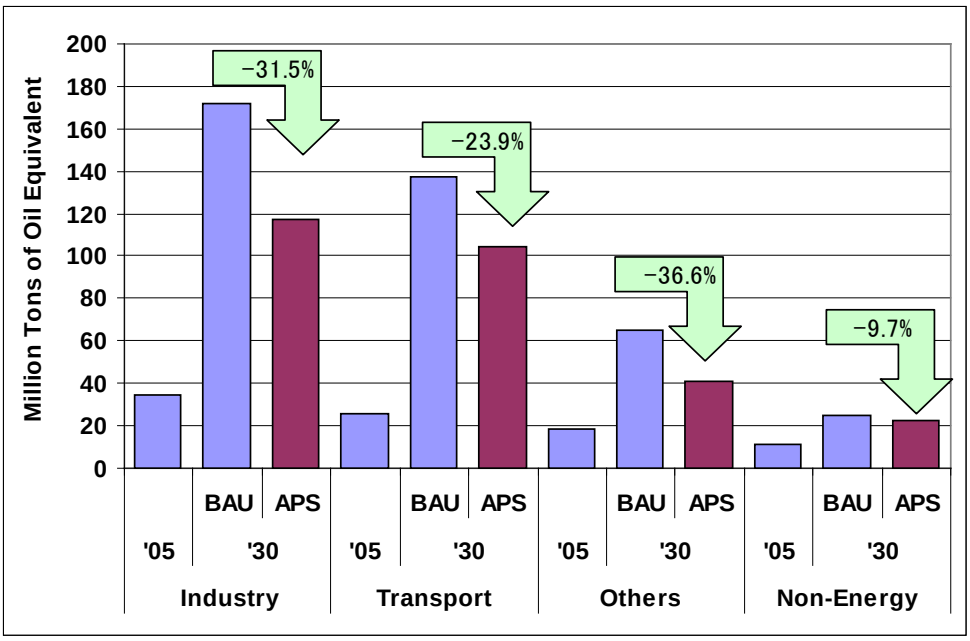
By fuel type, the consumption of coal, oil, natural gas, and electricity is projected to increase over the 2005-2030 period. Coal and electricity are assumed to grow faster than natural gas and oil at average annual rates of 8.0 and 7.9 percent respectively. Consumption of natural gas and oil is projected to increase at average annual rates of 6.4 and 5.7 percent, respectively over 2005-2030.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a slower rate than in the BAU scenario at an average of 4.6 percent per year to 2030. That is, from 89.7 Mtoe in 2005 to 277.2 Mtoe in 2030. This slower rate of increase in the APS, relative to the BAU scenario, is projected to be the result of the aggressive program for demand side management in all sectors, particularly in the transport sector. As a result, the growth rate of energy consumption in the transport sector is projected to decline to 5.3 percent per year as compared to 6.9 percent per year in the BAU over the period 2005-2030. Slower rates of growth in energy consumption will also be experienced across all sectors in the APS relative to the BAU scenario.

Figure 20 shows the final energy consumption in 2005 and 2030 in both the BAU and APS.

Figure 20. Final energy Consumption by Sector in Indonesia, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Indonesia grew at almost the same rate as final energy consumption at about 5.0 percent per year from 64.6 Mtoe in 1990 to 135.1 Mtoe in 2005. Among the major energy sources, the fastest growing fuels between 190 and 2005 were coal and geothermal energy. Coal consumption grew at an average annual rate of 13.2 percent while geothermal energy grew at 12.7 percent. Oil consumption increased slower at 4.5 percent per year while natural gas consumption grew at 3.4 percent per year. Hydro energy had a growth rate of 3.0 percent during the period but its share in the total remained minimal at less than 1.0 percent in 2005.

Business-as-Usual Scenario

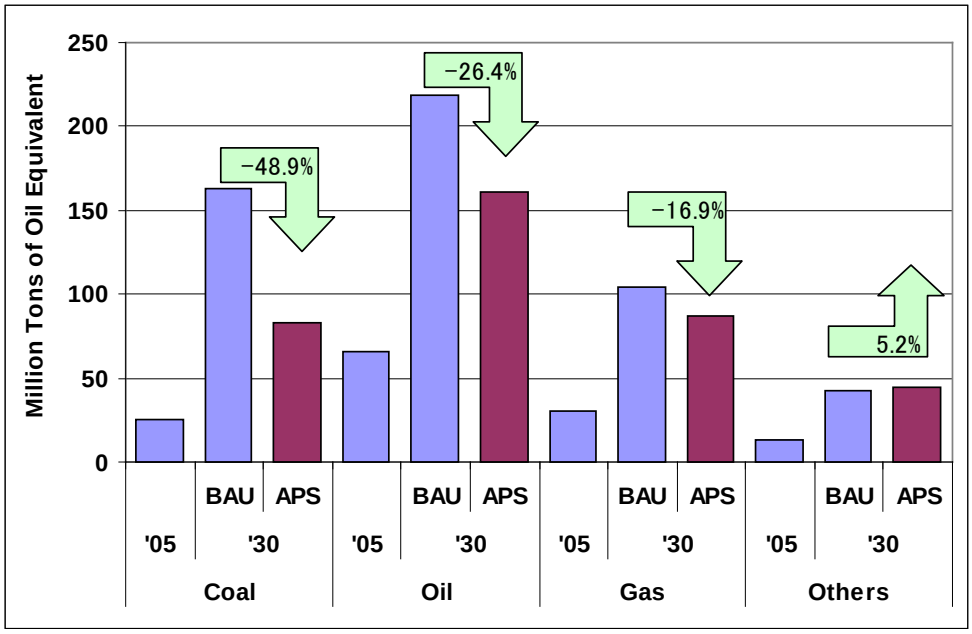
In the BAU scenario, Indonesia's primary energy demand is projected to increase at an annual average rate of 5.7 percent over the period 2005-30 to 542.9 Mtoe in 2030. Coal and geothermal are projected to continue to grow at the fastest rate. The growth in the demand for these energy sources are expected to accelerate to 7.7 percent and 8.3 percent per year respectively over the period 2005-2030. This is in line with the government's First and Second phases of the accelerated program to develop 10000+ MW of coal and geothermal by 2020.

Consumption of natural gas is projected to grow faster than oil and hydro at an average of 5.1 percent per year over the period 2005-2030. However, its share in the total primary energy demand is expected to decline from 22.6 percent in 2005 to 19.7 percent in 2030. Oil consumption is projected to increase at an annual average rate of 4.9 percent over the period 2005-2030 with a declining share from 49.0 percent in 2005 to 40.7 percent in 2030 in total primary energy demand. Hydro is expected to increase at an average annual rate of 3.4 percent between 2005 and 2030 and its share in the total will remain less than 1 percent. There is assumed to be no uptake of nuclear in the BAU scenario. Thus, other renewable energy is projected to increase in the future primary energy supply mix as cleaner fuel alternatives to oil. However, their share in the total fuel mix is projected to remain small.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate, relative to the BAU scenario, at 4.3 percent per year over the period 2005-2030, to 383.8 Mtoe in 2030. All fuels are still projected to experience positive average annual growth rates; however, these will be slower than in the BAU scenario. These decreases in consumption relative to the BAU scenario are mainly due to energy efficiency and conservation measures on the demand side.

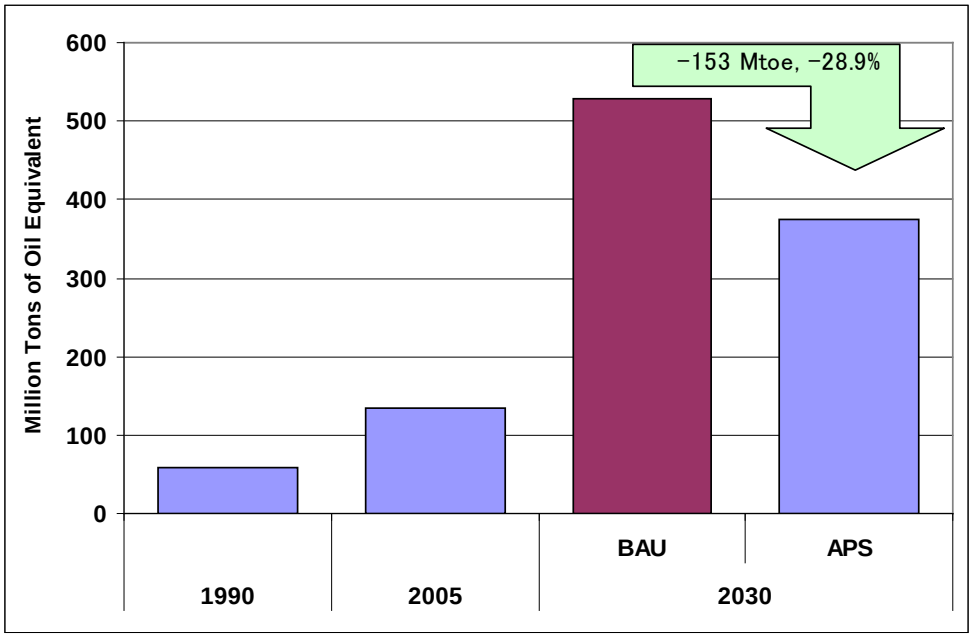
Figure 21. Primary Energy Demand by Source in Indonesia, BAU and APS



3.3. 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 about 153 Mtoe in 2030 (Figure 22). This is more than Indonesia's energy consumption in 2005. At current oil prices, this could amount to around US$55 billion of oil import savings.

Figure 22. Total Primary Energy Demand in Indonesia, BAU and APS



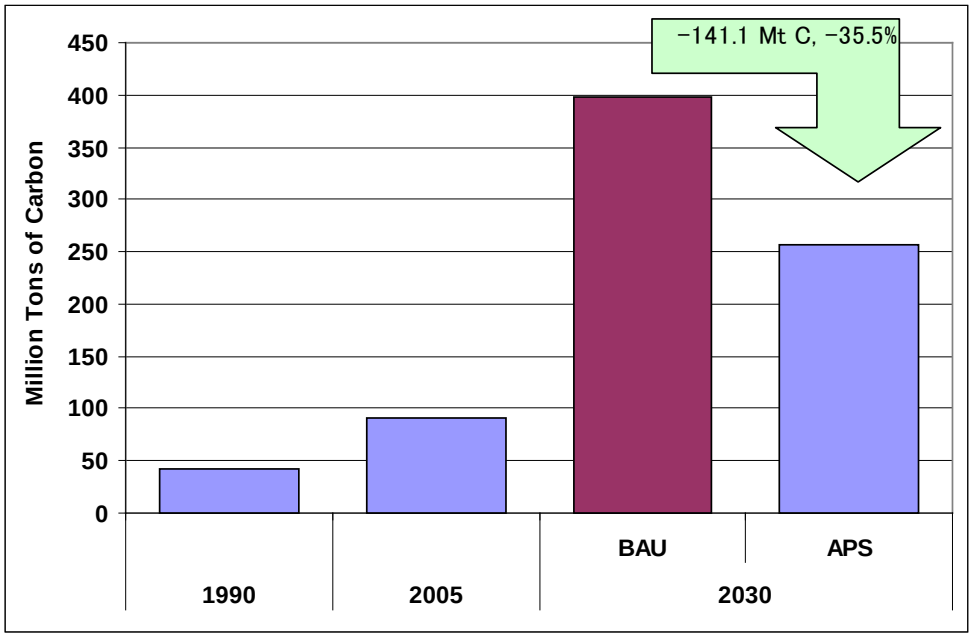
In terms of final energy consumption savings, there is estimated to be a saving of 54 Mtoe in the transportation sector, 45 Mtoe in the industry sector and 25 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an average annual rate of 6.1 percent from around 91 million tons of carbon (Mt C) in 2005 to 401 Mt C in 2030 in the BAU scenario (Figure 23). This increase is driven by the increasing use of carbon intensive fuels, in particular coal for power generation and industry, and oil in the transport sector.

In the APS, the annual average growth in CO_2 emissions from 2005 to 2030 is expected to be lower than in the BAU scenario at 4.1 percent. This lower growth rate is the result of a significant decrease in coal consumption in the power sector in the APS, relative to the BAU scenario. This rate of decrease is also higher than the rate of decrease in primary energy demand of 28.9 percent. This indicates that the energy saving goals and action plans of Indonesia are also very effective at reducing growth in CO_2 emissions.

Figure 23. CO_2 Emissions from Energy Combustion in Indonesia, BAU and APS



4. Implications and Policy Recommendations

As a developing country, Indonesia's primary energy intensity (TPES/GDP) has been increasing since 1990. In the future, it is expected that there will be more improved and efficient energy technologies being used in the country both by energy producers and consumers. Thus, as Indonesia's economy improves, it is projected that primary energy

intensity will decrease. In the BAU scenario it is projected to decrease at an average annual rate of 0.5 percent while in the APS the projected average annual rate of decline is 1.8 percent.

The elasticity of final energy consumption is also projected to decrease to below 1.0 indicating that growth in final energy consumption will be slower than growth in GDP over the 2005-2030 period in both scenarios. This can be easily achieved if the energy efficiency and conservation programmes are implemented extensively throughout the country.

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 more than 30 percent in 2030 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.

Chapter 8

Japan Country Report

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2009

This chapter should be cited as
Aoshima, M. (2009), 'Japan Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.97-102.

Japan

Ms. Momoko Aoshima

1. Background

Japan is a small island nation in Eastern Asia. It consists of several thousand islands spanning across a land area of approximately 377,800 square kilometres and most of its land area is mountainous and thickly forested. It is the world's second largest economy after the United States with real gross domestic product (GDP) in 2005 of about US$ 4,993 billion (constant 2000 prices). Its population is currently about 128 million people with a per capita income of US$ 39,100 in 2005.

Japan possesses a modest amount of indigenous energy resources and imports almost all of its crude oil, coal and natural gas requirements to sustain economic activity. In the end of 2007, proven energy reserves included around 44 million barrels of oil, 738 BCF of natural gas and 355 Mt of coal.

Japan's total primary energy demand was 530.5 Mtoe in 2005. By fuel, oil represented the largest share at 47.4 percent, coal was second at 21.1 percent, followed by nuclear energy (15.0 percent) natural gas (13.3 percent) and others represented the remainder. In 2005, net imports of energy, accounted for about 84 percent of the total primary energy demand. With limited indigenous energy sources, Japan imported almost 99 percent of oil, 99 percent of coal and 96 percent of gas.

Japan is the world's largest 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 2005, primary natural gas supply was 70.5 Mtoe.

Japan has 274 GW of installed electricity generating capacity and generated about 1,094 TWh of electricity in 2005. The generation amount by energy type is broken-down as: thermal (coal, natural gas and oil) at 63 percent, nuclear (28 percent), hydro (7 percent) and geothermal, solar and wind taking up the remainder.

2. Modelling Assumptions

In this outlook, Japan's gross domestic product (GDP) is assumed to grow at an average annual rate of 1.0 percent from 2005 to 2030. Growth is projected to slow down from 2005 to 2010 at 0.7 percent per year due to recent economic recession. However, GDP from 2010 is projected to be strong at an average of 1.0 percent until 2030. The industry structure, with the maturing of society and the economy, will become increasingly oriented toward services. Population growth, on the other hand, will be decreasing by about 0.4 percent per annum from 2005 to 2030 due to the declining birth rate. Japan's population is projected to decrease from 128 million in 2005 to 115 million in 2030.

Ten additional nuclear power plants are assumed to be constructed by 2030 and the utility rate is expected to grow through 2030. The capacity of hydro power plants would be around 70 percent of the potential that would translate to an increase in capacity by 2030. Supply from oil fired power plants is projected to decrease while that of nuclear power is expected to increase. In addition, natural gas power plants capacity is expected to increase due to the relatively small environmental burden from the fuel.

Japan's energy saving goals would be attained through the implementation of 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 sector, the top-runner program is projected to induce huge savings in addition to 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. Total Final Energy Consumption

Japan's final energy consumption experienced a low growth of 1.4 percent per annum from 304.4 Mtoe in 1990 to 350.8 Mtoe in 2005. The residential/commercial (other) sector had the highest growth rate during this period at 3.0 percent per annum followed by the transportation sector with 1.9 percent. Consumption in the industry sector grew at a very slow pace of 0.1 percent per annum over the period 1990-2005. Oil was the most consumed product having a share of 62.3 percent in 1990, slightly decreasing to 59.4 percent in 2005. Electricity was the second most consumed product.

Business-as-Usual (BAU) Scenario

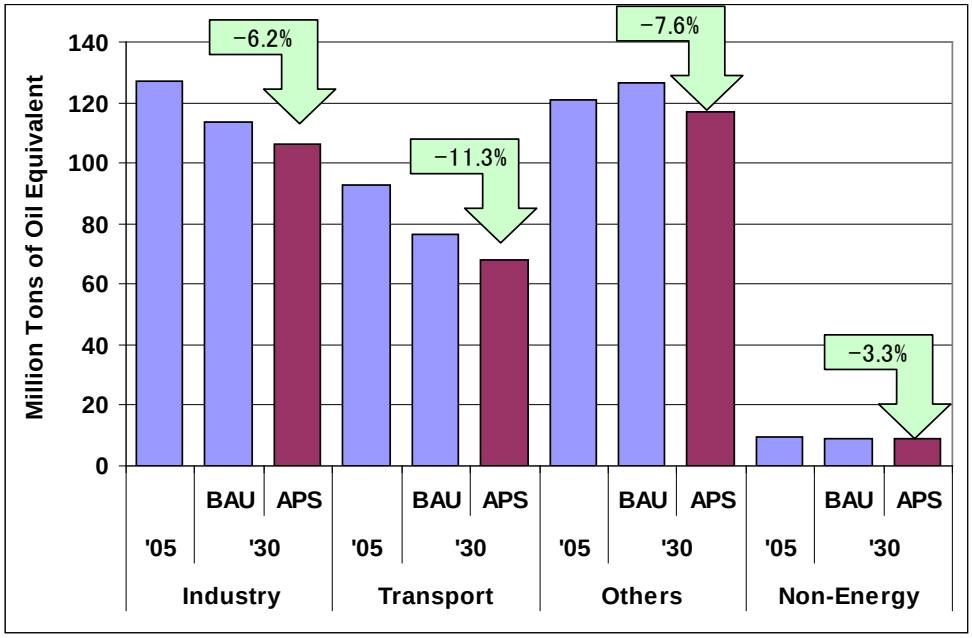
With the projected relatively low economic growth and population decline, final energy consumption from 2005 to 2030 is also projected to decline at an average rate of 0.3 percent per annum in the BAU scenario. This is also driven by the projected decline in the consumption of the industry and transportation sectors brought about by improving energy efficiency. The consumption of the residential and commercial (other) sector is, however, projected to grow at an average annual rate of 0.2 percent between 2005 and 2030.

By fuel type, consumption of coal and oil is projected to decrease at an average annual rate of 1.3 and 0.9 percent, respectively between 2005 and 2030. Consumption of natural gas and electricity are projected to increase, however, at a rate of 1.1 and 0.7 percent per annum respectively over the same period.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to decline at a faster rate of 0.6 percent per annum from 350.8 Mtoe in 2005 to 299.7 Mtoe in 2030. The fastest decline of 1.3 percent per annum will be experienced in the transportation sector due to the top-runner program and more aggressive energy management systems. Declines in consumption will also be experienced across all sectors. The sectoral final energy consumption in the BAU and APS are shown in Figure 24.

Figure 24. Final Energy Consumption by Sector in Japan, BAU and APS



3.2. Primary Energy Demand

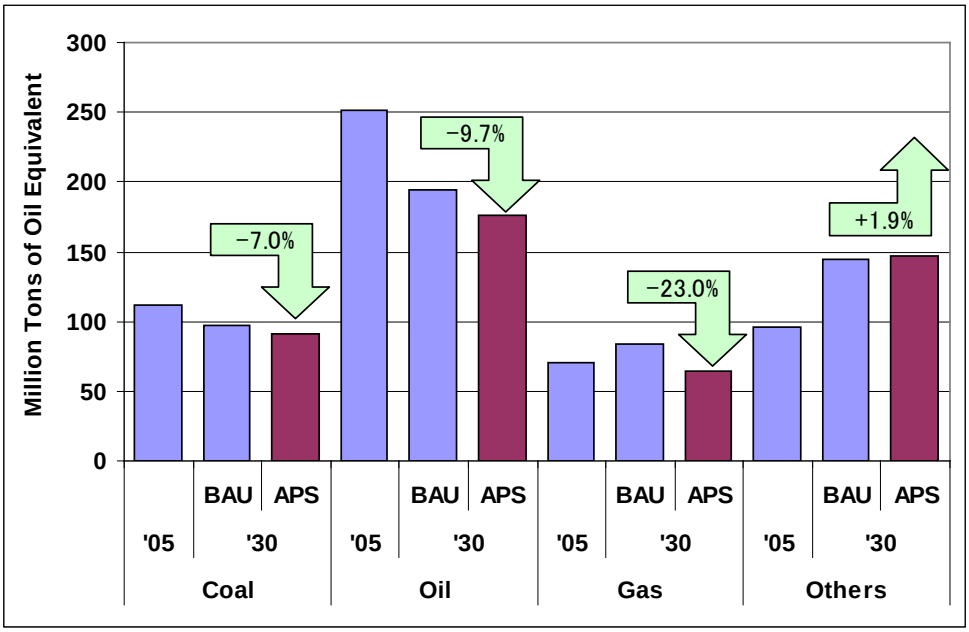
Primary energy demand in Japan grew at a faster rate than final energy consumption at 1.2 percent per annum from 444.5 Mtoe in 1990 to 530.5 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas, geothermal and nuclear energy. Natural gas consumption grew at an average annual rate of 4.8 percent while nuclear energy grew at 4.2 percent over the period 1990-2005. Oil consumption declined by 0.1 percent per annum over the same period. Geothermal energy had a respectable growth rate of 4.4 percent during the period but its share in total primary energy demand was minimal at 0.6 percent in 2005.

