II. Individual Country Reports

Individual Country Reports

Country Report 1

Australia Country Report

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Australia

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 2008). Australia is overwhelmingly a net energy exporter, with trade in energy dominated by coal, liquefied natural gas (LNG) and uranium. Australia is the largest exporter of coal and since the late 1980s has emerged as one of the largest exporters of LNG. However, Australia is a net importer of liquid fuels, including crude oil and other refinery feedstocks and refined petroleum products, such as gasoline, diesel and fuel oil (ABARE 2008).

As of January 2006 Australia has demonstrated economic resources of around 77 Gt (gigatonnes) of coal, 644 GL (gigalitres) of crude oil, condensate and liquefied petroleum gas (LPG), 2,429 BCM (billion cubic metres) of natural gas and 714 kt (kilotonnes) of uranium (ABARE 2008).

In 2005 Australia's primary energy demand was around 122 Mtoe (million tonnes 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.

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

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 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.

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 (as details were not available at the time of the modelling) the Australian Government is also committed to: reducing Australia's greenhouse gas emissions by 60 percent of 2000 levels by 2050; implementing a comprehensive emissions trading scheme by 2010 and increasing the proportion of renewable energy to 20 percent of national electricity supply 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.

3.1.1. 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.

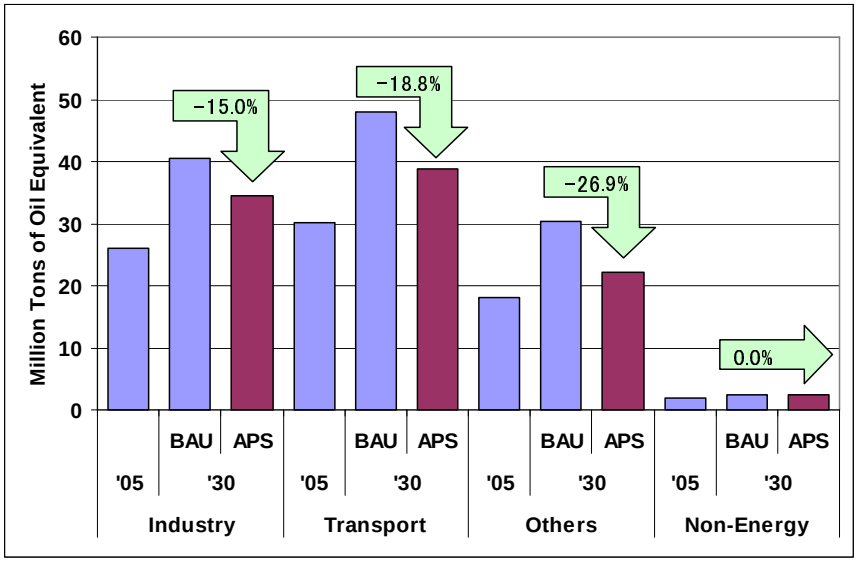
3.1.2. Alternative Policy Scenario (APS)

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, 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.

3.2.1. Business-as-Usual (BAU) Scenario

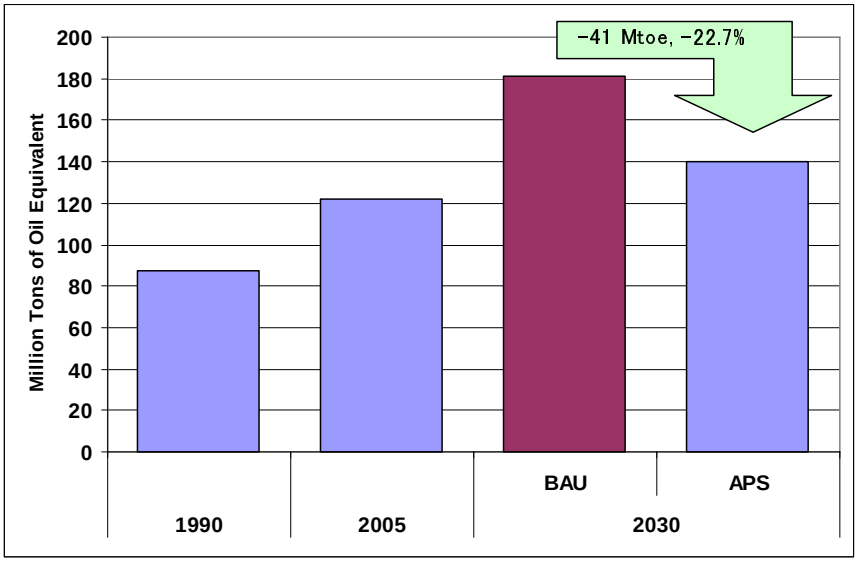
In the BAU scenario Australia's primary energy demand is projected to increase at an average annual rate of about 1.6 percent increasing from about 122 Mtoe in 2005 to about 181 Mtoe in 2030 (Figure 2).

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.

Figure 2: Primary Energy Demand to 2030, BAU and APS



3.2.2. 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

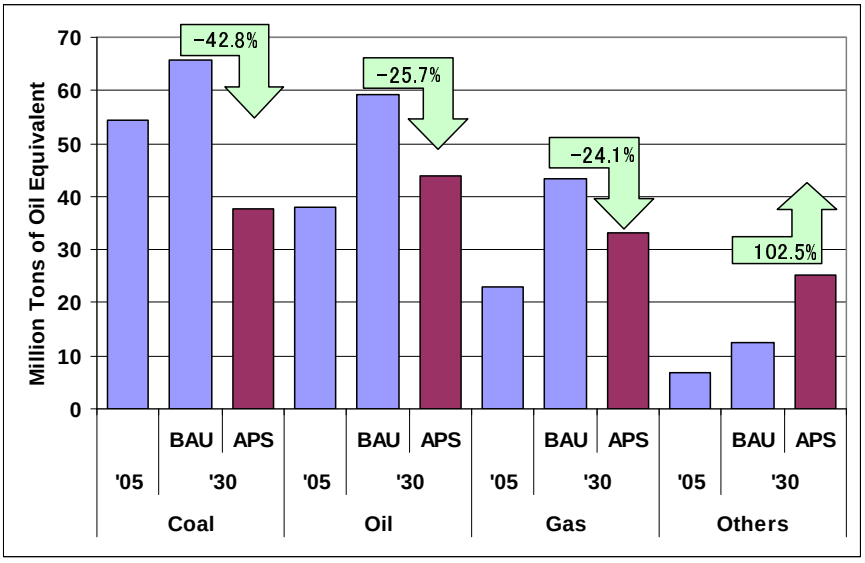
the period 2005-2030.

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 3).

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.

Figure 3: Primary Energy Demand in Australia by Source, BAU and APS



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

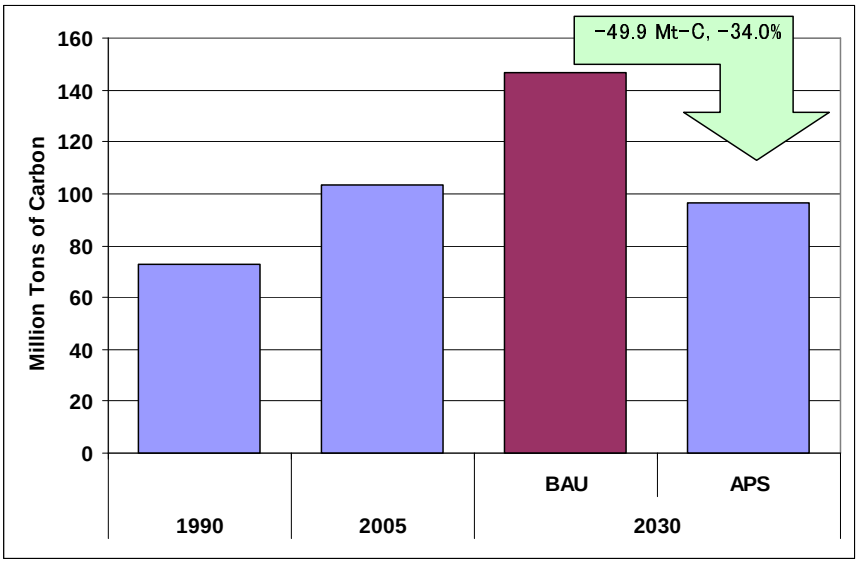
As a result of the enhanced deployment of more energy efficient technologies across the economy, primary energy demand in Australia in 2030 is projected to be reduced by about 41 Mtoe or 23 percent in the APS, relative to the BAU scenario. The projected reductions in energy consumption by fuel in the 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.

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.

Figure 4: CO_2 Emissions from Energy Consumption, 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 2010 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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Matysek, A. Ford, M., Jakeman, G., Gurney, A. and Fisher, B.S. (2006) *Technology: Its role in economic development and climate change*, Prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra, July.

Country Report 2

Brunei Darussalam Country Report

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March 2008

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Brunei Darussalam

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 products (GDP) per capita in the region of about US$13,139 for the same year. Brunei's GDP in 2005 was about US$4.9 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 inland 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 0.8 Mtoe[2]. Transport was the largest energy consuming sector accounting for about 0.4 Mtoe of final energy consumption.

Brunei's total primary energy demand in 2005 was about 2.6 Mtoe. Oil and natural gas are the only forms of primary energy used in Brunei. The share of natural gas is about 70 percent while oil contributes about 30 percent. Natural gas is mainly used for generating electricity and town gas whereas oil is used primarily for petroleum products.

Brunei generated about 2,913 GWh of electricity in 2005, using a total installed generating capacity of about 690.5 MW. About 99 percent of the electricity in Brunei is generated by natural gas, while oil (diesel) supplies the remainder.

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

2. Modelling Assumptions

Brunei's assumptions about future GDP growth were developed by the Institute of Energy Economics, Japan (IEEJ). GDP in Brunei is assumed to increase at an average annual rate of 3.8 percent from 2005 to 2030. Growth in GDP between 2005 and 2010 is assumed to average about 4.2 percent per year, before declining to 3.8 percent per year and 3.5 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 1.6 percent from 2005 to 2030.

The share of natural gas and oil is projected to remain fairly constant throughout the projection period.

Brunei currently has a range of energy efficiency and conservation programmes in place, with a key focus on raising awareness through campaigns, publications, media and other means. Brunei's energy saving goals and plans are being finalised. In anticipation of the completion of these energy saving goals and plans, outlook results for Brunei in this document (as of 2007) are based on one scenario. That is, there is assumed to be no change in energy consumption or the corresponding fuel mix between the BAU scenario and the APS.

3. Outlook Results

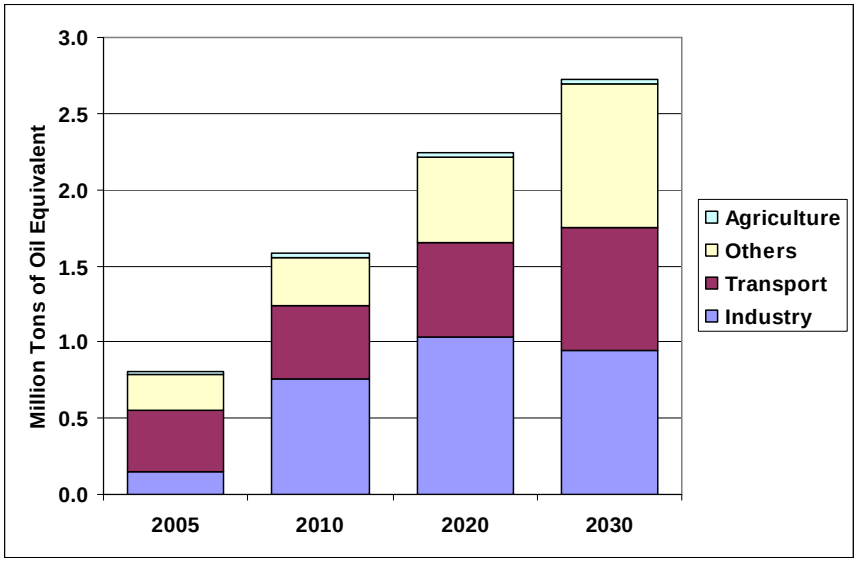
3.1. Total Final Energy Consumption

Total final energy consumption in Brunei increased at an average annual rate of 4.4 percent from 0.4 Mtoe in 1990 to 0.8 Mtoe in 2005. From 1990 to 2005, the residential/commercial (other) sector had the highest growth rate of 7.2 percent per year followed by the transportation sector with 3.9 percent per year and the industrial sector with 2.5 percent per year. The transportation sector was the largest energy consuming sector accounting for about 53.5 percent of final energy consumption in 1990. There

was a slight decrease in its share to 50.2 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.

From 2005 to 2030, Brunei's total final energy consumption is projected to grow at an average rate of 5.0 percent per year driven in part by the assumed growth in GDP and population. There is projected to be a significant increase in energy demands in the residential/commercial (other) sector with a projected 5.7 percent growth rate per year from 2005 to 2030. Emerging industrial activities are expected to drive a 7.7 percent growth per year from 2005 to 2030 in the industry sector (Figure 5). In should be noted, as mentioned and explained earlier, that the projections for both the BAU and APS are the same.

Figure 5: Final Energy Consumption Outlook, BAU=APS, 2005 and 2030



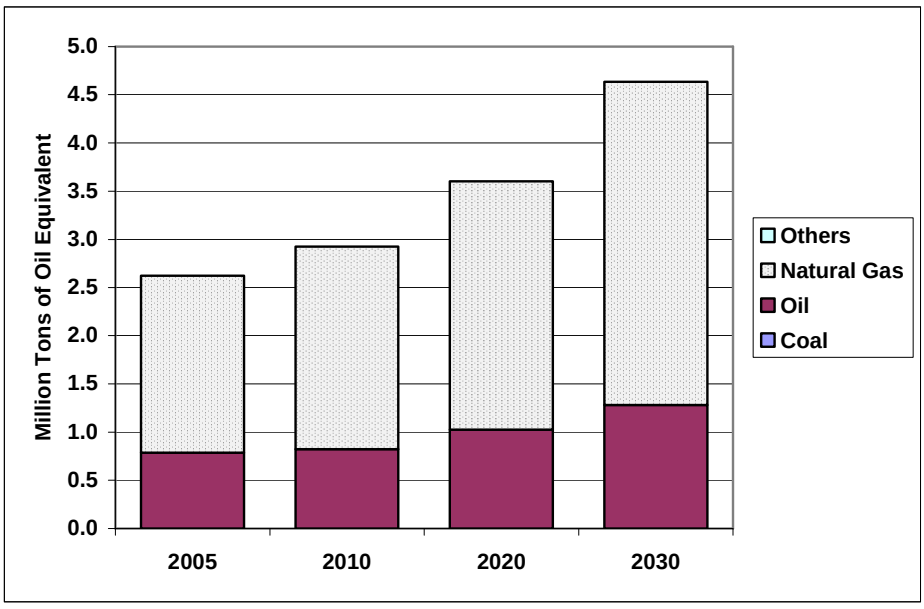
In final energy consumption, oil and electricity are projected to grow at an average annual rate of 2.8 percent and 5.9 percent respectively. The final consumption of natural gas in the industrial sector is projected to emerge from about 2010 and remain fairly flat throughout the projection period.

3.2. Primary Energy Demand

Primary energy demand in Brunei grew at an average annual rate of about 2.5 percent from about 1.8 Mtoe in 1990 to 2.6 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 93.2 percent in 1990 before falling to 70.1 percent in 2005. However, oil consumption increased at a fast growth rate of 13.2 percent per year from 1990 to 2005.

From 2005 to 2030, oil and natural gas are projected to remain as Brunei's only primary energy sources. Primary energy demand is projected to increase to 4.6 Mtoe in 2030 at an average growth rate of 2.3 percent per year between 2005 and 2030. Oil consumption is projected to grow at a slower rate of about two percent per year while natural gas consumption is projected to grow on average at 2.4 percent per year from 2005 to 2030. The share of oil in primary energy demand is also expected to decline from 29.9 percent in 2005 to 27.6 percent in 2030 as a result of the increase in natural gas consumption during this period (Figure 6).

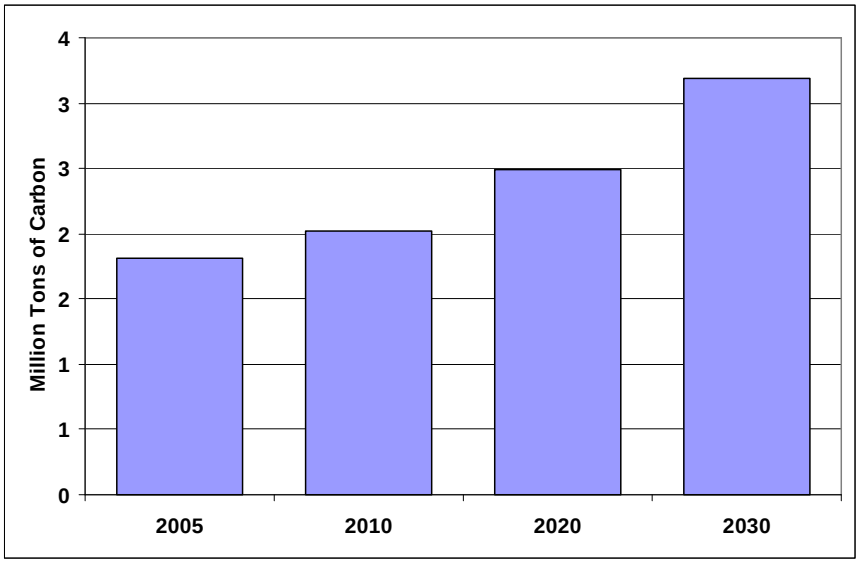
Figure 6: Primary Energy Demand in Brunei



3.3. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 2.3 percent per annum from 1.8 Mt-C in 2005 to 3.2 Mt-C in 2030 in the BAU scenario. (Figure 7)

Figure 7: Evolution of CO_2 Emissions in Brunei



4. Implications and Policy Recommendations

Energy consumption has increased significantly since 1980 and as projected, energy demand will continue to grow. Given this trend and the dominance of oil and gas in the energy mix, Brunei is currently adopting energy efficiency and conservation (EEC) as an important tool and of top priority in pursuit of energy security. Nation-wide awareness campaign on EEC will be the initial driver to jumpstart this effort.

Apart from that, Brunei also has other EEC programmes in the pipeline focusing on demand side management such as improving EEC technologies through auditing, labelling, and best practices. In principle, Brunei is actively promoting and implementing improvement of EEC in all sectors. Another crucial step being taken in improving EEC is that Brunei is currently formulating its energy saving goals and plans which will contribute to a reduction in energy consumption.

In moving forward, Brunei needs to implement its prospective energy saving goals in order to meet the targeted reduction, or the optimum reduction in energy consumption.

Country Report 3

Cambodia Country Report

Edito Barcelona
The Energy Data and Modelling Unit, The Institute of Energy Economics, Japan

March 2008

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Cambodia

Cambodia

Mr. Edito Barcelona

1. Background

Cambodia is the third smallest country in Southeast Asia with a land area of 177 thousand square kilometres[3]. 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. Its population in 2005 was estimated at 14 million. The gross domestic product (GDP) in 2005 is about US$ 5.7 billion at 2000 constant prices with a substantial agriculture share of 34 percent[4].

Cambodia's conventional primary energy demand in 2005 stood at 1.2 Mtoe while its final energy consumption stood at 1.1 Mtoe[5]. It is dependent on imports of petroleum products having no crude oil production as well as oil refining facilities. It electricity supply is also dominated by oil at 91.5 percent with the remaining filled-up by hydro.

Cambodia has a 10 GW potential for hydropower with only 20 MW of installed capacity to date. It also possesses coal resources but exploration of the whole country is not yet complete although some explored sites were proven to have commercial quantities.

2. Modelling Assumptions

In forecasting energy demand to 2030, it is assumed that the GDP of Cambodia will grow at an annual rate of 7.0 percent. Its population on the other hand is projected to grow at 1.5 percent per annum resulting to a growth rate of GDP per capita of 5.4 percent per year.

[3] World Bank, 2007, World Development Indicators 2007.
[4] Ibid.
[5] International Energy Agency, 2007, Energy Balances of Non-OECD Countries 2007.

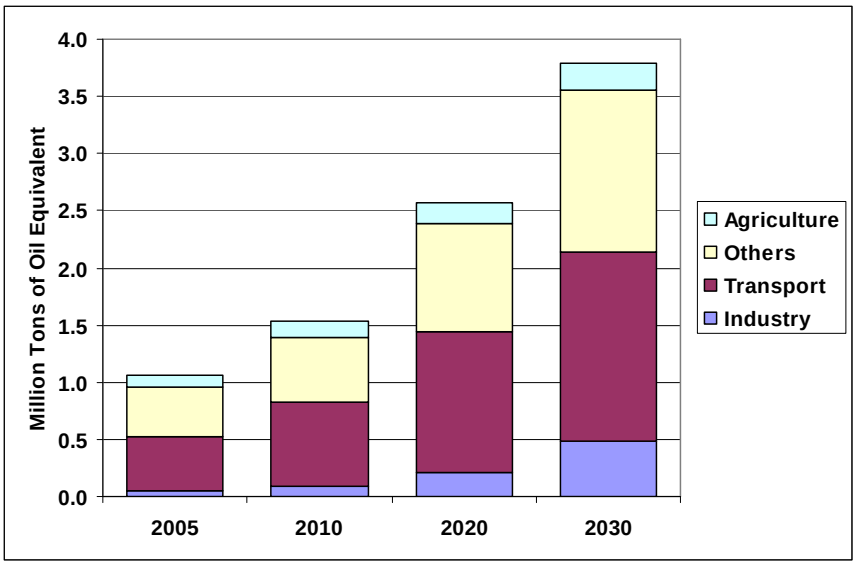
In regard to future electricity supply, Cambodia is expected to make use of its coal and hydro resources but will continue to rely on oil to serve demands in remote communities. As to energy savings potential, Cambodia has not yet quantified the energy savings that would be induced by its current energy efficiency and conservation programs. In this regard, this outlook will only be able to forecast energy demand in the Business-as-Usual (BAU) scenario.

3. Outlook Results

3.1. Total Final Energy Consumption

Cambodia's final energy consumption grew at an average annual rate of 10.9 percent from 1995 to 2005. This growth is driven by the industrial sector which grew at a rapid rate of 33.5 percent during the ten-year period. The other sector which comprises the residential and commercial sectors grew at 16.9 percent annually while the transportation sector has a modest annual growth of 5.1 percent. In terms of energy, petroleum products comprise more than 90 percent of the total final consumption with electricity as the only other fuel used.

Figure 8: Final Energy Consumption from 2005 to 2030

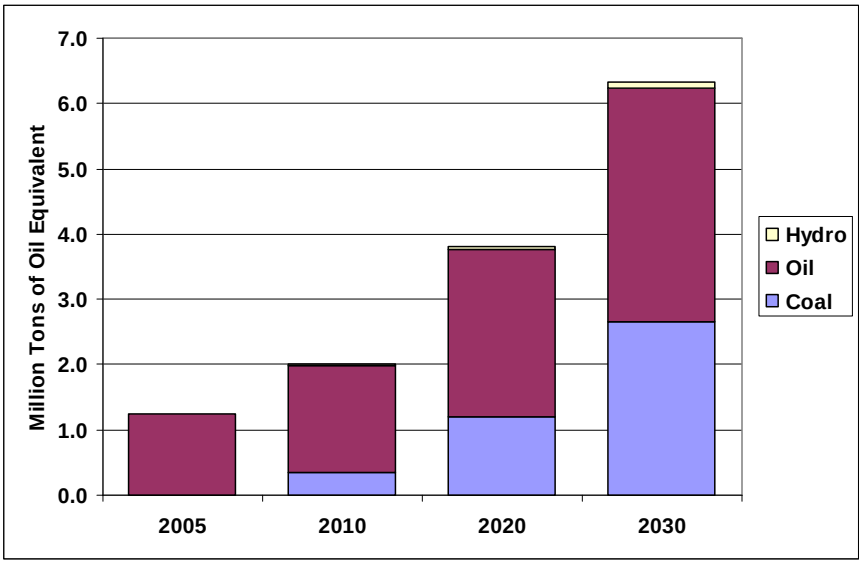


From 2005 to 2030, Cambodia's final energy consumption will grow at an average annual rate of 5.2 percent (Figure 8). The industrial sector will post the highest growth rate of 9.2 percent per annum followed by the transportation sector at 5.2 percent and the residential/commercial sector at 4.9 percent. Electricity demand will post an average annual growth rate of 11.0 percent while demand for petroleum products will grow by 4.2 percent.

