PART II. COUNTRY REPORTS

Chapter 2

Australia Country Report

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Australia

Ms Edwina Heyhoe and Mr Evan Calford

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. Real gross domestic product (GDP) in 2005 was around US$468 billion (at constant 2000 US$ values[1]), which translates to 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 (Geoscience Australia and ABARE 2010). Australia is overwhelmingly a net energy exporter, with trade in energy dominated by coal, liquefied natural gas (LNG) and uranium. Australia accounts for approximately one-third of world black coal trade — almost 60 per cent of world metallurgical trade and 20 per cent of thermal coal trade (ABARE 2009). Since the late 1980s, Australia has also emerged as one of the largest exporters of LNG to the Asia Pacific region. However, Australia is a net importer of crude oil and refined petroleum products (ABARE 2010).

At current rates of production, Australia's energy resources are expected to last for many more decades. The proportion of economic demonstrated reserves (EDR) to current production is estimated at 490 years for brown coal, 90 years for black coal and nearly 63 years for conventional gas (Geoscience Australia and ABARE 2010).

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

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

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

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 marginally slower than the average annual growth of about 1.2 percent between 1990 and 2005.

Over the period 2000-2008, Australia's growth in gross domestic product (GDP) averaged about 3.2 percent annually. Average annual growth in Australia's gross domestic product is assumed to remain fairly strong throughout the projection period, averaging about 2.9 percent per year between 2008 and 2030. The potential aftershock impacts of the global economic crisis have not been accounted for. The Australian economy is also expected to continue to shift in terms of structure away from agriculture and industry towards the services sector.

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. In electricity generation, coal is projected to remain the largest supplier of energy despite a decrease in the share of coal fired generation, accounting for a projected 42 per cent of total generation at 2030 in the baseline scenario. However, there are projected to be significant increases over time in the share of gas and non-hydro renewables in the baseline scenario, and by 2030 gas and non-hydro renewables account for more than half of total electricity generation. 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. These policies include a national strategy for a renewable energy target, research and development funding for cleaner technologies, financial incentives for energy efficient and renewable technologies, and policies for industry such as the Energy Efficiency Opportunities (EEO) program. EEO requires high energy using businesses to undertake rigorous assessments to identify and evaluate cost effective energy savings opportunities and report publicly and to the government on the results.

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. Australia's 2020 target range for reducing emissions is 5 per cent unconditional, with up to 15 per cent and 25 per cent both conditional on the extent of action by others, as set out in May 2009, and reaffirmed in Australia's submission to the Copenhagen Accord in January 2010. The Australian Government has committed to a long-term goal of

reducing Australia's greenhouse gas emissions to 60 per cent below 2000 levels by 2050.

The Australian Government is in the process of developing policies to enable the abatement targets to be met.

Australia has also provided legislated support to renewable energy technologies via the Renewable Energy Target (RET). The RET sets a 20 per cent target for renewable energy by 2020 and mandates that 45,850 GWh must be produced from renewable sources in that year. The target will be maintained at 45,000 GWh from 2020 to 2030, at which time it is expected that the prevailing carbon price will be high enough to support renewable electricity generation. From 2011, the RET scheme will operate as two separate components – the large scale Renewable Energy Target and the small scale Renewable Energy Scheme.

The assumed carbon price begins at \$8.9 per t CO_2-e (2007-08 A\$) in 2011-12, rises to \$21.5 in 2012-13 and then increases to \$41.8 in 2029-30[2]. The modelling also assumes the operation of the Clean Energy Initiative (CEI). The CEI will fund two to four new carbon capture and storage power stations amounting to 1000MW generation capacity under the CCS Flagships program, as well as up to four solar projects amounting to 1000MW generation capacity under the Solar Flagships program.

3. Outlook Results

3.1. Total Final Energy Consumption

Total final energy consumption in Australia grew at an average annual rate of about 1.8 percent between 1990 and 2005 from about 58 Mtoe in 1990 to 76 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.

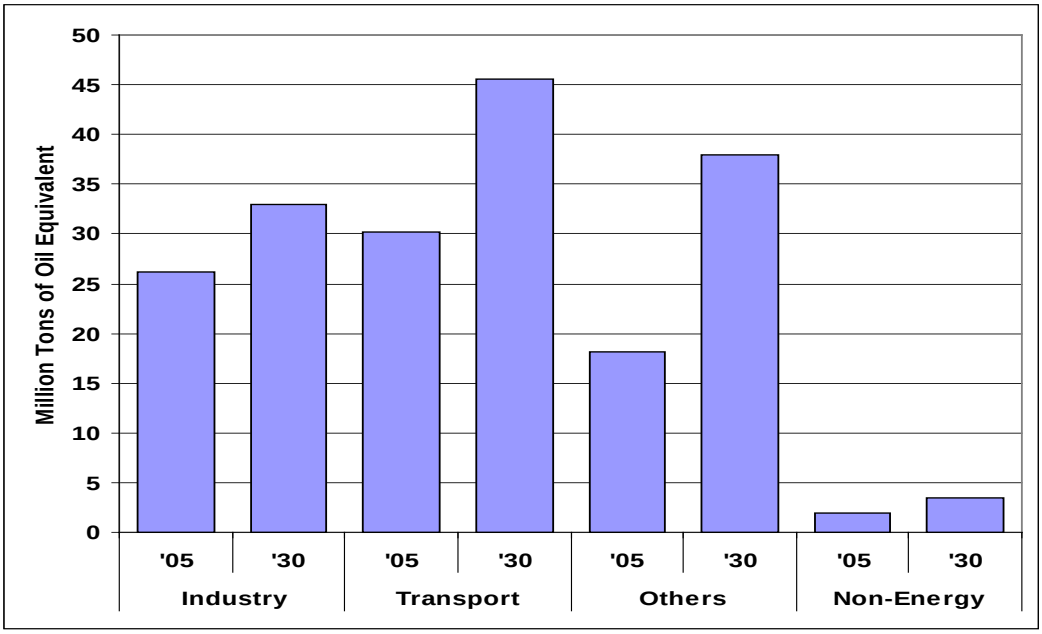
Oil (51 percent) accounted for the largest share of final energy in 2005, followed by electricity (23 percent) and natural gas (16 percent). The fastest average annual growth in final energy consumption occurred in the electricity sector at about 3.2 percent over the period 1990 to 2005.

Total final energy consumption in Australia is expected to increase at an average annual rate of about 1.8 percent over the period 2005 to 2030 from about 76 Mtoe in 2005 to about 120 Mtoe in 2030. Growth in final energy consumption is projected to be slower than growth in Australia's GDP indicating continuing improvements in the energy intensity of economic output.

[2] The assumed carbon price path is related to Australia achieving a 5 percent reduction in emissions at 2020 (the CPRS–5 scenario) sourced from Australian Government (2008).

In this scenario, strong average annual growth in final energy consumption over the period 2005 to 2030 is expected in electricity (2.0 percent) and natural gas (2.1 percent). Continued average annual growth is expected in oil (1.8 percent), others (1.7 percent), including renewables, and coal (0.2 percent) over the same period.