Business-as-Usual Scenario

In the BAU scenario, Japan's primary energy demand is projected to decline at an average annual rate of 0.1 percent per annum from 530.5 Mtoe in 2005 to 521.0 Mtoe in 2030. This decline is due to the decreasing use of coal and oil at annual average rates of 0.5 percent and 1.0 percent, respectively over the period 2005-30. The shares of coal and oil in 2005 and 2030 are projected to decrease from 21.1 percent to 18.7 percent and

47.4 percent to 37.4 percent, respectively. Natural gas and nuclear energy consumption will, however, increase at average annual rates of 0.7 percent and 1.8 percent, respectively over the period 2005-30. The primary energy demand by source in 2005 and 2030 in BAU and APS are shown in Figure 25.

Figure 25. Primary Energy Demand by Source in Japan, BAU and APS



Alternative Policy Scenario

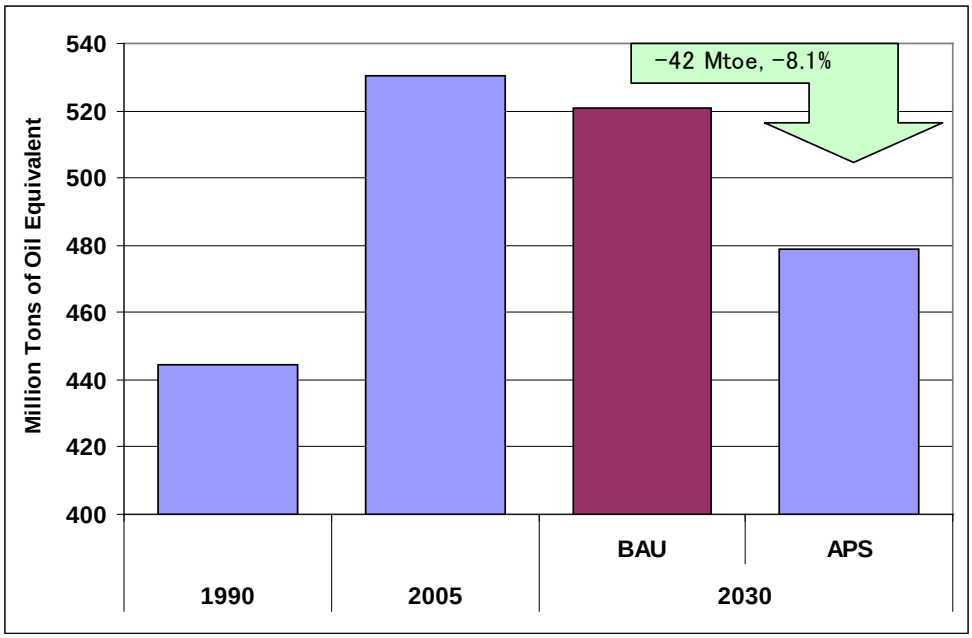
In the APS, the projected primary energy demand will decline at a faster rate of 0.4 percent per annum to 478.7 Mtoe in 2030, lower by 51.8 Mtoe than the consumption in 2005. Coal, oil and natural gas will have decreasing average annual growth rates of 0.8 percent, 1.4 percent and 0.4 percent, respectively. These decreases are mainly due to energy efficiency and conservation measures in the demand side.

3.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Japan are 42.3 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 8.1 percent reduction of Japan's BAU consumption in 2030 (Figure 26).

In terms of savings in final energy consumption, there is an estimated saving of 9.6 Mtoe the residential/commercial sector, 8.6 Mtoe in the transportation sector and 7.0 Mtoe in the industrial sector at 2030 in the APS, relative to BAU. The energy savings in transportation achieved from 2005 to 2030 are 16.5 Mtoe and 25.1 Mtoe in the BAU and APS respectively, due to the increase of more efficient vehicles.

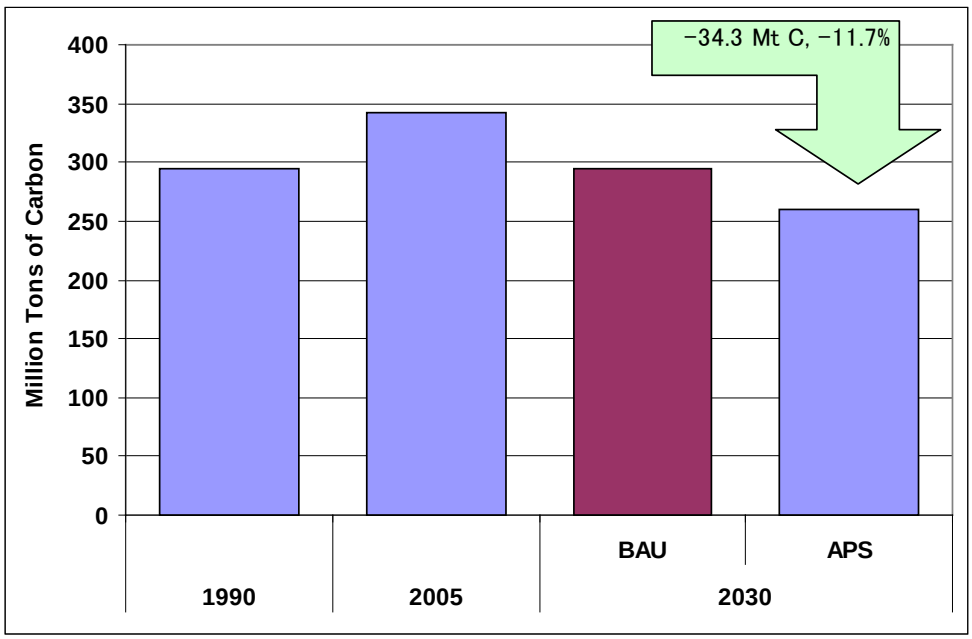
Figure 26. Primary Energy Consumption in Japan, BAU and APS



3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to decrease by about 0.6 percent from 342 Mt-C in 2005 to 293.9 Mt-C in 2030 in the BAU scenario. This decrease is faster than the decrease in primary energy demand indicating that Japan will be using less-carbon intensive fuels.

Figure 27. CO_2 Emission from Energy Combustion in Japan, BAU and APS



In the APS, the annual decrease in CO_2 emissions from 2005 to 2030 is projected to be about 1.1 percent. This decrease rate is also faster than the decrease in primary energy demand of 0.4 percent. In addition, CO_2 emissions in 2030 are projected to be lower than the 1990 level in the APS (Figure 27). This indicates that the energy saving goals and action plans of Japan are very effective in reducing CO_2 emissions.

4. Implications and Policy Recommendations

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

In the APS, CO_2 emissions in 2030 are projected to be lower than the 1990 level. This indicates that Japan could meet its target of reducing GHG emissions by half from 2005 to 2050. However, to achieve the result, Japan should effectively implement its policies on energy efficiency such as the Top Runner program. 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 when developing energy efficiency policies but also the world market as a whole as reduced energy consumption of the world would mean more available energy for years to come.

Chapter 9

Republic of Korea Country Report

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2009

This chapter should be cited as
Kim, S.-I. (2009), 'Republic of Korea Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.103-108.

Republic of Korea

Dr. Soo-Il Kim

1. Background

The Republic of Korea is located in the southern half of the Korean Peninsula and has a 238 km boundary with North Korea. It occupies 98,480 square kilometres and includes about 3,000 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 48 million, about 85 percent of which live in urban areas. Korea has experienced tremendous economic growth over the last decades. After impressive growth, gross domestic product (GDP) plunged by -7 percent in 1998, but has since rebounded. The economy is dominated by manufacturing, particularly of electronic products, passenger vehicles and petrochemicals. Agriculture, forestry and fishing made up only 3 percent of total GDP in 2003.

Korea has no domestic oil resources and only a very small amount of natural gas has been produced locally. However, Korea is the world's second largest importer of liquefied natural gas (LNG). The country does have indigenous anthracite coal resources, and imports most of its coal, which is bituminous coal. The Korean government has estimated that the cost of energy imports in 2005 was US$ 66 billion, a 33 percent increase from 2004.

Although total primary energy demand is dominated by oil and coal, nuclear power and LNG also supply a significant share of the country's primary energy. Total primary energy demand increased by over nine-folds between 1975 and 2005, growing at an average annual rate of 7.3 percent since 1985 and 4.1 percent since 1995. The greatest average annual increase in fossil fuels over the last decade has been in natural gas at a rate of nearly 13 percent. Oil has risen at an average annual rate of 0.5 percent over the last decade.

Total final energy consumption (TFEC) in 2005 was 163.1 million tons of oil equivalent (Mtoe) with an average annual growth rate of over 5.6 percent from 1990. Nearly half (44 percent) of TFEC in 2005 was used by the industry sector, with an average annual growth rate of 8.5 percent since 1984 and 7.1 percent between 1990 and 2005. Consumption of natural gas in the industry sector has grown eleven fold in the last decade and oil accounts for a relatively large share of industry consumption – 56.3 percent of the total in 2005. Final consumption in the transport sector accounted for about 21 percent of TFEC in 2005, and grew at an average annual rate of 9 percent between 1974 and 2004 and 6.0 percent over the period 1990-2005. Outside the transport and industry sectors, consumption increased by 28 percent over the last decade.

In 2005, generators in Korea produced 362 terawatt hours (TWh) of electricity. In 2005, coal and nuclear combined provided over three-quarters of Korea's electricity. Natural gas fuelled 16.1 percent of generation in 2005. Total electricity consumption has grown at an average annual rate of 8.8 percent over the period 1990-2005. When broken down

by fuel, coal, natural gas and nuclear have grown by an average annual rate of 13.5 percent, 12.8 percent and 7 percent, respectively over the period 1990-2005.

2. Modelling Assumptions

In this report, Korea's gross domestic product (GDP) is assumed to grow at an average annual rate of 3.3 percent from 2005 to 2030. Following the global recession in 2009, economic growth in Korea is expected to recover at 4.1 percent per year from 2010 to 2020, tapering off to 2.8 percent per year from 2020-2030. In the APS, GDP is assumed to grow at the rate of 3.8 percent annually from 2005 to 2030. Population is projected to increase by 0.3 percent per annum until 2010 and remain fairly flat after then.

With regards to future electricity supply, Korea is expected to continue to use coal and nuclear energy for base load generation. Supply from nuclear and LNG power plants are projected to increase while oil power plants will decrease and hydro will remain constant. There is projected to be an increasing share of electricity from wind energy driven by the renewable portfolio standard (RPS).

Korea's energy saving goals could be attained through the implementation of energy efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from the expansion of the energy conservation voluntary agreement, 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 logistics system, expanding public transportation and improving the efficiency of vehicles. In the residential and commercial (other) sector, the minimum efficiency standards program is projected to induce huge savings in addition to standby Korea 2010, the community energy system.

3. Outlook Results

3.1. Total Final Energy Consumption

Korea's final energy consumption experienced a high growth of 5.6 percent per annum from 72 Mtoe in 1990 to 163 Mtoe in 2005[6]. The industry sector including non-energy had the highest growth rate during this period at 6.9 percent per annum followed by the transportation sector with 6.0 percent. Consumption in the residential/commercial/ public (other) sector grew at a relatively slow pace of 3.1 percent per annum. Oil was the most consumed product having a share of 59.9 percent in 1990, decreasing to 56.3 percent in 2005. Coal was the second most consumed product in 1990 but in 2005 electricity was the second most consumed product.

[6] The outlook results are based on the net calorific values as converted by IEEJ from original data submitted by the Republic of Korea.

Business as Usual (BAU) Scenario

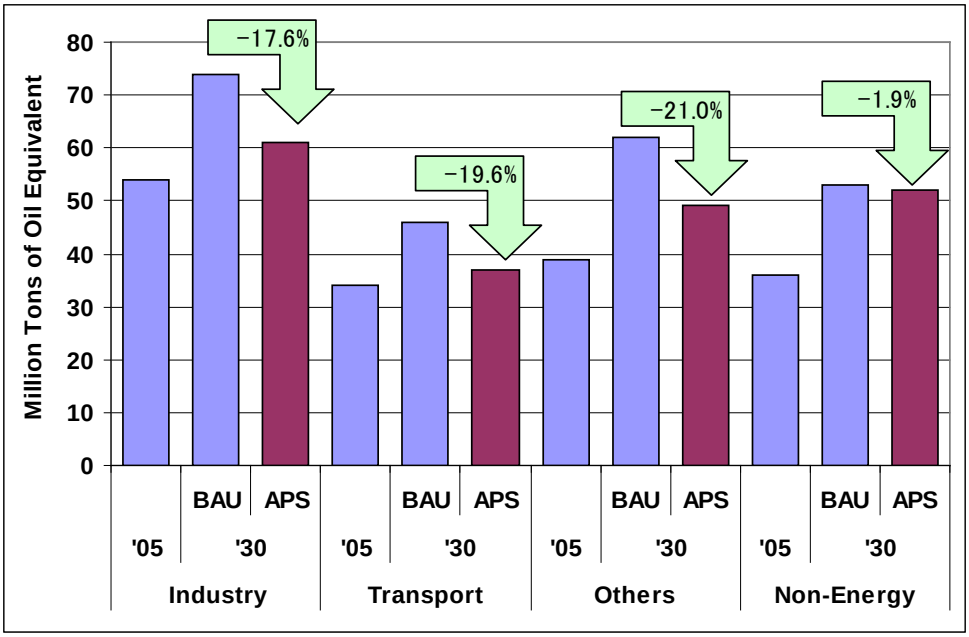
With projected low economic and population growth, final energy consumption from 2005 to 2030 is projected to increase at a low average rate of 1.5 percent per annum in the BAU scenario. This is mainly due to the projected decline in the growth of energy consumption in the industry and transportation sectors. The consumption of the residential and commercial (other) sector is projected to grow at the highest average annual rate of 1.9 percent.

By fuel type, consumption of oil, natural gas and electricity is projected to increase at average annual rates of 0.7, 2.9 and 2.0 percent, respectively over the period 2005-2030. Consumption of coal is projected to increase at 1.3 percent per annum over the same period due to the operation of the integrated steel mill of Hyundai Steel.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a rate of 0.8 percent per annum from 163 Mtoe in 2005 to 199 Mtoe in 2030. The residential and commercial (other) sector is projected to have the fastest average annual consumption growth at 0.9 percent over the period 2005-30. Energy consumption in the transportation sector is projected to increase at the rate of 0.3 percent per cent per annum over the same period. Declines in the rate of growth are expected across all sectors, relative to the BAU scenario (Figure 28).

Figure 28. Final Energy Consumption by Sector in Korea, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Korea grew at an average rate of 6.2 percent per annum from 89 Mtoe in 1990 to 219 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas and nuclear energy. Natural gas consumption grew at an average annual rate of 16.6 percent while nuclear energy grew at 7.0 percent over the period 1990-2005. Oil and coal consumption increased by 4.8 and 5.5 percent per annum, respectively over the same period.

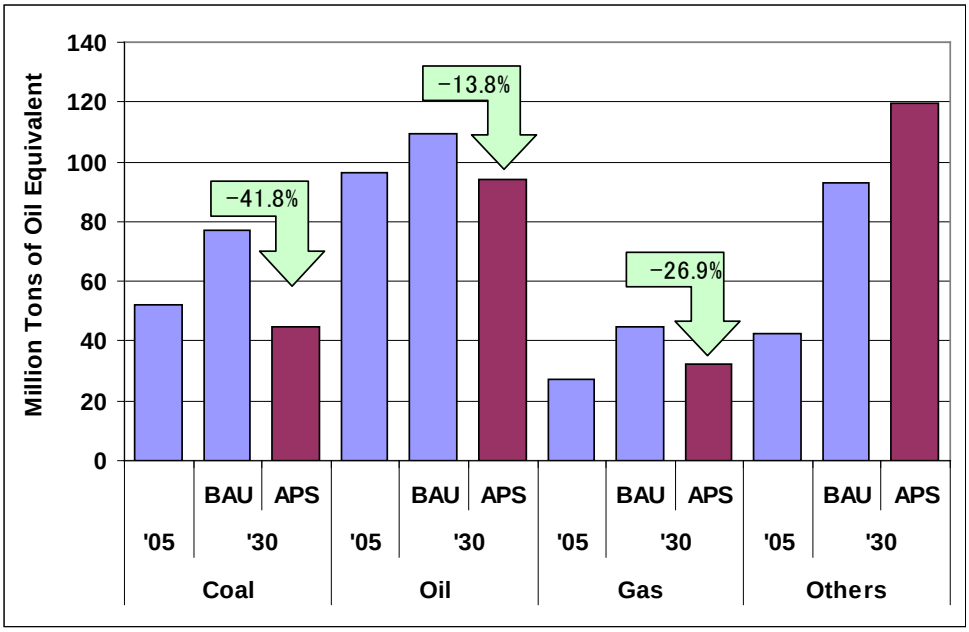
Business as Usual Scenario

In the BAU scenario, primary energy demand in Korea is projected to increase at an annual average rate of 1.6 percent per annum to 324 Mtoe in 2030. There are projected to be flat or relatively slow growth rates in oil and natural gas at annual rates of 0.5 percent and 2.7 percent, respectively over the period 2005-2030. The share of oil is projected to decrease from 44.2 percent in 2005 to 33.8 percent in 2030. Nuclear energy consumption is projected to rapidly increase at an average annual rate of 2.7 percent over the period 2005-2030.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a lower rate of 1.2 percent per annum to 291 Mtoe in 2030. Coal will decline on average by 0.6 percent per year while oil will decrease at 0.1 percent per year over the period 2005-2030. Consumption of natural gas is projected to increase at an annual average rate of 0.7 percent (Figure 29). Energy efficiency and conservation measures on the demand side mainly contribute to the reduction in consumption growth.

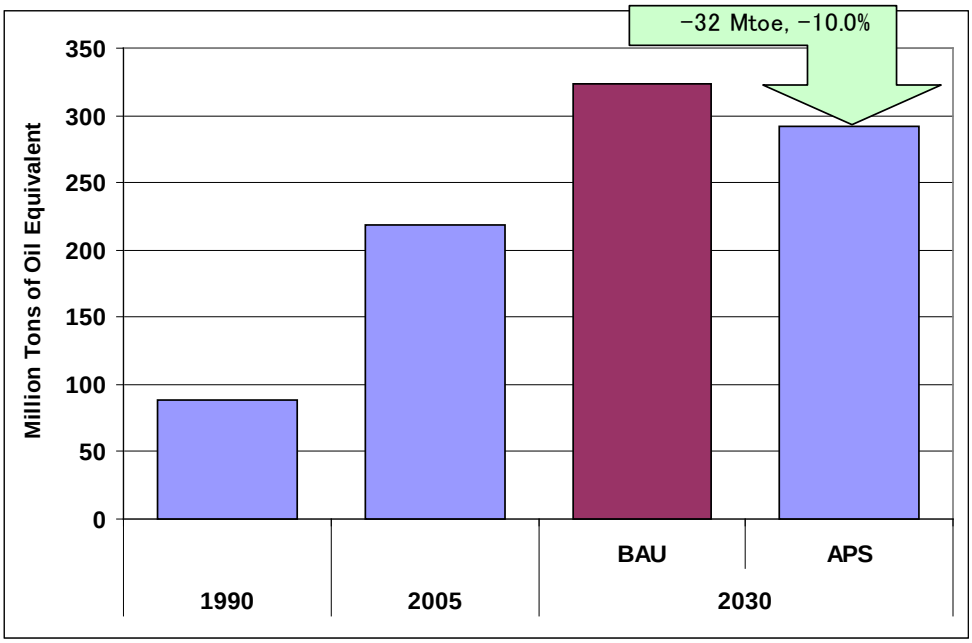
Figure 29. Primary Energy Demand by Source in Korea, BAU and APS



3.3. Projected Energy Saving

The energy savings that could be derived from the energy saving goals, action plans and policies of Korea is 32.2 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2030 (Figure 30). This is equivalent to 14.7 percent of Korea's consumption in 2005.

Figure 30. Total Primary Energy Demand in Korea to 2030, BAU and APS



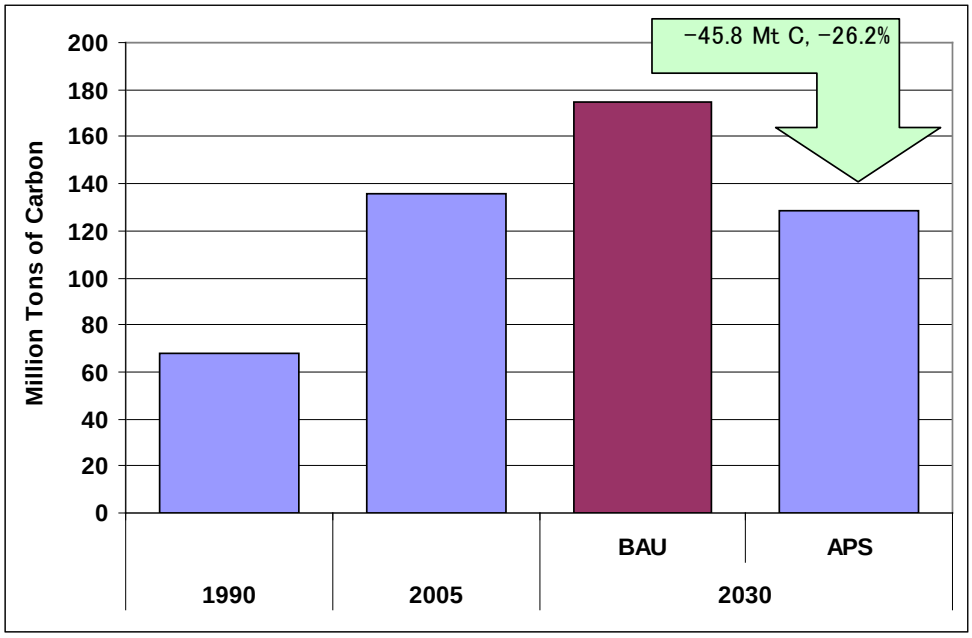
In terms of final energy consumption savings in 2030, there is estimated to be savings of 13 Mtoe in the residential/commercial (other) sector, 13 Mtoe in the industry sector and 9 Mtoe in the transportation sector.