3.2 Primary Energy Demand

Cambodia's primary energy demand grew at an average annual rate of 9.9 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 0.7 percent to the total primary energy demand.

Figure 9: Primary Energy Demand from 2005 to 2030



From 2005 to 2030, the country's primary energy demand will grew at an average annual rate of 6.7 percent. In view of the rapid growth in electricity demand of 11 percent annually, hydroelectricity production will increase by 9.7 percent per annum. In addition, coal power plants will be built in the country to meet the growing electricity demand especially in its developing industrial sector. Coal will start to figure in the

primary energy demand mix starting in 2010 with a share of 17 percent and increasing to 42 percent in 2030. (Figure 9)

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. This study was therefore not able to generate energy demand forecast for the APS. Hence, no energy savings potential was estimated.

Cambodia's energy efficiency and conservation program 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 a more efficient energy use, increased access to energy efficiency projects financing and the establishment of energy efficiency regulatory framework.

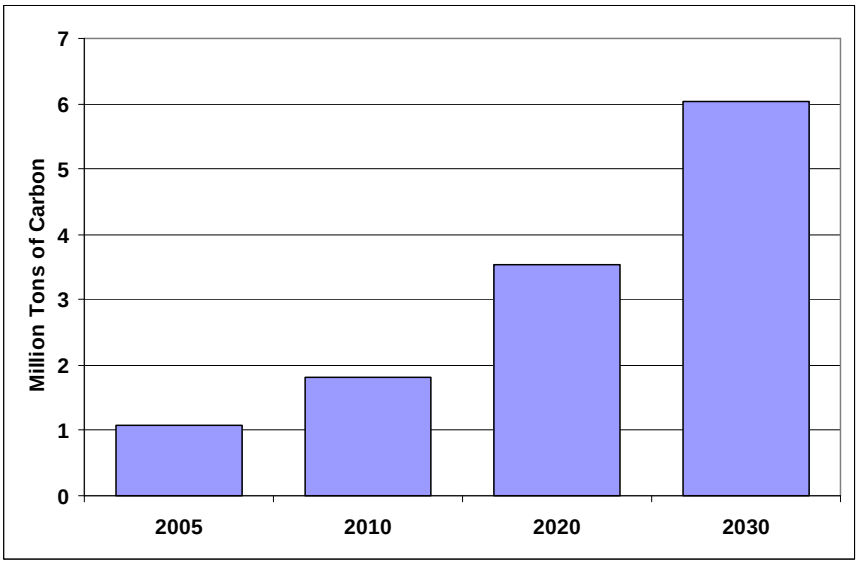
As a start, Cambodia is implementing the following pilot projects:

- Improving the efficiency of the overall supply chain for home lighting in rural areas by the provision of decentralized rural energy service through 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 organization 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 1.1 Mt-C in 2005 to 6.0 Mt-C in 2030 at an average annual growth rate of 7.2 percent. This growth rate is higher than that of the primary energy demand in view of the introduction of coal, which is a carbon-rich fuel, in the primary energy mix by 2010. (Figure 10)

Figure 10: CO_2 Emissions in Cambodia from 2005 to 2030



Country Report 4

China Country Report

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China

China

Ms. Cecilya Laksmiwati Malik

1. Background

China is the largest populated country in the world. It has a population of 1.1 billion in 1990 and reached 1.3 billion in 2005. This is an average annual growth rate of 0.9 percent over these past 15 years. From 2005 onward, the population is expected not to increase as fast as before due to the implication of their one child per family policy. China's population will increase at an average annual growth rate of 0.4 percent reaching 1.45 billion people by 2030.

China's economy has been growing at an average annual growth rate of 10.1 percent over the last 15 years; i.e. from 445 billions of 2000 US$ in 1990 to almost 1890 billions of 2000 US$ in 2005. For the future, the GDP growth rate is expected to slow down and has been assumed to grow at an average growth rate of 6.2 percent per annum reaching 8594 billions of 2000 US$ by 2030. Given the GDP and population evolution, the GDP per capita of China will improve from 1400 USD per person in 2005 to almost 6000 US$ per person in 2030.

In terms of energy resources, China is endowed with oil, gas and coal resources and hydro potential of 676 GW. .For coal resources, it has recoverable reserves of 114.5 billion tones and China's extensive use of coal domestically has raised concern to the region's environmental impacts.

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 plays a major role in the primary energy mix, but at a lower share of 73 percent. The shares 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 started to have a 1 percent

share in the total primary energy mix of China. Overall, the primary energy demand of China increased at an average annual growth rate of 5.6 percent from 663 Mtoe in 1990 to 1494 Mtoe in 2005. Comparing the primary energy demand and GDP of China, it showed that the energy intensity (primary energy demand per unit of GDP) decreased from 1491 toe/million 2000 US$ to 790 toe/million 2000 US$

The final energy consumption of China increased at a lower annual growth rate of 4.5 percent from 463 Mtoe in 1990 to 890 Mtoe in 2005. Most of the fuel consumed by the final sector was coal amounting to 68 percent in 1990 and 42 percent in 2005. Oil consumption amounted only 18 percent of the total final energy demand of China, but it has since increased rapidly at 8.2 percent per annum making the share to increase to 30.4 percent in 2005. Electricity is also becoming important for China as it share increased from 9 percent in 1990 to 19 percent in 2005. This is due to its rapid annual growth rate of 8.9 percent, faster than any of the other fuels consumed by the final consumption sectors. The remaining fuels, natural gas and heat, constituted less than 5 percent of the total final energy consumption and have been growing at a fast rate of 8.2 percent per annum over the 1990-2005 period.

By sector, industry is the major energy-consuming sector of China followed by the residential/commercial (Other) sector. The share of industry's consumption in the total final energy consumption has increased from 56 percent in 1990 to 58 percent in 2005. The shares of the 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 the faster growth of industry and by the transport, which grew at 7.8 percent per annum.

In China, power generation from coal accounted for around 71.3 percent of total generation in 1990 and had increase to 79 percent in 2005. Hydro share in the total generation mix is around 20.4 percent in 1990 and reduced to almost 16 percent in 2005. The remaining sources, gas and oil, together constituted less than 10 percent of the total generation. For 2005, oil shares in total generation declined since nuclear power plant has started to be in operation.

2. Outlook Results

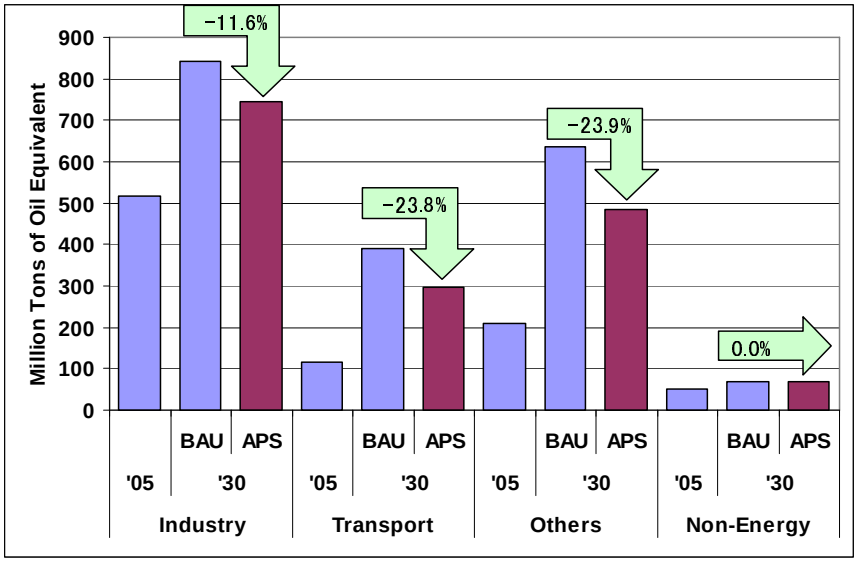
2.1. Total Final Energy Consumption

China's final energy consumption is still expected to continue growing but at a slower rate than the previous 15 years since GDP and population will also be experiencing slower growth rate in the future.

2.1.1. Business-as-Usual (BAU) Scenario

The final energy consumption from 2005 to 2030 is projected to increase at an average rate of 3.2 percent per annum. The consumption of the transportation sector is projected to grow the fastest with annual growth rate of 5.0 percent followed by the residential/commercial sector at 4.6 percent over the period 2005-2030. The consumption of the industry sector is projected to grow at an average annual rate of 2.0 percent over the period 2005-2030 (Figure 11).

Figure 11: Final Energy Consumption in 2005 and 2030, BAU vs. APS



By fuel type, natural gas is projected to grow the fastest at 7.3 percent per annum over

the period 2005-2030. Oil is projected to have the second highest growth rate of 4.0 percent per annum over the same period. Consumption of electricity and coal are projected to increase at an average annual rate of 4.0 and 0.6 percent, respectively over the period 2005-2030.

2.1.2. Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a slower rate of 2.4 percent per annum from 890 Mtoe in 2005 to 1596 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 transportation sector due to improvement in end-use technologies and the introduction of energy management systems. For coal, the consumption is not even expected to increase, but will decline at an average rate of 0.2 percent per annum, reducing its share in the total primary energy mix in 2030.

2.2. Primary Energy Demand

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

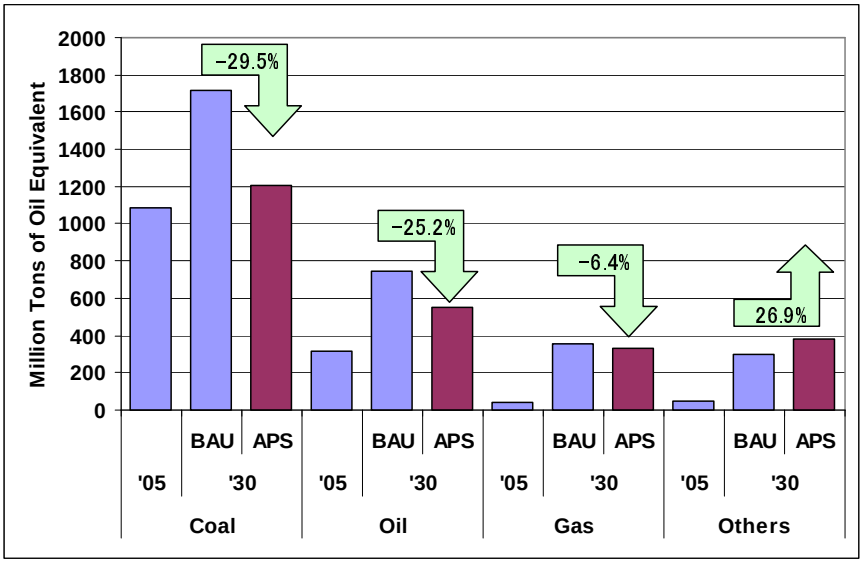
2.2.1. Business-as-Usual (BAU) Scenario

In the BAU scenario, China's primary energy demand is projected to increase at an annual rate of 3.0 percent per annum to 3,110 Mtoe in 2030. Coal will still constitute the largest share in the total primary energy mix of China, but is expected to grow the slowest than the other fuels at an annual average rate of 1.8 percent. Consequently, the share of coal in total primary energy mix will decrease from 73 percent in 2005 to almost 55 percent in 2030.

Natural gas is expected to increase the fastest over the 2005-2030 period at an annual

average rate of 9.1 percent followed by nuclear at 7.8 percent. Oil and hydro will grow at a slower rate of 3.4 and 3.3 percent per annum respectively over the period 2005-2030. The shares of these energy sources will be increasing over the 2005-2030 period. For natural gas the share is projected to increase from 2.7 percent to 11.4 percent over the period 2005-2030 whereas the share of nuclear will increase from 0.9 percent to 2.9 percent. The shares of oil and hydro are projected to increase from 21.3 percent to 23.8 percent and from 2.3 percent to 2.4 percent, respectively over the period 2005-2030.

Figure 12: Primary energy demand in 2005 and 2030, BAU vs. APS



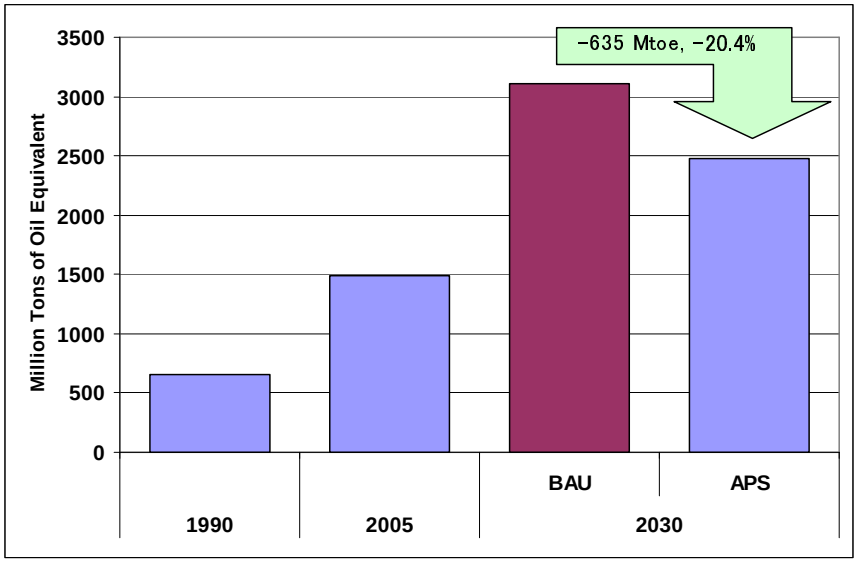
2.2.2. Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate of 2.1 percent per annum to 2475 Mtoe in 2030. Coal, oil and gas demand are projected to continue increasing over the 2005-30 period but at a slower rate than the BAU (Figure 12). These energy sources are projected to grow at an annual average rate of 0.4 percent (coal), 2.2 percent (oil) and 8.8 percent (natural gas). These decreases in consumption rates, relative to the BAU scenario, are mainly due to energy efficiency and conservation measures in the demand side. For nuclear the annual average growth rate will be higher than the BAU at 9.3 percent while for hydro, the growth remains the same.

2.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of China are 635 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 20 percent of China's consumption in 2030 (Figure 13).

Figure 13: Evolution of Primary energy demand



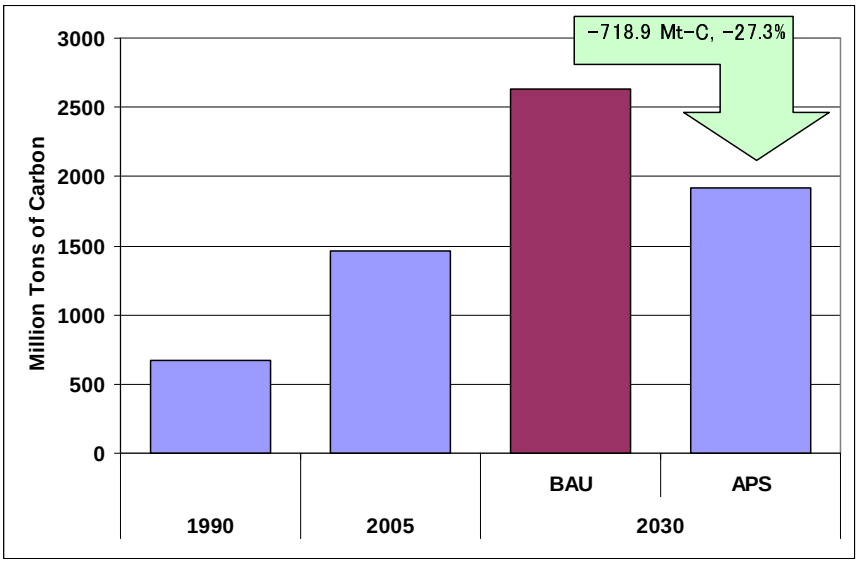
In terms of savings in final energy consumption, there is an estimated saving of 96 Mtoe in the industry sector, 93 Mtoe in the transportation sector and 152 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

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 1467 Mt-C in 2005 to 2633 Mt-C in 2030 in the BAU scenario. This percentage increase is lower than the percentage increase in primary energy demand of 3.0 percent per annum.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 1.1 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 is effective in reducing CO_2 emissions (Figure 14).

Figure 14: Evolution of CO_2 Emissions in China



Country Report 5

India Country Report

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March 2008

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India

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 has a population of 849.5 million in 1990 and has since been increasing at an average rate of 1.7 percent per annum reaching 1094.6 million in 2005. Its GDP in 2005 amounted to 654.8 billion in 2000 US$ while in 1990 it was only 273.9 billion in 2000 US$. So, India's GDP has been growing at an annual average rate of 6 percent over the period of 1990-2005. India's GDP components are 55 percent services, 27 percent industrial and 18 percent agricultural. GDP per capita stood at 600 US$ per person in 2005 while in 1990 it was only 200 US$ per person.

India's total primary energy demand was 379 Mtoe in 2005. The demand has grown at an average rate of 4.8 percent per annum since 1990. By fuel, coal represented the largest share at 54.8 percent, followed by oil at 33.9 percent. The remaining shares were: natural gas (7.6 percent), hydro (2.3 percent), nuclear (1.3 percent) and others (0.2 percent). Compared to 1990, the share of coal had been lower. Similarly, hydro share also declined from 3.3 percent in 1990. These reductions in the share of coal and hydro had been contributed by the rapid increase of natural gas and nuclear energy; 7.4 percent per annum and 7.2 percent per annum, respectively. Coal is mainly consumed for power generation and industry.

India's generated almost 700 TWh of electricity in 2005. The annual average growth rate of electricity production has been growing at almost the same rate of GDP (6 percent) over the period 1990-2005. The share of generation from coal in 2005 amounted to 68.7 percent while the remaining are those of 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 outlook, India's gross domestic product (GDP) is assumed to grow at an average annual growth 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 share of electricity from natural gas fired and nuclear power plants are projected to increase whereas the shares of coal, oil, hydro and others are expected to decrease. Natural gas share in total generation of electricity will doubled from its share in 2005, which was 8.9 percent.

India's energy saving goals would 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 the 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 in more effective traffic management.

3. Outlook Results

3.1. Total Final Energy Consumption

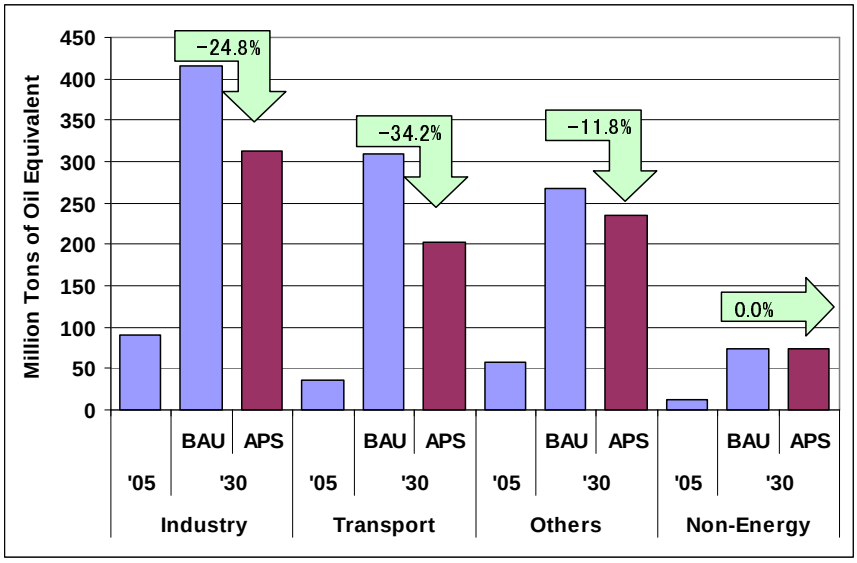
India's final energy consumption experienced a growth of 3.6 percent per annum from 117 Mtoe in 1990 to 199 Mtoe in 2005. The transport sector grew at 4.1 percent per annum followed by the residential/commercial (other) sector at 4.0 percent per annum between 1990 and 2005. The industrial sector was 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, and increasing to 53.4 percent in 2005. Coal was the second most consumed product at 35.4 percent of the total final energy consumption in 1990 but decreased to 18.9 percent in 2005. Electricity share, which was 15.6 percent in 1990 increased to 20.6 percent in 2005. Similarly, natural gas share also experienced an increase from 4.8 percent in 1990 to 7.0 percent in 2005.

3.1.1. 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 6.9 percent per annum from 199 Mtoe in 2005 to 1,065 Mtoe in 2030. The consumption of the transportation sector is projected to grow the fastest with annual growth of 8.8 percent per annum followed by the industry and the residential/commercial (other) sector, both at 6.3 percent per annum over the period 2005-2030 (Figure 15).

Figure 15: Final Energy Consumption in 2005 and 2030, BAU vs. APS



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 7.1

percent per annum over the same period. Consumption of natural gas and coal are projected to increase at an average annual rate of 6.1 and 6.0 percent, respectively over the period 2005-2030.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower rate of 5.8 percent per annum from 199 Mtoe in 2005 to 825 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 the transportation sectors due to improvement in end-use technologies and the introduction of energy management systems.

3.2. 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. Others energy resource 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.

3.2.1. Business-as-Usual (BAU) Scenario

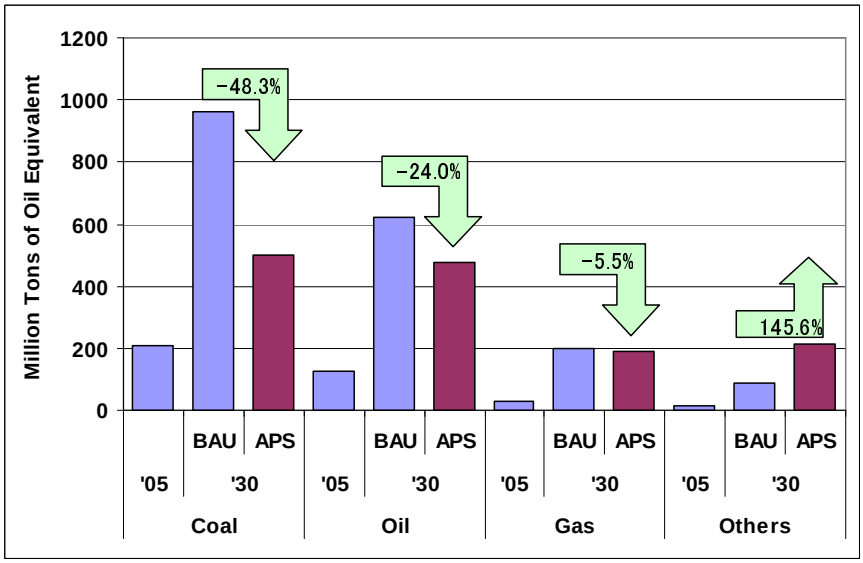
In the BAU scenario, India’s primary energy demand is projected to increase at an annual rate of 6.6 percent per annum to 1,876 Mtoe in 2030. Nuclear energy is expected to grow the fastest at an annual average rate of 9.4 percent followed by natural gas at 8.1 percent over the period 2005-2030. The share of oil, coal and hydro is projected to increase at an annual average rate of 6.5, 6.3 and 6.7 percent respectively over the same

period.

3.2.2. Alternative Policy Scenario

In the APS, India's primary energy demand is projected to increase at a lower rate of 5.3 from 379 Mtoe in 2005 to 1,375 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 natural gas will grow at slower annual rates of 5.4 percent, 3.6 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 increase from 0.2 percent in 2005 to 1.9 percent in 2030. Figure 16 shows the future primary energy demand mix in both the BAU scenario and APS.