Figure II-1. Final Energy Consumption by Sector in Australia



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.

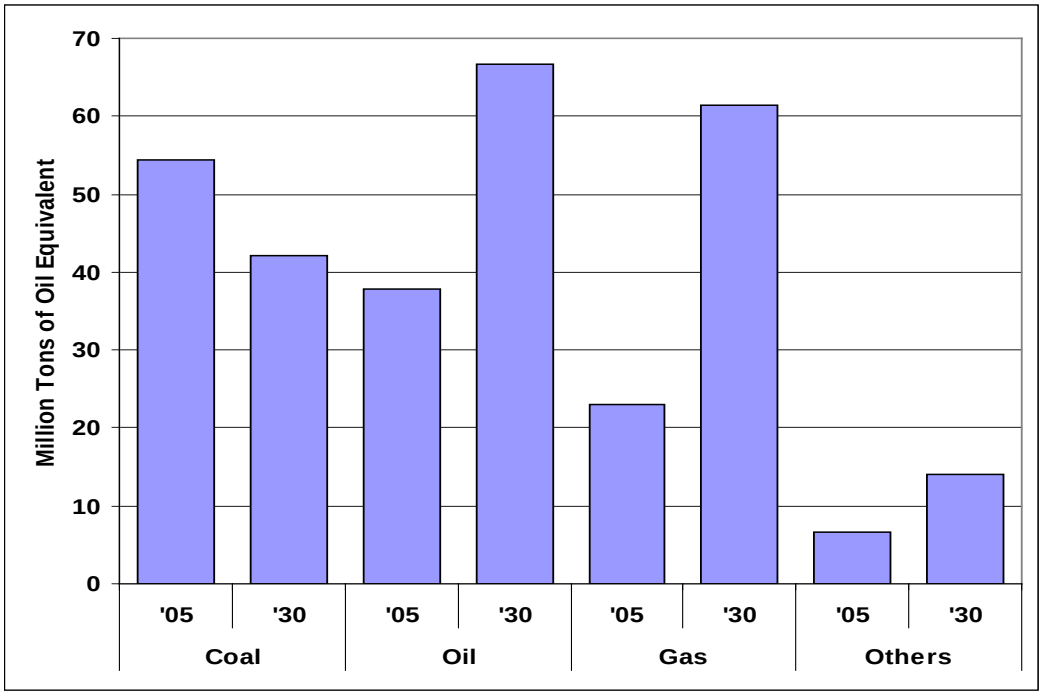
Coal (45 percent) accounted for the largest share of primary energy in 2005, followed by oil (31 percent) and natural gas (19 percent). Hydro and other renewable energy sources accounted for the remaining 5 percent of primary energy in Australia.

In the baseline scenario Australia's primary energy demand is projected to increase at an average annual rate of about 1.7 percent increasing from about 122 Mtoe in 2005 to about 184 Mtoe in 2030.

Coal consumption is projected to decrease at an average annual rate of about 1 percent over the period 2005 to 2030. Consequently, the share of coal in primary energy demand is projected to decline from about 45 percent in 2005 to 23 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 33 percent in 2030. The strong growth in natural gas consumption (averaging about 4 percent per year over 2005-30) is driven by increasing availability of gas including coal seam gas and the assumed national and state policy initiatives designed to encourage the use of lower emission fuels. The share of oil in

Australia's primarily energy consumption mix is expected to increase modestly to about 36 percent in 2030.

Figure II-2. Primary Energy Demand by Source in Australia



Strong growth in primary energy demand is projected to occur in non-hydro renewables primarily in response to the RET.

4. Implications and Policy Recommendations.

Australia's economy is more emissions intensive than most developed countries reflecting to a large extent its resource endowment and economic structure. Increases in population and economic activity are projected to lead to increased demand for energy services.

Achieving significant reductions in Australia's emissions requires abatement across all sectors of the economy. Encouraging the uptake of currently available energy efficiency opportunities will reduce both current emissions and the requirement for new emissions intensive energy infrastructure, which will potentially have a significant impact on the long term emissions pathway (Gurney et al. 2007). Broader emissions abatement policies, such as the proposed carbon emissions reduction target, will affect the emissions intensity of the Australian economy into the medium and longer term.

Given the varying nature of market barriers that limit the uptake of energy efficient and low emission technologies across sectors, a range of policies have been enacted or being considered. These include education and training initiatives, information measures such

as labelling, energy performance standards, and renewable energy targets in the medium term.

Governments can also play a key role in creating policy environments that are conducive to increased levels of research and development in industry, as well as provide funding for basic research and development in mitigation and adaptation measures and technologies. The Australian government is considering mechanisms for wide ranging carbon pricing applicable to most energy related sectors.

Accelerating the development and global deployment of advanced 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).

5. References

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Chapter 3

Brunei Darussalam Country Report

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Brunei Darussalam

Dr. Chee Ming Lim

1. Background

Brunei Darussalam is an independent sovereign constitutional Sultanate, head by His Majesty Sultan Hassanal Bolkiah. Brunei Darussalam is situated on the north-east coast of Borneo Island in South-east Asia, occupying 1%, 5,765 square kilometres, of the land area on the island of Borneo. The development policy of Brunei Darussalam is based on the principle of prudent use of natural resources. His Majesty the Sultan of Brunei has placed great emphasis on environmental protection and conservation. This resulted in the conservation of the rainforest which currently makes about 65% of the land area.

1.1 Socio-Economic Situation

Brunei is an energy exporting country in Southeast Asia, exporting about 17.4 Mtoe. With a population of just over 400.0 thousand, Brunei Darussalam enjoys a high standard of living with the positive social indicators, like literacy rates and life expectancy. The 2009 per capita GDP PPP for Brunei Darussalam is CID 48194[3]. Brunei Darussalam's GDP is projected to grow at an average of 3.9 percent and the population growth at 2.1 percent[4].

In the long-term development plan called Wawasan 2035[5], Brunei Darussalam has set out to achieve:

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

1.2 Energy Supply-Demand Situation

The main energy sources in Brunei Darussalam are natural gas and oil. The primary energy consumption for these two sources of energy in 2005 were 1.8 Mtoe and 0.8 Mtoe for gas and oil, respectively. The use of natural gas is mainly for the generation of electricity and town gas. In mid-2010, the production of methanol came on line using natural gas as feed stock. The use of oil is primarily for petroleum products.

In the electricity sector, 3,396 GWh was generated in 2007. The installed generation capacity in 2010 stands at 690.5 MW, 99.0 percent of it came from natural gas. The efficiencies of power plants commissioned before 2005 are estimated to be around 25.0

[3] Asian Development Bank Key Indicators for Asia 2009.
[4] UN population Data 2009.
[5] Department of Economic Planning and Development. Development Board, http://www.depd.gov.bn/productservice.html

percent.