3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 1.0 percent from 136.0 Mt C in 2005 to 174.5 Mt C in 2030 in the BAU scenario. This increase is slower than the increase in primary energy demand indicating that Korea will be using less-carbon intensive fuels and/or more energy efficient technologies.

In the APS, CO_2 emissions are projected to decrease at an annual average rate of 0.2 percent from 2005 to 2030. This indicates that the energy saving goals and action plans of Korea are very effective in reducing CO_2 emissions (Figure 31).

Figure 31. CO_2 Emission from Energy Consumption in Korea, BAU and APS



4. Implications and Policy Recommendations

Since the economic growth of Korea in the 1990s was led by high energy consuming industries, Korea's total primary energy demand and final energy consumption in the 1990s had rapidly increased at a faster rate than GDP. Since 1997, however, as the share of high energy consuming industries decreased, energy intensity has also improved. Since the end of the 1990s growth in energy consumption tends to be stable compared to GDP growth.

Korea has promoted the diversification of energy resources from excessive external energy dependence and the substitution of energy to improve Korea's energy supply security. Policy goals of Korea include encouraging conversion into a low energy consuming economic structure and implementation of policies harmonising energy, the economy, and the environment. "Green Growth" policy was announced to accomplish improved energy efficiency and energy savings target as well as achieving CO_2 emission reductions.

Chapter 10

Lao PDR Country Report

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2009

This chapter should be cited as
Kouphokham, K. (2009), 'Lao PDR Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.109-113.

Lao PDR

Mr. Khamso Kouphokham

1. Background

Lao People's Democratic Republic (Lao PDR) is a small country in Southeast Asia. It is located in the middle of the Southeast Asian peninsula and has a border with five countries namely China in the North, Vietnam in the East, Cambodia in the South and Thailand and Myanmar in the West. The country is about 70 percent covered by mountains. Laos consists of 17 provinces. Its capital city is Vientiane. Lao PDR has a total area of 236,800 square kilometres and had a population of 5.6 million people in 2005. The gross domestic product (GDP) of Laos grew at an average annual rate of about 6.2 percent between 1990 and 2005 to about US$2.4 billion.

Laos's total primary energy demand in 2005 was 0.58 Mtoe. The country's primary energy demand is supplied by three main types of energy: oil, hydro and coal. In 2005 oil accounted for 62.5 percent of the primary energy demand with the balance shared between hydro and coal. The country exported about 64 percent of the electricity generated from its hydro power plants.

Lao PDR has large hydropower potential at up to 23 gigawatts. However until 2006, only about 3 percent of the hydropower resource potential in Laos had been used or 673 megawatts (MW). Currently electricity is generated in Laos using hydropower, diesel generators and solar photovoltaic. Hydropower accounts for 99.8 percent or 673 MW of total installed generation capacity, diesel generation accounts for 0.87 MW and solar photovoltaic accounts for 0.3 MW. In 2006, Laos generated about 3.6 terawatt hours (TWh) of electricity. Of this, 2,487 gigawatt hours (GWh) was exported to Thailand. Electricity exports to neighbouring countries are expected to increase in the future.

2. Modelling Assumptions

In this report, the GDP of Lao PDR is assumed to grow at an average annual rate of 7.5 percent from 2005 to 2030 while population is assumed to grow at an average annual rate of 1.9 percent.

Hydro is expected to remain the main source of electricity generation in Lao PDR. However, the country is planning to develop its first coal thermal power plant between 2008 and 2010. The installed capacity of this thermal power plant will be 1,800 MW.

In this study, Lao PDR will achieve energy savings mainly through the implementation of the government's energy conservation program, which aims for a 10 percent reduction in electricity consumption in state buildings. Other sectors such as private industries and buildings, have been implementing the Promotion of Energy Efficiency and Conservation (PROMEEC) program under the ASEAN-Japan Cooperation Program. This project focuses on the training of government and private personnel to carry out

energy efficiency and conservation activities. However, the possible savings that could be derived from this capacity building program has not been quantified.

3. Outlook Results

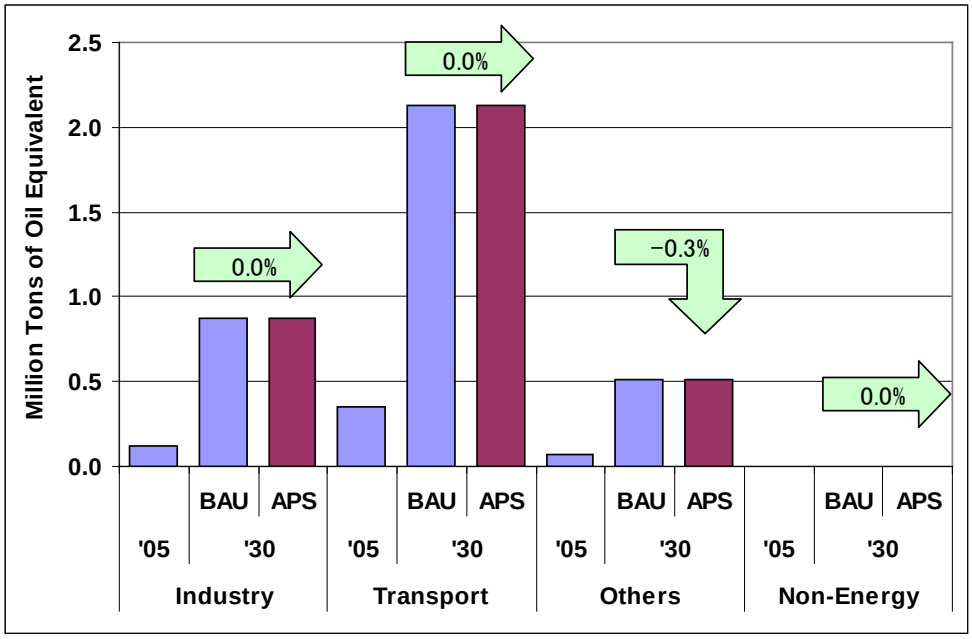
3.1. Total Final Energy Consumption

Lao PDR's final energy consumption grew at an average annual rate of 4.7 percent from 0.27 Mtoe in 1990 to 0.54 Mtoe in 2005. The industry sector had the highest growth rate during this period at 7.6 percent per annum followed by the other sectors at 4.2 percent per annum. The transport sector which was responsible for 65.5 percent of total final energy consumption in 2005 had a slower growth rate of 4.0 percent. In terms of energy types in 2005, oil was the most consumed product having a share of around 65 percent followed by electricity which accounted for 16 percent.

Business-as-Usual (BAU) Scenario

From 2005 to 2030, high growth in energy consumption in all sectors in Lao PDR is expected. The industry sector will have the highest growth rate of 8.4 percent followed by the other sector (mainly residential and commercial) at 8.3 percent. Final energy consumption in the transport sector will have a moderate growth rate of 7.5 percent.

Figure 32. Final Energy Consumption by Sector in Lao PDR, BAU and APS



Alternative Policy Scenario (APS)

In the APS, the growth of final energy consumption will be slightly lower than in the BAU. This is achieved through the 10 percent reduction in the electricity consumption

of the government sector which is a part of the other sector. This reduction in terms of total final energy consumption will, however, be very minimal at 0.001 million tons of oil equivalent (Mtoe) or 0.04 percent in 2030 in the APS, relative to the BAU scenario (Figure 32).

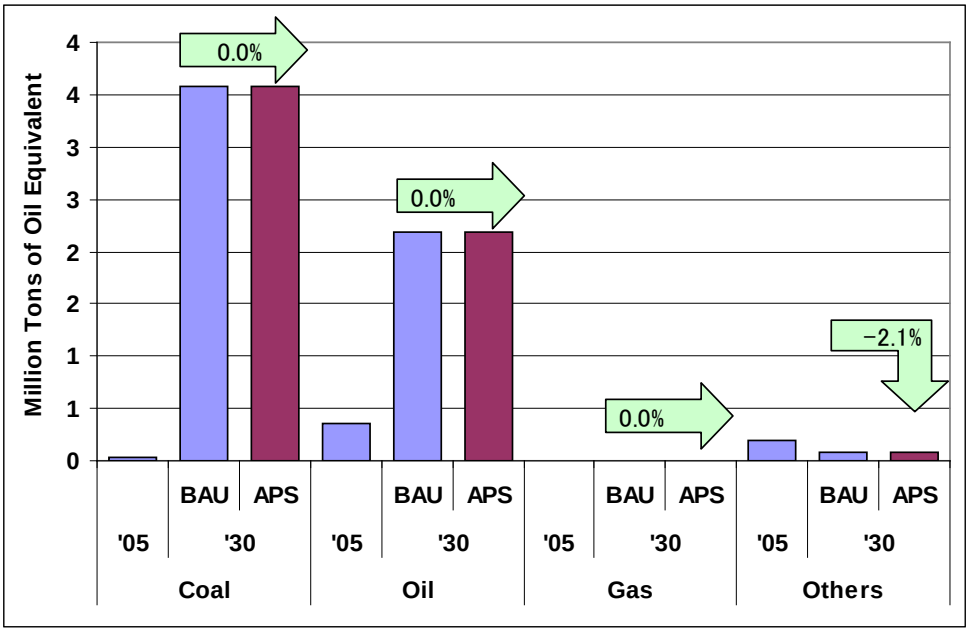
3.5 Primary Energy Demand

The primary energy demand of Lao PDR grew at an average annual rate of 4.9 percent from 1990 to 2005. Hydro grew the fastest during the period at 10.2 percent per annum due to exports of electricity to Thailand. Oil demand increased at an annual growth rate of 3.3 percent.

Business-as-Usual (BAU) Scenario

Primary energy demand will increase at an average annual rate of 9.7 percent from 0.58 Mtoe in 2005 to 5.857 Mtoe in 2030. Coal demand will increase sharply from 0.03 Mtoe in 2005 to 3.58 Mtoe in 2030 at an average annual growth rate of 21.1 percent due to the use coal for electricity generation from 2010 onwards. Hydro will also increase sharply (11.0 percent per annum) but at a lower rate compared with that of coal. It will increase from 0.3 Mtoe in 2005 to 4.1 Mtoe in 2030. Oil demand will rise at a relatively slow pace (7.5 percent per annum) from 0.4 Mtoe in 2005 to 2.2 Mtoe in 2030.

Figure 33. Primary Energy Demand by Source in Lao PDR, BAU and APS



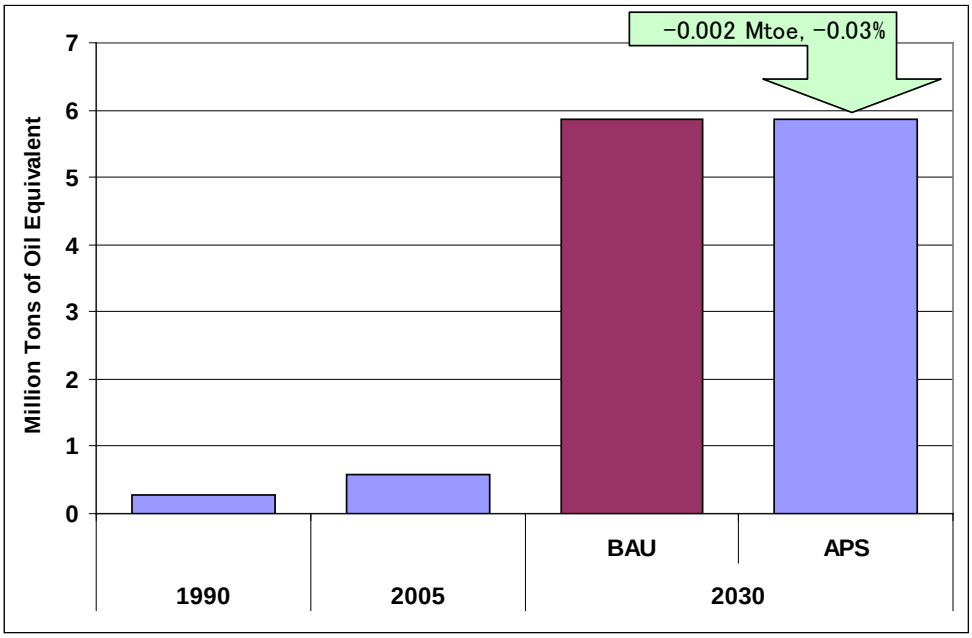
Alternative Policy Scenario

In the APS, the primary energy demand trends throughout the projection period will almost be the same as those in the BAU. In 2030 the difference is projected to be 0.002 Mtoe and primary energy demand is projected to be 5.855 Mtoe in the APS (Figure 33).

3.6 Projected Energy Savings

Lao PDR will achieve energy savings through the implementation of the Energy Efficiency and Conservation Program of the government in private and public sectors. As the program is still small the energy savings that can be derived are also small. Likewise, only the savings in the government sector have been quantified during the course of the study. The energy savings in the APS that were estimated would only amount to 0.002 Mtoe or 0.03 percent of the projected consumption in 2030 in the BAU.

Figure 34. Total Primary Energy Demand in Lao PDR, BAU and APS



3.7 CO_2 Emissions

In this report, no carbon dioxide (CO_2) emission reductions can be obtained as it is assumed that any surplus electricity resulting from energy conservation will be exported to Lao PDR's neighbouring countries. The use of coal for electricity generation will drive the 12.2 percent annual growth in CO_2 emissions of Lao PDR from 2005 to 2030. It should be noted that the emissions associated with electricity exports will be accounted for in Lao PDR.

4. Implications and Policy Recommendations

In this report, Lao PDR will experience increases both in primary energy demand and primary energy intensity driven by projected economic growth of 7.5 percent per annum to 2030. Increases in electricity demand will be driven by expanding rural electrification – the government is targeting to achieve an electrification rate of 90 percent in 2020.

In order to increase the reduction in energy consumption and increase energy savings, Lao PDR has to be more active in implementing energy efficiency and conservation (EEC) programs. These programs could initially focus on raising the public awareness on energy efficiency and conservation. This can help all sectors to better understand the importance and necessity of implementing the EEC activities. Sectors could voluntarily implement the EEC activities resulting in more sustainable activities. At the same time, the government should also provide the necessary information and know–how in best practices on EEC to the people. More importantly, in order to have sound energy savings in the country and contribute to solving the problems of climate change, Lao PDR urgently needs to strengthen its capacity in terms of developing and practically implementing a national energy savings goal and action plan. Therefore Lao PDR requests the assistance of Japan and other countries to help Laos in developing its own energy saving goal and action plan.

Chapter 11

Malaysia Country Report

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2009

This chapter should be cited as
Mustapa, S. I. (2009), 'Malaysia Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.115-121.

Malaysia

By Ms. Siti Indati Mustapa

1. Background

Malaysia is a country in Southeast Asia with a total landmass of 329,847 square kilometres. Malaysia is separated into two regions, Peninsular Malaysia and the states of Sabah and Sarawak in the island of Borneo by the South China Sea. Currently, Malaysia's total population stands at 27.3 million of which about 80 percent live in Peninsular Malaysia, the hub of the country's economic activities.

Malaysia has progressed into a nation that has diversified successfully to rise as one of the top exporters of manufactured goods. In 2005, Malaysia's real gross domestic product (GDP) was US$112 billion. In 2008 the manufacturing sector contributed to over 26 percent of the national GDP.

Similar to many other developing countries, energy has been the prime driver of the rapid growth of Malaysia's economy. Endowed with an abundance of domestic energy resources, especially oil and gas, as well as renewables such as hydro, biomass and solar energy, the growth and development of the Malaysian energy sector will continue to contribute towards industrialisation, socio-economic welfare as well as export earnings.

The country's total oil reserves stood at 5.46 billion barrels as of January 2008 supported by the rising reserves from the deepwater discoveries in offshore Sabah. Meanwhile, natural gas reserves are estimated at 14.67 billion barrels of oil equivalent (boe), sufficient to cover 36 years of gas output at current production levels. The country's coal reserves, mainly in Sarawak and Sabah, were estimated at 1,843 million tonnes.

Malaysia is the second largest oil and gas producer in Southeast Asia after Indonesia and the world's second biggest exporter of liquefied natural gas (LNG). Malaysia exported 64 percent of its oil and 41 percent of its gas production but imported 95 percent of its coal consumption in 2005.

In tandem with Malaysia's rapid economic development, final energy consumption grew at a fast rate to reach 38 Mtoe in 2005. A substantial portion of the energy consumed was from oil, with a share of 61.1 percent, which was mainly used in the industrial and transport sectors. The share of natural gas consumption also increased in the electricity generation and industrial sectors.

In 2005 Malaysia generated 87 terawatthours (TWh) of electricity. Natural gas continued to remain the main fuel source for electricity generation with a share of 64 percent followed by coal at 27 percent, hydro at 7 percent and diesel and fuel oil making up the remainder. In 2007, Malaysia had 21.8 gigawatts (GW) of installed generation capacity.

2. Modelling Assumptions

In this report, Malaysia's GDP is assumed to grow at an average annual rate of 4.7 percent from 2005 to 2030. Growth is expected to be 3.75 percent from 2005 to 2010, strengthening to 5.5 percent from 2010-2020 and tapering off to 4.5 percent from 2020-2030.

Annual average population growth is assumed to be 1.89 percent from 2000-2010, 1.68 percent from 2011-2020 and 1.49 percent from 2021-2030. These projections are in line with those of the Department of Statistics of Malaysia.

As for the future electricity supply fuel mix, natural gas and coal will continue to dominate. Supply from oil-fired power plants will be significantly reduced while hydro is expected to increase its share gradually. There is also expected to be an increasing share of electricity from renewable energy such as biomass, biogas, mini hydro, solar and solid waste, as a result of the implementation of future renewable energy policy. Nuclear is also assumed to be a part of the future supply mix for power generation from around 2020 in the APS.

Malaysia's energy saving goals are expected to be attained through the implementation of energy efficiency programs in all energy consuming sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies as well as aggressive energy efficiency efforts. In the residential and commercial sector, the utilization of more efficient electrical appliances is projected to induce savings in addition to energy management systems. In the transport sector, efficiency improvements will be achieved through the use of biofuels to reduce dependency on oil and curb carbon dioxide (CO_2) emissions.

3. Outlook Results

3.1. Total Final Energy Consumption

Malaysia's final energy consumption experienced a high growth of 7.2 percent per annum from 13.3 Mtoe in 1990 to 37.6 Mtoe in 2005. The residential/commercial sector had the highest growth rate during this period at 7.9 percent per annum followed by the industrial and transportation sectors, growing at 7.2 and 7.1 percent per annum respectively. Oil was the most consumed product having a share of 75.3 percent in 1990 which decreased to 61.1 percent in 2005.

Business-as-Usual (BAU) Scenario

With the projected continuous economic growth of 4.7 percent per annum and population growth of 1.6 percent per annum, final energy consumption from 2005 to 2030 is also projected to grow at an average rate of 4.7 percent per annum in the BAU scenario. The highest growth rate is expected to occur in the residential/commercial sectors at 5.3 percent per annum mainly driven by the increasing demand for electrical

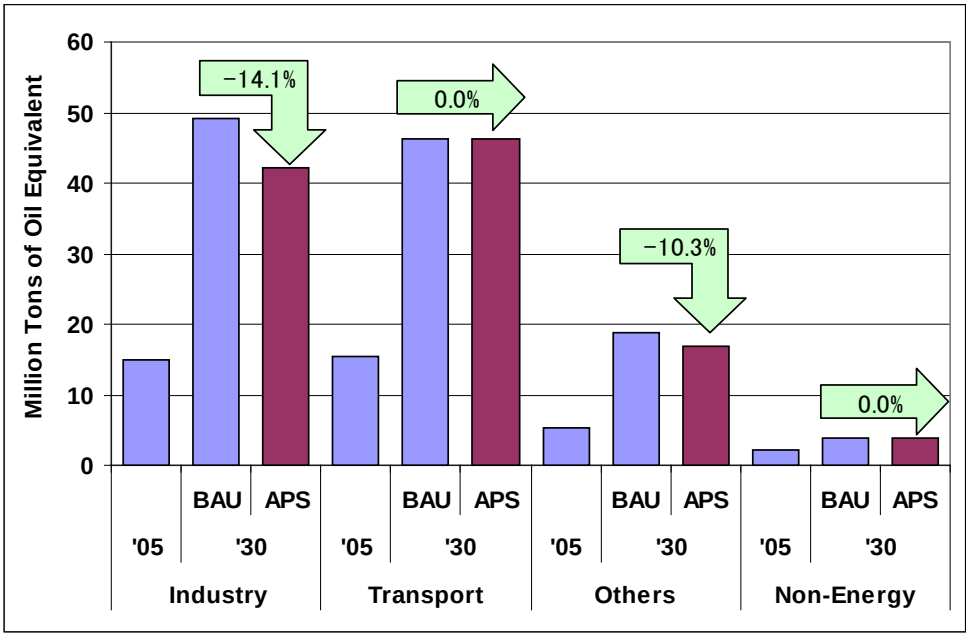
appliances. The industrial and transportation sectors are projected to increase their consumption by 4.9 percent and 4.5 percent per annum, respectively between 2005 and 2030. Demand by the industrial and transportation sectors accounted for more than 81 percent of the total final energy demand in 2030.

The consumption of coal and oil in final energy is projected to increase at an average annual rate of 5.8 and 4.1 percent, respectively between 2005 and 2030. Consumption of natural gas and electricity will increase at 5.3 percent and 5.4 percent respectively per year over 2005 to 2030.