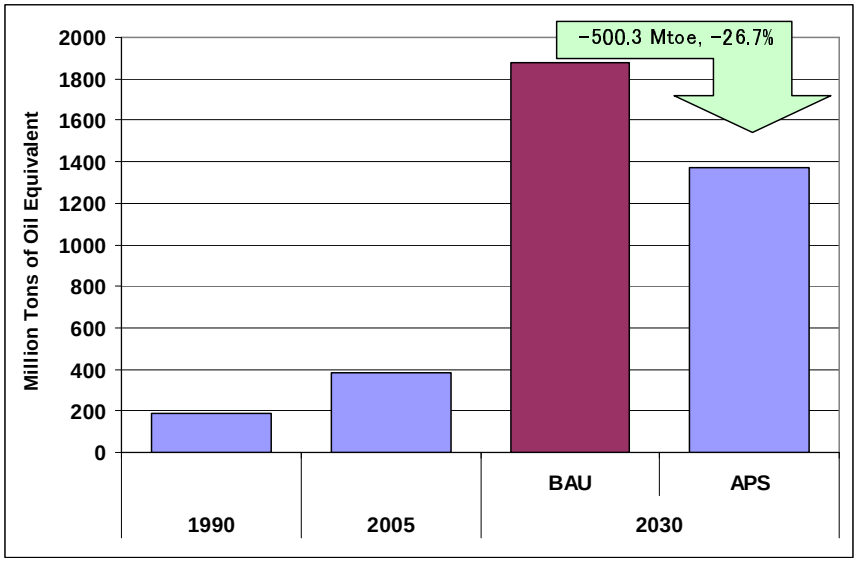
Figure 16: Primary Energy Demand in 2005 and 2030, BAU vs APS



3.3. Projected Energy Saving

The total energy savings that could be derived from the EEC goals and action plans of India would amount to 500 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 26.7 percent of India's primary energy demand in 2030 (Figure17).

Figure 17: Evolution of Primary Energy Demand in India



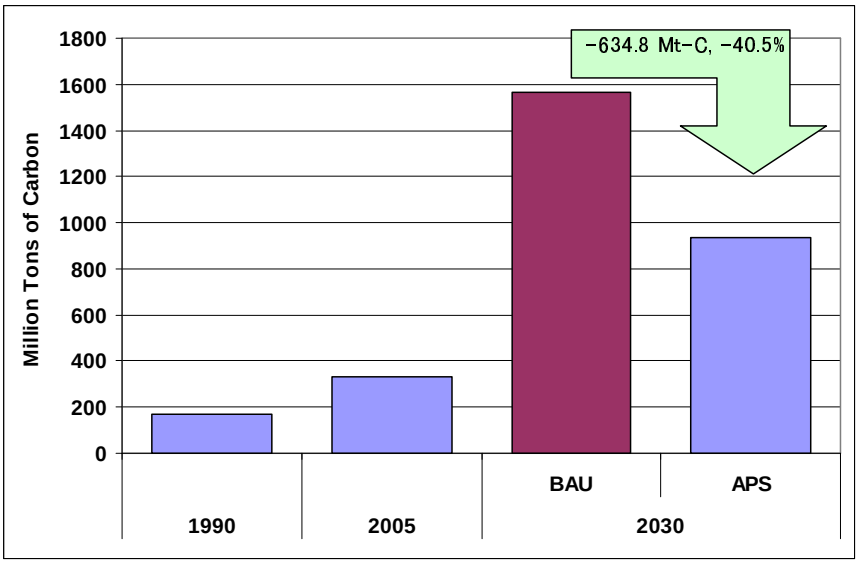
In terms of savings in final energy consumption, there is an estimated saving of 104 Mtoe in the industry sector, 105 Mtoe in the transportation sector and 217 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 6.4 percent per annum from 329 Mt-C in 2005 to 1,568 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.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 4.3 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 is effective in reducing CO_2 emissions (Figure 18)

Figure18: Evolution of CO_2 Emissions in India



Country Report 6

Indonesia Country Report

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March 2008

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Indonesia

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 208 billion 2000 US$ dollars. Compared to 1990, it has grown at an average rate of 4.4 percent per annum to 2005. The GDP per capita in 2005 was 900 US dollars while in 1990 it was only 600 US dollars.

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 proven reserves are 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 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 TCF) 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, wind, etc. For hydro, the estimated potential is around 75 GW while for geothermal its' potential is 27 GW.

Indonesia's total primary energy supply (TPES) was 128.4 Mtoe in 2005. By fuel, oil represented the largest share at 51.2 percent, followed by natural gas at 23.8 percent and coal at 19.8 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 TWh of electricity in 2005. 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 outlook, Indonesia's gross domestic product (GDP) is assumed to grow at an average annual rate of 6.5 percent from 2005 to 2030. The bases for this are the short term projections of the Coordinating Ministry for all economic ministries, Bank Indonesia and others. These projections assumed GDP growth in the range of 5.9 percent per year to 6.7 percent per year until 2010. The "Indonesia vision 2030" produced by the Indonesia Forum Foundation (IFF) assumed a GDP growth rate of 7.2 percent per annum in order to achieve the target of GDP/capita USD 18,000 by 2030. The latter is considered too high by many economists. Thus, the assumed growth of 6.5 percent per annum from 2005 to 2030 used in this study is considered to be more

realistic.

Population growth is assumed to increase at an average of 1.1 percent per annum from 2005 to 2030. Growth is assumed to be slightly faster from 2005 to 2010 at 1.2 percent per annum, tapering off to 1.1 percent per annum from 2010-2020 and to 1.0 percent per annum 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 is assumed to continue to use coal and natural gas as the dominant fuel inputs for power generation. Supply from oil-fired power plants will is assumed to decrease significantly. Hydro and geothermal energy resources will remain more or less the same. Other renewable energy such as wind and solar are projected to have an increasing share in the future electricity supply mix in response to the renewable portfolio standard (RPS). Nuclear is also assumed to be a part of the future supply mix for power generation in Indonesia after 2010.

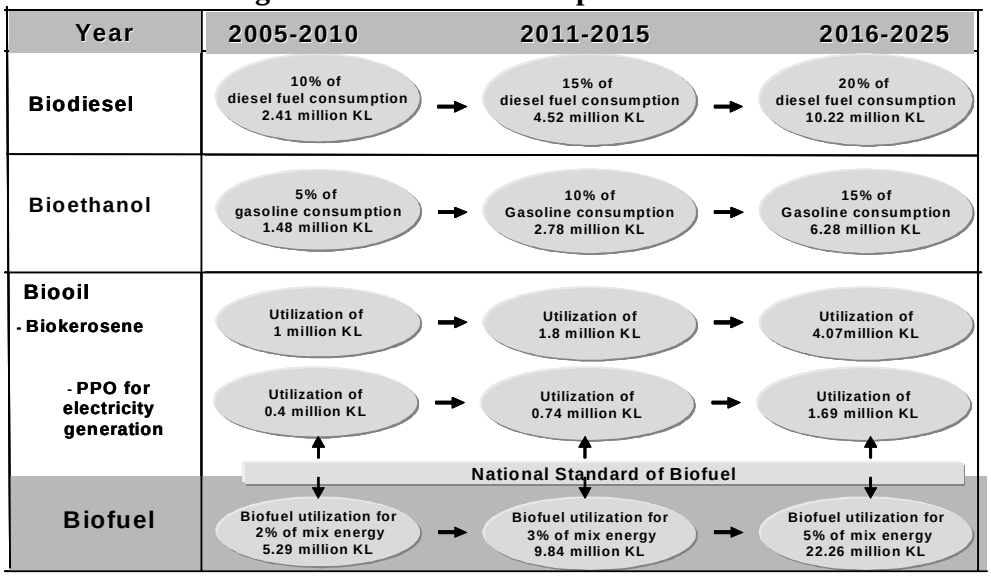
The National Energy Policy 2005-2025 stated that the goal for energy savings is to achieve GDP energy elasticity of less than 1 by 2025. This means that energy demand growth should be less than the corresponding GDP growth. The following Energy Demand-Side Management programs are in place in order to achieve this energy saving goal:

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

Indonesia is also considering the use of biofuels as an alternative to oil. Figure 19 shows

the roadmap for biofuel development taken from the Strategic Planning on National Energy Development Plan.

Figure 19: Biofuel Roadmap of Indonesia



Source: Directorate General for Electricity and Energy Utilization (DJLPE)

3. Outlook Results

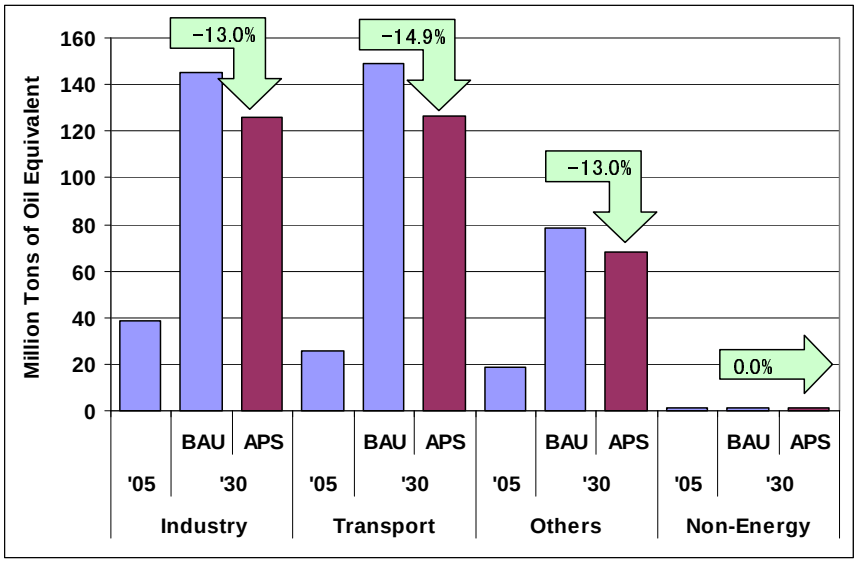
3.1. Total Final Energy Consumption

Indonesia's final energy consumption increased at an average annual growth rate of 5.6 percent over the 1990 to 2005 period from 37.2 Mtoe to 83.9 Mtoe. The industry and transport sectors had the highest growth rates during this period at 5.8 percent per annum each. Final energy consumption in the other sectors, which mainly consists of the residential and commercial sectors grew at a slower rate of 5.1 percent per annum over the period 1990-2005. Oil plays a major role in the country's final energy consumption. Its' share, however, in total final energy consumption shows a decreasing trend, from 74.1 percent in 1990 to 62.4 percent in 2005. Natural gas was the second most consumed product followed by coal and electricity.

3.1.1. Business-as-Usual (BAU) Scenario

Given the projected economic and population growth, final energy consumption from 2005 to 2030 will experience an increasing trend with an average growth rate of 6.2 percent per annum in the BAU scenario. This is mainly due to the rapid increase of consumption in the transportation sector which is still heavily dependent on oil. The consumption of the industry and the residential and commercial (other) sector is projected to grow at a slower rate of 5.4 percent and 5.9 percent respectively (Figure 20). Use of natural gas for feedstock is included in the demand of the industry sector.

Figure 20: Final Energy Consumption in 2005 and 2030, BAU vs. APS



By fuel type, consumption of coal, oil, natural gas, and electricity is projected to increase over the 2005-2030 period. Electricity and natural gas are assumed to grow faster than coal and oil. Consumption of coal and oil is projected to increase at an average annual rate of 5.5 and 6.0 percent, respectively over 2005-2030. Consumption of natural gas and electricity is projected to increase at an average annual rate of 6.4 and 7.1 percent respectively.

3.1.2. 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 5.5 percent per annum. That is, from 83.9 Mtoe in 2005 to 322.2 Mtoe in 2030. This slower rate of increase in the APS 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 6.6 percent per annum as compared to 7.3 percent per annum in the RS over the period 2005-2030. Slower rates of growth in energy consumption will be experienced also across all sectors in the APS relative to the BAU scenario.

3.2. Primary Energy Demand

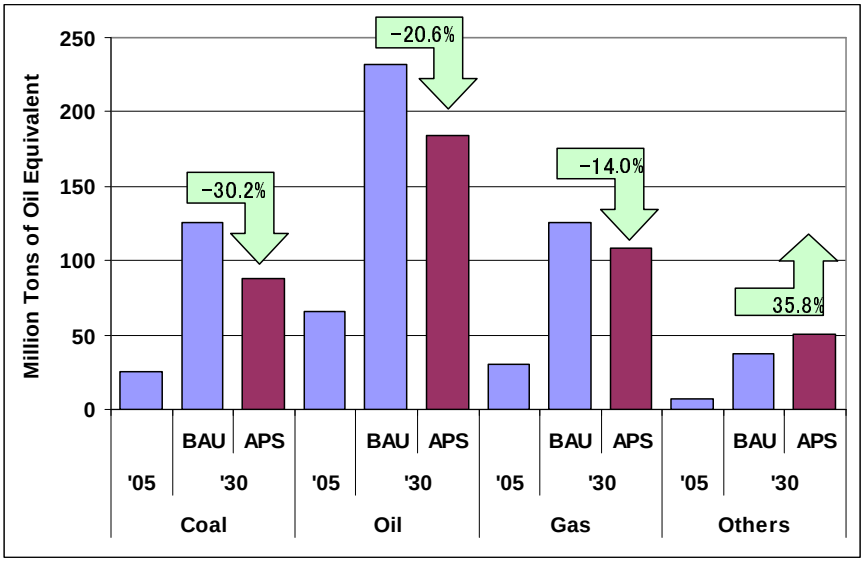
Primary energy demand in Indonesia grew at a slower average rate of 5.4 percent per annum than final energy consumption from 58.2 Mtoe in 1990 to 128.4 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were coal and geothermal energy. Coal consumption grew at an average annual rate of 13.2 percent while geothermal energy grew at 12.7 percent. Oil consumption increased slower at 4.5 percent per annum while natural gas consumption grew at 3.4 percent per annum. Hydro energy had a growth rate of 3.2 percent during the period but its share in the total remained minimal at less than 1.0 percent in 2005.

3.2.1. Business-as-Usual (BAU) Scenario

In the BAU scenario, Indonesia's primary energy demand is projected to increase at an annual average rate of 5.8 percent over the period 2005-30 to 520.5 Mtoe in 2030 (Figure 21). Coal and geothermal are projected to still be the fastest growing fuels but at a slower annual average growth rate of 6.6 percent and 6.9 percent respectively over the period 2005-2030. Consumption of natural gas is projected to grow faster than oil and hydro at an average of 5.8 percent per annum over the period 2005-2030 but its share in the total remains almost the same as in 2005 at around 24 per cent. Oil consumption is

projected to increase at an annual average rate of 5.2 percent over the period 2005-2030 but its share is projected to decline from 51.2 percent in 2005 to 44.6 percent in 2030. Hydro is expected to increase at an average annual rate of 4.8 percent between 2005 and 2030 and its share in the total is projected to decline slightly to 2030 to less than 1 percent. Nuclear and other renewable energy is projected to appear in the future primary energy supply mix as cleaner fuel alternatives to oil, but their share in the total fuel mix is projected to remain small.

Figure 21: Primary Energy Demand in 2005 and 2030, BAU vs APS



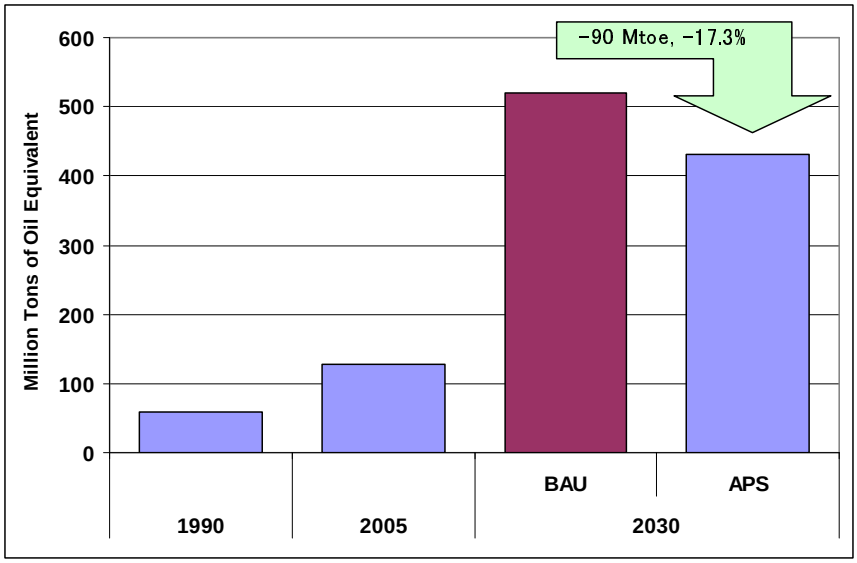
3.2.2. Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate of 5.0 percent per annum over the period 2005-2030, relative to the BAU scenario, to 430.5 Mtoe in 2030. All fuels are still projected to experience positive average annual growth rates; however these will be slower than in the RS. These decreases in consumption relative to BAU are mainly due to energy efficiency and conservation measures on the demand side.

3.3. Projected Energy Savings

The energy savings that could be derived from the EEC goals and action plans of Indonesia are about 90.0 Mtoe, the difference between primary energy demand in the BAU scenario and the APS (Figure 22). This is slightly more than Indonesia's energy consumption in 2005. At current oil prices, this could reach around 55 billion US$ of oil import savings.

Figure 22: Evolution of Primary Energy Demand to 2030, BAU and APS



In terms of final energy consumption savings, there is estimated to be a saving of 22.2 Mtoe in the transportation sector, 18.8 Mtoe in the industry sector and 10.2 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

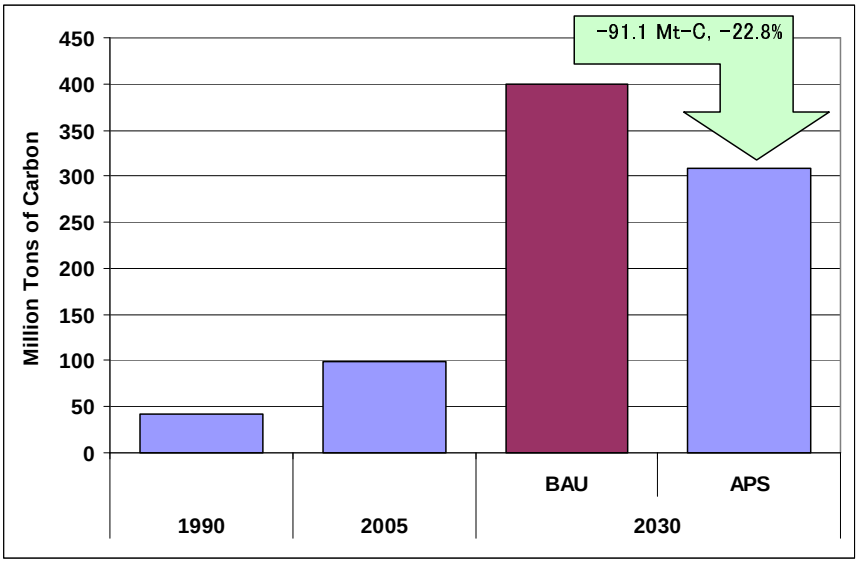
3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase at an average annual rate of 5.8 percent from around 98 Mt-C in 2005 to 400 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, annual average growth in CO_2 emissions from 2005 to 2030 is expected to be lower than in the BAU scenario at 4.7 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 0.7 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: Evolution of CO_2 Emissions in Indonesia to 2030, 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 0.7 percent while in the APS the projected average annual rate of decline is 1.4 percent.

The final energy consumption elasticity 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. This relies on the energy efficiency and conservation

programmes being implemented extensively in 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 be increased further by introducing more efficient vehicles and boilers in both the transport and industrial sectors. Thus, the current saving in energy of around 17 percent between the BAU scenario and the APS might even be increased to 20-25 percent. 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.

Country Report 7

Japan Country Report

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Japan

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$ 4993 billion (2000 US$ at PPP). Its population is currently about 128 million people with a per capita income of US$ 39100 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 2005, proven energy reserves included around 0.59 million barrels of oil, 33 BCM of natural gas and 359 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 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: steaming 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 1.5 percent from 2005 to 2030. Growth is projected to be strongest from 2005 to 2010 at 2.3 percent per year, tapering off to 1.5 percent per year from 2010-2020 and to 1.1 percent per year from 2020-2030. 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 0.3 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 117 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 slight translate to a 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 1.0 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 2.0 percent per annum followed by the transportation sector with 1.3 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.

3.1.1. Business-as-Usual (BAU) Scenario

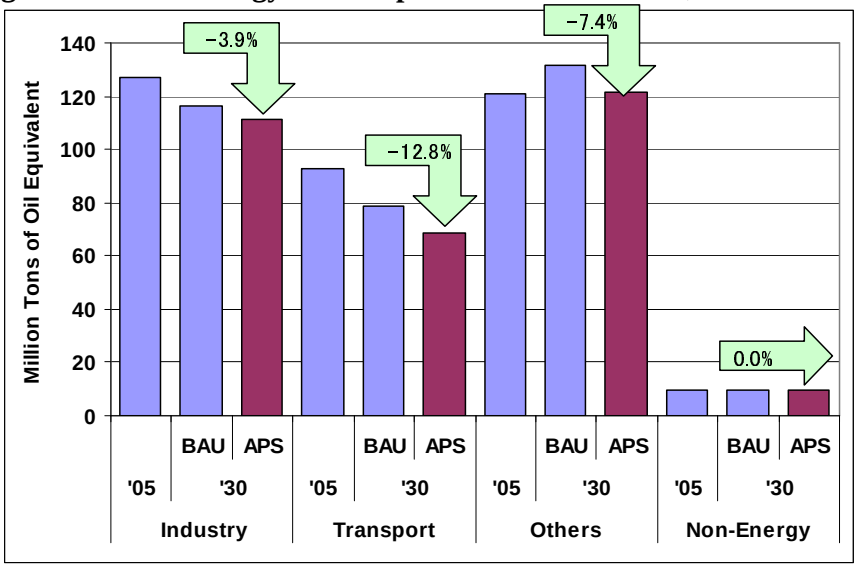
With the projected relatively low economic growth and population decline, final energy consumption from 2005 to 2030 is also projected to decline at an average rate of 0.2 percent per annum in the BAU scenario. This is also driven by the projected decline in the consumption of the industry and transportation 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 0.3 percent between 2005 and 2030 (Figure 24). By fuel type, consumption of coal and oil is projected to decrease at an average annual rate of 1.3 and 0.7 percent, respectively between 2005 and 2030. Consumption of natural gas and electricity are projected to increase, however, at a rate of 1.0 and 0.8 percent per annum respectively over the same period.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption is projected to decline at a faster rate of 0.5 percent per annum from 350.8 Mtoe in 2005 to 311.4 Mtoe in 2030. The fastest decline of 1.2 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.