1.3 Energy Policies

1.3.1 Supply

Brunei Darussalam has sufficient reserves of gas and oil. In 2007, Brunei Darussalam produced 20.2 Mtoe of gas and oil, 17.4 Mtoe of which was exported. The implementations of alternative energy sources are currently being studied. On the other hand, policies pertaining to the use of renewable energy will not likely be released before the expected completion of the study by mid-2011. The study covers amongst others: wind, hydro, tidal, bio-energy, and solar. In the meantime, a 1.2 MWp solar photo-voltaic demonstration plant has been commissioned. The solar PV implementation study is over a period of 3 years. The PV plant has six types of PV modules installed. Other renewable energy demonstration/research plants may come on-line in the near future.

1.3.2 Consumption

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

Brunei Darussalam is committed in achieving a target of 25.0 percent improvement in energy efficiency by 2030, relative to 2005 levels.

1.3.2 Energy Market Reforms, new energy policies under consideration, etc

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

2. Outlook Results

2.1 Final Energy Consumption (FEC)

Business-as-Usual Scenario (BAU)

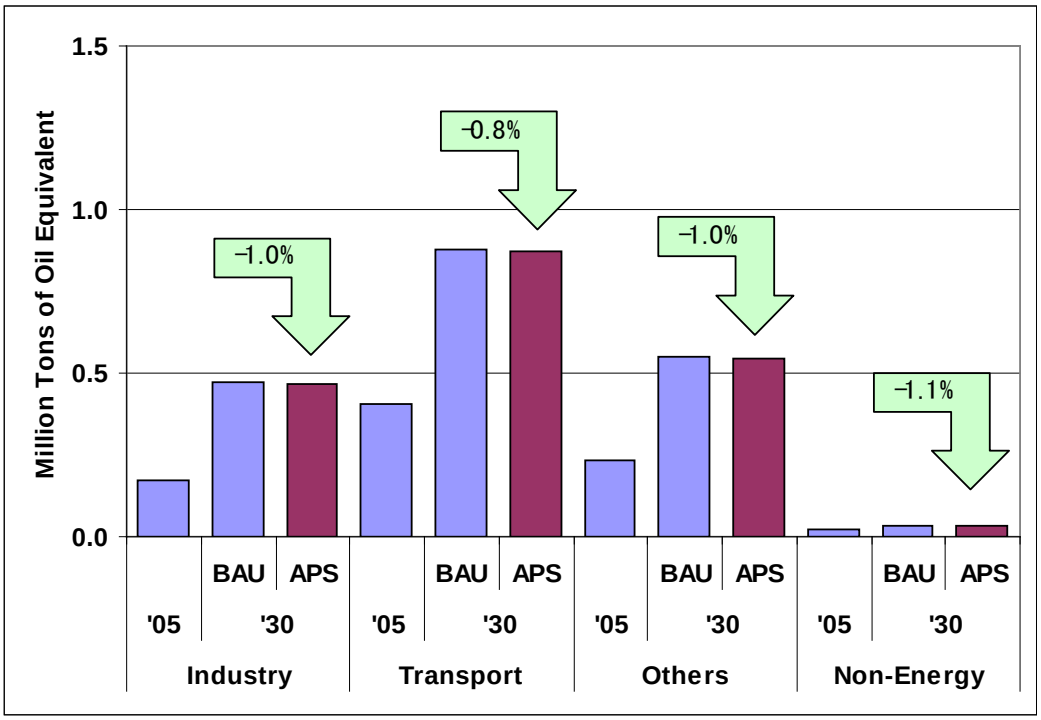
Energy consumption of Brunei Darussalam is increasing over the years. The FEC increased from 0.4 Mtoe in 1990 to 0.8 Mtoe in 2005. The projected average annual increase in FEC from 2005 to 2030 is 3.4 percent. The projection is linked to GDP

growth. The GDP growth in the model is set at a constant rate of 3.8 percent per year with GDP deflator applied.

The highest rate of increase in FEC by sector from the study is from the industrial sector. The industrial sector is expected to grow at an average annual growth of 4.1 percent. The FEC in the residential and commercial sectors[6] will also see a steady increase at 3.5 percent per year. This is in-line with the population increase of 2.1 percent per year and the increase in economic activities in the commercial sector.

Oil, mainly as transportation fuel, remains the highest energy source used. The FEC for oil is 0.4 Mtoe in 2005, corresponding to about 68.3 percent of the total fuel consumed, and by 2030, FEC for oil is expected to be 1.3 Mtoe. The increase in oil consumption is mainly attributed to the increase in the number of road vehicles. The model also assumed a 1.0 percent of electricity production is based on oil. The demand for electricity is expected to increase on average of 3.3 percent per year which translates to an increase of 4.7 percent per year in oil consumption. The difference in percentage growth is due to efficiency factor of electricity generators, set at approximately 35.0 percent.

Figure II-3. Final Energy Consumption by Sector, BAU and APS



Alternative Policy Scenario (APS)

In the APS the model is dictated by the energy conservation policy, whereby a 25.0 percent reduction from 2005 level is targeted. However, the model does not show a significant decrease in total FEC since only 0.9 percent decrease is observed between

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

the total FEC in 2030. Total FEC by sectoral profile in the alternative policy scenario remained almost similar with that of the reference scenario. The small difference is only the 0.01 Mtoe improvement in the transport sector. This correlates to improvement in the efficiency of internal combustion engines.

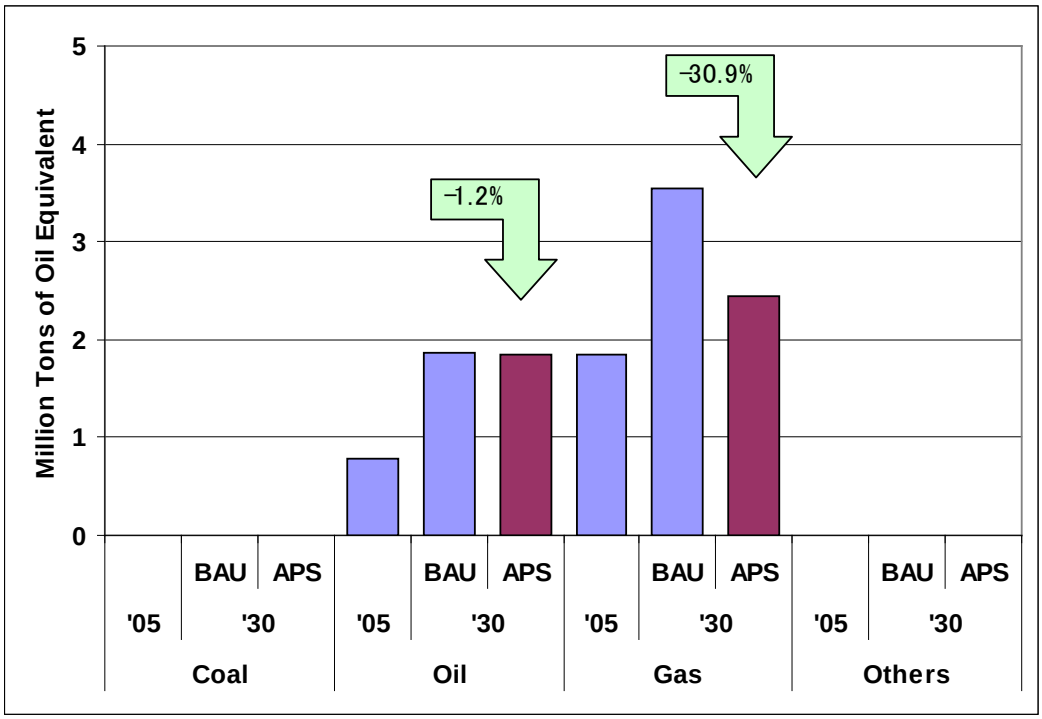
The shift in the energy mix may be changed if alternative energy sources are considered in the APS. It is appropriate to assume at this juncture that oil and gas remain as the main sources of energy as there was no strong indication of alternative energy policies to be implemented in the near future. Changes to this scenario maybe realized once an indication of policies on alternative energy are introduced.