Alternative Policy Scenario (APS)

In the APS, growth in final energy consumption will be slightly lower compared to that of the BAU scenario at 4.3 percent per annum. That is, from 37.6 Mtoe in 2005 to 109.0 Mtoe in 2030. This 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 and residential/commercial sector. In the residential/commercial sector, the growth rate of energy consumption is projected to decline to 4.8 percent per annum in the APS as compared to 5.3 percent per annum in the BAU scenario. The growth rate of energy consumption in the industrial sector is projected to decline to 4.2 percent per annum in the APS as compared to 4.9 percent per annum in the BAU scenario over the period 2005-2030. The growth rates of energy consumption in other sectors will remain the same in the APS relative to the BAU scenario (Figure 35).

Figure 35. Final Energy Consumption by Sector in Malaysia, BAU and APS



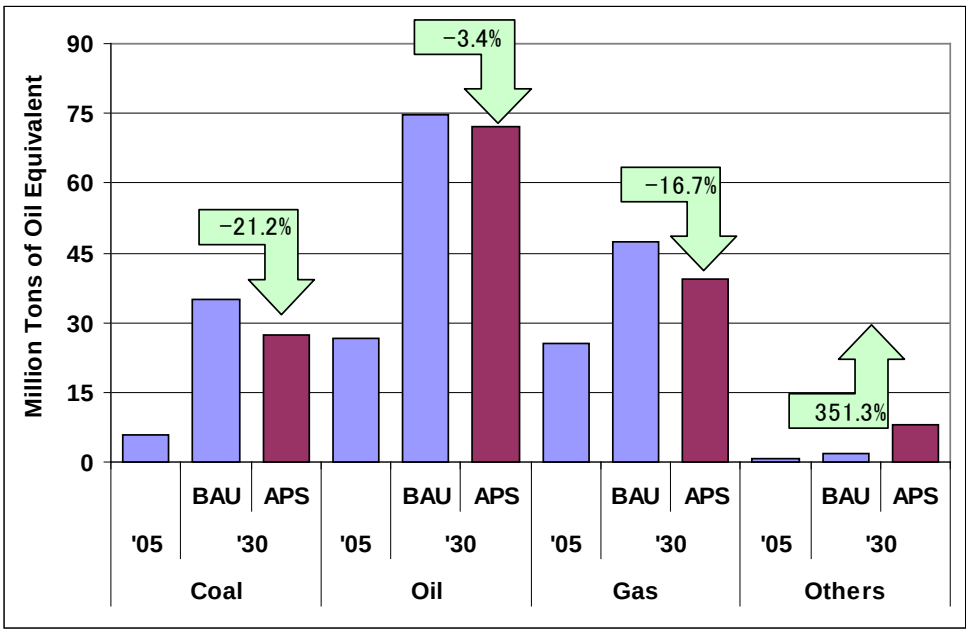
3.2. Primary Energy Demand

Primary energy demand in Malaysia grew at an annual average rate of 7.0 percent per year from 21 Mtoe in 1990 to 59 Mtoe in 2005. Among the major energy sources, the fastest growing energy sources were coal and natural gas, increasing at average annual rates of 12.2 percent and 9.2 percent, respectively between 1990 and 2005. Oil and hydro grew at lower average annual rates of 4.9 percent and 2.5 percent over the same period.

Business-as-Usual Scenario

In the BAU scenario, Malaysia's primary energy demand is projected to increase at an annual rate of 4.1 percent over the period 2005-2030 to 158.8 Mtoe in 2030. Over the same period (2005-2030), coal is projected to be the fastest growing fuel increasing at an average annual rate of 7.4 percent followed by hydro and oil. Oil is projected to remain the dominant fuel in primary energy demand and its consumption is projected to increase at an annual average rate of 4.2 percent between 2005 and 2030. The share of oil in primary energy demand is projected to increase slightly from 45.3 percent in 2005 to 47.1 percent in 2030. However, consumption of coal is projected to grow faster than oil and its share in primary energy consumption is projected to increase from 10 percent in 2005 to 21.9 percent in 2030. Consumption of natural gas is projected to increase but at a slower growth rate of 2.5 percent per annum over the period 2005 to 2030. Overall, oil and natural gas are projected to continue to dominate Malaysia's primary energy demand. However, their total shares will decrease from 89 percent in 2005 to 77 percent in 2030.

Figure 36. Primary Energy Demand by Source in Malaysia, BAU and APS



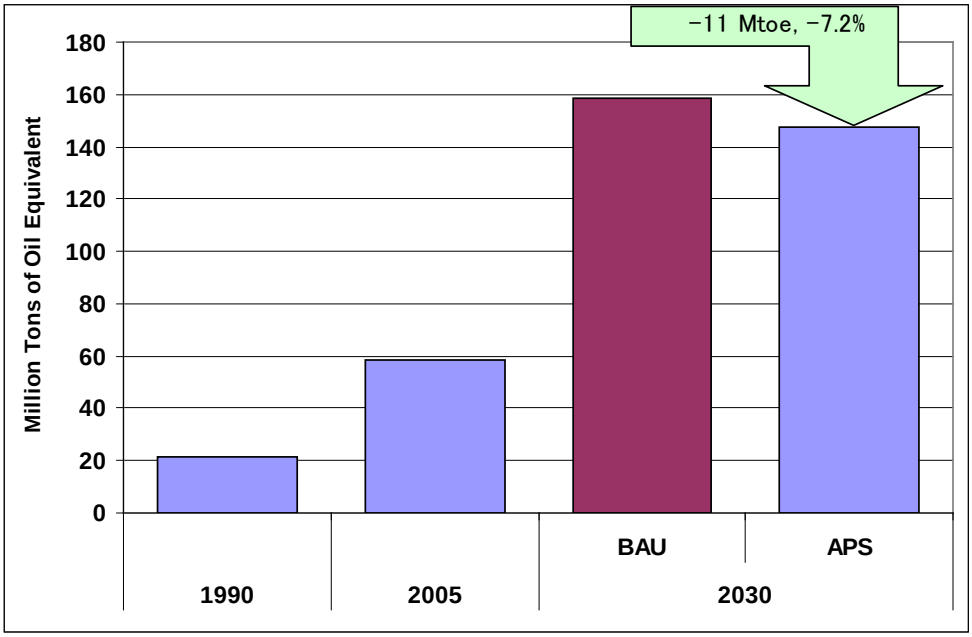
Alternative Policy Scenario

In the APS, primary energy consumption is projected to increase at a slower rate than in the BAU scenario at 3.8 percent per annum from to 147.4 Mtoe in 2030. Coal will grow the fastest at 6.4 percent per annum followed by hydro at 5.2 percent between 2005 and 2030. Oil and natural gas will have slower growth rates of 4.1 percent and 1.7 percent, respectively (Figure 36). The decline in the growth rate is mainly achieved as a result of energy efficiency and conservation measures on the demand side. Nuclear and other renewable energy sources are also projected to increase in the future primary energy demand mix as cleaner fuel alternatives. However, their shares in the total fuel mix are projected to remain relatively small.

3.3. Projected Energy Savings

The energy savings that could be achieved under the APS, relative to the BAU scenario, as a result of energy efficiency efforts and energy management are estimated at about 11 Mtoe in 2030 (Figure 37). This is equivalent to almost 20 percent of Malaysia's primary energy consumption in 2005.

Figure 37. Total Primary Energy Demand in Malaysia, BAU and APS



The above savings in energy at 2030 consist of savings of 6.9 Mtoe in the industrial sector and 1.9 Mtoe in the residential/commercial sector.

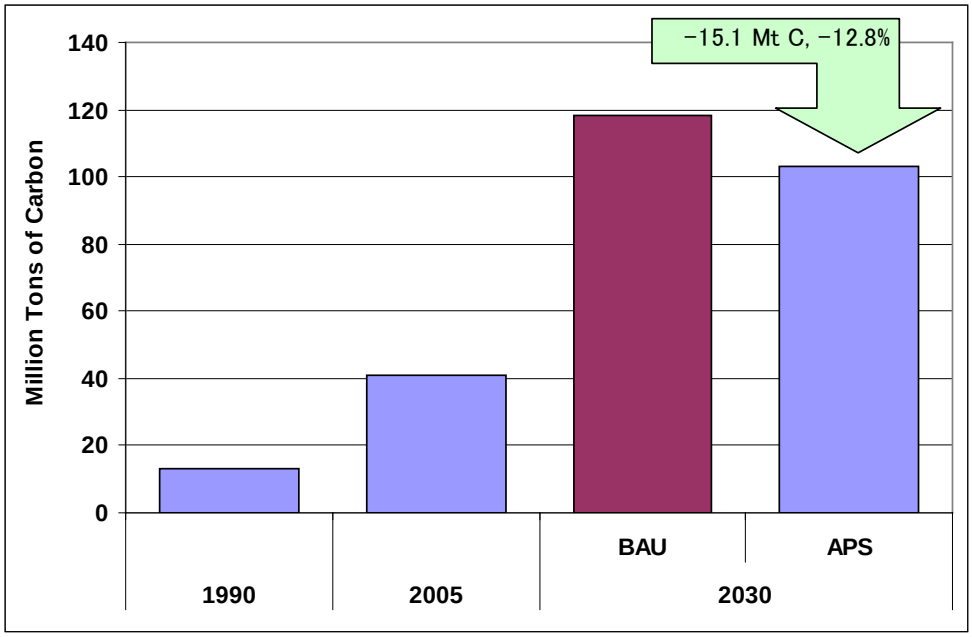
3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 187 percent from 41 million tons of carbon (Mt C) in 2005 to 118 Mt C in 2030 in the BAU, increasing at 4.3 percent per annum.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 will be lower than in the BAU scenario at 3.8 percent, which is fairly consistent with the growth in primary energy consumption. The reduction in CO_2 emissions in the APS of 15.1 Mt C or 12.8 percent relative to the BAU scenario is also due to a significant decrease in coal consumption for power generation in the APS, relative to the BAU scenario, as coal consumption is being replaced by natural gas and other clean energy sources such as nuclear and renewable energy.

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

Figure 38. CO_2 Emissions from Energy Consumption in Malaysia, BAU and APS



4. Conclusions

It is projected that under the BAU scenario, Malaysia's primary energy intensity will decrease at an annual rate of 0.6 percent between 2005 and 2030. In the APS primary energy intensity will decrease at a slightly higher rate of 0.9 percent per annum over the same period. This is due to expected improvements in energy efficiencies in the main consuming industries and in the commercial sector.

With greater industrialisation and urbanization, the efficient supply of energy at

reasonable costs and in sufficient quantity will be the paramount consideration in the development efforts of the energy sector. The Malaysian government continuously seeks various options to enhance the supply of energy through the development of renewable energy, particularly biomass and waste resources. Several important studies have been undertaken in terms of energy efficiency and renewable energy development that indicate that Malaysia's developmental goals can be achieved without a consequent increase in energy consumption. The further development and implementation of policies, legislation, economic incentives and education will also assist.

Chapter 12

Myanmar Country Report

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2009

This chapter should be cited as
Pe Zin Tun (2009), 'Myanmar Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.123-129.

Myanmar

Mr. Pe Zin Tun

1. Background

Myanmar has a total land area of 676,600 square kilometres. It stretches for 936 kilometres from East to West and 2,051 kilometres from North to South. Myanmar shares borders with China, Thailand, India, Bangladesh and Lao PDR.

Myanmar is rich in energy recourses and its 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 substantive amounts of natural gas and coal to neighbouring countries. However, it imports around 50 percent of its' total oil requirements.

The population of Myanmar grew at 1.2 percent per year between 1990 and 2005 to 48.0 million in 2005. Myanmar's gross domestic product (GDP) was US$13.3 billion in 2005 and its GDP per capita grew from US$0.1 thousand in 1990 to US$0.3 thousand in 2005. With the objectives of enhancing economic development in Myanmar, the Five-Year Short-Term interval 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.

Myanmar's total primary energy demand was 4.3 million tons of oil equivalent (Mtoe) in 2005. By fuel, oil represented the largest share at 47.0 percent; gas was second at 37.7 percent, followed by hydro with 6.0 percent. Natural gas is mainly used for electricity generation and in industry. Myanmar has 1512 megawatts (MW) of installed generation capacity and generated about 6.0 terawatthours (GWh) of electricity in 2005. In 2005 thermal (coal, natural gas and oil) and hydro accounted for 50.2 percent and 49.8 percent of total electricity generation respectively.

2. Modelling Assumptions

2.1. GDP and Population

In this report, Myanmar's GDP is assumed to grow at an average annual rate of 9.8 percent from 2005 to 2030. Growth is projected to be stronger from 2005 to 2010 at 13.1 percent per year. Average annual growth in GDP is projected to be 9.8 percent per year from 2010 to 2020 and 8.3 percent per year between 2020 and 2030. Population is assumed to increase by about 0.9 percent per year from 2005 to 2030.

2.2. Electricity Generation

The share of electricity from hydro is projected to increase while the share of oil, coal and natural gas is expected to decrease due to the government's plan to develop the abundant hydropower resources. Generation from natural gas power plants is expected

to remain fairly constant to 2030 in the BAU scenario. In contrast output from hydro power plants is projected to increase such that they will allow electricity exports from 2020. Reflecting the increasing efficiency of new technologies, the thermal efficiency of electricity generation in Myanmar is expected to increase from 21.7 percent in 1990 to 33.2 percent in 2030.

2.3. Energy Saving Goals and Action Plans

Savings in Myanmar's energy consumption can be attained through the implementation of energy efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from improvements in manufacturing technologies by at least 10 percent by 2020. In the residential and commercial (other) 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 mileage and more effective traffic management.

The government is also encouraging the use of biofuels in the transport and agriculture sectors to reduce oil dependency and curb carbon dioxide (CO_2) emissions. These efforts are still on going and the amount of biofuels that are used in the country is still small for the time being.

The following are the details of Myanmar's energy saving goals and action plans are outlined.

Myanmar's primary energy saving goal is to reduce energy consumption by 5 percent in 2020 and 8 percent in 2030, relative to existing BAU scenario. Specifically, these could be achieved using 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) fuel substitution of at least 8 percent by 2020.
- Increase the total installed power capacity of renewables to 15-20 percent (around 18%) by 2020.
- Improve energy efficiency in the commercial/residential sector by 5-8% (around 7%) by 2020.

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

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

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

In industry, the gradual replacement of low efficiency equipment with higher efficiency ones 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 savings 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 improvements in energy efficiency in existing buildings in the public and private sectors.
- Promote the use of higher energy efficient appliances and energy savings equipment in the residential and commercial sectors.
- Launch the use of bio-diesel (B100) in rural communities.
- Develop and expand the energy mix and supply sources through utilisation 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 and conservation and new and renewable sources of energy.
- Replace transformers and install the capacitor banks in necessary main sub-stations. Optimise the voltage, conductor size and loading of transformers.

3. Outlook Results

3.1. Total Final Energy Consumption

Total final energy consumption in Myanmar increased by about 6.3 percent per year from 1.3 Mtoe in 1990 to 3.3 Mtoe in 2005. The “other” sectors group, which comprises the commercial, residential and agricultural sectors, was the fastest growing consumer with average annual growth of 16.4 percent between 1990 and 2005. Average annual growth in the transport sector was about 7.5 percent over the period 1990-2005. The industry sector grew the slowest at 2.8 percent per year over the same period. Oil was the most consumed product having a share of 44.9 percent in total final energy consumption at 1990, increasing to 53.0 percent in 2005. Natural Gas was the second most consumed product.

Business-as-Usual (BAU) Scenario

Using the socio-economic assumptions stated above, final energy consumption in Myanmar is projected to grow at an annual rate of 8.1 percent from 2005 to 2030 in the BAU scenario. Final energy consumption is projected to grow the fastest to 2030 in the industry sector with annual average growth of 7.9 percent. In the transport and other sectors, consumption is projected to grow at an annual average rate of 8.9 percent and

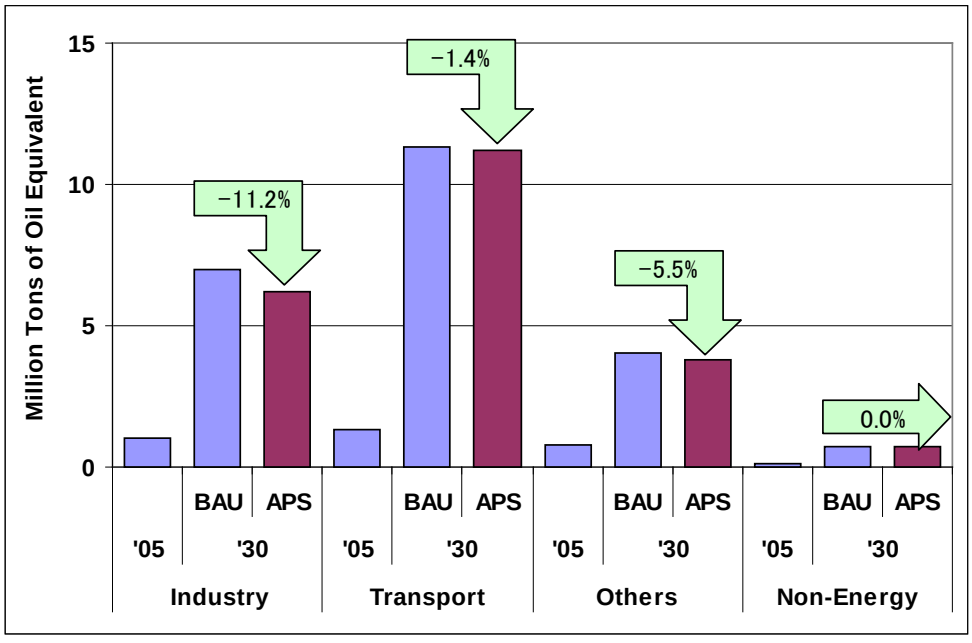
6.8 percent respectively.

Oil is projected to remain the dominant fuel source in final energy consumption with its share increasing from 53 percent in 2005 to 58 percent in 2030. Natural gas and coal are projected to have annual average growth rates of 7.2 percent and 8.6 percent respectively in the period 2005-30 driven by the projected growth in industry GDP. The share of natural gas in final energy consumption is projected to subsequently decrease from 25.4 percent in 2005 to 20.6 percent in 2030. The share of coal, however, will increase from 2.9 percent in 2005 to 3.3 percent in 2030 in the BAU scenario. Electricity will have the fastest growth rate of 10.3 percent per year to 2030. Its share will increase from 9.5 percent in 2005 to 15.9 percent in 2030.

Alternative Policy Scenario (APS)

In the APS, the growth in final energy consumption is projected to grow at a lower average annual rate of 7.9 percent as compared to the 8.1 percent annual growth in the BAU. The reason for the slower growth rate is the slower growth in the industrial consumption as a result of technological improvement in manufacturing processes and the reduction of final energy consumption of electricity and oil in the other sectors. Figure 39 shows the sectoral final energy consumption in Myanmar in the BAU and APS.

Figure 39. Final Energy Consumption by Sector in Myanmar, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Myanmar grew at an average annual rate of 5.4 percent from 1.9 Mtoe in 1990 to 4.3 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were oil and hydro with average annual growth rates of 7.0 percent and 6.3 percent, respectively. Natural gas consumption grew at an average annual rate of 5.2

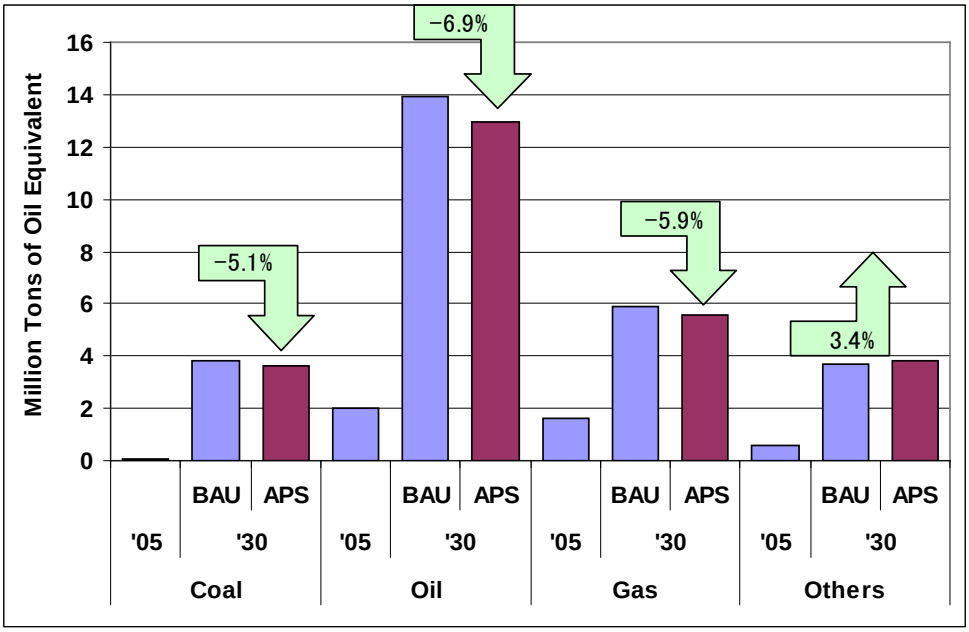
percent over the period 1990-2005. Coal consumption increased by 2.4 percent per year over the same period.

Oil and gas dominated the primary energy demand mix in 2005 with respective shares of 47.0 percent and 37.7 percent.

Business as usual (BAU) Scenario

In the BAU scenario, Myanmar's primary energy demand is projected to increase at an annual average rate of 7.7 percent per year to 27.3 Mtoe in 2030. Coal is expected to grow the fastest at an annual average rate of 15.9 percent followed by hydro at 10.6 percent over the period 2005-2030.
Oil, despite its lower annual growth rate of 8.0 percent will continue to dominate the primary energy mix with its shares to the total increasing further to 51.0 percent. Coal and hydro will also increase their shares from 2.2 percent to 13.9 percent and 6.0 percent to 11.7 percent, respectively.