Figure 24: Final Energy Consumption in 2005 and 2030, BAU and APS



3.2. Primary Energy Demand

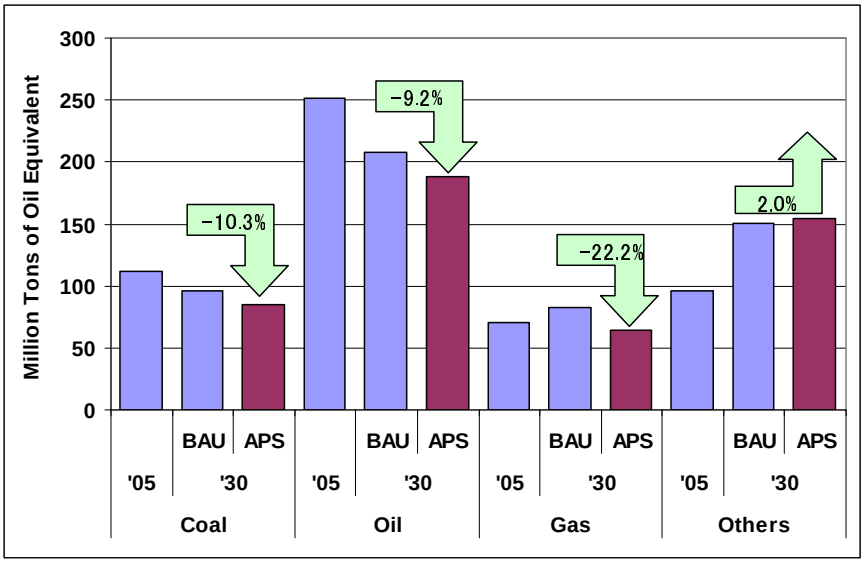
Primary energy demand in Japan grew at a faster rate than final energy consumption at 1.2 percent per annum from 444.5 Mtoe in 1990 to 530.5 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas, geothermal and nuclear energy. Natural gas consumption grew at an average annual rate of 3.2percent while nuclear energy grew at 2.8 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.

3.2.1. Business-as-Usual (BAU) Scenario

In the BAU scenario, Japan's primary energy demand is projected to decline at an annual average rate of 0.2 percent per annum between 2020 and 2030 to 536.4 Mtoe in 2030. This decline is due to the decreasing use of coal and oil at annual average rates of 0.6 percent and 0.8 percent, respectively over the period 2005-30. The share of coal and

oil in 2005 and 2030 is projected to decrease from 21.1 percent to 17.8 percent and 47.4 percent to 38.7 percent, respectively. Natural gas and nuclear energy consumption will, however, increase at average annual rates of 0.6 percent and 2.0 percent, respectively over the period 2005-30 (Figure 25).

Figure 25: Primary Energy Demand in Japan, BAU and APS



3.2.2. Alternative Policy Scenario

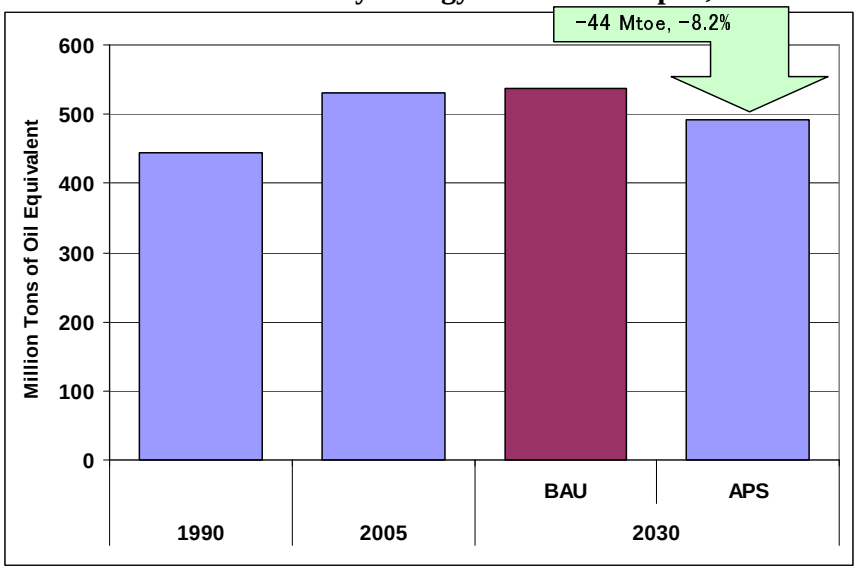
In the APS, the projected primary energy demand will decline at a faster rate of 0.3 percent per annum (the same rate as the final energy consumption) to 492.2 Mtoe in 2030, just 38.3 Mtoe higher than the consumption in 2005. Coal, oil and natural gas will have decreasing average annual growth rate of 1.1 percent, 1.2 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 44.2 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 8.2 percent of Japan's consumption in 2030 (Figure

26).

Figure 26: Evolution of Primary Energy Demand in Japan, BAU and APS



In terms of savings in final energy consumption, there is an estimated saving of 9.7 Mtoe the residential/commercial sector, 10.2 Mtoe in the transportation sector and 4.5 Mtoe in the industrial sector at 2030 in the APS, relative to BAU.

The energy savings in transportation achieved from 2005 to 2030 are 14.2 Mtoe and 24.4 Mtoe in the BAU and APS respectively, due to the increase of more efficient vehicles.

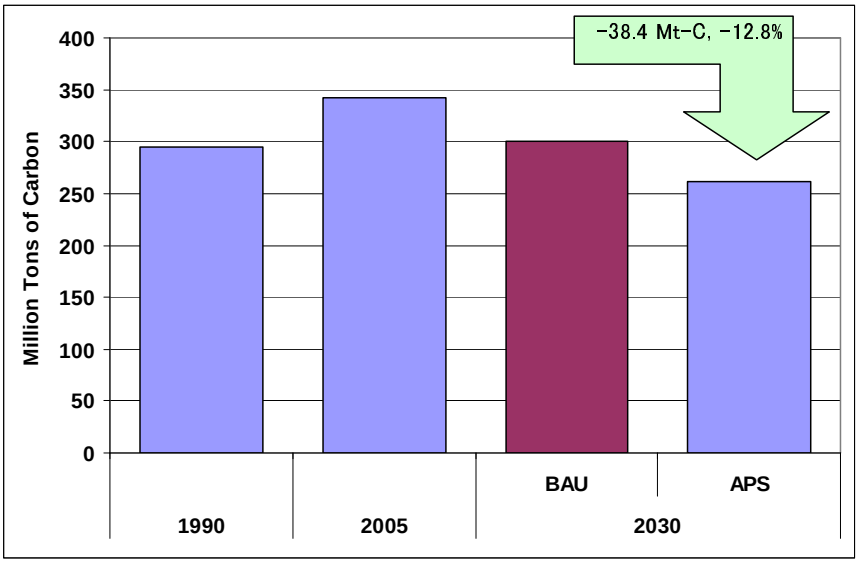
3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to decrease by about 0.5 percent from 342 Mt-C in 2005 to 299.8 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.

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 0.3 percent. In addition, CO_2 emissions in 2030 are projected to be lower than the 1990 level in the APS. This indicates that the energy saving goals and action plans of Japan are very effective in reducing CO_2 emissions (Figure 27).

Figure 27: Evolution of CO_2 Emissions in Japan



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 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.

Country Report 8

Republic of Korea

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Republic of Korea

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, GDP plunged to -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 would be 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 over ninefold 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, but oil has risen at an average annual rate of 0.5 percent over the last decade.

Total final energy consumption (TFEC) in 2005 was 146.1 Mtoe with an average annual growth rate of over 7 percent for the last two decades. Nearly half (48 percent) of TFEC in 2005 was used by the industry sector, with an average annual 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 –57 percent of the total in 2004. Final consumption in the transport sector accounted for about 22 percent of TFEC in 2005, and grew at an average annual rate of 9 percent between 1974 and 2004 and 5.2 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 389 TWh of electricity. In 2005, coal and nuclear combined provided over three-quarters of Korea's electricity. Natural gas fuelled 16 percent of generation in 2005. Total electricity consumption has grown at an average annual rate of 9.1 percent over the period 1990-2005. When broken down by fuel, coal, natural gas and nuclear have grown by an average annual rate of 15.3 percent, 13.3 percent and 7 percent, respectively over the period 1990-2005.

2. Modelling Assumptions

In this outlook, Korea's gross domestic product (GDP) is assumed to grow at an average annual rate of 3.8 percent from 2005 to 2030. Growth is expected to be strongest from 2005 to 2010 at 4.9 percent per year, tapering off to 4.3 percent per year from 2010-2020 and to 2.8 percent per year from 2020-2030. Population, on the other hand, is projected to increase by 0.2 percent per annum until 2010 and then remain fairly flat after that.

In regard 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 fossil fuel 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 would be attained through the implementation of energy efficiency programs in all energy consuming sectors. For the industry sector, energy savings are expected from the expansion of the energy conservation voluntary agreement, the high efficient equipment program, the development of alternative energy and improvements in efficient technologies. The transport sector aims to save energy by the enhancement of the efficiency of logistics system, the expansion of public transportation and improvements in 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

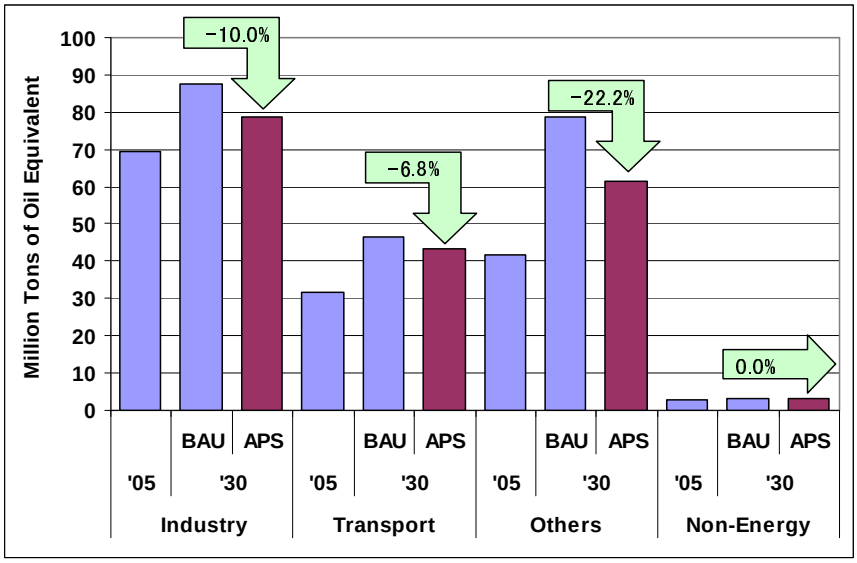
Korea's final energy consumption experienced a high growth of 5.5 percent per annum from 65.1 Mtoe in 1990 to 146.1 Mtoe in 2005. The industry sector had the highest growth rate during this period at 7.1 percent per annum followed by the transportation sector with 5.2 percent. Consumption in the residential/commercial/public (other) sector grew at a relatively slow pace of 3.7 percent per annum. Oil was the most consumed product having a share of 67.3 percent in 1990, decreasing to 58.2 percent in 2005. Coal was the second most consumed product in 1990 but in 2005 electricity was the second most consumed product.

3.1.1. Business-as-Usual (BAU) Scenario

With the projected low economic and population growth, final energy consumption from 2005 to 2030 is projected to increase at a low average rate of 1.6 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 2.6 percent (Figure 28).

Figure 28: Final Energy Consumption in 2005 and 2030, BAU vs. APS



By fuel type, consumption of oil, natural gas and electricity is projected to increase at an average annual rate of 0.6, 1.4 and 3.9 percent, respectively over the period 2005-2030. Consumption of coal, however, is projected to decrease at 0.6 percent per annum over the same period.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a rate of 1.0 percent per annum from 146.1 Mtoe in 2005 to 186.4 Mtoe in 2030. The residential and commercial (other) sector is projected to have the fastest average annual consumption growth at 1.5 percent over the period 2005-30. Energy consumption in the transportation sector is projected to increase at the rate of 1.2 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.

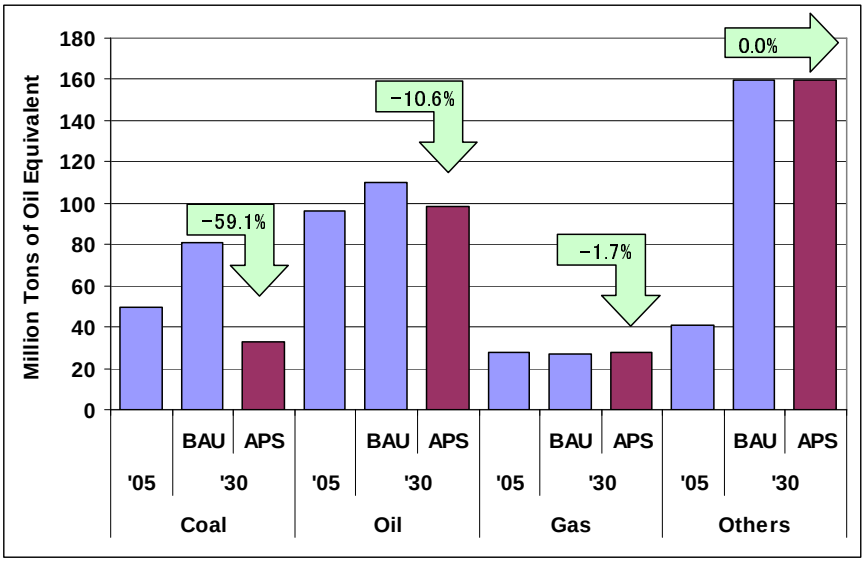
3.2. Primary Energy Demand

Primary energy demand in Korea grew at the rate of 5.7 percent per annum from 93.4 Mtoe in 1990 to 213.8 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 each increased by 4.5 percent per annum over the same period.

3.2.1. Business-as-Usual (BAU)Scenario

In the BAU scenario, primary energy demand in Korea is projected to increase at an annual average rate of 2.3 percent per annum to 377.5 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 0.0 percent, respectively over the period 1990-2030. The share of oil is projected to decrease from 45.0 percent in 2005 to 29.1 percent in 2030. Nuclear energy consumption is projected to rapidly increase at an average annual rate of 5.7 percent over the period 2005-2030.

Figure 29: Primary Energy Demand in 2005 and 2030, RS vs APS



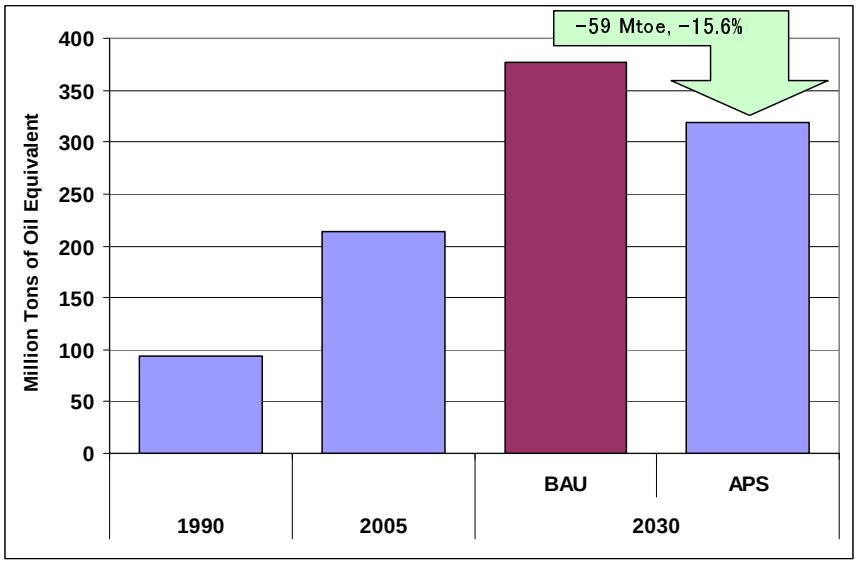
3.2.2. Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a lower rate of 1.6 percent per annum to 318.7 Mtoe in 2030. Coal will have a decreasing average annual rate of 1.6 percent while oil will increase at 0.1 percent over the period 2005-2030. Consumption of natural gas is projected to be about the same in 2030 as It was in 2005 (Figure 29). Energy efficiency and conservation measures on the demand side mainly contribute to the reduction in consumption growth.

3.3. Projected Energy Saving

The energy savings that could be derived from the energy saving goals and action plans of Korea is 58.8 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS in 2030 (Figure 30). This is equivalent to 27.5 percent of Korea's consumption in 2005.

Figure 30: Evolution of Primary Energy Demand



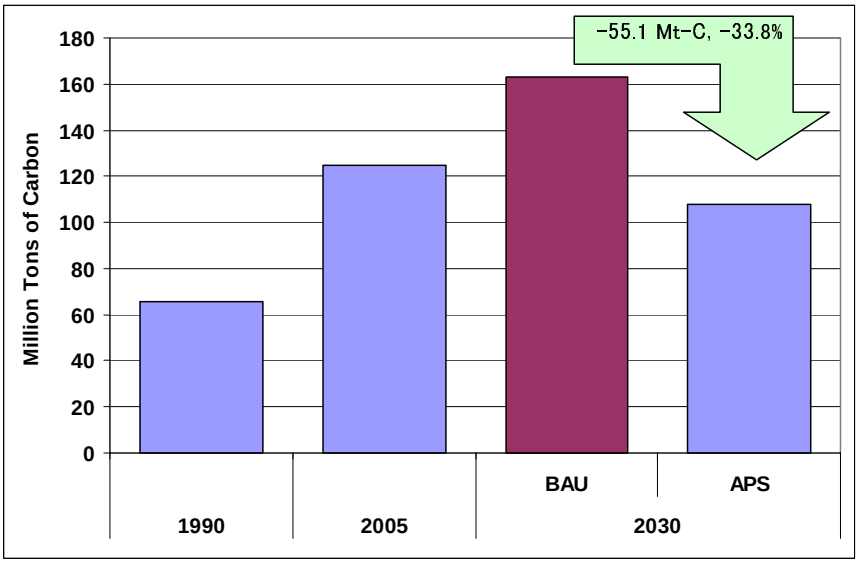
In terms of final energy consumption savings, there is estimated to be a saving of 17.5 Mtoe in the residential/commercial (other) sector, 8.8 Mtoe in the industry sector and 3.2 Mtoe in the transportation sector.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 1.1 percent from 124.9 Mt-C in 2005 to 163.0 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 or more energy efficient technologies.

In the APS, CO_2 emissions are projected to decrease at an annual average rate of 0.6 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: Evolution of CO_2 Emissions in Korea



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 2000. 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. Key policy goals in Korea include encouraging conversion into a low energy consuming economic structure and implementation of policies harmonising energy, the economy, and the environment. To accomplish improved energy efficiency and energy savings target as well as a CO_2 emission reduction, it is important that the continuity or improvement of energy relevant policies should be guaranteed by the new Administration of Korea.

Country Report 9

Lao PDR Country Report

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March 2008

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Lao PDR

Lao PDR

Mr. Khamso Kouphokham

1. Background

Lao People's Democratic Republic (Lao PDR) is a small country in South East Asia. It is located in the middle of the South East Asia peninsula and has a border with five countries namely China in the North, Vietnam in the East, Cambodia in the South, Thailand and Myanmar in the West. Its land 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 has population of 5,609,997 people in 2005. The gross domestic product (GDP) in 2005 is about US$ 153 million at the 1990 constant price with the annual growth of 7.3 percent.

Laos's total primary energy demand in 2005 was 0.48 Mtoe. The country's primary energy demand mix consists of three types of energy such as oil, hydro and coal. Oil comprise more than 70 percent of the primary energy demand with the balance shared between hydro and coal.

Lao PDR has a large potential for hydropower of up to 23 Gigawatts. Up to year 2006, the country has used only about 3 percent of its hydropower resources at 673 megawatts. For electricity supply, currently, Laos has used 3 types of electricity generation sources. These include hydropower, diesel generators and solar photovoltaic sets. Hydropower accounts for 99.8 percent equivalent 672 MW of the power generation installed capacity, diesel generation type accounts for 0.87 MW and solar photovoltaic type accounts for 0.3 MW. In 2006, Laos has generated about 3.6 TWh of electricity. From this total electricity generated, 2,487 GWh was exported to Thailand. The export of power to the neighbouring countries is expected to be high in the future.

2. Modelling Assumptions

In this outlook, the GDP of Lao PDR is assumed to grow at an average annual growth rate of 7.5 percent from 2005 to 2030 while population growth is assumed to grow at an average annual growth rate of 2.5 percent. However the country will experience the decreasing population growth rate of 1.6 percent from 2005 to 2010.

In regard to future electricity supply, Lao PDR will continue to use hydro and coal as primary energy for generating electricity. But coal will be used for the power generation only after 2010, as the country is planning to develop its first coal thermal power plant between 2008 and 2010. The installed capacity of this thermal power plant is 1,800 MW. However, the coal thermal power generation will constitute a small share in the power generation mix compared with hydropower.

In this study, Lao PDR will get the energy savings mainly through the implementation of the government's energy conservation program. The government's energy conservation program aims for a 10 percent reduction of electricity consumption in state buildings. Other sectors such as private industries and buildings, have been implementing the project named the Promotion of Energy Efficiency and Conservation (PROMEEC) under the ASEAN-Japan Cooperation Project. This project focuses on the training of the government and private personnel to carry out t energy efficiency and conservation activities.

3. Outlook Results

3.1. Total Final Energy Consumption

Lao PDR's final energy consumption in 2005 was 0.46 Mtoe growing at an average annual rate of 4.6 percent from 1990 of 0.23 Mtoe. The industry sector had the highest growth rate during this period at 23.7 percent per annum followed by the other sectors at 11.7 percent per annum. The transport sector which was responsible for 63 percent of the total consumption in 2005 had a slow growth rate of 2.7 percent. In terms of energy

types in 2005, oil was the most consumed product having a share of 74 percent followed by electricity which accounted for 20 percent.

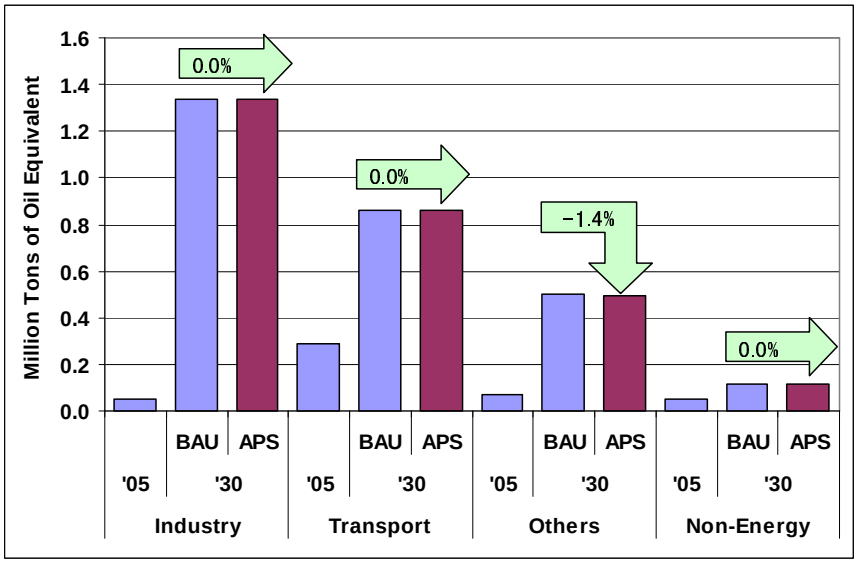
3.1.2. Business-as-Usual (BAU) Scenario

From 2005 to 2030, Lao PDR will experience the high growth of energy consumption in all sectors such as Industry, Transport and Others. The Industry sector will have the highest growth rate of 13.7 percent followed by the other sector at 8.3 percent. The final consumption of the transport sector will have a moderate growth rate of 4.4 percent while agriculture consumption will grow at 3.4 percent per annum.