2.2 Primary Energy Supply

Business-as-Usual Scenario

The primary energy supply (PES) is dominated by natural gas at 70.1 percent in 2005. PES increase is expected to be at an average of 2.9 percent per year for the period of 2005 to 2030, and in absolute values; from 2.6 Mtoe to 5.4 Mtoe. In the 2010 model, solar source is being included which is at 1.0 ktoe.

Figure II-4. Primary Energy Demand, BAU and APS



PES for oil will grow at 3.5 percent per year and the PES for natural gas is expected to increase at 2.7 percent per year. These figures show that Brunei Darussalam will continue to be a net exporter of energy. The energy balance table shows that in 2030

Brunei Darussalam will still be exporting 18.9 Mtoe of liquefied natural gas and crude oil.

Alternative Policy Scenario

A significant decrease in PES is observed between the BAU and the APS in year 2030. The difference between the two scenarios is 1.1 Mtoe which corresponds to 20.7 percent reduction. In the intermediate year of 2020, the difference between BAU and APS in absolute value is 0.6 Mtoe which corresponds to a decrease of 13.7 percent.

2.3 Power Generation

Business-as-Usual Scenario

In Brunei Darussalam, power generation is dominated by natural gas; only 1.0 percent is contributed by diesel. In 2005, a total of 3,264.0 GWh of electricity was generated and by 2030 7,604.4 GWh of electricity will be needed. This shows an average annual increase of 3.4 percent. The percentage increase in diesel generation over the same period is also 3.4 percent.

The model assumes low efficiency electricity generation. The efficiency is set only at 24.0 percent which implies that for 0.6 Mtoe or 7.6 GWh of electricity generated, approximately 2.6 Mtoe of natural gas is needed.

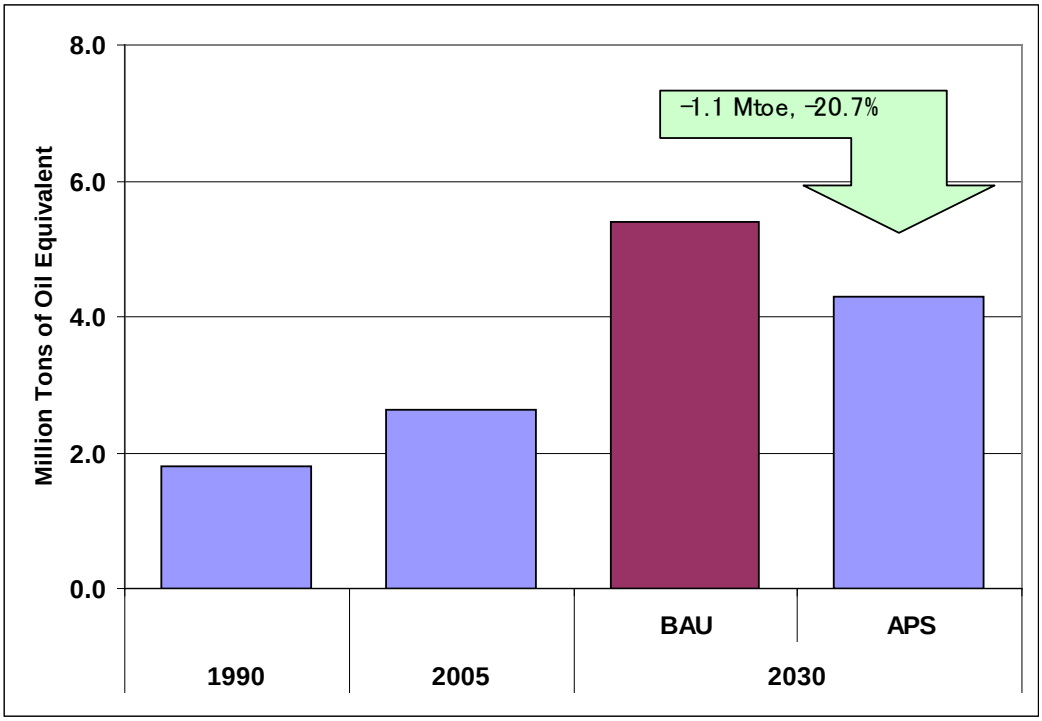
Alternative Policy Scenario

In the APS, the efficiencies of power generation plants were improved to 40.0 percent and this produced a significant change drop in natural gas consumption. The model shows in 2030 for 7.4 GWh of electricity only requires 1.6 Mtoe of natural gas. The APS did not take into account any improvement in diesel generators.

2.4 Projected Energy Savings

The energy savings (the difference between primary energy demand in the BAU scenario and the APS) that could be achieved through the energy efficiency and conservation goals and action plans of Brunei is about 1.1 Mtoe, equivalent to 20.7 percent reduction from the BAU in the year 2030 (Figure II-5).