Figure 40. Primary Energy Demand by Source in Myanmar, BAU and APS



Alternative Policy Scenario

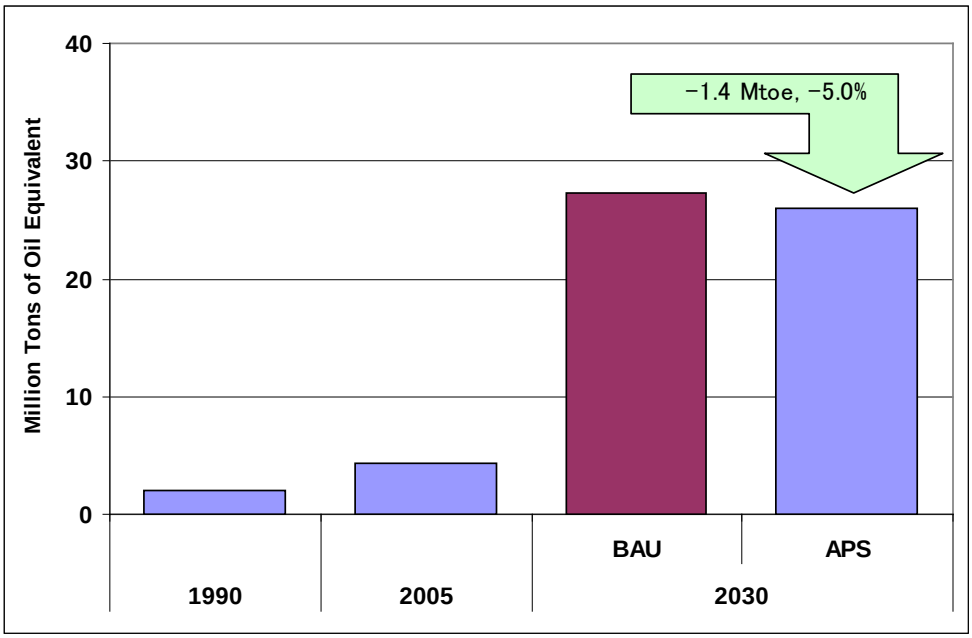
In the APS, Myanmar's primary energy demand is projected to increase at a slightly slower rate than in the BAU scenario at 7.5 percent per year from 4.3 Mtoe in 2005 to 26.0 Mtoe in 2030. Coal will be the fastest growing fuel at 15.6 percent per year followed by hydro at 10.0 percent per year between 2005 and 2030. Oil and natural gas are expected to grow at slower annual rates of 7.7 percent and 5.0 percent, respectively over the same time period. Figure 40 shows the future primary energy demand mix in both the BAU scenario and APS.

3.3. 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 consumption requirements have to be met mainly from domestic sources. Obviously there is a gap between demand and supply but on the other hand, the demand is often very much higher than actual energy requirements. Due to these constraints, historically derived coefficients are applied to allocate energy and 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 savings in energy could be due to savings in final energy consumption in the residential/commercial sectors, the transportation sectors and the industrial sector. In this regard, Myanmar has implemented a range of energy efficiency and conservation goals and action plans which target energy savings in all sectors of the economy in cooperation with both the private and public sectors. There is an estimated saving of 1.4 Mtoe in 2030 in the APS, relative to the BAU scenario. This is equivalent to 5.0 percent of the primary energy demand in the BAU in 2030. Myanmar has plans to decrease growth in primary energy demand by implementing a range of energy efficiency and conservation measures on the demand side.

Figure 41. Total Primary Energy Demand in Myanmar, BAU and APS

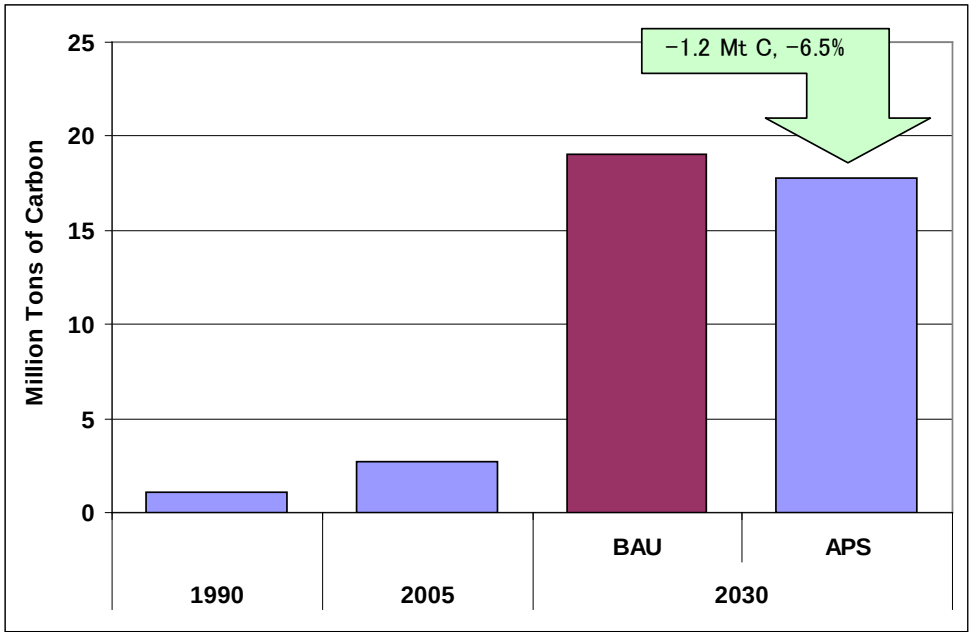


5.1. CO_2 Emissions from Energy Consumption

In the APS, the energy efficiency policy of Myanmar is projected to reduce growth in CO_2 emissions from energy consumption. At 2030 in the APS, CO_2 emissions from energy consumption are projected to reach about 17.8 million tons of carbon (Mt C)

which is about 5.0 percent below BAU levels (Figure 42).

Figure 42. CO_2 Emission from Energy Consumption in Myanmar, BAU and APS



4. Implications and Policy Recommendations

Myanmar's primary energy intensity (TPES/GDP) has been declining since 1980. However, energy consumption is still increasing due to economic and population growth and more vehicles on the road.

Myanmar should increase adoption of energy efficient technologies to further reduce growth in energy consumption and should also aim to diversify energy availability. The government should encourage sectors to follow the government programs and action plans for energy efficiency by providing incentives to these sectors.

Chapter 13

New Zealand Country Report

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2009

This chapter should be cited as
Lawrence, S. (2009), 'New Zealand Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.131-137.

New Zealand

By Mr. Simon Lawrence

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 4.2 million. Although there is some light and heavy industry, foreign trade is heavily dependent on agriculture, tourism, forestry, and fishing. In 2005 New Zealand had a gross domestic product (GDP) of about US$62 billion, or about US$15,100 per capita. While the latter figure is below many OECD countries, New Zealand tends to rank 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 a net exporter of coal, but 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 16.9 million tons of oil equivalent (Mtoe) in 2005. By fuel, oil represented the largest share at about 40 percent, gas was second at about 19 percent, followed by hydro, coal, and geothermal, each with 11-12 percent. New Zealand obtains about 30 percent of its primary energy supply from renewable sources, including hydro, geothermal, woody biomass, and wind.

In 2006, electricity generation accounted for 55 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 56 percent of gas use, petrochemicals for 15 percent, and other industrial use for 20 percent. Commercial and residential use accounted for most of the reminder. Reticulated natural gas is only available on the North Island. Transport accounted for an estimated 86 percent of New Zealand's oil consumption. New Zealand is heavily dependent on private road vehicles and air transport, with oil providing 99 percent of New Zealand's transport energy.

New Zealand had 8.8 gigawatts (GW) of installed generating capacity and generated about 43 terawatt hours (TWh) of electricity in 2005. The generation by energy type is broken down as: hydro at 55 percent, thermal (coal and gas) 36 percent, geothermal 7 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 gross domestic product (GDP) is assumed to grow at an average annual rate of 3 percent from 2010 to 2020, tapering off to around 2 percent per year from 2020-2030. Population will increase by around 25 percent by 2030, relative to 2005 levels.

In the business as usual (BAU) scenario, an increasing amount of New Zealand's electricity supply is projected to come from geothermal. Hydro will remain fairly steady as the best hydro sites have already been developed. Gas use in electricity generation will drop somewhat, due to the expected depletion of the Maui gas field, New Zealand's largest. Wind generation will continue to grow, but will still contribute only a small share of New Zealand's electricity by 2030.

New Zealand's energy efficiency has historically improved at a rate of about 0.5-1.0 percent per year and this rate is assumed to continue in the BAU scenario. New gas discoveries are assumed to average 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. The Alternative Policy Scenario (APS) presented here assumes the successful implementation of these.

3. Outlook Results

3.1. Total Final Energy Consumption

New Zealand's final energy consumption experienced a growth of 2.0 percent per year from 9.5 Mtoe in 1990 to 12.7 Mtoe in 2005. The transport sector had the highest growth rate during this period at 3.4 percent per year followed by the 'other' sector (primarily residential and commercial) with 1.9 percent per year. The industrial sector consumption grew at a slow pace of 0.5 percent per year, reflecting a shift to less energy-intensive industry. Oil was the most consumed energy source having a share of 46.6 percent in 1990 and increasing to 53.4 percent in 2005. Electricity was the second most consumed energy source.

Business as Usual Scenario

In the BAU scenario, final energy consumption from 2005 to 2030 is projected to grow at an average rate of 0.8 percent per year.

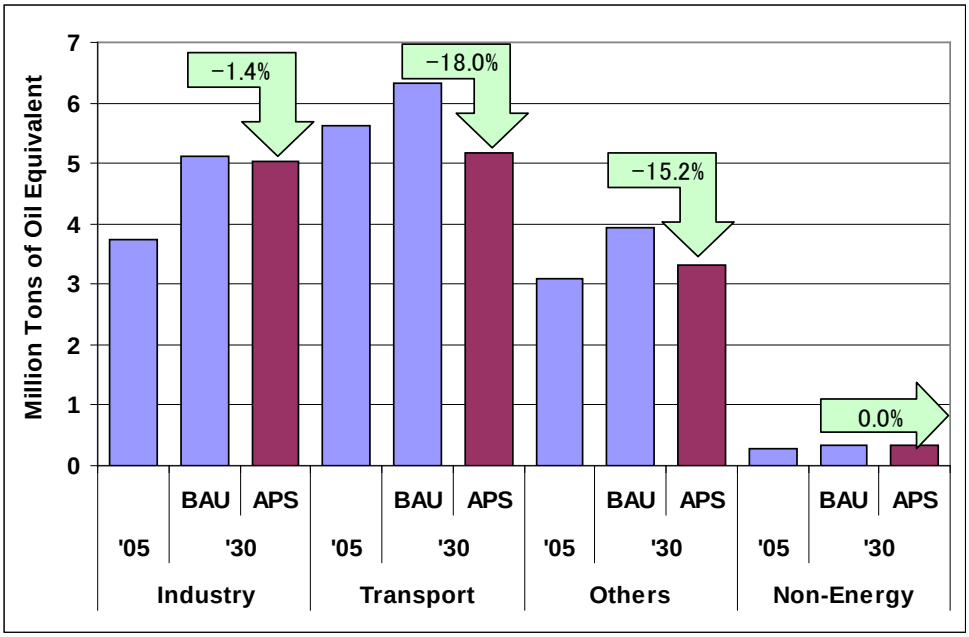
By fuel type, final consumption of coal will decrease at an average rate of 0.4 percent per year. Final consumption of oil will increase by 0.4 percent per year, while natural

gas and electricity will increase by 1.3 and 1.4 percent per year respectively.

Alternative Policy Scenario

In the APS, final energy consumption will grow at a rate of only 0.3 percent per year from 12.7 Mtoe in 2005 to 13.9 Mtoe in 2030. Energy use in the transport sector will drop by an average of 0.3 percent per year reflecting a shift to more energy efficient vehicles, particularly electric vehicles. Energy use in the 'Other' sector will grow by only 0.3 percent per year, reflecting improved residential and commercial energy efficiency. The sectoral final energy consumption in New Zealand in 2005 and 2030 in the BAU and APS is shown in Figure 43.

Figure 43. Final Energy Consumption by Sector in New Zealand, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in New Zealand grew at a rate of 1.4 percent per year from 13.8 Mtoe in 1990 to 16.9 Mtoe in 2005. The fastest growing primary fuel in percentage terms was coal at 3.9 percent per year, reflecting growing electricity generation demand. The fastest growing primary fuel in absolute terms was oil from 4.0 Mtoe in 1990 to 6.8 Mtoe in 2005, reflecting rapid growth in transport energy demand. Natural gas declined at an average annual rate of 1.3 percent, reflecting declining production from the Maui gas field. Although the statistics show a decline in primary geothermal consumption, this was simply due to an increase in the assumed conversion efficiency of geothermal electricity generation from 10 to 15 percent from 2000. Electricity produced from geothermal sources actually grew by 1.7 percent per year over this period. Hydroelectricity production was more or less unchanged.

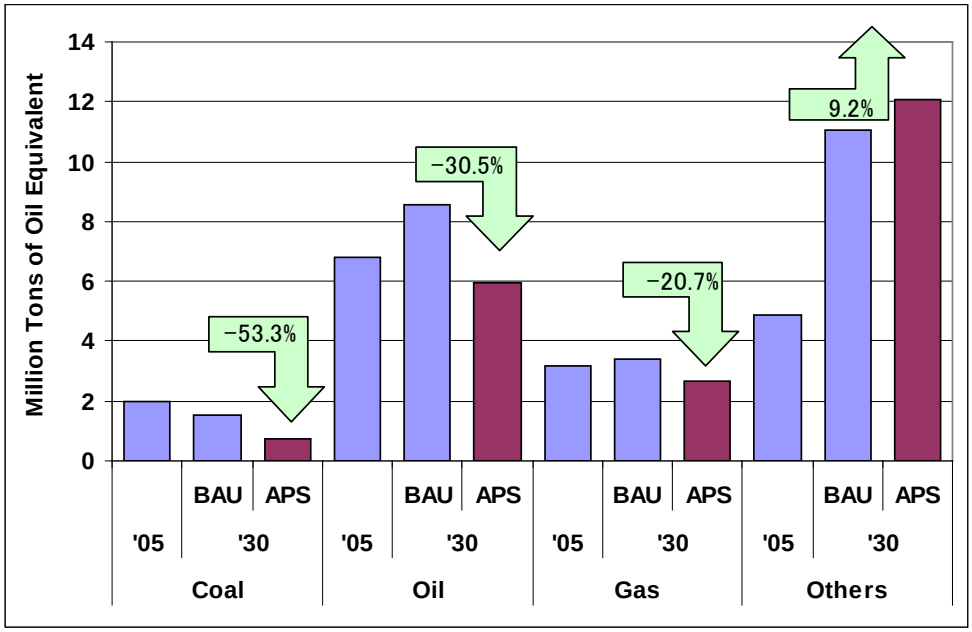
Business as Usual Scenario

In the BAU scenario, New Zealand's primary energy demand will grow at an annual rate of 1.5 percent per year to 24.5 Mtoe in 2030. However, this growth rate is somewhat misleading, as more than half of this growth is in primary geothermal energy, which has an assumed conversion efficiency of 15 percent. Leaving out geothermal energy, primary energy demand will grow by about 0.7 percent per year. This growth is mainly due to continued increases in oil consumption at an annual rate of 0.9 percent. 'Other' primary energy will grow by 2.1 percent per year, reflecting mainly the expected growth in wind power.

Alternative Policy Scenario

In the APS, primary energy demand is projected to grow at a slower rate of 0.9 percent per year to 21.4 Mtoe in 2030. Again, this figure is rather misleading, since it reflects large growth in geothermal electricity generation with only 15 percent conversion efficiency. Leaving out geothermal, primary energy demand will be almost the same in 2030 as it was in 2005. Geothermal primary energy is expected to grow by 5.2 percent per year, while 'other' primary energy, which includes wind and biomass, is expected to grow by 3.6 percent per year (note that the 'Others' shown in Figure 44 also includes hydro and geothermal). Oil and gas are expected to show modest declines of 0.1 and 0.4 percent per year respectively, while coal will show a significant decline of 3.2 percent per year. The apparent growth in hydro is, again, largely due to the fact that 2005 was a relatively dry year.

Figure 44. Primary Energy Demand by Source in New Zealand, BAU and APS

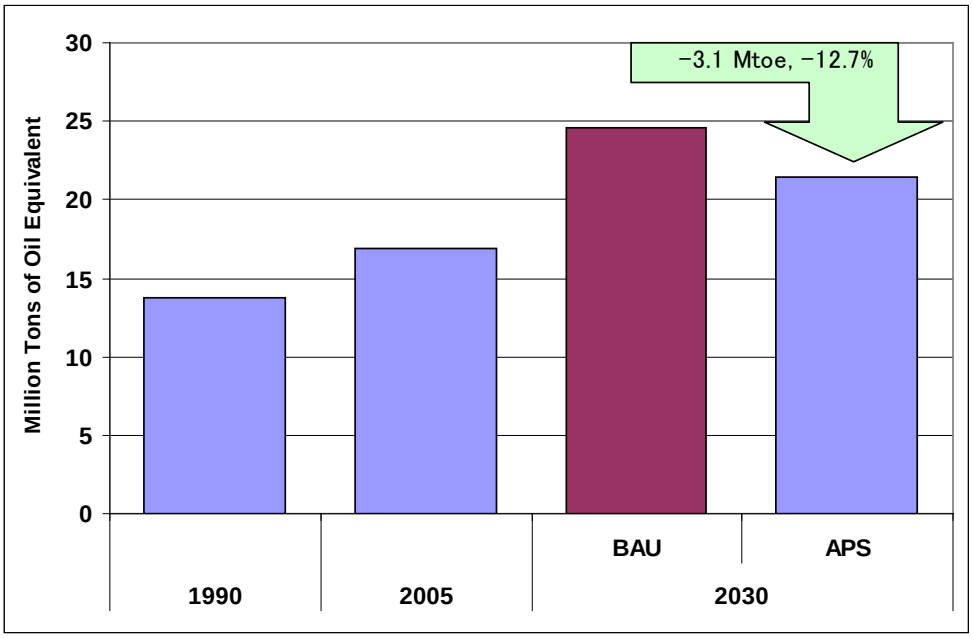


3.3. Projected Energy Savings

Under the APS, energy savings could amount to 3.1 Mtoe in 2030, the difference between the primary energy demand of the BAU scenario and the APS – 12.7 percent less than business as usual in 2030 (Figure 45).

The above savings in primary energy are mainly due to a switch 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 45. Total Primary Energy Demand in New Zealand, BAU and APS

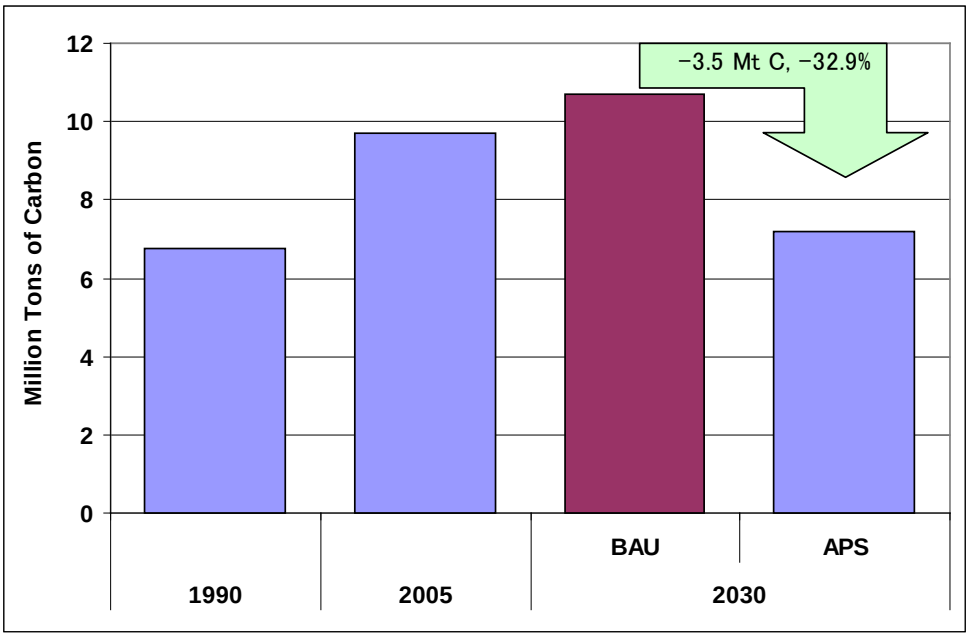


3.4. CO_2 Emissions

The calculated carbon dioxide (CO_2) emissions in the BAU scenario will increase by 0.4 percent per year from 9.7 million tons of carbon (Mt C) in 2005 to 10.7 Mt C in 2030. This increase is roughly in line with the increase in primary energy other than geothermal discussed above.

In the APS, there will be a decrease in CO_2 emissions from 2005 to 2030 of 1.2 percent per year. Since primary energy demand excluding geothermal is more or less stable over this time period, this decrease reflects the switch to renewable energy in electricity generation, and a switch from oil to electric vehicles in transport. Figure 46 shows the CO_2 emissions from energy consumption in New Zealand from 2005 to 2030.

Figure 46. CO_2 Emissions from Energy Consumption in New Zealand, BAU and APS



4. Implications and Policy Recommendations

Although New Zealand's primary energy intensity (energy per dollar of GDP) has been on a decline 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 encourage investment in new renewable generation technologies, with geothermal and wind particularly prospective options for New Zealand. New Zealand's large base of renewable generation, however, makes reducing emissions from electricity generation a challenge as there are limited opportunities to switch existing thermal generation to less emissions intensive, or renewable, technologies.

New Zealand has many opportunities to improve energy efficiency, for example, through upgrading the poorly-insulated building stock and inefficient vehicle fleet, and the government maintains a number of programmes in these areas. The commercial building and industrial sectors also represent an area where gains in energy efficiency improvements are possible.