3.1.3. Alternative Policy Scenario (APS)

In the APS, the growth of final energy consumption will be slightly lower than in the BAU. This is due to the 10 percent reduction in the electricity consumption of the government sector which is a part of the other sector. The reduction will however be very minimal at 0.01 Mtoe or 0.4 percent of the total final energy consumption in 2030 in the BAU scenario. (Figure 32)

Figure 32: Final Energy Consumption in 2005 and 2030, BAU vs. APS



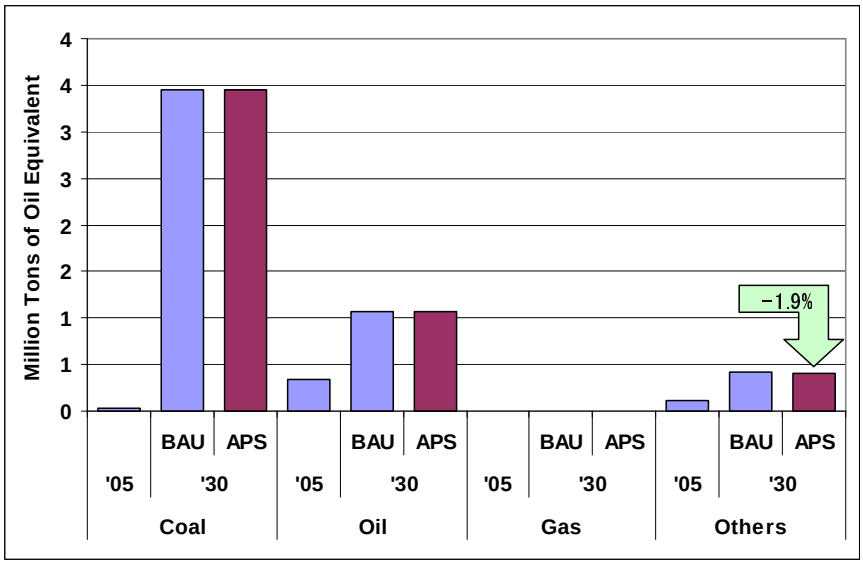
3.5 Primary Energy Demand

The primary energy demand of Lao PDR grew at an average annual rate of 4.6 percent from 1990 to 2005. Hydro grew the fastest during the period due to exports of electricity to Thailand. Oil demand increased at an annual growth rate of 3.0 percent while coal started to figure in the primary energy mix in the middle part of the 1990's.

3.5.1 Business-as-Usual (BAU) Scenario

Primary energy demand will increase from 0.48 Mtoe in 2005 to 4.93 Mtoe in 2030. Coal demand will increase sharply from 0.03 Mtoe in 2005 to 3.45 Mtoe in 2030 at an average annual growth rate of 21.1 percent because Laos will use coal for electricity generation from 2010 onwards. Hydro will also increase sharply but at a lower rate compared with that of coal. It will increase from 0.3 Mtoe in 2005 to 3.19 Mtoe in 2030. Oil demand will rise at slow pace from 0.34 Mtoe in 2005 to 1.06 Mtoe in 2030.

Figure 33: Primary Energy Demand in 2005 and 2030, BAU vs. APS



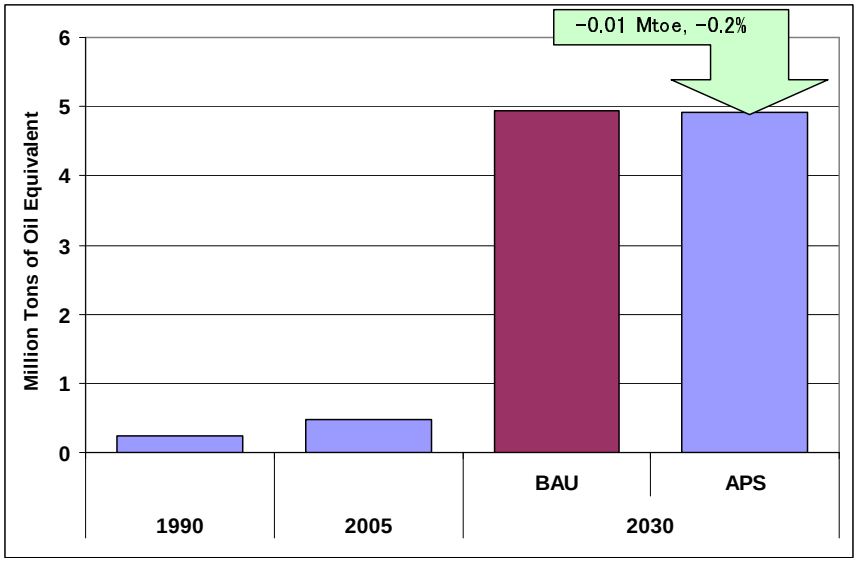
3.5.2 Alternative Policy Scenario

In the APS, the primary energy demand trends throughout the projection period will almost be the same as those in the BAU, except in 2030 on which the difference will be 0.01 Mtoe from 4.93 Mtoe in the BAU to 4.92 Mtoe in the APS. (Figure 33)

3.6 Projected Energy Savings

Lao PDR will get energy savings through implementation of 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 is quantified during the course of the study. In view of this, the energy savings that were estimated would only amount to 0.01 Mtoe or 0.2 percent of the projected consumption in 2030 in the BAU. (Figure 34)

Figure 34: Evolution of Primary Energy Demand, BAU vs. APS



3.7 CO_2 Emissions

In this outlook, no CO_2 emission reduction can be obtained as it is assumed that any

surplus electricity resulting from energy conservation will be exported to Lao PDR's neighbouring countries. It should be noted that as an electricity exporting country, the emissions associated with electricity generation will be accounted to the country whether or not the electricity produced is consumed domestically or exported.

4. Implications and Policy Recommendations

In this outlook, Lao PDR will experience the increase both in primary energy consumption and primary energy intensity due to projected economic growth of 7.5 percent per annum. It is also because of the expanding rural electrification in which the government is targeting to achieve an electrification ratio at 90 percent in 2020.

In order to increase the reduction of energy consumption and increase the energy savings, Lao PDR has to be more active in implementation of the Energy Efficiency and Conservation programs. The programs initially may focus on the 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. The affected sectors can voluntarily implement the EEC activities resulting 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.

Country Report 10

Malaysia Country Report

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March 2008

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Malaysia

Malaysia

Ms. Yuzlina Mohd. Yusop

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. 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$ 112.5 billion of which the manufacturing sector contributed to over 30 percent of the national GDP. Manufactured products continue to dominate the exports market accounting for over 77.4 percent of Malaysia's total exports in 2005. Its population is currently at 25.3 million people with per capita income was US$ 4,400.

Malaysia successfully diversified its energy consumption by taking advantage of domestic energy resource endowments. As of 1st January 2005, Malaysia's total oil reserves stood at 5.2 billion barrels while the gas reserves stood at 85.2 trillion standard cubic feet. The country's coal reserves, mainly in Sarawak and Sabah, were estimated at 1,483.06 million tones.

Malaysia's total primary energy demand was 102.2 Mtoe in 2005. By fuel, natural gas represented the largest share at 62.9 percent; oil was second at 35.3 percent, followed by hydro (1.3 percent) and coal at 0.5 percent. In 2005, net export of energy sources, was 28.4 Mtoe which accounted for 46.9 percent of the total primary energy consumption. Malaysia exported 52.3 percent of oil and 38.6 percent of gas production but imported 96 percent of its coal consumption.

In 2005, Malaysia is the third largest exporter of LNG in the world and the main export destinations are Japan, South Korea and Taiwan. In 2005, of the 36.4 Mtoe production

of natural gas, 90 percent was converted into LNG for export. For domestic purposes, natural gas is mainly used for electricity generation, followed by reticulated gas for industrial and residential use as well as feedstock to petrochemical industries. In 2005, primary natural gas supply was 64.3 Mtoe.

Malaysia has 22.3 GW of installed generating capacity and generated about 91 TWh of electricity in 2005. The energy input in power stations is broken-down as: natural gas at 62 percent, coal (28 percent), hydro (7 percent) and diesel and fuel oil taking up the remainder.

2. Modelling Assumptions

In this outlook, Malaysia's gross domestic product (GDP) is assumed to grow at an average annual growth rate of 5.5 percent from 2005 to 2030. Growth would be 5.5 percent per year from 2005 to 2010, strengthening to 6.0 percent per year from 2010-2020 and tapering off to 5.0 percent per year from 2020-2030. Population will be increasing by 2.0 percent per annum from 2005 to 2030.

In regard to future electricity supply, Malaysia will continue to use natural gas and coal. Supply from oil-fired power plants will be phased out while hydro is expected to increase its share gradually. There would be an increasing share of electricity from renewable energy in view of the implementation of future renewable energy policy.

Malaysia'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 improvement of manufacturing technologies as well as aggressive energy efficiency effort. 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 improvement will be achieved through the increase of vehicle fuelled by natural gas as well as improved mileage.

Malaysia also considers the use of biofuels to reduce dependency on oil and curb CO_2 emissions. However, there is still no estimated amount of biofuels that would be used in the country for the time being.

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 13.2 Mtoe in 1990 to 37.5 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, both growing at 7.1 percent per annum. Oil was the most consumed product having a share of 75.7 percent in 1990 and slightly decreasing to 61.3 percent in 2005. Electricity was the second most consumed product.

3.1.1. Business-as-Usual (BAU) Scenario (BAU)

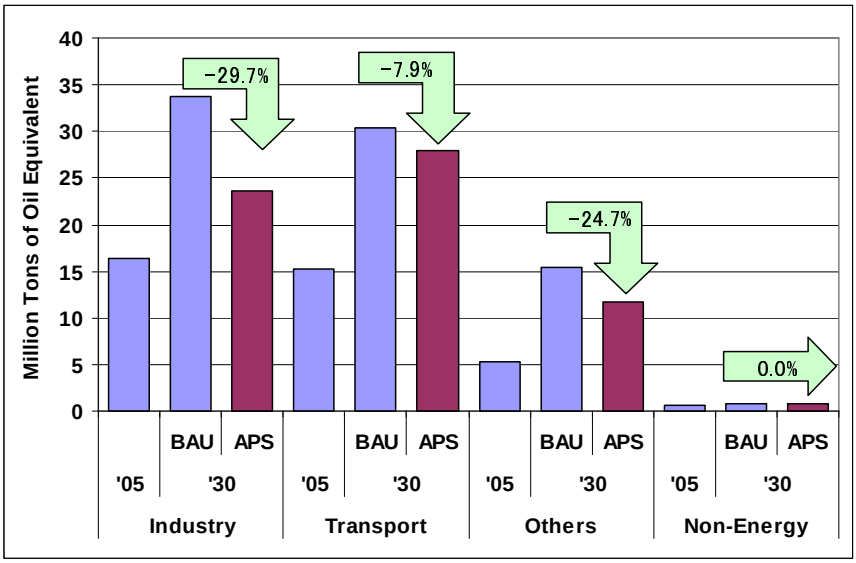
With the projected continuous economic growth at 5.5 percent per annum and population growth of 2.0 percent per annum, final energy consumption from 2005 to 2030 is also projected to grow at an average rate of 3.1 percent per annum in the BAU. The highest growth rate will be experienced in the residential/commercial sectors growing at 4.4 percent per annum mainly contributed by the increasing demand for electrical appliances. The industrial and transportation sectors are projected to increase their consumption at 2.9 percent and 2.8 percent per annum, respectively. The industrial and transportation demand accounted for more than 70 percent of the total energy demand.

Per fuel type, consumption coal and oil will increase at an average annual rate of 2.7 and 2.3 percent, respectively. Consumption of natural gas and electricity will increase at a higher rate of 3.4 and 4.8 percent respectively.

3.1.2. Alternative Policy Scenario

In the APS, the growth of final energy consumption will be lower compared to that of the BAU scenario at 2.2 percent per annum, i.e. from 80.4 Mtoe in 2005 to 64.2 Mtoe in 2030. The highest reduction will be experienced in the industrial sector growing at only 1.5 percent per annum due to improvement of manufacturing technologies as well as aggressive energy efficiency efforts. Decline in consumption will be experienced across all sectors. See Figure 35.

Figure 35: Final Energy Consumption in 2005 and 2030, RS vs. APS



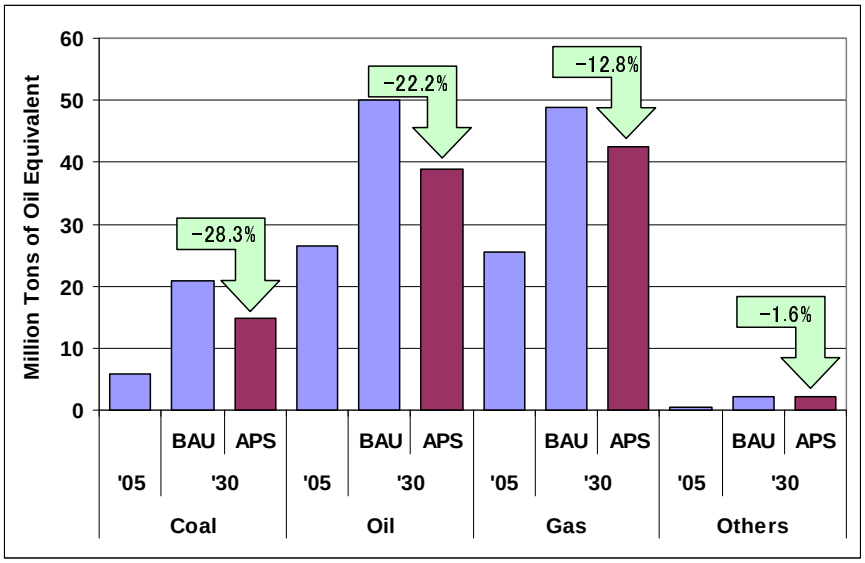
3.2. Primary Energy Demand

Primary energy demand of Malaysia grew at annual rate of 7.0 percent per annum 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. Oil and hydro grew at lower average annual rates of 4.9 percent and 2.5 percent.

3.2.1. Business-as-Usual (BAU) Scenario

In the BAU scenario, Malaysia's primary energy consumption will increase at an annual rate of 3.0 percent per annum to 122 Mtoe in 2030. Coal and hydro will have similar growth rates of 5.2 percent per annum while oil and natural gas will also have similar growth rates of 2.6 percent. In view of this, the shares of coal and hydro will increase from 10 percent to 17 percent and 0.9 percent to 1.5 percent, respectively. Consequently, oil and natural gas shares will decrease in 2030 but their total share will remain above 80 percent.

Figure 36: Primary Energy Consumption in 2005 and 2030, BAU vs. APS



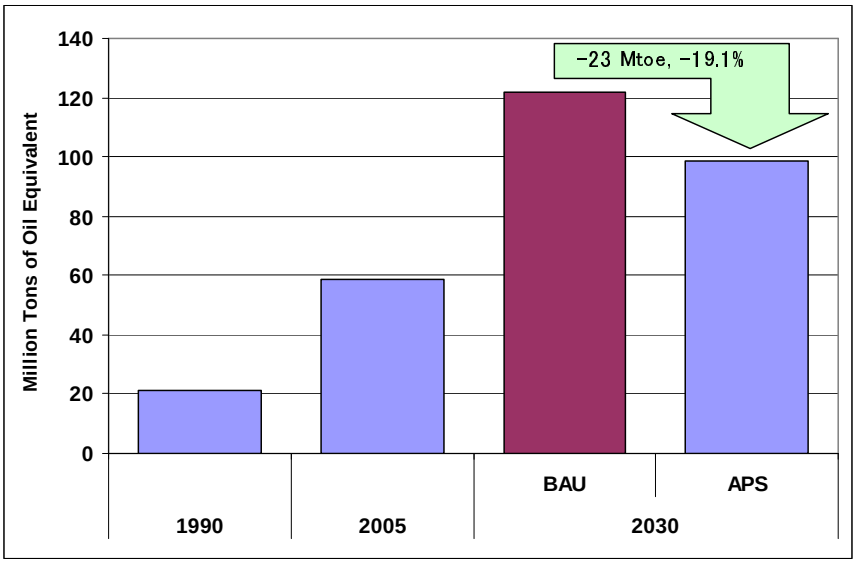
3.2.2. Alternative Policy Scenario

In the APS, the projected primary energy consumption will increase at a slower rate of 2.1 percent per annum to 99 Mtoe in 2030. Hydro will grow the fastest at 5.2 percent per annum followed by coal at 3.8 percent. Oil and natural gas will have slower growth rates of 1.5 percent and 2.1 percent, respectively. The decrease in growth rate is mainly due to energy efficiency and conservation measures in the demand side. See Figure 36.

3.3. Projected Energy Savings

The energy savings that could be derived from the energy efficiency efforts and energy management would be 23 Mtoe, the difference between the primary energy demand in the BAU and the APS (Figure 37). This is equivalent to almost 40 percent of Malaysia's primary energy consumption in 2005.

Figure 37: Evolution of Primary Energy Consumption



The above savings in primary energy are due to 10.0 Mtoe estimates savings in final energy consumption of the industrial sector, 3.8 Mtoe of the residential/commercial sector and 2.4 Mtoe of the transportation sector.

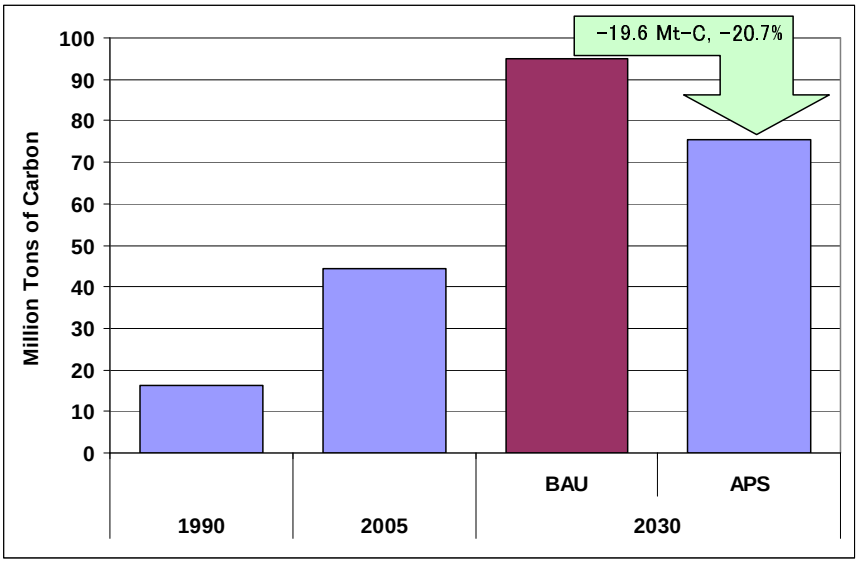
3.4. CO_2 Emissions from Energy Consumption

The calculated CO_2 emissions from the energy consumption projection will increase by 20.7 percent from 44.5 Mt-C in 2005 to 95.0 Mt-C in 2030 in the BAU, increasing at 3.1 percent per annum.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 will be 2.1 percent. This decrease in growth rate is consistent with the decrease in primary energy

consumption of 2.1 percent (Figure 38). This indicates that Malaysia's energy saving effort and better energy management system would be effective in reducing CO_2 emissions.

Figure 38: Evolution of CO_2 Emissions in Malaysia



4. Implications and Policy Recommendations

Malaysia's primary energy intensity has been increasing at a rate on 0.7 percent per annum from 1990 to 2005. It is projected that under BAU, the primary energy intensity will decrease at an annual rate of 2.4 percent per annum. This could be due to the improvement in energy efficiencies by the main consuming industries through demand side technologies implemented in the country. Increasing energy price might also be one reason why the country will aggressively improve its energy consumption through various energy efficiency programs.

Energy has played an important role in the development of Malaysia. With greater industrialisation and urbanization, the efficient supply of energy at economic cost 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. While the supply of energy often involves technical know-how, there are also other important ways of tackling energy issues. Various efforts are underway to intensify the utilization of energy through various energy efficiency efforts. Other means include policies, legislations, formulating economic incentives and education.

Country Report 11

Myanmar Country Report

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Myanmar

Myanmar

Mr. Pe Zin Tun

1. Background

Myanmar is the second largest country in South East Asia with 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 Laos. The length of the coastline is 2,229 kilometres.

It is rich in energy recourses and its' proven energy reserves comprise of 648.6 million barrels of oil, 122.5 trillion cubic feet of gas and 711 million metric tonnes 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 in the year 2005 was estimated at 53.5 million growing at 1.8 percent per year between 1990 and 2005. The gross domestic product (GDP) in 2005 was about US$ 7.3 billion and GDP per capita stood at 135,981 US$. 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 plan (1992-1995) achieved an average annual growth rate of 7.5 percent in GDP and the second plan (1996-2000) achieved an average annual growth rate of 8.5 percent in GDP. The third plan (2001-2005) achieved an average annual growth rate of 12.8 percent in GDP and the last five-year plan (2006-2010) has been formulated with an average annual growth rate of 12.0 percent in GDP.

Myanmar's total primary energy demand was 3.8 Mtoe in 2005. By fuel, oil represented the largest share at 59.9 percent Gas was second at 30 percent, followed by hydro with 6.7 percent. Natural Gas is mainly used for electricity generation and in industry. Myanmar has 1512 MW of installed generation capacity and generated about 6335

KWh of electricity in 2005. The generation amount by energy type in 2005 could be broken-down as; thermal (coal, natural gas and oil) at 53.5 percent and hydro at 46.4 percent.

2. Modelling Assumptions

In this outlook, Myanmar's GDP is assumed to grow at an average annual growth 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 and from 2010 to 2020 at 9.8 percent per year and 2020 to 2030 at 8.3 percent per year. Population is assumed to increase by about 1.8 percent per year from 2005 to 2030.

With regards to future electricity supply, Myanmar is projected to continue to use coal, natural gas and hydro. Supply from oil-fired power plants is expected to decrease in view of the government planning to develop the abundant hydropower resources. The capacity of natural gas power plants will remain constant whilst hydro power plants will increase such that they are projected to export electricity in 2020. In view of 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 39.0 percent in 2030.

Myanmar'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 (other) sector technology improvements are also projected to induce huge savings in addition to energy management systems. In the transport sector, efficiency improvement will not only be achieved by improved mileage but also in more effective traffic management.

Although Myanmar has considered the use of biofuels to reduce 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

Total final energy consumption in Myanmar was around 1.0 Mtoe in 1990 and increased to 2.9 Mtoe in 2005 growing at an average annual growth rate of 7.2 percent. The other sectors group, which comprises of commercial, residential and agricultural sectors, was the fastest growing consumer at 12.3 percent per annum followed by the transport sector at 8.5 percent over the period 1990-2005. The industry sector grew the slowest at 5.3 percent per year over the same period. Oil was the most consumed product having a share of 59 percent in total final energy consumption at 1990, increasing to 70 percent in 2005. Electricity was the second most consumed product.

Using the socio-economic assumptions stated above, final energy consumption in Myanmar is projected to grow at an annual rate of 8.8 percent from 2005 to 2030. Final energy consumption is projected to grow the fastest during the next 30 years in the industry sector with annual average growth projected at 11.8 percent driven by the increasing per capita income. In the transport and other sectors, consumption is projected to grow at an annual average rate of 6.5 percent and 7.4 percent respectively.

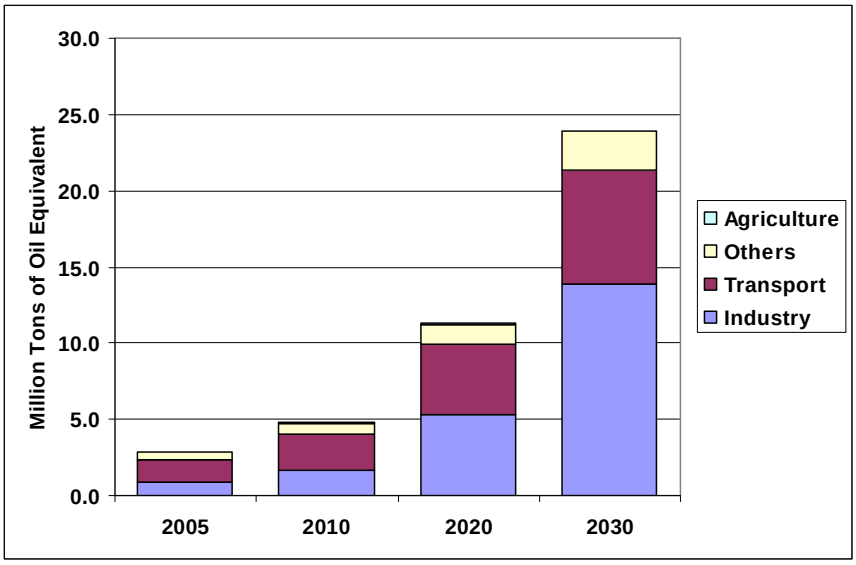
Among the types of final energy, natural Gas and coal are projected to have modest annual average growth rates of 11.8 percent per annum each in the period 2005-30 in view of the projected growth in industry GDP. The shares of natural gas and coal in final energy consumption are projected to subsequently increase from 11.6 percent and 3.5 percent respectively in 2005 to 22.7 percent and 6.9 percent in 2030 respectively. Electricity will have the second highest growth rate of 10.1 percent per annum during the next 30 years. Its share will increase from 14.7 percent in 2005 to 19.5 percent in 2030.