Figure II-5. Evolution of Primary Energy Demand, BAU and APS



2.5 Carbon Dioxide Emission

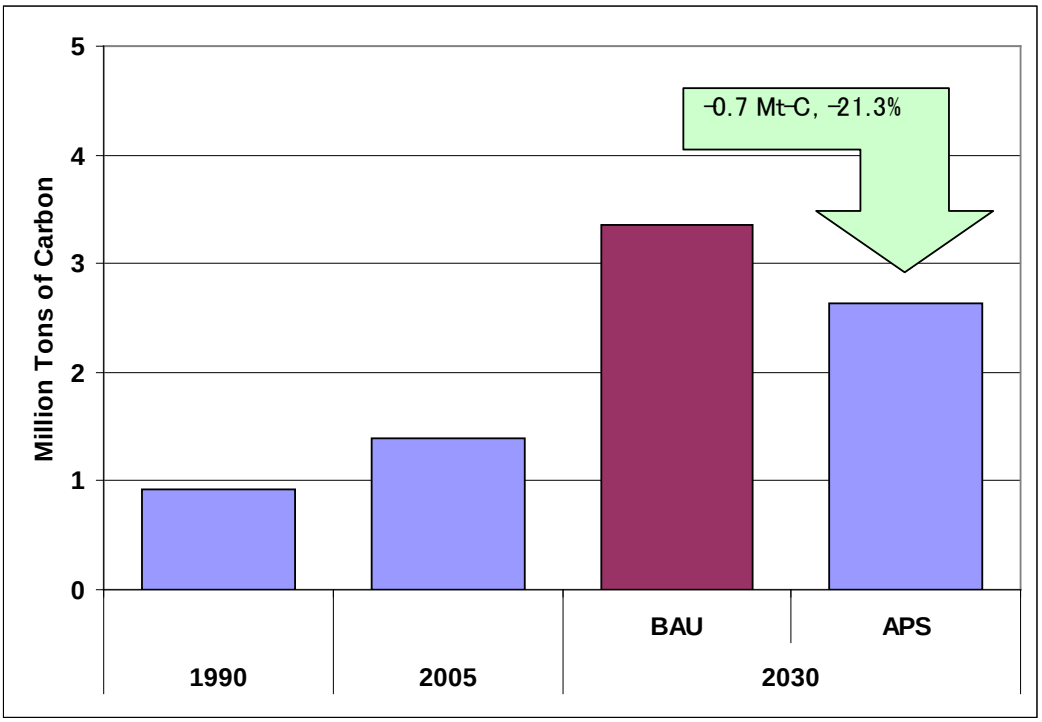
Business-as-Usual Scenario

The percentage increase in carbon dioxide emission correlates strongly to the increase in total primary energy supply (TPES). This is expected because the energy mix for Brunei Darussalam is 99.0 percent dependent on fossil fuel. In 2005, the energy balance table shows 1.4 Mt-C, this increased at a steady rate of 3.6 percent per year to a value of 3.4 Mt-C in year 2030.

Alternative Policy Scenario

In the APS, carbon dioxide emission decreased by 21.3 percent in 2030 as compared to BAU (Figure II-6). Results of the study showed that by 2030 a total of 2.6 Mt-C will be emitted in 2030. The decrease in carbon dioxide emission is significantly attributed to the improvements in the efficiencies of power generation plants. Carbon dioxide per TPES value does not show any significant increase, both BAU and APS remain at 0.6 t-C/toe. This is because no significant amount of non-fossil fuel was introduced in the APS.

Figure II-6. CO_2 Emission in Energy Consumption, BAU and APS



3. Findings and Policy Implications

3.1 Findings

Brunei Darussalam is highly dependent on fossil fuel. The energy profile remains predominantly gas and oil based. The introduction of non-fossil fuel will not be cost effective, and therefore, the most significant way to reduce carbon dioxide emission is to improve on energy efficiency. The model also shows that the improvement in energy efficiency not only reduces carbon dioxide emission but also improves energy intensity, where a decrease from 321.0 toe/Million 2000 US$ in BAU to 254.0 toe/Million 2000 US$ in the APS for the year 2030.

The BAU and the APS only placed emphasis on EEC. The result is significant showing significant reduction in carbon dioxide emission (21.0 percent) and TPES (20.7 percent).

The result of the study also shows that EEC improvement on generation plants have significant impact on TPES and CO2 emission.

Meanwhile, more emphasis should be given in the reduction of fuel consumption in the transport and others sector (residential and commercial) since these sectors consumed more energy based on the results of the study conducted. Initiatives in these sectors are necessary if significant decrease in TFEC is to be expected. An improved transport network could also play an important role in reducing TFEC and CO2 emission.

Further, the transport sector which is one of the largest consumers of oil in the country

will be crucial in achieving energy savings as well as in reducing CO2 emissions. Policies to tackle this problem should involve moving away from private to public transport. Currently, there is a proposal to introduce light-rail transit (LRT) to the capital which is still under discussion. Measures to introduce more energy efficient vehicles should also be looked in to. Another way to reduce consumption of fuel would be to educate the public and promote techniques for energy saving driving or eco-driving.

3.2 Policy Implications

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

Chapter 4

Cambodia Country Report

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Cambodia

Mr. LIENG Vuthy

1. Background

The Kingdom of Cambodia is located in the Lower Mekong region of Southeast Asia. It has an 800 km border with Thailand in the west, with Lao PDR in the north, and Viet Nam in the east. The physical landscape is dominated by lowland plains around the Mekong River and the Tonle Sap Lake. Of the country's area of 181,035 km^2, approximately 49% remains covered by forest. There are about 2.5 million hectares of arable land and over 0.5 million hectares of pasture land. The country's gross domestic product (GDP) in 2005 was about US$ 5.7 billion at constant 2000 prices with a substantial agriculture share of 34 percent. The population during the same year was 14.0 million.

Cambodia's conventional primary energy demand in 2005 stood at 1,303 ktoe while its final energy consumption stood at 1,007 ktoe. It is dependent on imports of petroleum products having no crude oil production or oil refining facilities. Its electricity supply is dominated by oil at 95 percent with hydro accounting for the rest.

Cambodia has 10,000 MW of hydropower potential; however, only 20 MW had been installed to date. Commercial quantities of coal have also been discovered in Cambodia but no official figures on recoverable reserves are available currently.

2. Modelling Assumptions

2.1. GDP and Population

In forecasting energy demand to 2030, it is assumed that the GDP of Cambodia will grow at an annual rate of 7.5 percent. Its population on the other hand is projected to grow at 1.7 percent per annum resulting in a growth rate of GDP per capita of 5.7 percent per annum to 2030.

2.2. Electricity Generation

With regards to the future electricity supply, coal is expected to dominate Cambodia's fuel mix in 2030 followed by hydro. This is a big change from the current oil-dominated electricity generation. According to the Electricity Supply Development Master Plan from year 2010-2020, Cambodia will have a total additional installed capacity of 3,173.2 MW, 900 MW of which will come from coal power plants to be installed from 2010 to 2018. Hydro will make up 1,873.2 MW of the total.

From 2020 to 2030, the additional capacity requirements will still be met by coal and hydro. The gross electricity generation also assumes net export of electricity to

neighbouring countries of 2,600 GWh in 2020 that will gradually increase to 3,080 GWh by 2030.

2.3. Energy Efficiency and Conservation Policies

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

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

- Improving the efficiency of the overall supply chain for home lighting in rural areas by the provision of decentralized rural energy services through a new generation of rural energy entrepreneurs.
- Assisting in market transformation for home and office electrical appliances through bulk purchase and dissemination of high performance lamps, showcasing of energy efficient products, support to competent organizations for testing and certification of energy efficient products and establishment of "Green Learning Rooms" in selected schools to impart life-long education on the relevance of energy efficiency and conservation.
- Improving energy efficiency in buildings and public facilities.

Cambodia has also embarked on preparing an action plan for energy efficiency and conservation in cooperation with the Energy Efficiency Design sub-working group created under the WG. Specific actions plans are being drafted for the industrial, transportation and other sectors. The initial estimates of sectoral demand reduction of existing consumers from these actions plans are 10% by 2030. These initial estimates were used in forecasting the energy demand in the APS.