Growth in energy consumption in the transport sector has slowed in recent years, largely as a result of high fuel prices and a shift to smaller vehicles. Further, 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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2009

This chapter should be cited as
Morales, L. T. (2009), 'Philippines Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.139-145.

Philippines

Ms. Lilibeth Tamayo Morales

1. Background

A. 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.

Despite the global financial crisis the country's Gross Domestic Product (GDP) grew by 4.6 percent in 2008, although this is 2.6 percent lower than the 7.2 percent growth in 2007. The industry sector managed a 5.0 percent growth due mainly to the stable output of the manufacturing and construction sectors with respective growths of 8.2 percent and 4.3 percent. The agriculture sector grew by a meagre 3.2 percent in 2008. The 2005 population was estimated at 83.5 million while GDP per capita was about US$1,100 in 2005.

B. Energy

The country's total primary energy supply in 2005 reached 37.0 million tons of oil equivalent (Mtoe). Oil accounted for 41.0 percent of the total energy supply followed by geothermal which comprised 23.0 percent.

Imports in 2005 on the other hand, declined by 4.0 percent relative to the 2004 level, following a significant cut in oil consumption both for power and non-power applications.

The country's total electricity generation in 2005 was 56.6 terawatthours (TWh) which is 1.1 percent higher than the 2004 level of 56.0 TWh. Generation from natural gas-fired power plants dominated the power generation mix providing 29.8 percent, while coal-fired power plants ranked second accounting for 27.0 percent or 15.3 TWh. Geothermal energy remained the 3rd largest provider of electricity with a 17.5 percent share in the generation mix in 2005.

2. Modelling Assumptions

The Philippine economy is projected to grow at a steady pace of 6.1 percent per annum during the projection period 2005 to 2030. This sustained growth is expected to be driven by the steady performance of the service sector and improved exports and agricultural output. Nonetheless, it will take a higher, sustained growth path to make appreciable progress given the Philippines' high annual population growth rate of 1.4

percent from 2005 to 2030.

To meet the country's increasing demand for electricity; the Philippines will source its energy from coal, oil, natural gas, hydro and geothermal. The relatively low contribution of oil in the total fuel input for power generation may be attributed to the restraint in oil use due to the continuous volatility of oil prices in the international market – as such no new oil plants will be constructed and aging oil-fired power plants will be decommissioned. Further, the government is pushing for renewable energy to supply the energy needs of the country which is expected to be given the necessary boost with the enactment of the Renewable Energy Law in December 2008.

Meanwhile, the intensified development and utilisation 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 environmentally-friendly energy sources. The major alternative fuels being promoted are biofuels which include biodiesel (cocomethyl esther) and bioethanol, autogas (LPG as transportation fuel) and compressed natural gas (CNG). The potential for using other sources such as jatropha curcas as a potential biodiesel feedstock is also being explored.

Meanwhile, the energy saving goals of the country will be achieved through a range of measures including intensified energy utilisation management programs in the commercial and industrial sectors, power plants and distribution utilities as well as the continuous use of alternative fuels and technologies.

3. Outlook Results

3.1. Total Final Energy Consumption

The Philippines' final energy consumption doubled from 10.3 Mtoe in 1990 to 23.1 Mtoe in 2005 at an average growth rate of 5.5 percent per annum. Over the period 1990-2005 energy demand in the transport sector grew the fastest at 9.1 percent per annum followed by the industry sector with average growth of 5.4 percent per annum. The residential/commercial (other) sector grew at a slow pace of 1.7 percent per annum. Oil remained the most consumed fuel with a share of 70.6 percent in 1990 which decreased to 59.8 percent in 2005.

Business as Usual (BAU) Scenario

Final energy consumption is expected to grow at an annual average rate of 5.1 percent in the BAU scenario over the period 2005 to 2030. This is due to increased activities in all sectors with the residential/commercial (other) sector growing the fastest at 6.8 percent per annum, followed by the transportation sector at an average rate of 5.3 percent per annum over the period 2005-2030.

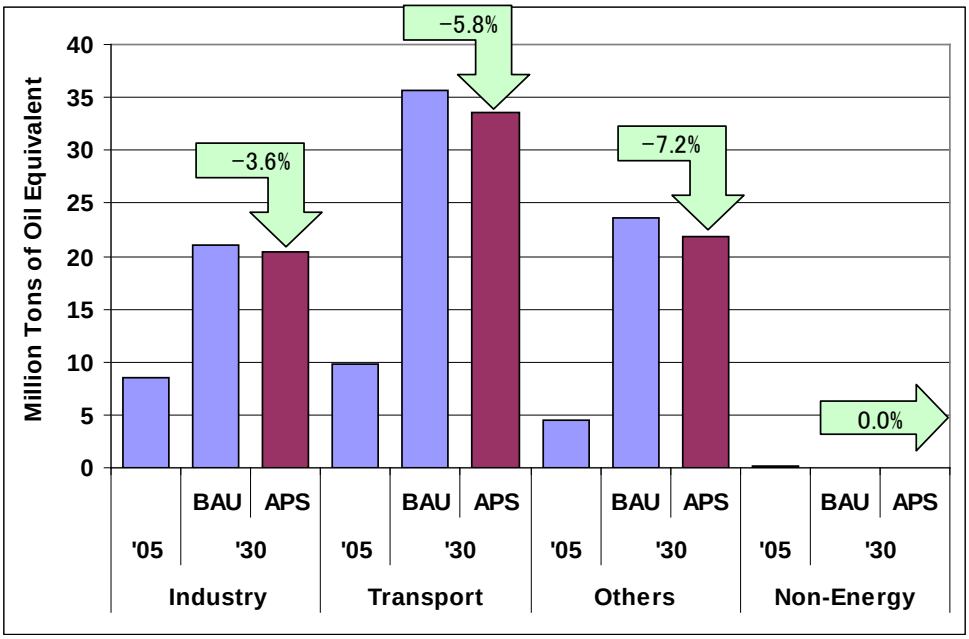
In terms of fuel, oil and electricity consumption are projected to grow the fastest at an

average rate of 5.0 and 7.3 percent per annum to 2030. Coal use will grow at an average annual rate of 2.4 percent.

Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower average rate of 4.9 percent per annum from 22.9 Mtoe in 2005 to 75.8 Mtoe in 2030. All sectors will contribute to the increase with the residential/commercial (other) sector projected to have the fastest average annual growth at 6.5 percent between 2005 and 2030. The transportation sector is projected to follow closely with an annual growth of 5.1 percent over the same period. Meanwhile, the industry sector is expected to grow at an annual average rate of 3.7 percent. The projected final energy consumption in the BAU and APS are shown in Figure 47.

Figure 47. Final Energy Consumption by Sector in the Philippines, BAU and APS



3.1. Primary Energy Demand

Primary energy demand in the Philippines grew at an annual average rate of 4.4 percent, from 19.3 Mtoe in 1990 to 37.0 Mtoe in 2005. Among the major energy sources, consumption of "others" (comprising of electricity, solar, wind and other sources of energy) grew the fastest at 12.0 percent per annum between 1990 and 2005. Coal followed next at 10.3 percent, geothermal at 4.0 percent per annum then hydro at 2.2 percent per annum. Oil which had the largest share in the total with 41.0 percent in 2005 grew the slowest at 1.6 percent per annum during the period 1990-2005.

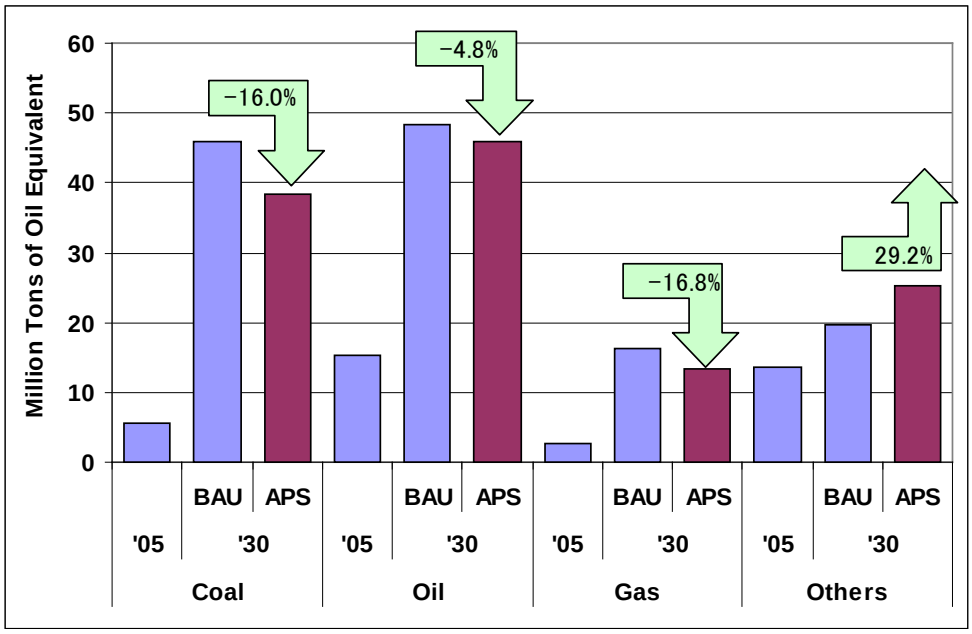
Business as Usual (BAU) Scenario

In the BAU scenario, the Philippines' primary energy demand is expected to increase by 5.1 percent per annum from 37.0 Mtoe in 2005 to 130.0 Mtoe in 2030. Demand for all major energy sources is projected to increase with coal use growing the fastest at 8.7 percent per annum from 2005 to 2030. Natural gas is also expected to expand with a high growth rate of 7.5 percent per year during the same period. Oil will remain as the major energy source and will grow at 4.7 percent per annum. This is followed by other fuels with an annual average growth rate of 2.6 percent over the period 2005 to 2030.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at an annual average rate of 4.9 percent increasing from 37.0 Mtoe in 2005 to 123.3 Mtoe in 2030. The share of oil, coal and natural gas will be 37.3, 31.2 and 10.9 percent respectively in 2030. Coal, natural gas and oil are projected to have average annual growth rates of 8.0 percent, 6.7 percent and 4.5 percent respectively over the period 2005 to 2030.

Figure 48. Primary Energy Demand by Source in the Philippines, BAU and APS



Given the potential severe impacts of climate altering greenhouse gases and skyrocketing crude oil prices, the Department of Energy has started a reassessment of nuclear energy as a long-term power option for the country. Thus in this study it is assumed that a nuclear power plant with 1000 MW capacity is introduced in the year 2025 in the APS case. By 2030, 2.6 percent of total primary energy demand will be supplied by nuclear energy. The contribution of nuclear to total electricity generation will reach 12.3 TWh by the year 2030.

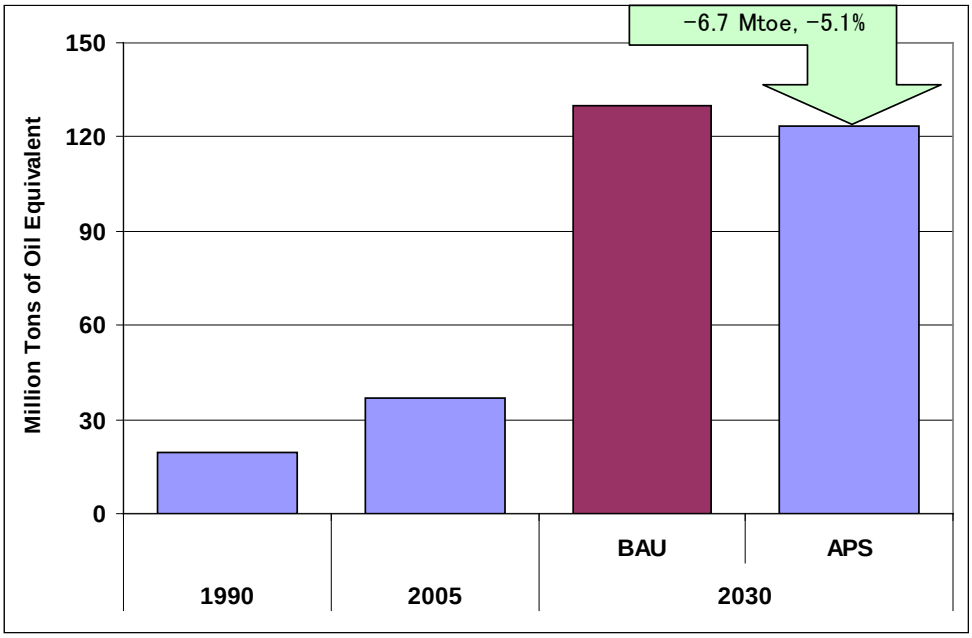
Figure 48 shows the primary energy demand by source in the Philippines in 2005 and

2030 both in the BAU and APS.

3.2. Projected Energy Savings

In 2030 it is estimated that the EEC goals, action plans and policies of the Philippines could result in savings of 6.7 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure 49). This level is about 29.0 percent of Philippine's consumption in 2005. At current oil prices (2008), this could lead to US$4.8 billion of oil import savings.

Figure 49. Total Primary Energy Demand in the Philippines, BAU and APS

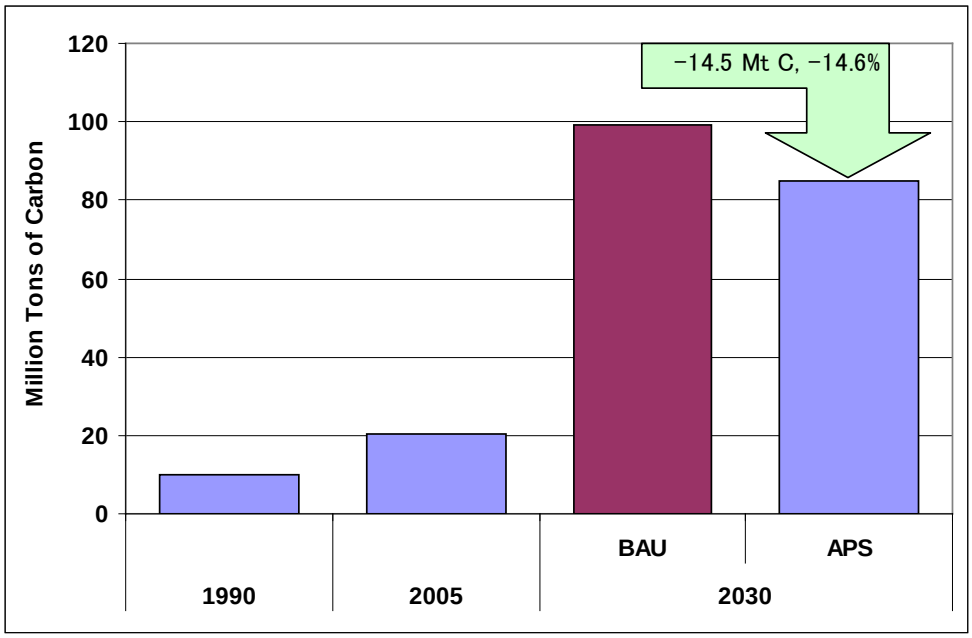


In terms of final energy consumption savings, the following savings were projected at 2030 in the APS, relative to the BAU scenario: residential/commercial (other) sector with 1.7 Mtoe, transport sector with 2.1 Mtoe and 0.8 Mtoe from the industry sector.

3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 6.5 percent annually from 20.4 Mt C in 2005 to 99.3 Mt C in 2030 in the BAU scenario. However, in the APS, CO_2 emissions are projected to be reduced by almost 14.6 percent in 2030 relative to the BAU scenario (Figure 50). This indicates that the energy saving goals, action plans and policies in the Philippines will be effective in reducing CO_2 emissions in the APS.

Figure 50. CO_2 Emission from Energy Consumption in the Philippines, BAU and APS



4. Implications and Policy Recommendations

In 2030 total final energy savings of 6.7 Mtoe could be achieved in the APS relative to the BAU. This is equivalent to a 5.1 percent reduction in total primary energy demand. Current policies on energy efficiency and conservation include: energy management activities conducted by the DOE such as spot checks on government agencies nationwide in compliance with Administrative Order No. 126 (Strengthening Measures to Address the Extraordinary Increase in World Oil Prices, Directing the Enhanced Implementation of the Government's Energy Conservation Program, and for other Purposes**)**, energy standards and labelling programs, energy audits of various commercial and industrial establishments, voluntary agreement programs, recognition awards and the various information and education campaigns (IEC) of the Department of Energy.

The continued improvement in the energy intensity of the Philippines to 2030 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. Responses to surging oil prices and their inflationary effects on the prices of basic commodities would also contribute to lowering the energy to GDP intensity level.

The government shall pursue its programs and projects that will further increase and enhance the utilisation of indigenous, clean and efficient alternative fuels. For the indigenous and clean energy sector, the passage of the Renewable Energy Act of 2008 is a big leap in the energy sector. This will not only promote the use of clean energy but will also lessen the need for energy imports. Additionally the introduction of alternative

fuels that include CME, fuel ethanol, CNG, autogas (LPG for transportation) and biodiesel will reduce the effects of continuous increases in the prices of crude oil in the world market and could also reduce greenhouse gas emissions. In addition, other technologies such as nuclear energy may be considered as an additional energy source in the future.

To institutionalize energy conservation and enhance the efficient use of energy in the country there is a need for an Energy Conservation Law to be passed to mainstream the energy conservation programs of the country.

Chapter 15

Singapore Country Report

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2009

This chapter should be cited as
Malik, C. L. (2009), 'Singapore Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.147-150.

Singapore

Ms. Cecilya Laksmiwati Malik

1. Background

Singapore is an island city-state located in South East Asia at the tip of Peninsular Malaysia. It has a total land area of 699 square kilometres and a population of 4.3 million in 2005. The population had increased from 3.05 million in 1990 at an annual average rate of 2.4 percent. It is expected that in the future, the growth in population will not be as high as it was in the past. An average population growth rate of 0.8 percent per annum was assumed in this report for the period 2005-2030. This will result in total population of 5.3 million in 2030.

Although Singapore is small in terms of land area and population, its economy has been growing rapidly. It is now that most industrialised and urbanised country in the Southeast Asia region. GDP in Singapore was US$112.7 billion in 2005 with a per capita GDP of US$26,000. There was a 3.9 percent per annum growth in GDP per capita from the 1990 level of US$14,700. The average GDP growth rate for Singapore was 6.4 percent per annum over the 1990 to 2005 period. It is expected that the GDP growth rate in Singapore will slow down at 3.7 percent per annum over the 2005-2030 period.

In terms of energy resources, Singapore has none. However, Singapore has the largest oil refining capacity in the Southeast Asia region. Singapore is a major exporter of petroleum products and is also an importer of natural gas from Malaysia and Indonesia. By 2012 Singapore will have an LNG terminal with an initial capacity of 3 million tons per annum serving Singapore's rising demands for natural gas.

Singapore has not provided quantified energy savings that would be induced by its current energy efficiency and conservation programs. However, it does have a quantitative goal to reduce primary energy intensity by 20 percent in 2020 and 35 percent in 2030 from the 2005 level. This level can be achieved by current policies. Thus, this outlook will only forecast energy demand in the Business as Usual (BAU) scenario.

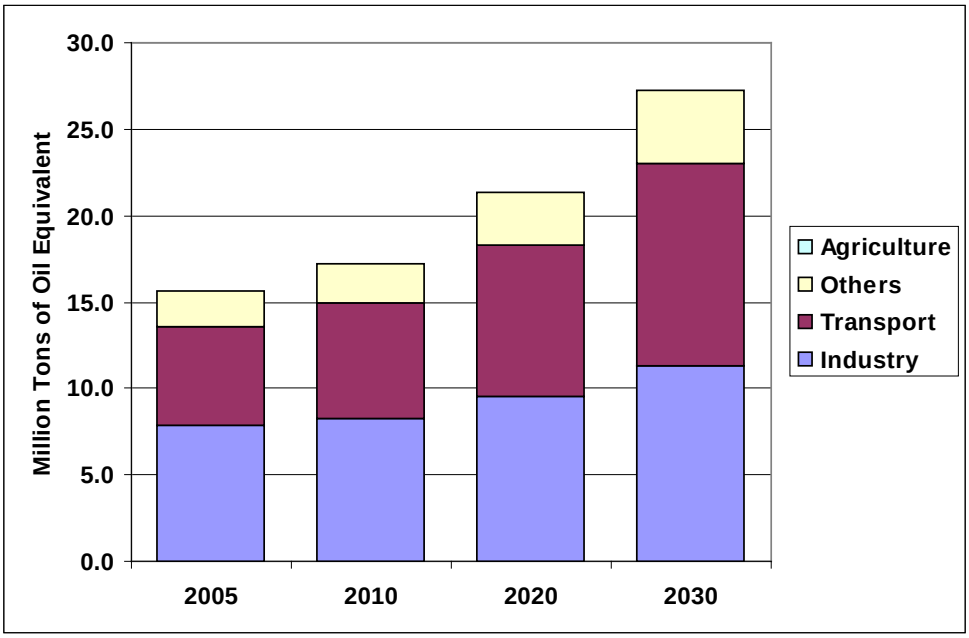
2. Outlook Results

2.1. Total Final Energy Consumption

Singapore's final energy consumption experienced a growth of 5.7 percent per annum from 6.8 million tons of oil equivalent (Mtoe) in 1990 to 15.6 Mtoe in 2005. The other sectors, constituting mainly the residential/commercial sector, had the highest growth rate during this period at 7.6 percent per annum followed by the industry sector at 6.9 percent per annum. Consumption in the transport sector grew at a slower pace of 3.8 percent per annum. Oil was the most consumed product having a share of 84.2 percent in 1990 which decreased slightly to 80.0 percent in 2005. Electricity was the second most consumed product.

With the projected economic growth of 3.7 percent and population increase of 0.8 percent per annum, final energy consumption from 2005 to 2030 is still expected to increase but at a slower rate than the previous 15 years. That is, at an average rate of 2.2 percent per annum in the BAU scenario. This slower rate of growth in the future is mainly due to the projected decline in the growth of industrial and transport sector consumption. Consumption by other sectors will also grow but at a lower average rate of 3.1 percent per year to 2030.