From 2005 to 2030, final energy consumption is also projected to rise at an average rate of 8.8 percent per annum using the projected economic and population growth. This is

due to the projected lift in the consumption of the industry and transportation sector brought about by improving energy efficiency. The consumption of the residential and commercial sector is projected, however, to grow at an average rate of 7.4 percent per annum between 2005 and 2030.

By fuel type, consumption of coal and oil is projected to increase at an average annual rate of 11.8 and 7.5 percent, respectively. Consumption of natural gas and electricity are also projected to increase at an average annual rate of 11.8 and 10.1 percent respectively over the period 2005-2030 (Figure 39).

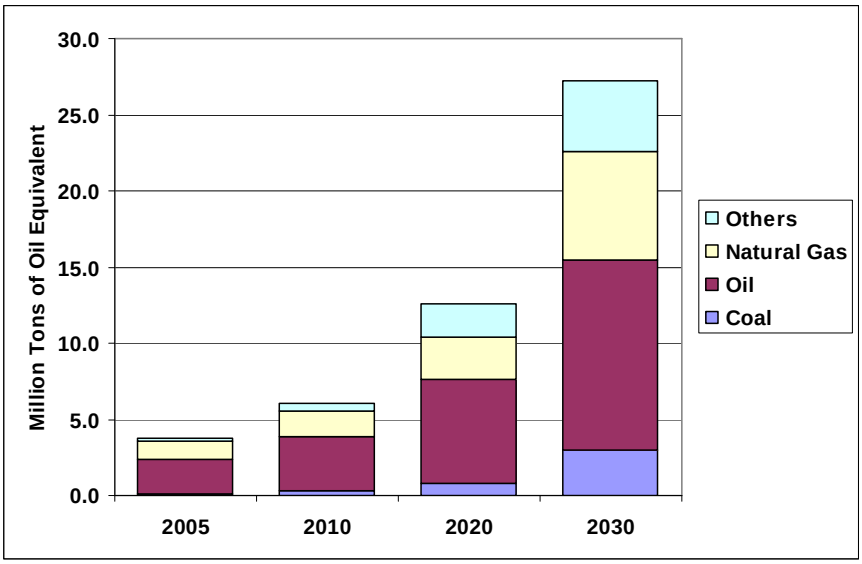
Figure 39: Final Energy Consumption Outlook, 2003 to 2030



3.2. Primary Energy Demand

Primary energy demand in Myanmar was 1.9 Mtoe in 1990 and 3.8 Mtoe in 2005, growing at an average annual rate of 4.7 percent. Among the major energy sources, the fastest growing fuels were hydro and oil energy. Natural gas consumption grew at an average annual rate of 2.8 percent over the period 1990-2005. Coal consumption increased by 4.8 percent per annum over the same period (Figure 40).

Figure 40: Primary Energy Demand in Myanmar, BAU=APS



3.3. Alternative Policy Scenario

Myanmar has not yet projected a specific APS for primary energy supply and final energy consumption but it has plans to decrease growth in primary energy demand by implementing energy efficiency and conservation measures in the demand side.

The EEC measures include the following:

Industry

- Encourage high-efficiency equipment and gradual replacement of low efficiency ones. Remove out-of-date equipment; reduce energy intensity in production; save energy in all activities in the public and private sectors.

Transportation

- Encourage fuel switching in the transport sector using bio-fuels and Natural Gas Vehicle as alternative fuels.
- Energy savings through exploiting more efficient transportation networks including road, waterway, railway, airway, seaway; developing high-capacity transportation with greater volumes of freight and passenger.

- Improvements in fuel efficiency in transport sector.

Residential and Commercial sector

- Encourage the use of alternative energy and improvements in energy efficiency in existing buildings in the public and private sectors.
- Promote the use of high energy efficient appliances and energy savings equipment in the residential and commercial sectors.
- Launching the use of bio-diesel (B 100) 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 & Renewable Sources of Energy.
- Replacing with appropriate new transformers and installing the capacitor bank in necessary main sub-stations. Optimise the voltage, conductor size and loading of transformers.

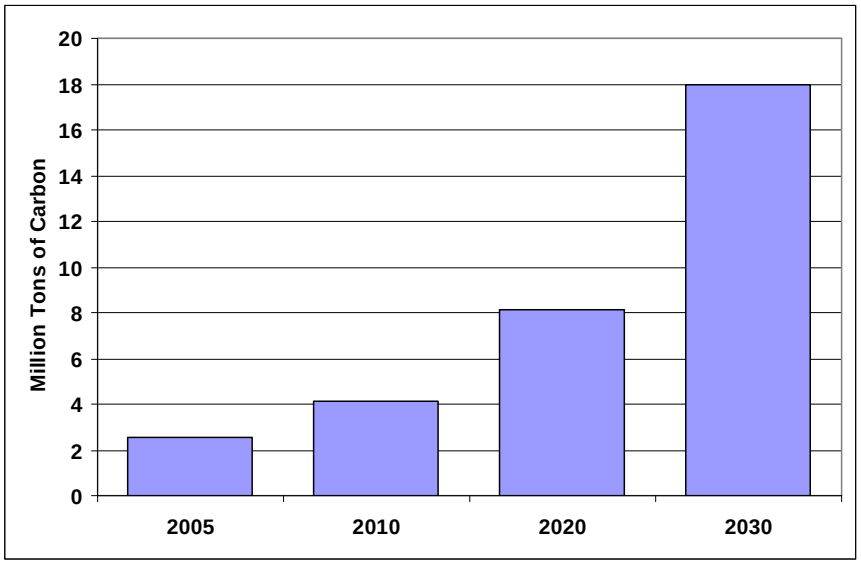
In Myanmar, commercial energy consumption is projected on the basis of energy requirements of the major sectors (industry, transport and agriculture, households). The choice of fuel type is determined by available supply, since energy consumption requirements have to be met mainly from domestic sources. Obviously there is a gap between demand and supply but on the other hand, the demand often very much higher than their 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, allocation is made in accordance with the registered licensed capacity of firm.

Future energy savings will be targeted to some amount of energy consumption in 2005 against the existing forecasts of energy development and socio-economic development without EEC. 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.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase from 2.5 Mt-C in 2005 to 18 Mt-C in 2030 in the BAU scenario (Figure 41).

Figure 41: Evolution of CO_2 Emissions in Myanmar



4. Implications and Policy Recommendations

Myanmar's primary energy intensity has been on a decline since 1980. However, Myanmar should also adopt energy efficient technologies to further reduce growth in energy consumption and should also aim to diversify energy availability.

Country Report 12

New Zealand Country Report

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March 2008

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New Zealand

New Zealand

Dr. Ralph Samuelson

1. Background

New Zealand is an island nation in the Pacific about 2,000 km southeast of Australia. It consists of two main islands (the North Island and South Island) where most of the population resides, and a number of smaller 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 GDP of about US$62.7 billion, or about US$15,300 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 totally self-sufficient in electricity and natural gas, and a net exporter of coal, but meets over 90 percent of its oil demand through imports. Energy reserves include around 15 million cubic meters (MCM) of oil and 52 billion cubic meters (BCM) of natural gas (each proven plus probable), as well as 8.6 billion tonnes of recoverable coal, 80 percent of which is lignite.

New Zealand's total primary energy demand was around 16.9 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 uses 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 GW of installed generating capacity and generated about 43 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 of 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 2.1 percent from 2005 to 2030. Growth is projected to be strongest from 2005 to 2010 at 2.6 percent per year, tapering off to 2.3 percent per year from 2010-2020 and to 1.7 percent per year from 2020-2030. Population is projected to increase by 0.7 percent per year from 2005 to 2030.

In the BAU scenario, an increasing amount of New Zealand's electricity supply is projected to come from coal and geothermal. Hydro is expected to remain fairly steady as the best hydro sites have already been developed. Gas use in electricity generation is projected to drop somewhat, due to the expected depletion of the Maui gas field, New Zealand's largest. Wind generation is expected to continue to grow, but would 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 PJ/year (about 1.6 BCM) with production from new discoveries starting in 2012. This is the historical average excluding the Maui field.

The New Zealand government recently announced the *New Zealand Energy Strategy*, a package of initiatives to help New Zealand respond to climate change while maintaining a secure energy supply. A key initiative is a proposed emissions trading scheme that will, in time, cover all sectors and all greenhouse gas emissions. The government has also set a target for 90 percent of electricity to be generated from renewable sources by 2025, as well as to increase the proportion of renewable energy in transport, in the form of biofuels and electricity. A companion *New Zealand Energy Efficiency and Conservation Strategy* will promote energy efficiency at home and at 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 two strategies.

3. Outlook Results

3.1. Total Final Energy Consumption

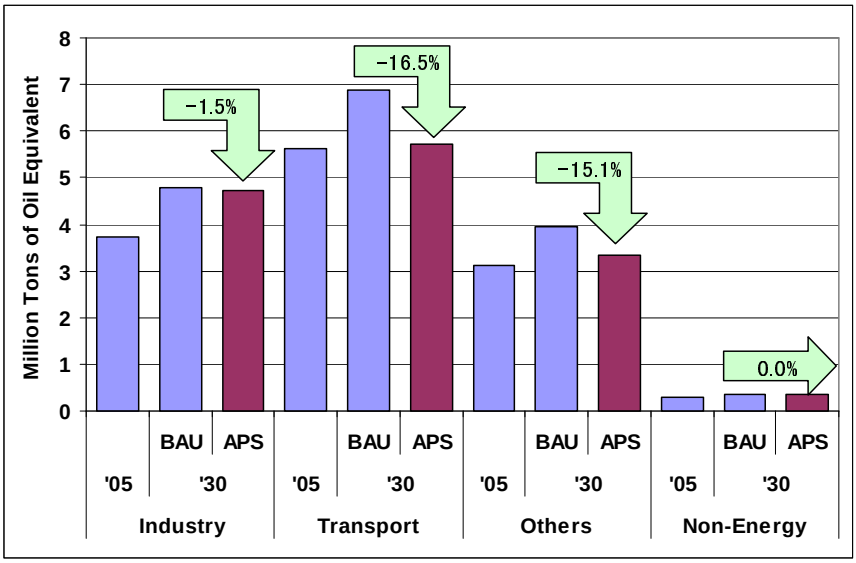
New Zealand's final energy consumption experienced growth of 2.0 percent per year from 9.5 Mtoe in 1990 to 12.7 Mtoe in 2005. The transport sector had the highest growth rate during this period at 3.4 percent per year followed by the 'other' sector (primarily residential and commercial) with 1.9 percent. The industry 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 which increased to 53.4 percent in 2005. Electricity was the second most consumed energy source.

3.1.1. Business-as-Usual (BAU) Scenario

Consistent with New Zealand's projected economic growth of about 2.1 percent per

year, offset somewhat by improved energy efficiency, final energy consumption from 2005 to 2030 is projected to grow at an average rate of 0.9 percent per year in the BAU scenario. Growth rates are fairly consistent across sectors.

Figure 42: Final Energy Consumption in 2005 and 2030, BAU and APS



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 0.6 percent per year, while natural gas and electricity will increase 1.3 and 1.2 percent per year respectively.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption will grow at a rate of only 0.4 percent per year from 12.7 Mtoe in 2005 to 14.2 Mtoe in 2030. Growth in the transport sector will slow to 0.1 percent per year reflecting a shift to more energy efficient vehicles, particularly electric vehicles. The fastest growth will be 1.0 percent per year in the industrial sector where, due to the internationally-standard nature of the technology used; New Zealand's effort to promote energy efficiency is least likely to be effective. Energy use in the 'Other' sector will grow by only 0.3 percent per year, reflecting improved residential and commercial energy efficiency.

3.2. Primary Energy Demand

Primary energy demand of 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 a 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 a statistical anomaly 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.

3.2.1. Business-as-Usual (BAU) Scenario

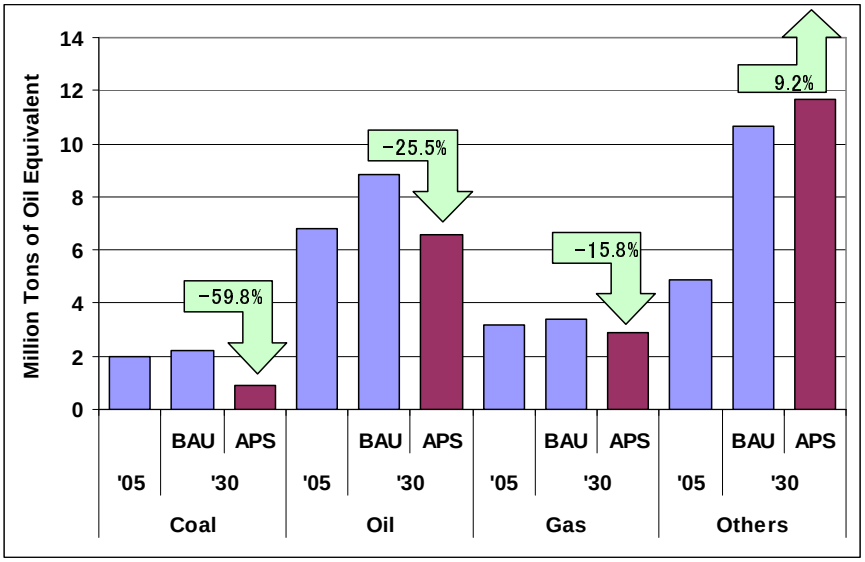
In the BAU Scenario, New Zealand's primary energy demand will grow at an annual rate of 1.6 percent per year to 25.1 Mtoe in 2030. However, this high growth rate is somewhat misleading, as more than half of this growth is in primary geothermal energy, which has an assumed conversion efficiency of only 15 percent. Leaving out geothermal energy, primary energy demand would grow by only about 0.8 percent per year. This growth is mainly due to continued increases in oil consumption at an annual rate of 1.0 percent. 'Other' primary energy will grow by 1.8 percent per year, reflecting mainly the expected growth in wind power. The remaining primary energy sources - coal, natural gas, and hydro - are expected to have only minimal growth.

3.2.2. Alternative Policy Scenario

In the APS, the projected primary energy demand will grow at a slower rate of 1.1 percent per year to 22.0 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 43 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 43: Primary Energy Demand in 2005 and 2030, BAU and APS

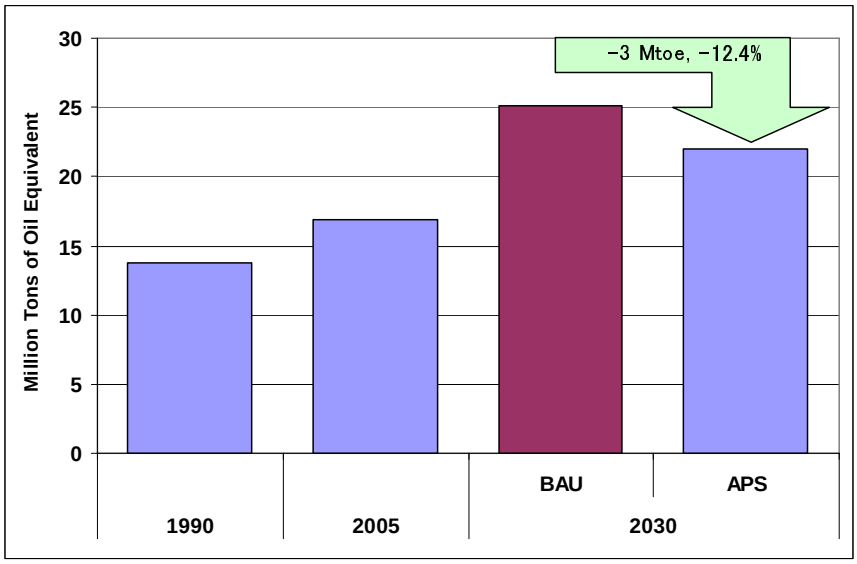


3.3. Projected Energy Saving

Under the APS, energy savings could amount to 3.1 Mtoe, 12.4 percent less than BAU (Figure 44).

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 44: Evolution of Primary Energy Demand, BAU and APS

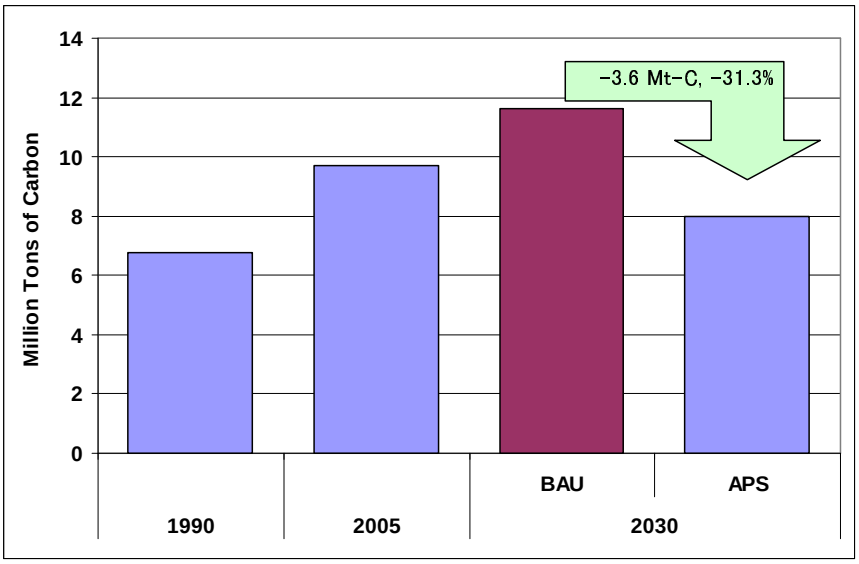


3.4. CO_2 Emissions from Energy Consumption

The calculated CO_2 emissions in the BAU scenario will increase by 0.7 percent per year from 9.7 Mt-C in 2005 to 11.6 Mt-C in 2030. This increase is roughly in line with the increase in primary energy other than geothermal discussed above.

In the Alternative Policy Scenario, there will be a decrease in CO_2 emissions from 2005 to 2030 of 0.8 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. The possible reduction in the APS relative to BAU scenario is shown in Figure 45.

Figure 45: Evolution of CO_2 Emissions in New Zealand



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 and increasing numbers of private road vehicles. New Zealand has historically generated a major portion of its electricity from renewable sources, especially hydro. However, in recent years, as hydro development has approached its natural limits, fossil-fuelled generation has grown rapidly.

New Zealand appears to be economically well-positioned to reduce greenhouse gas emissions. New Zealand has abundant renewable energy resources, including geothermal, wind, biomass, wave, and tidal power. It also has many opportunities to improve energy efficiency, for example, through upgrading the poorly-insulated building stock and inefficient vehicle fleet. Finally, it has a relatively small population, and therefore a relatively small energy demand to meet.

New Zealanders pride themselves on being 'clean and green'. The goal of reducing

greenhouse gas emissions enjoys wide popularity, as well as the support of both major political parties. The combination of economic and political feasibility provides New Zealand with an opportunity to become a world leader in demonstrating how a country can meet its energy needs in an environmentally sound and sustainable manner

Country Report 13

Philippines Country Report

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March 2008

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Philippines

Philippines

Ms. Elvira Gelindon

1. Background

The Philippines is an archipelago comprised of 7,107 islands which is in the midst of Southeast Asia's main water bodies: namely, the South China Sea, Philippine Sea, Sulu Sea, and Celebes Sea.

The country's economy kept its dynamic pace with Gross Domestic Product (GDP) growing by 5.1 percent in 2005 due largely to the 6.3 percent growth of the service sector. The industry sector managed a 4.8 growth due mainly to the stable output of the manufacturing and construction sectors with respective growths of 5.3 percent and 4.6 percent, despite the weak performance of the mining sector. The agriculture sector, however, experienced sluggish growth brought about by El Niño, growing by a meagre 2.0 percent in 2005. The 2005 population was estimated at 83.1 million persons while GDP per capita was about US$1,100.

The country's total primary energy supply in 2005 reached 33.8 million tonnes of oil equivalent (Mtoe). Total indigenous production accounted for about a 55.9 percent share and was about 2.7 percent higher than the previous year's production level.

Imports in 2005 on the other hand, declined by 1.8 percent vis-à-vis the 2004 import level, following a significant cut in oil consumption both for power and non-power applications. Oil remains the country's major source of fuel, accounting for 46.8 percent of the total primary energy.

The country's total electricity generation in 2005 was 56,568 GWh which is 1.1 percent higher than the 2004 level of 55,957 GWh. In 2005, 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 15,294.07 GWh. On the other hand, geothermal energy remained the 3rd largest provider of electricity with a 17.5 percent share in the generation mix in 2005.

Several factors such as policy, prices of competing fuels, technology choices and cost, deregulation or liberalisation of the industry and environmental considerations affect the country's energy mix.

2. Modelling Assumptions

The Philippine economy is expected to grow at a steady pace from 2005 to 2030. It is assumed in this study that the gross domestic product (GDP) of the country will continue to grow at an average annual rate of 6.8 percent growth from 2005 to 2030, reflecting the continued resilience 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 1.7 percent from 2005 to 2030.

To meet the country's increasing demand for electricity, the Philippines will source its energy from coal, 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.

Meanwhile, the intensified development and utilisation of alternative fuels for transport use is seen as a continuing strategy to reduce the country's dependence on imported oil. It also provides a viable solution to cushion the impact of highly volatile petroleum prices on the economy as well as to promote clean and environmentally-friendly energy sources. The major alternative fuels being promoted are biofuels which include biodiesel and bioethanol, autogas (LPG as transportation fuel) and compressed natural gas (CNG). The prospect of using jatropha curcas as a potential biodiesel feedstock is also being explored.

Thus, the energy savings goals of the country will be achieved through intensified energy utilisation management programs in the commercial and industrial sectors, power plants, distribution utilities as well as the continuous use of alternative fuels and technology, among others.

3. Outlook Results

3.1. Total Final Energy Consumption

The Philippines' final energy consumption doubled from 9.5 Mtoe in 1990 to 19.3 Mtoe in 2005 at an average growth rate of 4.8 percent per annum. Over the period 1990-1005 the transport sector grew the fastest at 9.4 percent per annum followed by the industry sector with growth of 2.2 percent per annum. The residential/commercial (other) sector grew at a very slow pace of 1.7 percent per annum. Oil remained the most consumed fuel with a share of 76.4 percent in 1990 which decreased slightly to 73.0 percent in 2005. Electricity is the second largest energy product consumed.

3.1.1. Business-as-Usual (BAU) Scenario

Final energy consumption is expected to grow at an annual average rate of 4.7 percent in the BAU scenario over the period 2005 to 2030. This is due to increased activities in all sectors with residential/commercial (other) sectors growing the fastest at 6.7 percent per annum, followed by the industry sector growing at an average rate of 5.6 percent per annum over the period 2005-30 (Figure 46).