3. Outlook Results

3.1. Total Final Energy Consumption

Cambodia's final energy consumption (not including biomass) grew at an average annual rate of 10.2 percent from 1995 to 2005. This growth was driven by the industrial sector which grew at a rapid rate of 30.7 percent during the ten-year period. The other sector which comprises the residential and commercial sectors grew at an average rate of 18.9 percent annually while the transportation sector had a more modest annual growth rate of 4.2 percent. In terms of energy, petroleum products comprise more than 90 percent of total final energy consumption with electricity supplying the rest.

Business-as-Usual (BAU) Scenario

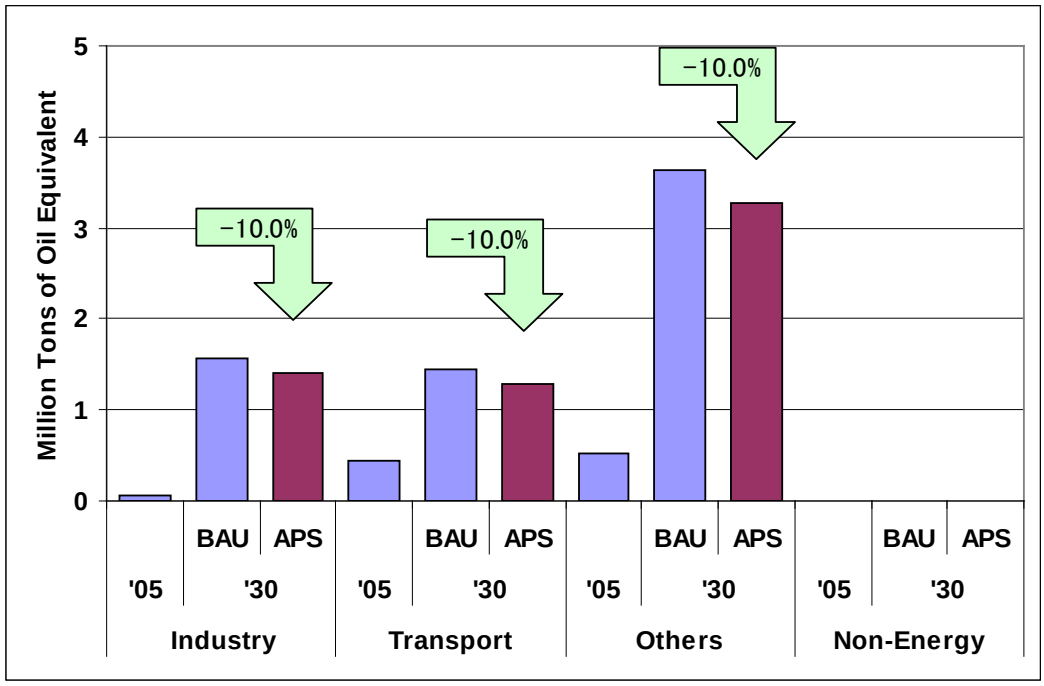
From 2005 to 2030, Cambodia's final energy consumption is projected to grow at an average annual rate of 7.8 percent in the BAU scenario. The industrial sector is expected to have the highest growth rate of 14.7 percent per annum followed by the transportation sector at 4.8 percent and the residential/commercial sector at 8.1 percent over the period 2005-2030. The rapid growth in the industrial demand is to due to the start of the commercial operation of the first cement manufacturing plant in 2008 which is expected to grow at the same rate as its economic growth. This is in view of the country's plan to meet its projected increasing demand for cement with local production.

By source, electricity consumption is expected to increase on average by 14.7 percent per annum while the demand for petroleum products will grow by 5.6 percent per annum to 2030. Coal consumption started in 2008 and is projected to more than double by 2030.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to grow at a slower rate of 7.4 percent per annum over the 2005-2030 period. This reflects the success of implementing the various energy efficiency action plans that were proposed across all sectors. The average annual growth rates of energy consumption in the industrial, transportation and others sectors will be 14.2 percent, 4.4 percent and 7.7 percent, respectively. The growth in electricity consumption will also be slower at 14.2 percent per annum while that of oil will be 4.9 percent per annum. The difference in the demand in the BAU and APS are shown in Figure II-7.

Figure II-7. Final Energy Demand by Sector in Cambodia



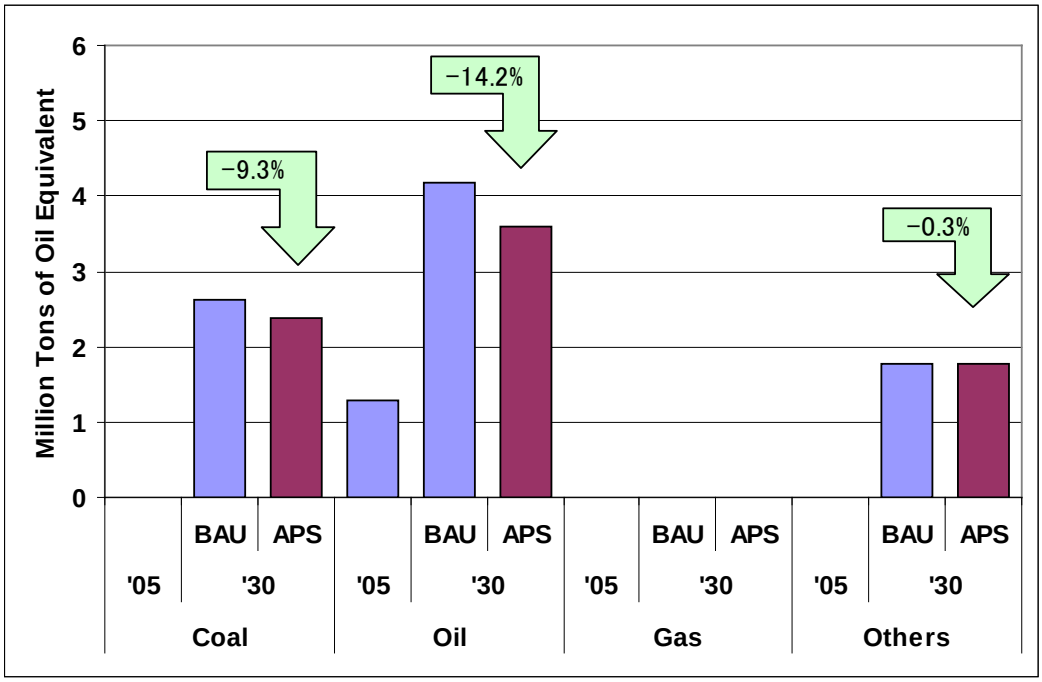
3.2 Primary Energy Demand

Cambodia's primary energy demand grew at an average annual rate of 10.4 percent from 1995 to 2005. Petroleum products were the only source of conventional energy supply in the country in 1995. By 2005, a small hydropower plant was built but only contributed 0.3 percent to the total primary energy demand.