Figure 51. Final Energy Consumption by Sector in Singapore from 1990 to 2030



By fuel type to 2030, consumption of coal, oil, and electricity will still grow but at a slower rate than in the previous 15 years. The increase in electricity consumption will be higher than oil and gas at an average rate of 3.4 percent per annum. Consumption of oil and natural gas will increase at 2.0 and 0.5 percent per annum, respectively to 2030.

Figure 51 shows the evolution of sectoral final energy consumption in Singapore from

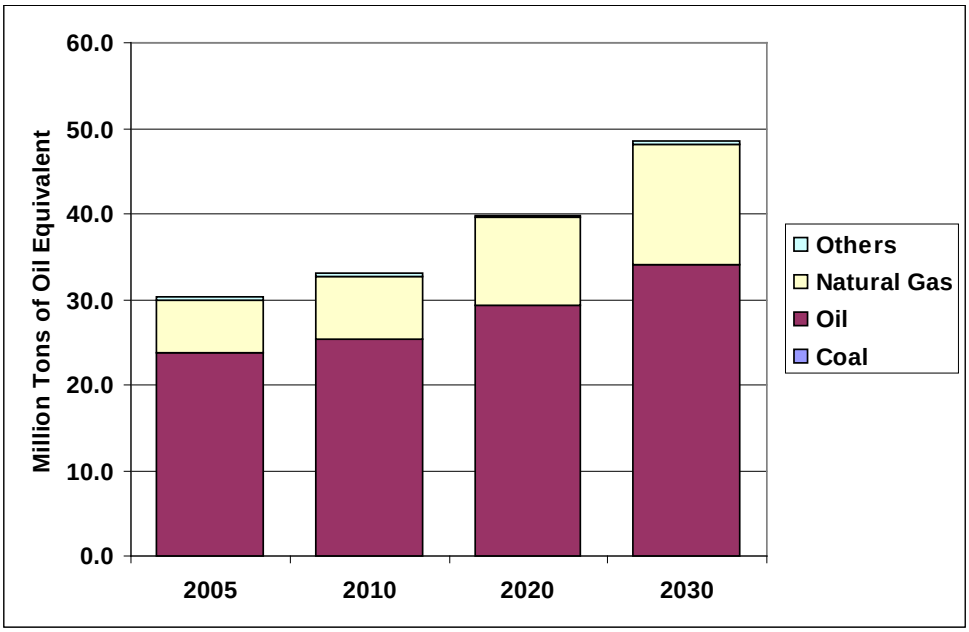
1990 to 2030.

2.2. Primary Energy Demand

Primary energy demand in Singapore grew at a slightly slower rate than final energy consumption at 5.6 percent per annum from 13.4 Mtoe in 1990 to 30.2 Mtoe in 2005. The main energy source of Singapore in 1990 was oil which increased from 13.4 Mtoe in 1990 to 23.8 Mtoe in 2005 at an average annual growth rate of 3.9 percent. Natural gas started to be consumed later on after the construction of a gas pipeline from Malaysia for the natural gas combined cycle power plants. In 2005, consumption of natural gas reached almost 6.1 Mtoe. Singapore also increased its gas supply by importing from Indonesia.

Singapore's primary energy consumption will increase at an annual rate of 1.9 percent per annum to 48.4 Mtoe in 2030. This decline in the rate of growth is due to the slower increase in the use of oil at an average annual rate of 1.4 percent. Consumption of natural gas will increase at a faster average annual rate of 3.4 percent in line with the expansion of gas fuelled power plants. Figure 52 shows the evolution of primary energy demand in Singapore from 1990 to 2030.

Figure 52. Primary Energy Demand by Source in Singapore from 1990 to 2030



2.3. Projected Energy Savings

Singapore's goal to reduce primary energy intensity by 20 percent in 2020 and 35 percent in 2030 from the 2005 level will be achievable under the current energy efficiency and conservation programmes. The primary energy intensity of Singapore declined from 299 tons of oil equivalent per US dollar (toe/US$) to 268 toe/US$ in

2005, indicating a 10 percent reduction. In 2020, the intensity is expected to continue declining to reach 207 toe/US$ in 2020 and 172 toe/US$ in 2030. This is thus a reduction of 22.8 percent in 2020 and 36.0 percent in 2030. In this regard, this study was therefore not able to generate an energy demand forecast for the APS.

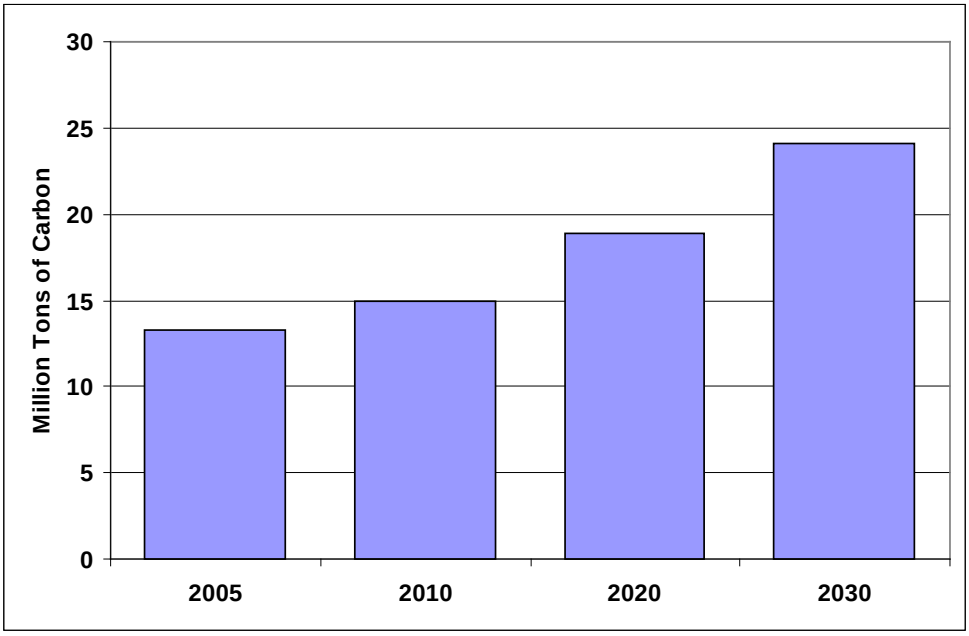
The energy efficiency initiatives of Singapore covered buildings, households and the industrial and transport sectors. These initiatives amongst others are as follows:

- Industry: Energy Efficiency Improvement Assistance Scheme (EAS); Design for Efficiency Scheme; Investment Allowance Scheme; Innovation for Environmental Sustainability (IES) Fund
- Transport: Promoting Public Transport; Mandatory Fuel Economy Labelling and Green Vehicle Rebate
- Buildings: Green Mark Buildings; Government Taking Lead on Environmental Sustainability through energy audits in government office buildings, Polytechnics and Institutes of Technical Education.
- Households: Energy Labelling on air-conditioners and refrigerators; 10 percent Energy Challenge; and Electricity Vending Systems (EVS)

2.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 2.4 percent per annum from 13.3 Mt C in 2005 to 24.1 Mt C in 2030 (Figure 53). This increase is higher than the increase in primary energy consumption reflecting the dominance of oil use as compared to the use of natural gas which is considered a less-carbon intensive fuel.

Figure 53. CO_2 Emission from Energy Consumption in Singapore



Chapter 16

Thailand Country Report

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2009

This chapter should be cited as
Sillavatkul, B. (2009), 'Thailand Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.151-157.

Thailand

Mr. Boonli Sillavatkul

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 high-lands in the Northeast. It has a small economy with a gross domestic product (GDP) in 2005 of around US$157 billion. The population is currently 65 million with an income per capita of US$ 2,400.

Thailand is an energy importer, especially of crude oil with very limited domestic resources. The indigenous energy resources in Thailand are mainly natural gas, coal (only lignite grade) and biomass. In 2005, proven reserves were 195 million barrels (30 million cubic metres) of oil, 11,700 billion cubic feet (316 billion cubic metres) of natural gas and 2,081 million tons of lignite.

Thailand's total primary energy demand was 89.9 million tons of oil equivalent (Mtoe) in 2005. By fuel type in 2005, oil accounted for the largest share at around 50.5 percent, followed by natural gas (28.8 percent), coal (11.8 percent) and others (8.9 percent). In 2005, net imports of energy accounted for 57 percent of the total primary energy supply. Due to very limited indigenous oil resources, Thailand imported nearly 82 percent of its crude oil and most of its bituminous coal. Although Thailand produces large quantities of natural gas, about 28 percent was still imported from its' neighbouring country, Myanmar.

In Thailand, natural gas is used as a major energy source for power generation. In 2005, primary natural gas supply was 25.9 Mtoe. Around 72 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 26.5 gigawatts (GW) of installed power capacity and power generation was about 130.6 terawatthours (TWh) in 2005. The share of different fuel types in total electricity generation in 2005 was: thermal (coal, natural gas and oil) at 94.1 percent, hydro at 4.4 percent and geothermal, solar, small hydro and biomass making up the remainder.

2. Modelling Assumptions

In this report, Thailand's GDP is assumed to grow at an average rate of 4.6 percent per year from 2005 to 2030. Given the impacts of the world economic crisis since 2008 on the Thai economy, growth in GDP between 2005 and 2010 will be slower than

previously expected at about 3.1 percent per annum. Population growth is also projected to be reasonably slow at around 0.3 percent per annum from 2005 to 2030. By comparison growth averaged about 1.2 percent per annum during the period 1990 and 2005.

With regard to power generation in Thailand, coal and natural gas are projected to be the largest energy sources. Conversely, the shares of fuel-oil and diesel power plants are projected to decrease. Nuclear power and renewable fuels, biomass in particular, are projected to increase their shares in the energy fuel mix in the APS relative to the BAU scenario. Biomass, including biogas and waste is projected to be the most significant renewable energy source in Thailand in the APS.

Thailand's energy saving goals can be achieved through the implementation of energy efficiency programs in all energy consumption sectors. In the industrial sector, improvements in technology development in manufacturing processes, along with efficiency labelling on appliances, 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 of a railway network for public transportation will also contribute to energy savings. Significant improvements in energy efficiency in passenger vehicles are also expected to be achieved due to new developments in car technologies and introduction of the Eco car program.

Government policies will also 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 fuels in power generation are expected to help reduce CO_2 emissions from electricity generation. Gasohol and bio-diesel as oil alternatives are also expected to help curb CO_2 emissions from transportation.

3. Outlook Results

3.1. Total Final Energy Consumption

Between 1990 and 2005 Thailand's final energy consumption grew at a robust rate on average at 5.9 percent per annum from 25.4 Mtoe in 1990 to 59.7 Mtoe in 2005. The transportation sector was the largest consumer of final energy at 11.4 Mtoe in 1990. By 2005 the share of transport had declined from 45 percent in 1990 to 37 percent. Strong growth in the industrial sector of about 7.8 per cent between 1990 and 2005 drove increases from 8.7 Mtoe in 1990 to 27.1 Mtoe in 2005. By 2005, the industrial sector had overtaken transport as the largest consumer of final energy - its share in 2005 was about 45 percent. Oil remained the dominant energy source in final energy consumption since 1990 accounting for 36.3 Mtoe or a 61 percent share in 2005. Electricity was the second largest energy source in final energy consumption, accounting for 10.4 Mtoe or a

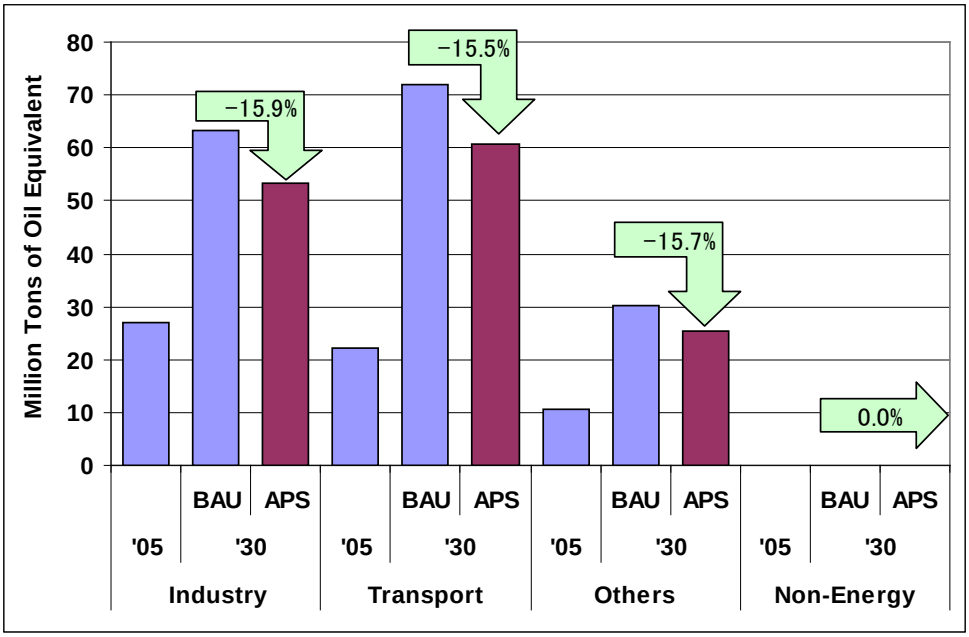
17.4 percent share in 2005.

Business-as-Usual (BAU) Scenario

Given moderate economic growth, (at an annual average rate of 4.6 percent,) and the low growth rate of population, (at an annual average rate of 0.3 percent), final energy consumption is projected to grow at a moderate rate of around 4.2 percent per annum during the period 2005-2030. The transportation and industry sectors are projected to remain the largest consumers with the highest shares of consumption at 43.5 percent and 38.2 percent respectively in 2030.

The transport sector is projected to overtake the industry sector as the largest consumer of final energy between 2010 and 2020. By fuel type, oil is expected to remain the largest final energy source throughout the projection period. Growth in oil is projected to decline moderately from 4.4 percent per annum during 1990-2005 to 3.9 percent per annum during 2005-2030. In 2030, the shares of electricity, coal and natural gas in final energy consumption are projected to increase to 23.5 percent, 12.5 percent and 5.3 percent respectively from 2005 levels.

Figure 54. Final Energy Consumption by Sector in Thailand, BAU and APS



Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to grow at 3.5 percent per annum, from 59.7 Mtoe in 2005 to 139.6 Mtoe in 2030, which is slower than the BAU average annual growth rate of 4.2 percent. Specifically, 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 54.

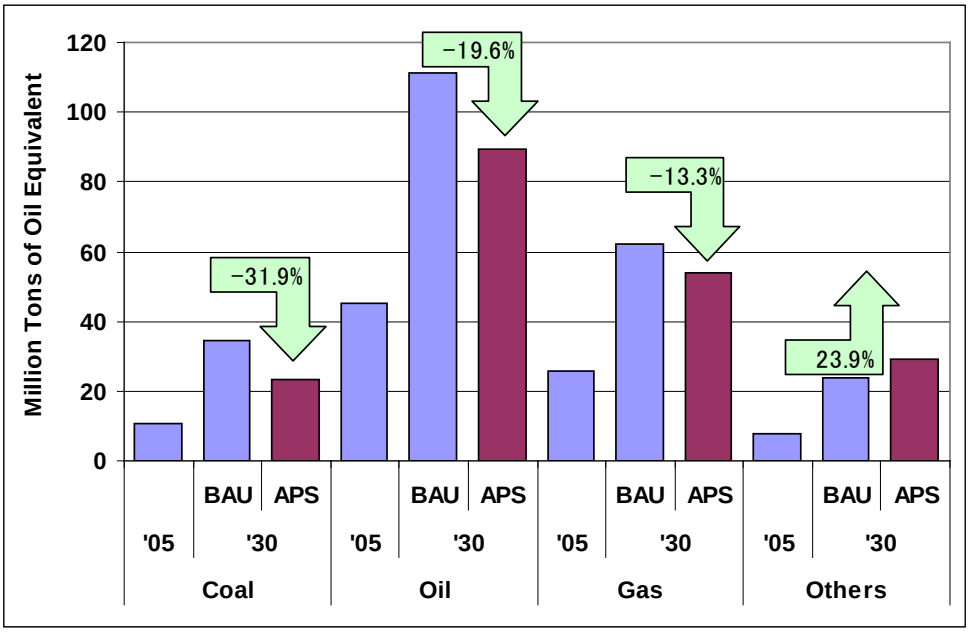
3.2. Primary Energy Demand

Primary energy demand grew reasonably fast at an average annual rate of 6.4 percent from 35.4 Mtoe in 1990 to 89.9 Mtoe in 2005 driven largely by fast economic development during 1990 and 1996. This growth in primary energy was achieved despite the severe economic crisis between 1997 and 1998 and a slow recovery during 1999 and 2005. In 2005, major sources of primary energy were oil, natural gas and coal with shares of 50.5 percent (45.4 Mtoe), 28.8 percent (25.9 Mtoe) and 11.8 percent (10.6 Mtoe) respectively. Although oil remained the largest source during 1990 and 2005, its share in primary energy demand shrank from 55.7 percent in 1990 to 50.5 percent in 2005. 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 28.8 percent in 2005. The share of hydropower remained relatively constant at around 2 to 3 percent from 1990 to 2005.

Business-as-Usual (BAU) Scenario

In the BAU scenario, primary energy demand is projected to grow moderately at about 3.9 percent per annum from 2005 to 2030, reaching about 231.4 Mtoe in 2030. The highest average annual growth rate of 4.8 percent is expected in coal with consumption expected to reach 34.6 Mtoe in 2030. Given very strong average annual growth in natural gas of 10.7 percent between 1990 and 2005, growth is expected to slow to about 3.6 percent per year between 2005 and 2030. It is recognised that future strong growth in natural gas consumption in power generation may be limited and it could be replaced by nuclear and other alternative fuels, according to the government plan.

Figure 55. Primary Energy Demand by Source in Thailand, BAU and APS



Alternative Policy Scenario (APS)

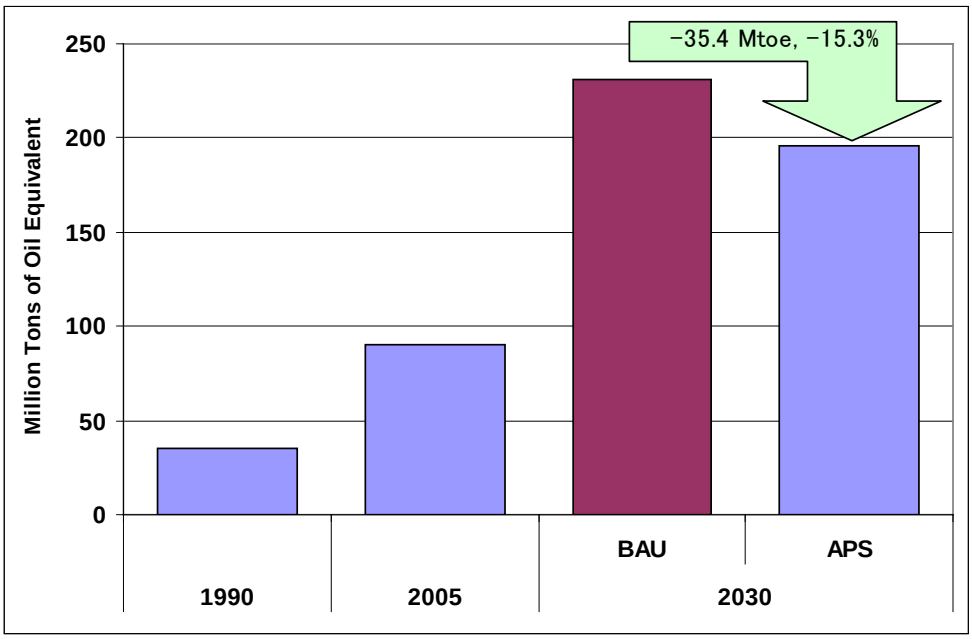
In the APS, growth in primary energy demand is projected to be slower than in the BAU scenario at only 3.2 percent per annum between 2005 and 2030 (compared with 3.9 percent in BAU) to reach 196.0 Mtoe in 2030. Primary energy demand is expected to be about 15.3 percent lower in the APS than in the BAU scenario in 2030 – an energy saving of about 35.4 Mtoe.

Natural gas is projected to increase from 25.9 Mtoe in 2005 to 53.8 Mtoe in 2030, at an annual average rate of 3.0 percent. Oil is also projected to increase from 45.4 Mtoe in 2005 to 89.4 Mtoe in 2030, at an annual average rate of 2.8 percent. These reductions in growth, 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 55.

3.3. Projected Energy Savings

The difference between primary energy demand in the BAU scenario and the APS at 2030 is 35.4 Mtoe (Figure 56). 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 39.4 percent of Thailand's primary energy demand in 2005. Oil will contribute the most at about 21.8 Mtoe in energy savings, while coal, as the second biggest, will contribute about 11.0 Mtoe.