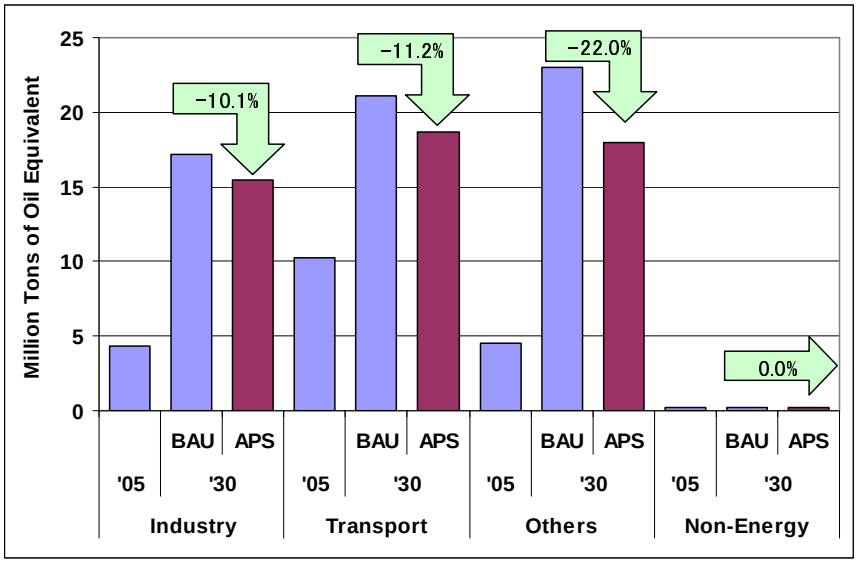
In terms of fuel, coal and electricity consumption are projected to grow the fastest at an average rate of 5.8 and 7.7 percent per annum. Oil will grow at average rates of 3.0 percent per annum.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption is projected to continue to increase at an average

rate of 4.1 percent per annum from 19.3 Mtoe in 2005 to 52.3 Mtoe in 2030. All sectors will contribute to the increase with the residential/commercial (other) sectors projected to have the fastest average annual growth at 5.7 percent between 2005 and 2030. The industry sector is projected to follow closely with average annual growth of 5.2 percent over the same period.

Figure 46: Final Energy Consumption in 2005 and 2030, BAU vs. APS



3.2. Primary Energy Demand

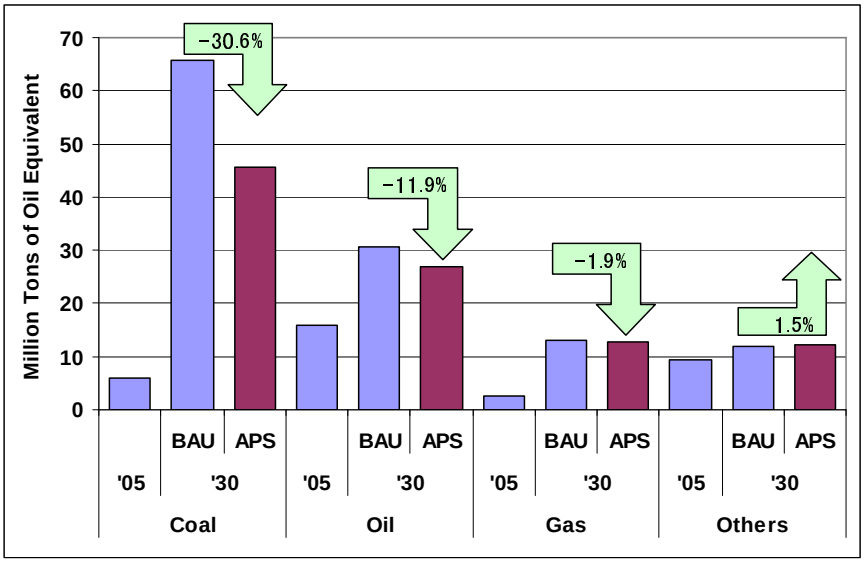
Primary energy demand in the Philippines grew at an annual average rate of 4.1 percent, from 18.5 Mtoe in 1990 to 33.8 Mtoe in 2005. Among the major energy sources, coal consumption grew the fastest at 10.9 percent per annum. Geothermal followed next at 4.0 percent per annum then hydro at 2.2 percent per annum. Oil which had the biggest share in the total with 46.8 percent at 2005 grew the slowest at 1.9 percent per annum during the period (Figure 47).

3.2.1. Business-as-Usual (BAU) Scenario

In the BAU scenario, the Philippines' primary energy demand is expected to increase by 5.2 percent per annum from 33.8 Mtoe in 2005 to 121.2 Mtoe in 2030. All major energy

sources are projected to increase with coal growing the fastest at 10.0 percent per annum from 2005 to 2030. Natural gas is also expected to expand with a high growth rate of 6.6 percent per year during the same period. Hydro will remain as the third major energy source and will grow at 2.9 percent per annum. This is followed by oil with an annual average growth rate of 2.7 percent over the period 2005 to 2030.

Figure 47: Primary Energy Demand in 2005 and 2030, RS vs. APS



3.2.2. Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at an annual average rate of 4.3 percent increasing from 33.8 Mtoe in 2005 to 97.4 Mtoe in 2030. In terms of energy sources, the APS will have similar fuel shares. Coal, natural gas and hydro are the three major sources and are projected to have average annual growth rates of 8.4 percent, 6.5 percent and 2.9 percent respectively over the period 2005 to 2030.

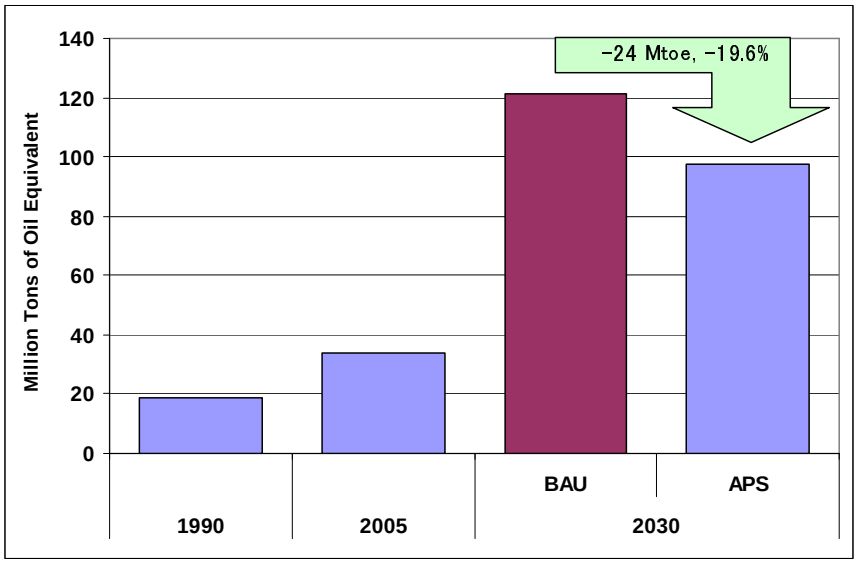
3.3. Projected Energy Savings

The energy savings that could be derived from the EEC goals and action plans of the Philippines is 23.8 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS. This level is about 70.5 percent of Philippine's

consumption in 2005. At current oil prices, this could reach around 14.5 billion US$ of oil import savings (Figure 48).

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 5.1 Mtoe, transport sector with 2.4 Mtoe and 1.7 Mtoe of the industry sector.

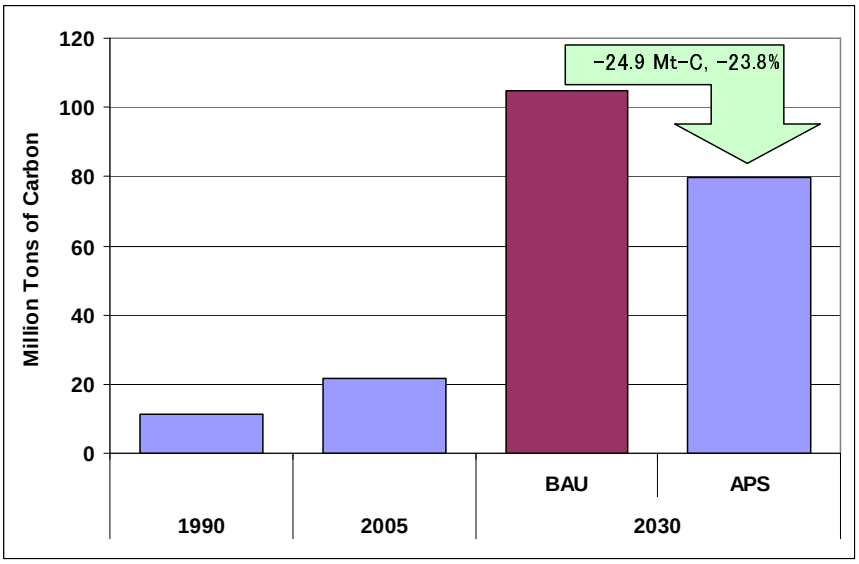
Figure 48: Evolution of Primary Energy Demand to 2030, BAU and APS



3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 6.5 percent annually from 21.4 Mt-C in 2005 to 104.7 Mt-C in 2030 in the BAU scenario. However, in the APS, CO_2 emissions are projected to be lower by almost 24 percent in 2030 than in the BAU scenario (Figure 49). This indicates that the energy savings goals and action plan of the Philippines will be effective in reducing CO_2 emissions in the APS.

Figure 49: Evolution of CO_2 Emissions to 2030, BAU and APS



4. Implications and Policy Recommendations

The continued slow down of the energy intensity of the Philippines, specifically for the last two years could be explained by the country's economic structure which relies more on its service sector rather than on energy intensive industries. The surging oil prices and their inflationary effect on the prices of basic commodities likewise contributed to the lower energy- to-GDP intensity level.

Meanwhile, the change in petroleum intensity can be attributed to the decline in the use of petroleum products particularly by the transport and residential sectors. These sectors were the most affected by the increase in the prices of petroleum products in the past years. Similarly, the relatively minimal growth in electricity consumption led to the decline in electricity intensity vis-à-vis economic output owing to the conservation measures exercised by most sectors (initiated by the government in its energy conservation programs) as a way of hedging against the high cost of electricity.

Seen as an essential strategy in rationalising the country's demand for petroleum products and eventually lessening the impact of escalating prices on the economy, the

NEECP (National Energy Efficiency and Conservation Program) shall continue to provide the framework for the country's efforts in promoting efficient and judicious utilisation of energy.

Likewise, the country shall pursue its development goals to increase support from the private sector to complement government resources in its Information and education campaign (IEC) in the different parts of the country, formulate monitoring mechanisms to determine the actual savings from the energy efficiency and conservation programs and review its policies on Demand Side Management (DSM).

The introduction of alternative fuels in the country provides a feasible part of the solution in minimising the effects of continuous increases in the prices of crude oil in the world market and the worsening condition of our environment. Hence, the government shall pursue its programs and projects that will further increase and enhance the utilisation of indigenous, clean and efficient alternative fuels that include CME, fuel ethanol, CNG, autogas (LPG for transportation) and jatropha.

Country Report 14

Singapore Country Report

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March 2008

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Singapore

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 has increased from 3 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 rate of 0.8 percent per annum was considered 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 making the country to be the most industrialised and urbanised in the Southeast Asia region. GDP in Singapore was 112.2 billions of 2000 US$ in 2005, which result in a GDP/capita of 25.2 thousands of 2000 US$/person. This was a 3.8 percent per annum growth rate in GDP/capita from the 1990 level of 14.7 thousands of 2000 US$/person. The average GDP growth rate for Singapore was 6.5 percent per annum over the 1990 to 2005 period. It is expected that there will be a slowing down of the GDP growth rate in Singapore to 4.0 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. In the future, Singapore is planning to build LNG terminals since their demand for natural gas will continue to increase.

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 Mtoe in 1990 to 15.8 Mtoe in 2005. The industry sector had the highest growth rate during this period at 8.9 percent per annum followed by the other sectors, constituting mainly the residential/commercial sector, with 6.5 percent per annum. The transport sector consumption grew at a slower pace of 3.5 percent per annum. Oil was the most consumed product having a share of 83.3 percent in 1990 and slightly decreasing to 81.7 percent in 2005. Electricity was the second most consumed product.

2.1.1. Business-As-Usual (BAU) Scenario

With the projected economic growth of 4.0 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; i.e. at an average rate of 2.8 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 the consumption of the industrial sector and also in the transportation sector. The consumption of the other sector will also grow but at a lower average rate of 3.6 percent.

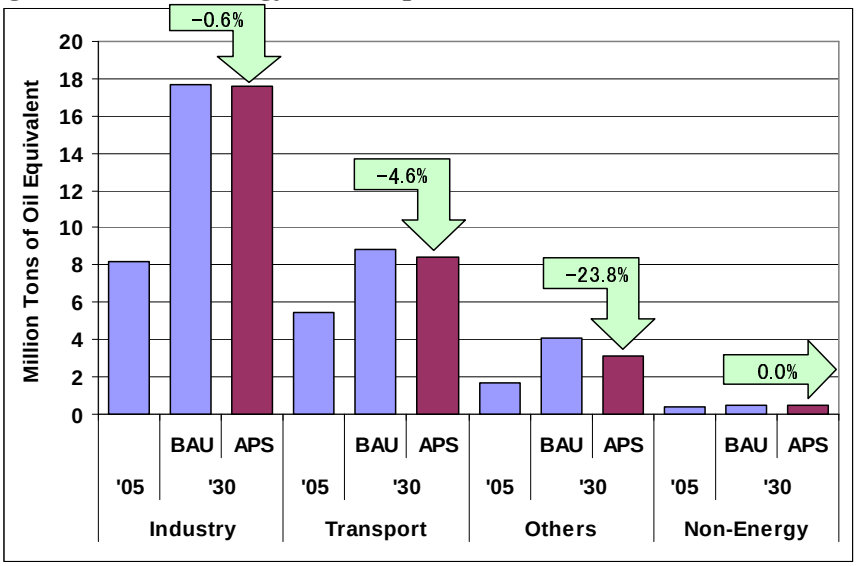
Per fuel type, consumption coal, oil, and electricity will still grow but at a slower rate than the previous 15 years. Electricity consumption will increase higher than oil and gas at an average rate of 3.8 percent per annum. Consumption of oil and natural gas will increase at 2.5 and 1.0 percent per annum, respectively.

2.1.2. Alternative Policy Scenario (APS)

In the APS, final energy consumption will increase at a slower rate of 2.6 percent per annum from 15.8 Mtoe in 2005 to 29.7 Mtoe in 2030. The fastest increase of 3.1 percent per annum will be experienced in the industry sector. But the energy saving

potential is largest in the Other sector due to the implementation of programs particularly in the residential and commercial (Other) sector such as energy audits and building standards and energy labelling of household appliances. Decline in consumption as compared to BAU will be experienced also in the transport sector as incentives to green and energy efficient vehicles are in place. Figure 50 shows the comparative energy consumption between the BAU scenario and APS.

Figure 50: Final Energy Consumption in 2005 and 2030, BAU vs. APS



2.2. Primary Energy Consumption

Primary energy consumption of Singapore grew at a slightly slower rate of 5.6 percent per annum than final energy consumption from 13.4 Mtoe in 1990 to 30.1 Mtoe in 2005. The main energy source of Singapore in 1990 was oil with the consumption was 13.3 Mtoe increasing to 24.2 Mtoe in 2005 at an average annual growth rate of 4.0 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 Mtoe. Singapore also extended its gas supply by importing from Indonesia.

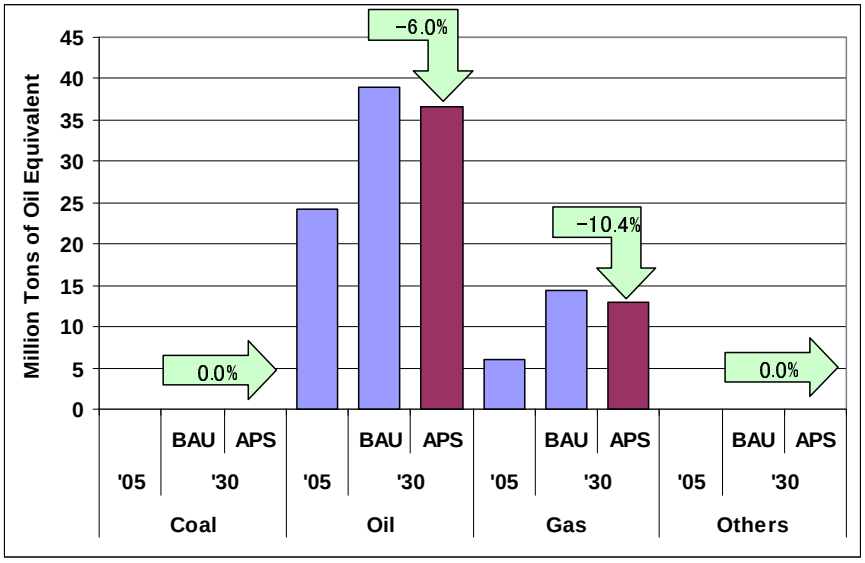
2.2.1. Business As Usual Scenario (BAU)

In the BAU, Singapore's primary energy consumption will increase at an annual rate of 2.3 percent per annum to 53.5 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 1.9 percent. Consumption of natural gas will increase at a faster average annual rate of 3.6 percent in line with the expansion of gas fuelled power plants.

2.2.2. Alternative Policy Scenario

In the APS, the projected primary energy consumption will increase at a lower rate than the BAU scenario at 2.0 percent per annum to 49.6 Mtoe in 2030. There will be reduction in the oil and gas consumed in the Singapore indicating some saving potential for these fuels. In the case of oil, the saving potential will be around 6 percent while for natural gas it will be around 10.4 percent (Figure 51). The higher saving potential from gas will mainly due to construction of higher efficiency gas combined cycle plants which is predicted to reach about 54 percent.

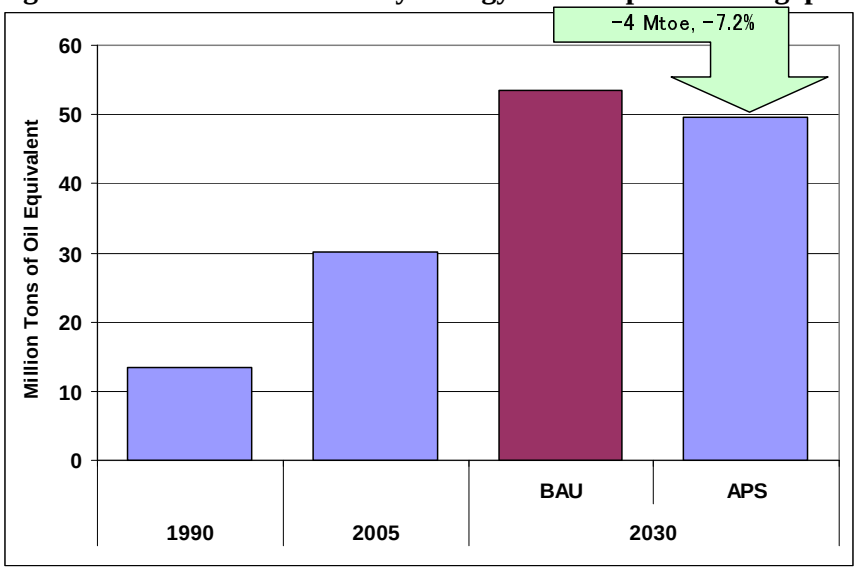
Figure 51: Primary Energy Consumption in 2005 and 2030, RS vs APS



2.3. Projected Energy Savings

In total, the energy savings that could be derived from the EEC goals and action plans of Singapore will be 3.9 Mtoe, the difference between the primary energy consumption of the BAU scenario and the APS (Figure 52). This is equivalent to 13.0 percent of Singapore's consumption in 2005. At current oil prices, this could reach around 2.3 billion US$ of oil import savings.

Figure 52: Evolution of Primary Energy Consumption of Singapore



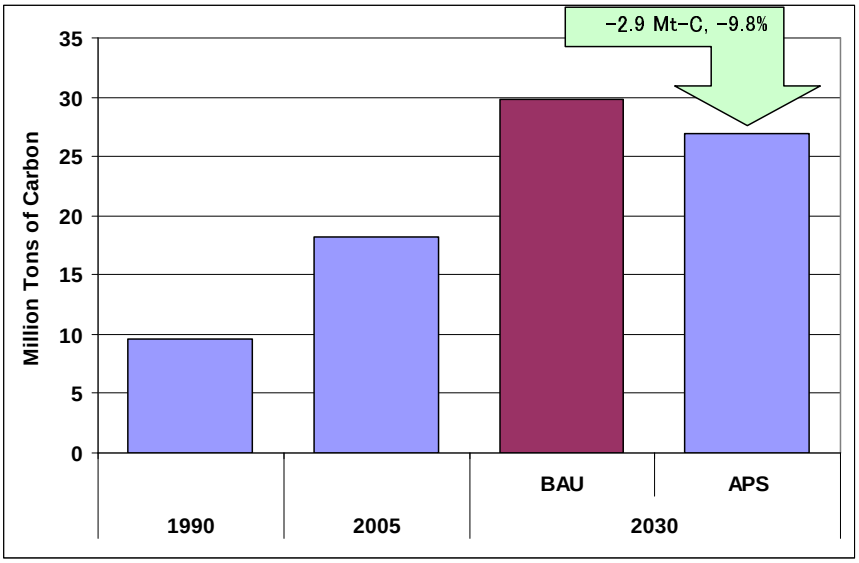
The above savings in primary energy are due to 1.0 Mtoe estimated savings in the final energy consumption of the residential/commercial sector, 0.8 Mtoe in the transportation sector and 0.1 Mtoe in the industrial sector.

2.4. CO_2 Emissions from Energy Consumption

The calculated CO_2 emissions from the energy consumption projection will increase by 2.0 percent per annum from 18.1 Mt-C in 2005 to 29.9 Mt-C in 2030 in the BAU. This increase is lower than the increase in primary energy consumption is due to the use of natural gas which is considered as less-carbon intensive fuels.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 will be 1.6 percent. Comparison between the BAU and APS resulted in a reduction by 7.2 percent of CO_2 emissions of the energy sector. (Figure 53)

Figure 53: Evolution of CO_2 Emissions in Singapore



Country Report 15

Thailand Country Report

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March 2008

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Thailand

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 km^2, with great plains in the centre, mountainous areas up north and high-lands in the Northeast. It has a small economy with GDP in 2005 of around US$157 billion. The population is currently 64 million with an income per capita of US$ 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 M barrel (30 MCM) of oil, 11,700 BCF (316 BCM) of natural gas and 2,081 Mt of lignite.

Thailand's total primary energy demand was 83.5 Mtoe in 2005. By fuel type in 2005, oil represented the largest share at around 55 percent, NG was the second at 31 percent, and coal was the third at 14 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 has large domestic production of NG, about 28 percent was still imported from the neighbouring country, Myanmar.

In Thailand, NG 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 in both power generation and industry. It was heavily used in cement and paper productions.

Thailand has 26.5 GW of installed power capacity and power generation was about 132.3 TWh in 2005. The generation amount by fuel types in 2005, was thermal (coal, natural gas and oil) at 93 percent, hydro at 4 percent and geothermal, solar, small hydro and biomass making up the remainder.

2. Modelling Assumptions

In this outlook, Thailand's gross domestic product (GDP) is assumed to grow at quite a steady rate at an average of 5.2 percent per annum from 2005 to 2030. Population growth is projected to be considerably slower at around 0.5 percent per annum from 2005 to 2030. For comparison the growth rate averaged about 1.1 percent per annum during the period 1990-2005.

With regard to power generation, Thailand is projected to continue to use natural gas and coal as major fuels in the next 15 years at least. On the other hand, fuel-oil and diesel power plant are projected to decrease, while large hydro will remain constant. Nuclear power and renewable fuels, biomass in particular, are projected to increase their shares in the energy fuel mix. Biomass, including biogas and waste will probably be the most significant fuels in meeting the renewable portfolio standard for power generation (RPS).

Thailand's energy saving goals would be achieved by the implementation of energy efficiency programs in all energy consumption sectors. In the industry sector, improvements in technology development in the manufacturing process, along with efficiency labelling on appliances, should help improve energy efficiency. In the residential and commercial (other) sector, energy savings are projected in large amounts driven by energy efficiency programs to promote public awareness in energy efficiency and energy efficiency labelling. In the transportation sector, Bangkok metropolitan will develop the railway network for public transportation within the metro area. Energy efficiency in passenger vehicles will also be expected to improve due to new developments in car technologies and introducing the Eco car program. Great improvements in energy efficiency in this sector are expected as a result.