Business-as-Usual Scenario

From 2005 to 2030, the country's primary energy demand is projected to grow at an average annual rate of 7.8 percent in the BAU scenario. Given the rapid growth in electricity demand of 14.7 percent annually, hydroelectricity production will increase on average by 28.6 percent per annum to 2030. This high growth in hydroelectricity is projected although coal is also being considered as a future source of electricity. Oil, in view of the retirement of oil-fired power plants in the country by 2020, will have a slow growth rate of 4.8 percent.

Figure II-8. Primary Energy Demand by Source in Cambodia



Alternative Policy Scenario

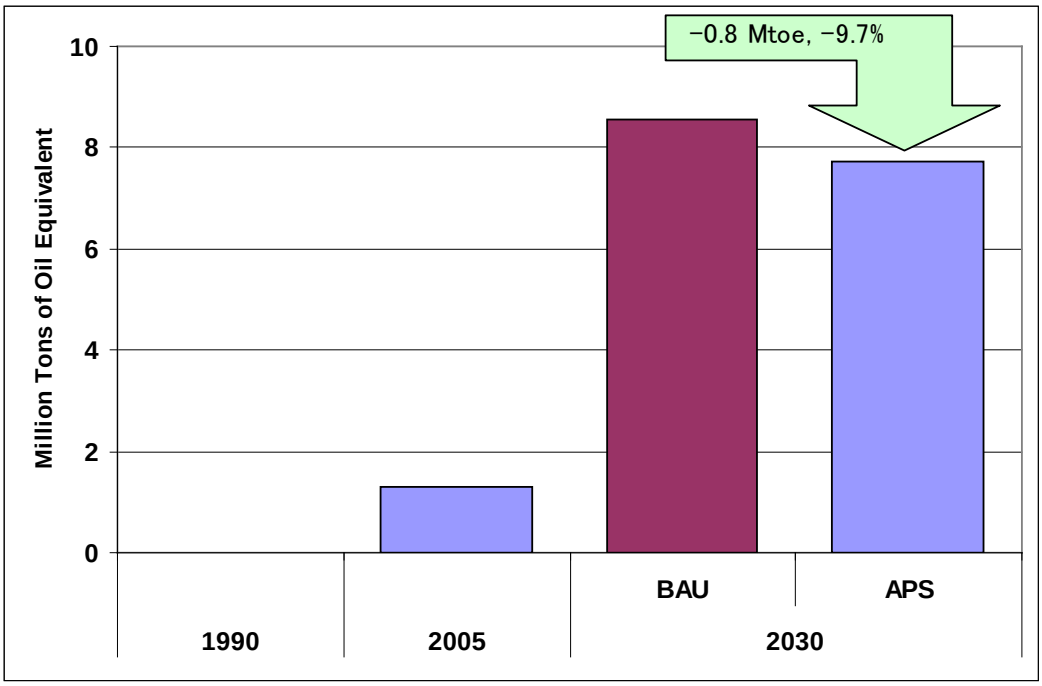
In the APS, primary energy demand will increase at a slower rate of 7.4 percent per annum. Hydroelectricity generation will also be at a slower rate of 28.1 percent per annum. The differences in the primary energy demand by source in the BAU and APS are shown in Figure II-8.

3.3 Projected Energy Savings

The initial estimates of the impacts of sectoral energy efficiency actions plants will result to a reduction in primary energy demand of 834 ktoe from BAU to APS. This is equivalent to a 9.7 percent primary energy savings by 2030. Figure II-9 shows the primary energy demand in Cambodia in the BAU and APS.

In terms of final energy consumption, sectoral savings in the APS relative to BAU will amount to 157 ktoe in the industrial sector, 144 ktoe in the transport sector and 364 ktoe in the other sectors.

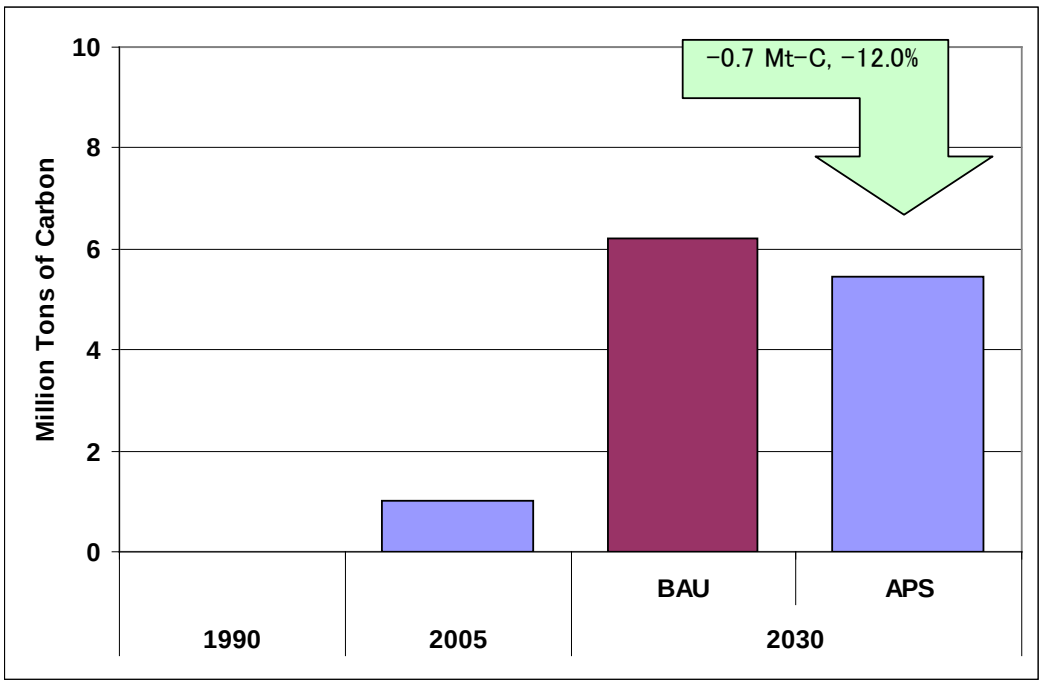
Figure II-9. Total Primary Energy Demand in Cambodia, BAU and APS



3.4 CO_2 Emissions from Energy Consumption

Based on the above projections, CO_2 emissions in Cambodia in the BAU will increase from 1,029 kilo tons of carbon (kt C) in 2005 to 6,194 kt C in 2030 at an average annual rate of 7.4 percent, 0.4 percentage points lower than the growth rate of primary energy demand. In the APS, the growth rate will be lower at 6.9 percent, also lower than the 7.4 percent growth rate in primary energy demand (Figure II-10).

Figure II-10. CO_2 Emission from Energy Consumption in Cambodia



4. Implications and Policy Recommendations

In 2005, Cambodia's per capita consumption of commercial energy of 0.1 toe/person are among the lowest in EAS at only 10% of the EAS average of 1.0 toe/person. As Cambodia endeavours to improve its economy and at the same time provide the necessary energy services to its population, it could be expected that energy consumption will also increase.