Figure 56. Total Primary Energy Demand in Thailand, BAU and APS



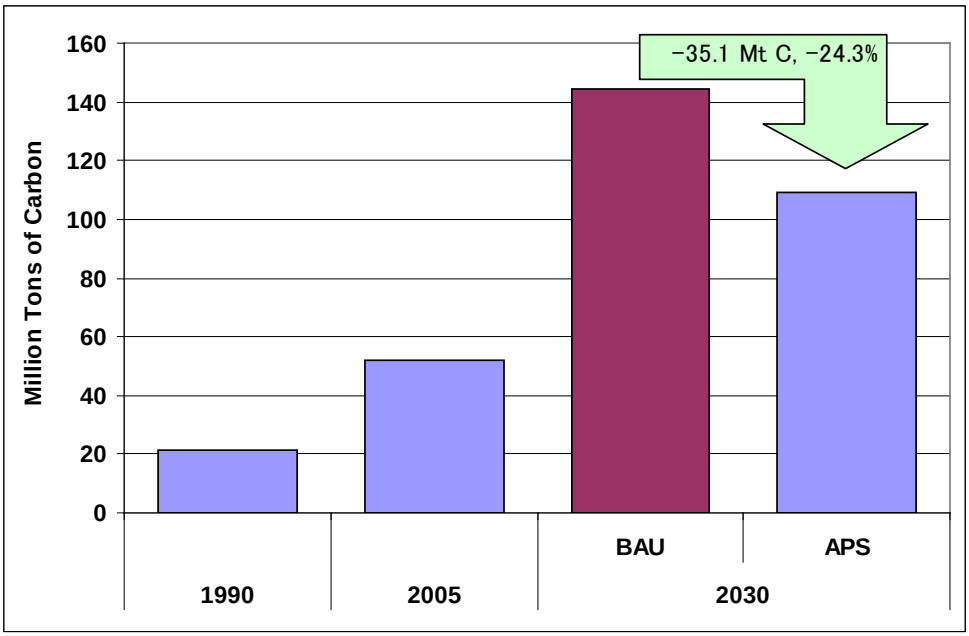
In final energy consumption, the savings in the APS, relative to the BAU scenario at 2030, could reach 26.0 Mtoe. A reduction in consumption by the transportation sector of 11.2 Mtoe is projected at 2030. Energy savings at 2030 in other sectors are: in the industrial sector – 10.1 Mtoe and in the other sector around 4.7 Mtoe.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 4.2 percent per year on average from 52.1 Mt C in 2005 to 144.4 Mt C in 2030 in the BAU scenario. Thailand plans to promote the use of primary energy sources which are less carbon intensive, for example, nuclear and renewable fuels.

In the APS, the average annual growth in CO_2 emissions from 2005 to 2030 is projected to be about 3.0 percent, and emissions are projected to rise to 109.3 Mt C in 2030. 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 57).

Figure 57. CO_2 Emissions from Energy Consumption in Thailand, BAU and APS



4. Implications and Policy Recommendations

Due to the economic boom during the period before the crisis in 1997, Thailand's primary energy intensity on average during 1990-2005 was rather high, although the crisis in 1997 held it back a bit. However, it has shown a significant decrease since the economy recovered from the 1997 crisis. Furthermore, with Thailand's effort in energy efficiency programs in a wide range of areas (including industry, transportation and residential sectors), and the dramatic soar in world oil prices, the intensity is expected to

further improve as time goes by.

Thailand has a target to save energy in the transportation sector by reducing the consumption of gasoline and diesel by at least 4-5 percent a year in the near future. This target now also applies to the industry and residential sectors. These sectors will focus on decreasing consumption in electric power and fuel oil mainly.

Improving energy efficiency will also help Thailand (which is an oil importer), to address the challenges faced by rising 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 try to be more self sufficient and more sustainable. Furthermore, Thailand realises that cooperation on energy savings is important and that all countries should respond.

Although Thailand has a 15 year plan, it is important that practical ways for achieving long-term action plans and strategic goals are implemented and to drive conservation policies in the future. Furthermore, policy evaluations should also be undertaken to identify potential areas for improvement. Cooperation among Thai government energy agencies also needs to be improved. Lastly, enhancements to Thailand's energy end-use database should be made. This is useful for improving energy projections and also policy design and evaluation.

Chapter 17

Vietnam Country Report

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This chapter should be cited as
Nguyen, Q. K. and M. B. Nguyen (2009), 'Vietnam Country Report' in Kimura, S. (ed.), *Analysis on Energy Saving Potential in East Asia Region*, ERIA Research Project Report 2008-8-1, Jakarta: ERIA, pp.159-165.

Vietnam

Dr. Nguyen Quoc Khanh
Mr. Nguyen Minh Bao

1. Background

Vietnam lies in the centre of South East Asia. It has a total land area of about 331,111 square kilometres and a population of 83.1 million in 2005. Its gross domestic product (GDP) in 2005 amounted to US$ 44.7 billion in 2000 US$ values. Vietnam's GDP components are: 40.3 percent commercial, 40.1 percent industrial and 19.6 percent agricultural. GDP per capita stood at US$ 538 per person in 2005.

Vietnam possesses a rather good amount of indigenous energy resources. It has 3,390 million tons of proven recoverable reserves of coal, 460 million cubic metres of crude oil and 610 billion cubic metres of gas reserves.

Vietnam's total primary energy supply (TPES) was 27.3 million tons of oil equivalent (Mtoe) in 2005. By fuel, oil accounted the largest share at 45.4 percent, coal was second at 29.8 percent, followed by natural gas (18 percent) and others accounted for the remainder. Vietnam is a net energy exporter of crude oil and coal but is an importer of petroleum products in view of the absence of an oil refinery in the country.

Coal is mainly used in the industry sector with consumption in 2005 of 4.8 Mtoe, whereas gas is mainly used for electricity generation.

Vietnam has 11 gigawatts (GW) of installed generating capacity and generated about 53.5 terawatthours (TWh) of electricity in 2005. The generation amount by energy type is broken down as: thermal (coal, natural gas and oil) at 59.9 percent and hydro (40.1 percent).

2. Modelling Assumptions

In this report, Vietnam's gross domestic product (GDP) is assumed to grow at an average annual growth rate of 8.3 percent from 2005 to 2030. Growth is projected to be stronger from 2005 to 2020 at 8.5 percent per year, tapering off to 8.0 percent per year from 2020-2030. Population growth, on the other hand, is projected to increase by 0.9 percent per annum from 2005 to 2030.

With regards to future electricity supply, the share of electricity from coal fired power plants is projected to increase whereas the share of others is expected to decrease. The use of nuclear energy is projected to start in 2020 in view of Vietnam's recent nuclear power development plan.

Vietnam's energy saving goals can be attained through the implementation of energy

efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from improvements in manufacturing technologies. In the residential and commercial sector, efficient end use technologies and energy management systems are projected to induce significant savings. In the transport sector, efficiency improvements will not only be achieved by improved mileage but also via more effective traffic management.

Although Vietnam has considered the use of biofuels to reduce its dependency on oil and curb CO_2 emissions, there is still no estimate of the amount of biofuels that would be used in the country for the time being.

3. Outlook Results

3.1. Total Final Energy Consumption

Vietnam's final energy consumption experienced a rapid growth of 11.5 percent per annum from 4.2 Mtoe in 1990 to 21.6 Mtoe in 2005. The industrial sector grew the fastest at 11.8 percent per annum followed by the residential/commercial (other) sector at 11.4 percent per annum between 1990 and 2005. The transportation sector was the slowest growing consumer at 11.3 percent per annum over the same period. Oil was the most consumed product having a share of 55.9 percent in total final energy consumption in 1990, slightly decreasing to 53.6 percent in 2005. Coal was the second most consumed product.

Business as Usual (BAU) Scenario

With the projected strong economic growth and population increase, final energy consumption from 2005 to 2030 is projected to increase at an average rate of 8.6 percent per annum. Consumption by the industry sector is projected to grow the fastest with annual growth of 8.9 percent per annum followed by the transportation sector at 8.4 percent per annum over the period 2005-2030. Consumption by the residential/commercial (other) sector is projected to grow at an average annual rate of 8.3 percent over the period 2005-2030.

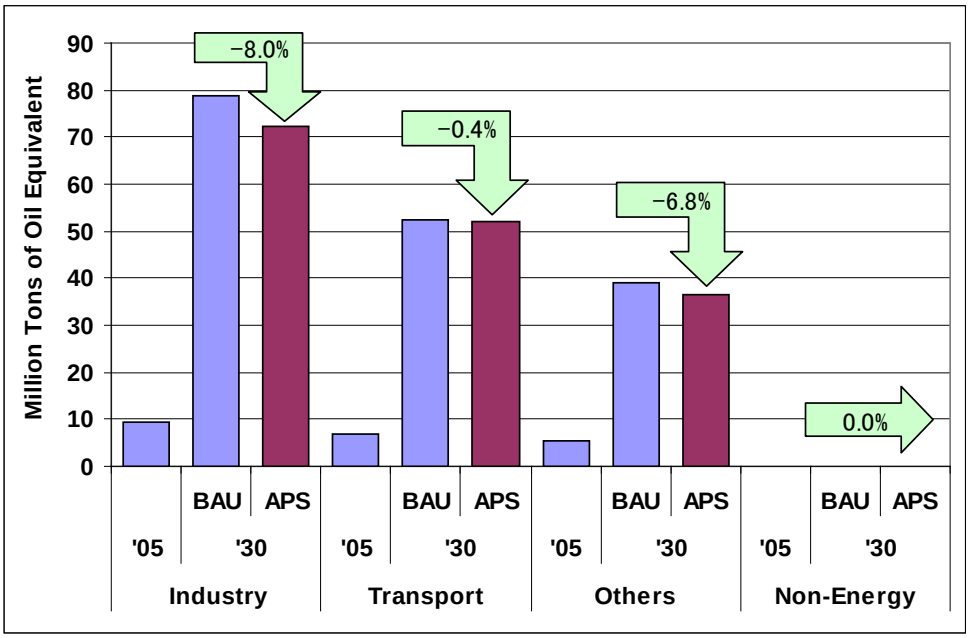
By fuel type, natural gas is projected to grow the fastest at 14.7 percent per annum over the period 2005-30. Electricity is projected to have the second highest growth rate of 8.7 percent per annum over the same period. Consumption of oil and coal are projected to increase at an average annual rate of 8.5 and 8.4 percent, respectively over the period 2005-30.

Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower rate of 8.4 percent per annum from 21.6 Mtoe in 2005 to 161.0 Mtoe in 2030 due to energy efficiency and conservation programs. The decrease in the consumption growth rate is expected to occur across all sectors, particularly in the industrial sector and the

residential/commercial (other) sector due to improvements in end-use technologies and the introduction of energy management systems.

Figure 58. Final Energy Consumption by Sector in Viet Nam, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Vietnam grew at a slower rate than final energy consumption at 11.4 percent per annum from 5.4 Mtoe in 1990 to 27.3 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas, oil and coal. Natural gas consumption grew at an average annual rate of 63.8 percent while coal and oil grew at 9.0 percent and 10.6 percent, respectively per annum over the period 1990-2005. Hydro energy had a respectable growth rate of 9.7 percent per annum during the period but its share in total primary energy demand remained small at 6.8 percent in 2005.

Business as Usual Scenario

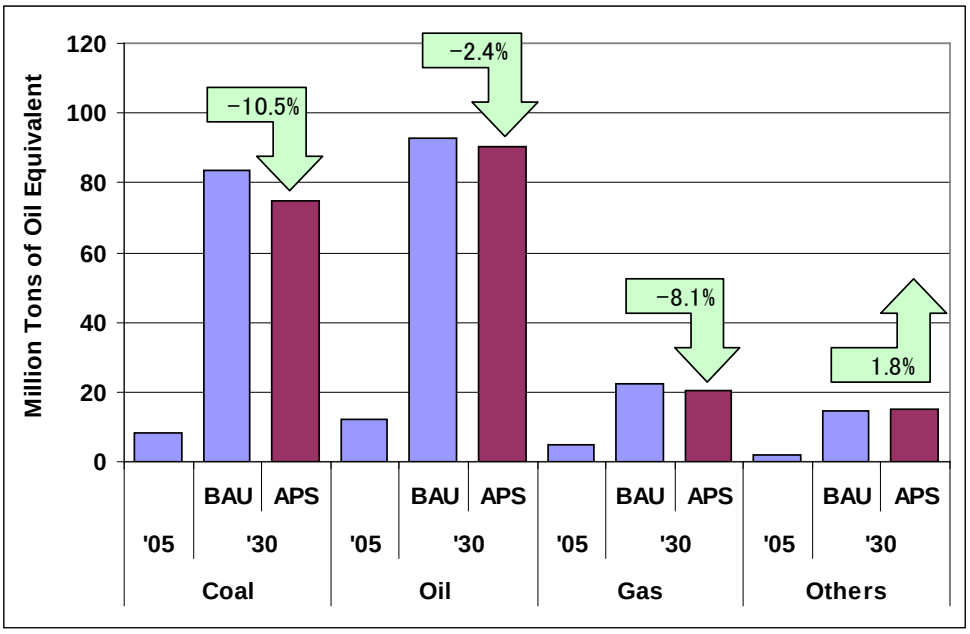
In the BAU scenario, Vietnam's primary energy demand is projected to increase at an annual rate of 8.6 percent over the period 2005-30 to 213.3 Mtoe in 2030. Coal is expected to grow the fastest at an annual average rate of 9.8 percent followed by oil and natural gas at 8.4 percent and 6.2 percent, respectively over the period 2005-30. The share of coal is projected to increase from 29.8 percent to 39.3 percent over the period 2005-30 whereas the shares of oil and natural gas are projected to decrease from 45.4 percent to 43.4 percent and from 18.0 percent to 10.4 percent, respectively over the period 2005-30.

Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate of 8.3

percent per annum over the period 2005-30 to 200.8 Mtoe in 2030 (Figure 59). Coal, oil and natural gas are projected to grow at an average annual rate of 9.3 percent, 8.3 percent and 5.9 percent, respectively over the period 2005-30. These decreases in growth rates relative to the BAU scenario are mainly due to energy efficiency and conservation measures on the demand side.

Figure 59. Primary Energy Demand by Source in Viet Nam, BAU and APS

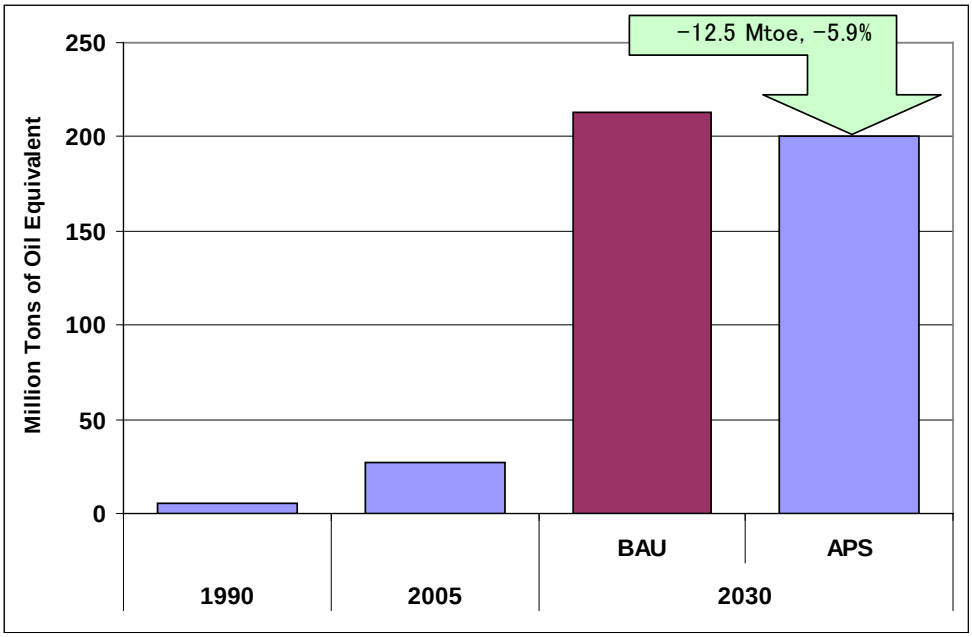


3.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Vietnam are 12.5 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS at 2030. This is equivalent to a 5.9 percent reduction of the projected consumption in the BAU scenario in 2030 (Figure 60).

In terms of savings in final energy consumption, there is an estimated saving of 6.3 Mtoe in the industry sector, 2.6 Mtoe in the residential/commercial (other) sector and 0.2 Mtoe in the transportation sector at 2030 in the APS, relative to the BAU scenario.

Figure 60. Total Primary Energy Demand in Viet Nam, BAU and APS

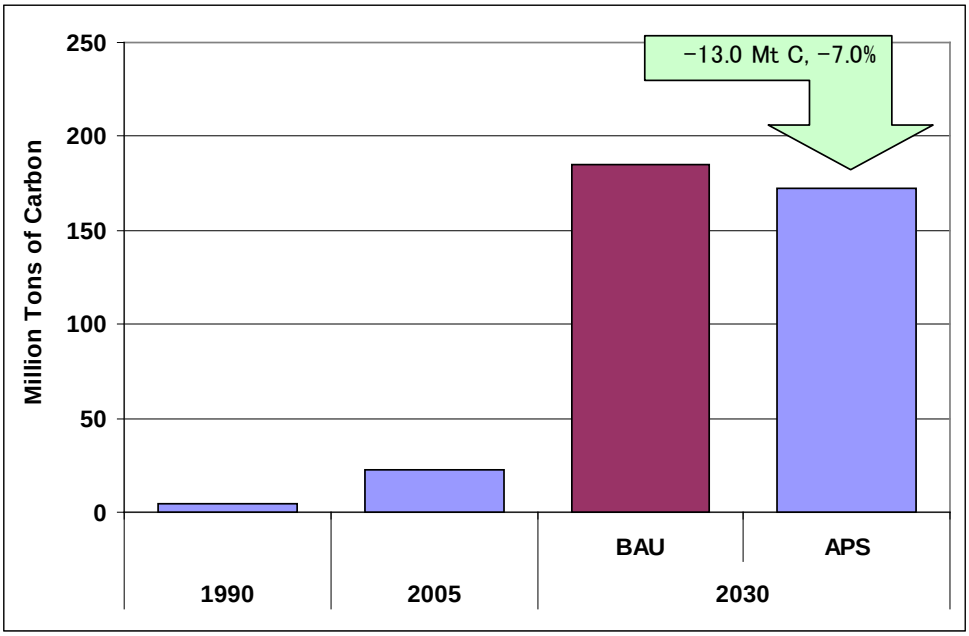


3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 8.7 percent per annum from 22.9 Mt C in 2005 to 185.1 Mt C in 2030 in the BAU scenario. This percentage increase is higher than the percentage increase in primary energy demand reflecting the expected use of more-carbon intensive fuels in Vietnam.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 8.4 percent. This rate is also higher than the average annual growth rate in primary energy demand of 8.3 percent over the same period. However, the reduction in the growth rate of CO_2 between the APS and the BAU scenario indicates that the energy saving goals and action plans of Vietnam are very effective in reducing CO_2 emissions (Figure 61).

Figure 61. CO_2 Emissions from Energy Consumption in Viet Nam, BAU and APS



4. Implications and Policy Recommendations

Vietnam's primary energy intensity is amongst the highest in the world. This is due to a low energy technology base on both the supply side and demand side. Therefore, it is important that Vietnam implements energy conservation measures. By doing this, Vietnam will reduce its energy consumption and thus delay the time when Vietnam is expected to become a net energy importer.

The energy savings that could be derived from the EEC goals of Vietnam are 12.5 Mtoe, equivalent to a 5.9 percent reduction in Vietnam's consumption in 2030. It is expected these goals would be attained through the implementation of energy efficiency programs mainly in the industry sector and in the residential/commercial (other) sector. For the industry sector, energy savings are expected from improvements in manufacturing technologies. In the residential and commercial sector, efficient end use technologies and energy management systems are projected to induce significant savings.

To be able to implement these energy efficiency programs and thus attain the EEC goals, the following measures are recommended:

- **Collection of end-use energy consumption data**: The absence of detailed end-use energy consumption data can severely limit the design and monitoring of effective energy saving programs. Therefore, it is proposed that a comprehensive end-use energy consumption data collection campaign be carried out. To be able to do this on a regular basis, a data acquisition system should be created and the present data acquisition system of the General Statistics Office of Vietnam which is collecting socio-economic data could be expanded for this function.
- **Restructuring of the economy**: Restructuring of the economy toward less

emissions intensive industries can contribute to reducing energy consumption at the economy wide level.

- **Energy saving potential in the transport sector**. Transportation is one of the largest energy consumers in Vietnam. However, the potential for energy savings in this sector is not yet well evaluated in the present action plan, possibly due to a lack of data. It is expected that efficiency improvements in the transport sector will not only be achieved through improved mileage but also through more effective traffic management.
- **Awareness raising campaigns**: Saving measures range from no-cost, low cost to high investment cost solutions. Therefore, it is important that no-cost and low cost measures be focused on first – these might be promoted through information campaigns.
- **Gradual removal of subsidized energy prices:** Low energy prices especially in energy intensive industries (cement, fertilizer, pulp and paper**)** do not encourage energy efficiency.
- **Programs for large consumers:** Large consumers are obliged to report energy consumption to the Office of EEC on an annual basis. These consumers, on the other hand, need support measures to implement EEC measures. Support measures include training, financial assistance, etc.
- **Promotion of ESCO:** Energy Service Company (ESCO) provides energy auditing services, provides consultancy on the financial aspects of EEC projects, and implements EEC projects for industrial enterprises and commercial buildings in some cases is as an investor. Thus, ESCO act as an implementer of EEC policies and to some extent determines the success of an EEC action plan, and thus should be encouraged.
- **Tax and duty removal:** Along with the above instruments, duties and taxes for EEC equipment and appliances should be adjusted. Relatively high import duties and other taxes can limit the potential for commercially viable, market driven EEC programs.
- **Promotion of Renewable energies.** Along with measures on the demand side, attention should be paid to the supply side. The technologies used in existing power plants especially coal fired power plants in Vietnam are relatively inefficient and should be improved and upgraded. Along with that, attention should also be focused on renewable energy as Vietnam possesses good potential for renewable energy.
- **Energy indicators to monitor implementation of action plan**: These would help evaluate the performance of EEC programs and thus are an important component when formulating follow-up activities.
- **Cooperation with countries with success in EEC**: Being a late adopter in some energy efficient technologies and measures, Vietnam should increase efforts to introduce improved technologies and efficient energy management models. In this regard, it is recommended that Vietnam learn from the experiences of other countries such as Japan and Thailand. Such cooperation could contribute to the formulation and implementation of a master plan on EEC or a concrete EEC project.