Given the increased use of alternative fuels, such as nuclear power, the RPS should be expanded and increased use of biofuels should be encouraged. CO_2 emission reductions should also occur. Nuclear power and renewable fuel in power generation is expected to help reduce CO_2 emissions from electricity generation. Gasohol and bio-diesel as oil alternative are expected to help curb CO_2 emissions from transportation.

3. Outlook Results

3.1. Total Final Energy Consumption

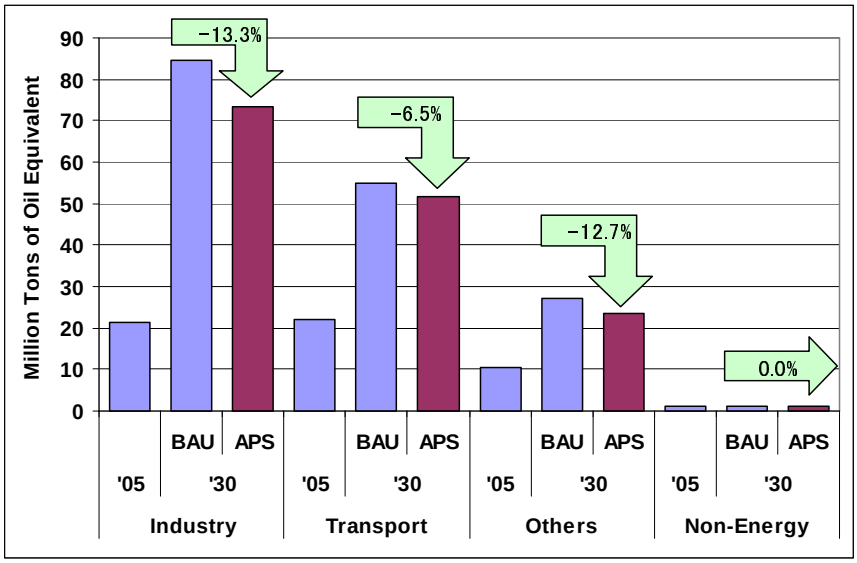
Thailand's final energy consumption during 1990-2005 grew at a robust rate, on average at 6.5 percent per annum or from 21.6 Mtoe in 1990 to 55.3 Mtoe in 2005. The transportation consumed the largest share: 10.9 Mtoe in 1990 and 22.1 Mtoe in 2005, nearly half of the total final energy consumption. Nevertheless, the industry sector played a more significant role in terms of growth in energy consumption, growing from 6.0 Mtoe in 1990 to 21.5 Mtoe in 2005. Its share became as high as 38.9 percent in 2005, compared to the 39.9 percent share of the transportation sector in the same year. Oil has remained the dominant energy source in final energy consumption since 1990 accounting for 36.4 Mtoe or a 65.8 percent share in 2005. Electricity was the second largest in final energy consumption, accounting for 10.4 Mtoe or a 18.9 percent share.

3.1.1. Business-as-Usual (BAU) Scenario

Given moderate economic growth, (at an annual average of 5.2 percent,) and the low growth rate of population, (at an annual average of 0.5 percent,), final energy consumption is projected to grow at the moderate rate of around 4.5 percent per annum during the period 2005-2030. The transportation and industry sectors are projected to remain the largest in final energy consumption, with the highest shares of consumption at 32.8 percent and 50.4 percent respectively in 2030 (Figure 54). The industry sector is projected to become the largest sector by 2030. By fuel type in this projection, oil is projected to remain the largest in the next 25 years until 2030. However, its growth rate is projected to decline from 5.3 percent per annum during 1990-2005 to 3.0 percent per

annum during 2005-2030. In 2030, the shares of natural gas, electricity and coal in final energy consumption are projected to be 20.2 percent, 20.0 percent and 14.7 percent respectively.

Figure 54: Final Energy Consumption in 2005 and 2030, BAU vs APS



3.1.2. Alternative Policy Scenario (APS)

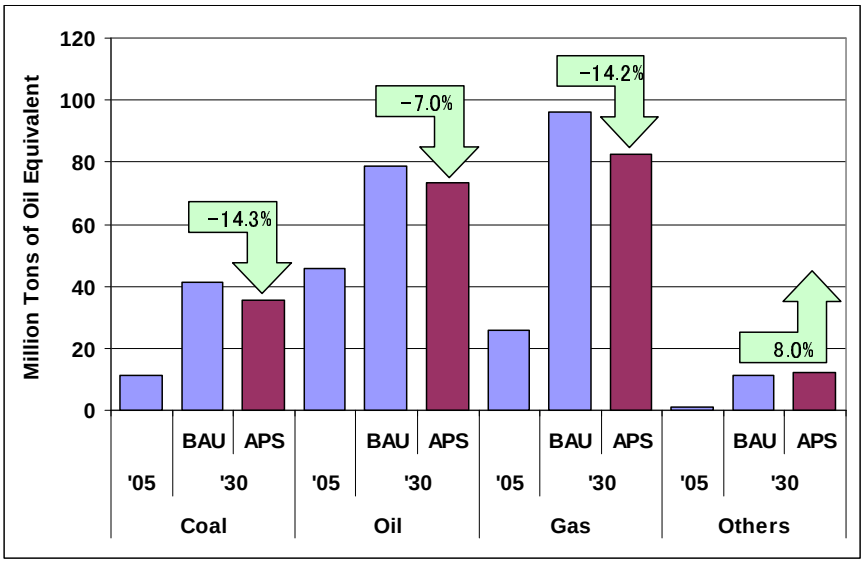
In the APS, final energy consumption is projected to grow at 4.1 percent per annum, from 55.3 Mtoe in 2005 to 149.7 Mtoe in 2030, which is a bit slower than the BAU average annual growth rate of 4.5 percent. The slower growth is driven from the industry, transportation and other sectors. The most energy savings will occur from efficiency improvement programs implemented in the industry and transportation sectors.

3.2. Primary Energy Demand

Primary energy demand grew at a very fast rate at an average of 7.3 percent per annum from 29.2 Mtoe in 1990 to 83.5 Mtoe in 2005 due to fast economic development during 1990-1996. This growth rate was achieved even though there was a severe economic crisis between 1997 and 1998 and a slow recovery during 1999-2005. In 2005, major

sources of primary energy were oil, natural gas and coal with shares of 54.5 percent, 31.0 percent and 13.5 percent respectively, with 99.0 percent of the total, or in Mtoe around 45.5, 25.9 and 11.2 respectively. Although oil remained the largest source during 1990-2005, its share shrank significantly from 67.8 percent in 1990 to 54.5 percent in 2005. On the other hand, natural gas, which is mainly consumed in the power generation sector, became an important source of energy with its share increasing from 17.4 percent in 1990 to 31.0 percent in 2005. Hydropower remained constant at around 0.4 to 0.5 Mtoe from 1990 to 2005.

Figure 55: Primary Energy Demand in 2005 and 2030, BAU and APS



3.2.1. Business-as-Usual (BAU) Scenario

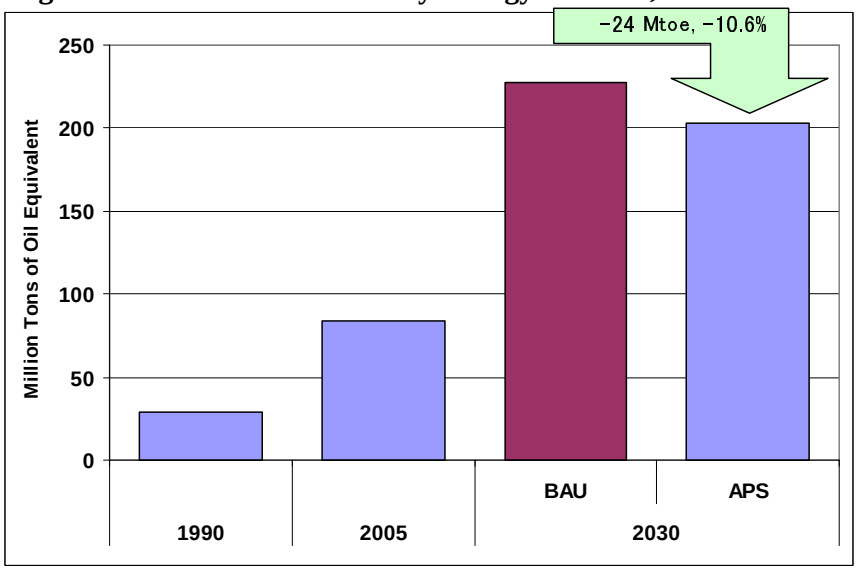
In the BAU scenario, primary energy demand is projected to grow moderately at about 4.1 percent per annum in the next 25 year period from 2005 to 2030, reaching about 227.1 Mtoe in 2030. The highest yearly growth rate will occur in coal, 5.3 percent on average to reach 41.1 Mtoe in 2030. Natural gas is predicted to have the highest growth at about 5.4 percent on average per year, compared to growth rate of 11.5 percent per year between 1990 and 2005. Since natural gas consumption in power generation may reach its limit in the fuel portfolio, it could be replaced by nuclear, according to the government plan.

3.2.2. Alternative Policy Scenario (APS)

In the APS, primary energy demand would have a slower rate of growth than in the BAU scenario at only 3.6 percent per annum (compared with 4.1 percent in BAU) to reach 203 Mtoe in 2030. This means that the APS will save 24.1 Mtoe of energy which is a 10.6 percent reduction relative to the BAU scenario in 2030.

Natural gas is projected to increase from 25.9 Mtoe in 2005 to 82.5 Mtoe in 2030, which is 4.7 percent growth rate per year on average. Oil is also projected to increase from 45.5 Mtoe in 2005 to 73.2 Mtoe in 2030, which is an annual increase on average of about 1.9 percent. These decreases in growth, relative to the BAU scenario, are mainly achieved from energy efficiency and conservation measures on the demand side. The differences in the projections between the two scenarios are shown in Figure 55.

Figure 56: Evolution of Primary Energy Demand, BAU and APS



3.3. Projected Energy Saving

The energy saving that could be derived from the EEC goals and action plans is 24.1 Mtoe, the difference between primary energy demand of the RS and the APS at 2030

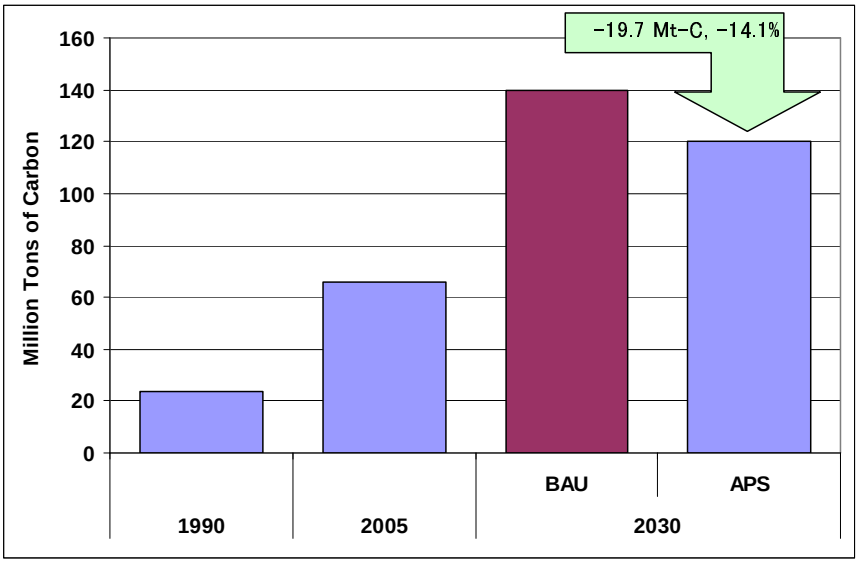
(Figure 56). This is equivalent to about 28.9 percent of Thailand's primary energy demand in 2005. Natural gas will contribute about 13.7 Mtoe in energy savings, while coal will contribute about 5.9 Mtoe.

In final energy consumption, the savings in the APS, relative to the BAU scenario at 2030, could reach 18.3 Mtoe. A reduction in consumption by the industrial sector of 11.3 Mtoe is projected at 2030. Energy savings at 2030 in other sectors are: in the transportation sector - 3.6 Mtoe and in the other sectors around 3.4 Mtoe.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 3.1 percent per year on average from 66.0 Mt-C in 2005 to 140.0 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.

Figure 57: Evolution of CO_2 Emissions in Thailand



In the APS, the average annual change in CO_2 emissions from 2005 to 2030 is projected to be about, and emissions are projected to rise to 120.2 Mt-C in 2030. This carbon decrease points to a remarkable potential for energy efficiency and savings via action

plans (Figure 57).

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), and the dramatic soar of 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. In the industry and residential sectors, the target of 4-5 percent target has also been set. These sectors will focus on decreasing consumption in electric power and fuel oil mainly.

Improving energy efficiency is one of the appropriate solutions of a small economy, like Thailand (which is an oil importer), to address the challenges faced by the world oil price rising. Thailand is committed to trying to reduce its energy consumption, especially oil, and is looking for more sustainable energy sources and environmentally friendly fuels in addition. Changes in Thailand's energy consumption might have significant impacts on world energy. However, the more Thailand saves energy, the less sensitive to world energy fluctuation we will be. 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.

Country Report 16

Vietnam Country Report

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Vietnam

Vietnam

Dr. Nguyen Quoc Khan

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 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 538 US$ per person in 2005.

Vietnam possesses a rather good amount of indigenous energy resources. It has 3,390 million tonnes 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 Mtoe in 2005. By fuel, oil represented the largest share at 45.6 percent, coal was second at 29.7 percent, followed by natural gas (18 percent) and others represented 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 GW of installed generating capacity and generated about 53.5 TWh of electricity in 2005. The generation amount by energy type is broken-down as: thermal (coal, natural gas and oil) at 59.8 percent and hydro (40.1 percent).

2. Modelling Assumptions

In this outlook, 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 2020-2025. 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 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, 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 in more effective traffic management.

Although Vietnam has considered the use of biofuels to reduce 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

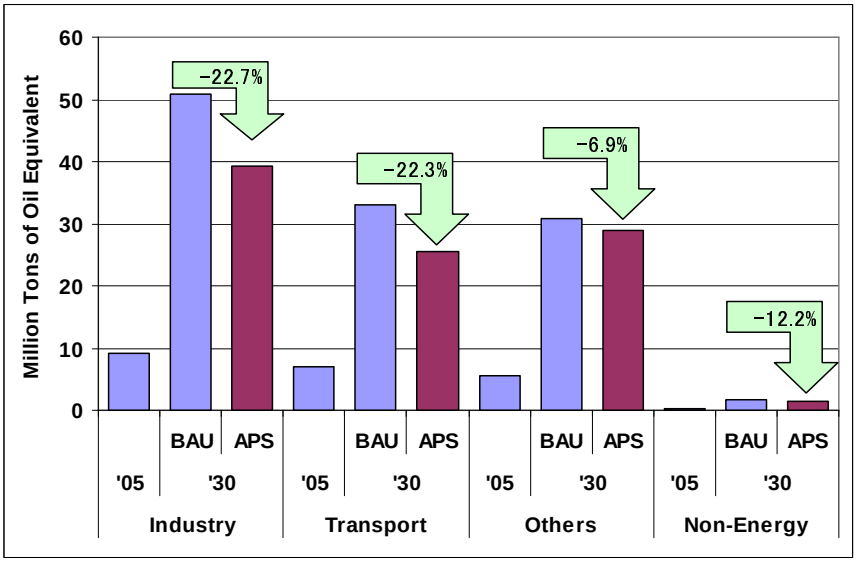
Vietnam's final energy consumption experienced a rapid growth of 11.7 percent per annum from 4.2 Mtoe in 1990 to 22.0 Mtoe in 2005. The industrial sector grew the

fastest at 11.9 percent per annum followed by the residential/commercial (other) sector at 11.5 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 54.4 percent in 2005. Coal was the second most consumed product.

3.1.1. 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 6.9 percent per annum. The consumption of the residential/commercial (other) sector is projected to grow the fastest with annual growth of 7.2 percent per annum followed by the industry sector at 7.1 percent per annum over the period 2005-2030. The consumption of the transportation sector is projected to grow at an average annual rate of 6.4 percent over the period 2005-30 (Figure 58).

Figure 58: Final Energy Consumption in 2005 and 2030, BAU vs. APS



By fuel type, natural gas is projected to grow the fastest at 18.9 percent per annum over the period 2005-30. Electricity is projected to have the second highest growth rate of 9.4

percent per annum over the same period. Consumption of oil and coal are projected to increase at an average annual rate of 6.0 and 4.9 percent, respectively over the period 2005-30.

3.1.2. Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower rate of 6.0 percent per annum from 22.0 Mtoe in 2005 to 95.2 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 transportation sector due to improvement in end-use technologies and the introduction of energy management systems.

3.2. Primary Energy Demand

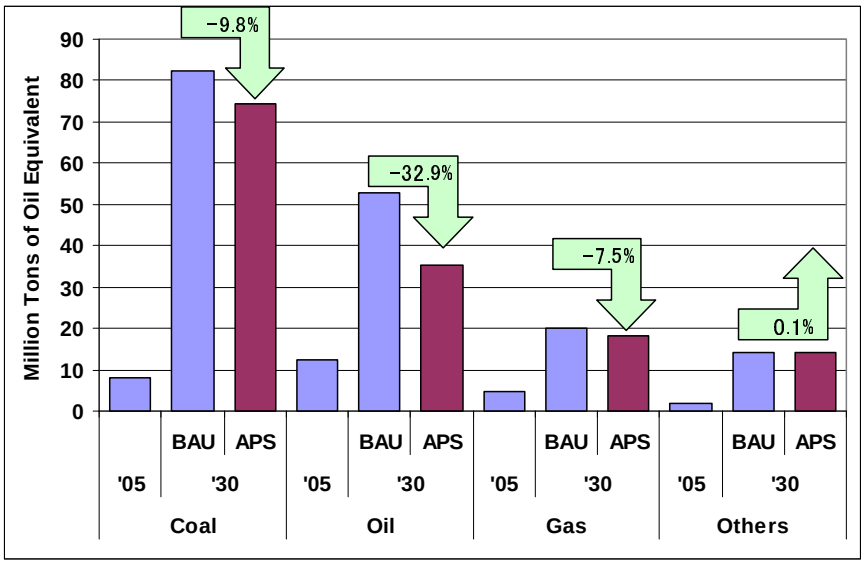
Primary energy demand in Vietnam grew at a slower rate than final energy consumption at 11.4 percent per annum from 5.4 Mtoe in 1990 to 27.3 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas, oil and coal. Natural gas consumption grew at an average annual rate of 64.9 percent while coal and oil grew at 9.0 percent and 10.6 percent, respectively per annum overt 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 6.7 percent in 2005.

3.2.1. Business-as-Usual (BAU)Scenario

In the BAU scenario, Vietnam's primary energy demand is projected to increase at an annual rate of 7.6 percent per annum over the period 2005-30 to 169.1 Mtoe in 2030. Coal is expected to grow the fastest at an annual average rate of 9.7 percent followed by oil and natural gas at 5.9 percent and 5.7 percent, respectively over the period 2005-30. The share of coal is projected to increase from 29.7 percent to 48.6 percent over the period 2005-30 whereas the shares of oil and natural gas are projected to decrease from 45.6 percent to 31.2 percent and from 18.0 percent to 11.7 percent, respectively over the

period 2005-30 (Figure 59).

Figure 59: Primary Energy Demand in 2005 and 2030, BAU vs. APS



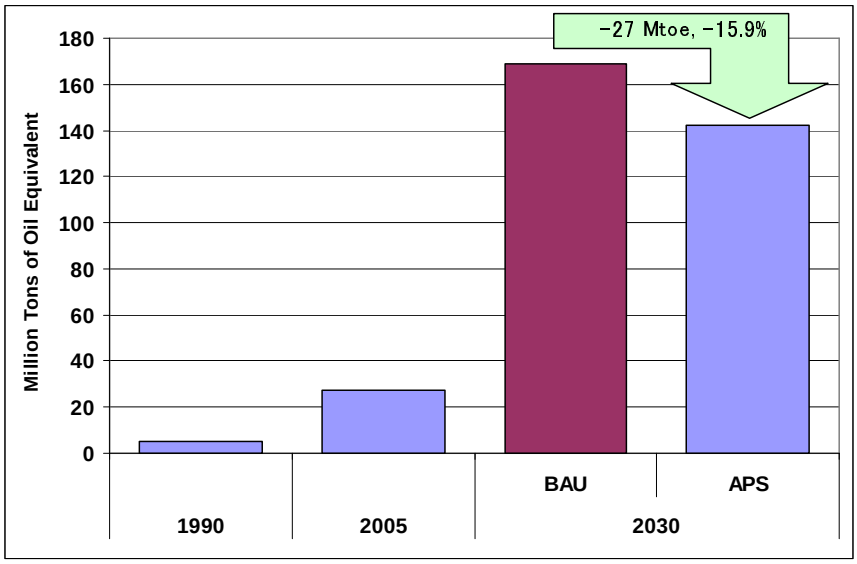
3.2.2. Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate of 6.8 percent per annum over the period 2005-30 to 142.3 Mtoe in 2030. Coal, oil and natural gas are projected to grow at an average annual rate of 9.2 percent, 4.3 percent and 5.4 percent, respectively over the period 2005-30. These decreases in consumption rates, relative to the BAU scenario, are mainly due to energy efficiency and conservation measures n the demand side.

3.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Vietnam are 26.9 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 15.9 percent of Vietnam's consumption in 2030 (Figure 60).

Figure 60: Evolution of Primary Energy Demand, BAU and APS



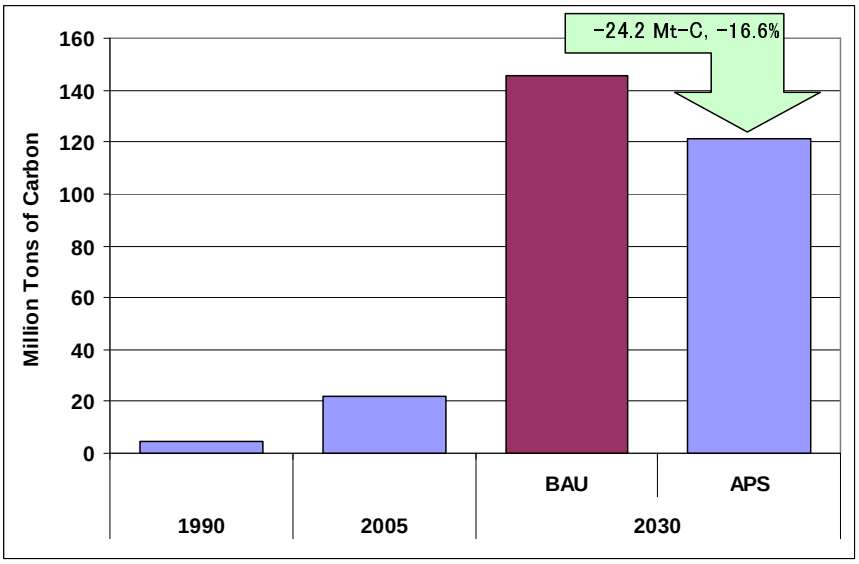
In terms of savings in final energy consumption, there is an estimated saving of 11.6 Mtoe in the industry sector, 7.4 Mtoe in the transportation sector and 2.1 Mtoe in the residential/commercial (other) sector at 2030 in the APS, relative to the BAU scenario.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 7.8 percent per annum from 22.1 Mt-C in 2005 to 145.4 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 7.0 percent. This rate is also higher than the average annual growth rate in primary energy demand of 6.8 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 Vietnam is very effective in reducing CO_2 emissions (Figure 61).

Figure 61: Evolution of CO_2 Emissions in Vietnam



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 would reduce its energy consumption and thus delay the time when Vietnam is expected to become a net energy importer.

It is recommended that energy savings be carried out in all energy consuming sectors. 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. In the transport sector, efficiency improvement will not only be achieved by improved mileage but also in more effective traffic management.

Being a late adopter in some energy efficiency 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.