However, there are proven ways to minimize the growth of energy consumption without affecting economic growth. One of these proven ways is energy efficiency and conservation. Currently, with the support of the ERIA, Cambodia is preparing an energy efficiency and conservation action plan. This is a very important activity that will certainly need the support and commitment of the Cambodian government.

Chapter 5

China Country Report

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China

Dr. Hua LIAO

1. Background

1.1 Natural Condition and History

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

China is a country with over 5,000 years long history and one of the five countries with great ancient civilization. The People's Republic of China was founded on October 1, 1949. Today, China is implementing reforms and opening up its economy, and has established a socialist market economy, thereby charting the course for socialist modernization with Chinese characteristics.

1.2 Economy and Population

China's real gross domestic product (GDP) in 2010 was around US$5,878 billion (at current prices and exchange rate), which translates into a per capita income of around US$ 4,382, ranking about the 90th in the world.

China is the world's most populous country. It has a population about 1.37 billion (according to its 2010 population census), which makes up about 20 percent of the world total. To mitigate population growth, the country has implemented a family planning policy since the 1970s. China is experiencing a fast urbanization process. About 49.7 percent of people lived in urban areas in 2010.

1.3 Energy Situation

In terms of energy resources, China is endowed with coal, oil and gas reserves and hydropower. China is the world's top coal producer and has the third largest coal reserves with recoverable reserves of 114.5 billion tonnes. In 2010, China produced 3.245 billion tons of raw coal. China is still a major crude oil producer, and produced 203 million tons of crude oil in 2010. However, driven by very fast increase in oil demand, China became an oil importer in the 1990s. Currently, approximately 60 percent of China's oil consumption is met by imported oil. China is also a large energy intensive commodities producer and exporter. In 2010, it produced 798 million tons of finished steel and 1.88 billion tons of cement. It exported 43 million tons of finished steel during the year.

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

By primary fuels in 1990, coal accounted for 79.7 percent while oil was 16.6 percent, natural gas almost 2 percent and hydro 1.6 percent. In 2005, coal was still a major fuel, but with a lower share at 72.3 percent. The share of other energy sources increased from their 1990 levels to 21.2 percent for oil, 2.7 percent for gas, 2.3 percent for hydro and 0.9 percent for nuclear in 2005. All in all, primary energy consumption in China increased at an average annual rate of 5.6 percent from 663 Mtoe in 1990 to 1,505 Mtoe in 2005. Energy intensity (primary energy demand per unit of GDP) decreased from 1,491 tons of oil equivalent per million US$ (toe/million US$ AT 2000 values) in 1990 to 795 toe/million US$ in 2010.

Final energy consumption in China increased at a lower annual average growth rate of 4.5 percent from 463 Mtoe in 1990 to 894 Mtoe in 2005. Coal accounted for 68.0 percent in 1990 and 41.7 percent in 2005 of the total final energy consumption. In 1990, oil accounted for 18.1 percent of total final energy consumption. Growth in oil consumption has increased rapidly at 8.2 percent per annum leading to a significant increase in its share to 30.3 percent in 2005. Electricity is also increasingly important and it had a high annual growth rate of 9.9 percent between 1990 and 2005, which was higher than any of the other conventional energy sources. Electricity share in final energy consumption has increased from 9 percent in 1990 to 19.2 percent in 2005. The remaining fuels, natural gas and heat, grew at a similar fast rate of 8.2 percent per annum during the same period but collectively only constituted about 8.5 percent of total final energy consumption in 2005.

Industry is the major energy consuming sector in China followed by the residential and commercial (“others”) sectors. The share of industry consumption increased from 52 percent in 1990 to 53 percent in 2005. The share of energy consumption in the others sector declined from 30.7 percent in 1990 to 23.6 percent in 2005. This was due to the faster growth in the industry and transport sectors, which grew at 4.6 and 7.8 percent per annum, respectively, from 1990 to 2005.

In China, coal-fired power generation accounted for around 71.3 percent of total electricity generation in 1990. By 2005, this share increased to 78.9 percent. The share of hydro was 20.4 percent in 1990 and it was decreased to 15.9 percent in 2005. Gas and oil, collectively, accounted for about 3.0 per cent of total generation in 2005. The share of oil in total generation declined to 2.5 percent in 2005 while the share of nuclear power increased to about 2.1 percent.

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

2. Modelling Assumptions

1.1.Population and Gross Domestic Product

The model is developed by the Institute of Energy Economics of Japan (IEEJ). Among the assumptions used in the model are GDP and population.

China had a population of 1.14 billion in 1990 and 1.3 billion in 2005. There was an average annual growth rate of 0.9 percent over those 20 years. From 2005 onward, the population growth is expected to be slower, due to implementation of the one child per family policy. China's population is projected to increase at average rate of 0.5 percent per year and reach 1.46 billion people by 2030.

China's economy grew at an average annual rate of 10.1 percent between 1990 and 2005. The GDP grew from US$ 445 billion (2000 US$ values) in 1990 to about US$ 1,893 billion in 2010. Future GDP growth is expected to be slower. In this study, GDP is assumed to grow at an average rate of 7.7 percent per annum and it will reach US$ 11,996 billion by 2030. Given the GDP and population projections, GDP per capita in China is projected to increase from US$ 1,500 per person in 2010 to US$ 8,200 per person in 2030.

2.2 Energy and Climate Change Policies

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

In previous five years, China has made great achievements on energy conservation. Its energy intensity was reduced by over 19%. Many polluting and inefficient factories and equipment have shut down. In 2006-2010, a total capacity of 72.1 GW of small thermal power units with low energy efficiency were shut down, backward production capacities of over 330 million tons of cement per year, 68 million tons of steel were phased out. In 2010, hydropower generation was 72.1 TWh, accounting for 15.1% of the national power generation. For many years, China has stably ranked first in the world in both installed and under-construction capacities and power generation of hydropower. At end-2010, the total installed capacity of hydropower is over 213 GW and the total installed capacity of wind power reached 41.83 GW, ranking the first in the world.

In addition, the top 1000 energy intensive enterprises in China were required to implement measures to save energy. New vehicle fuel standards have also been established. New buildings are required to meet 50 percent energy saving standard so as to improve building energy efficiency. Efficient fluorescent lamps have been widely promoted to enterprises and people. Energy audits for factories are subsidized. Statistical and dynamic monitoring systems of energy consumption for industrial

enterprises have also been developed. Furthermore, a number of energy efficiency standards on industrial devices and household appliances have been enforced.

In 2011, the Government continues to set a challenging goal of reducing its national energy intensity by about 16 percent by 2015, as part of its 12th Five-Year Socio-Economic Development Plan. In order to achieve this goal, the Government has already implemented administrative, market-based and legal measures to promote energy conservation, and it will continue to implement new policies. Energy intensity reduction goals will be assigned to provincial governments and progress will be announced publicly every year.

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

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

3. Outlook Results

3.1 Total Final Energy Consumption

From 2005 to 2030, China's final energy consumption is expected to grow but at a slower pace because growth rates of GDP and population are lower, comparing with those in 1990-2005.

Business-as-Usual (BAU) Scenario

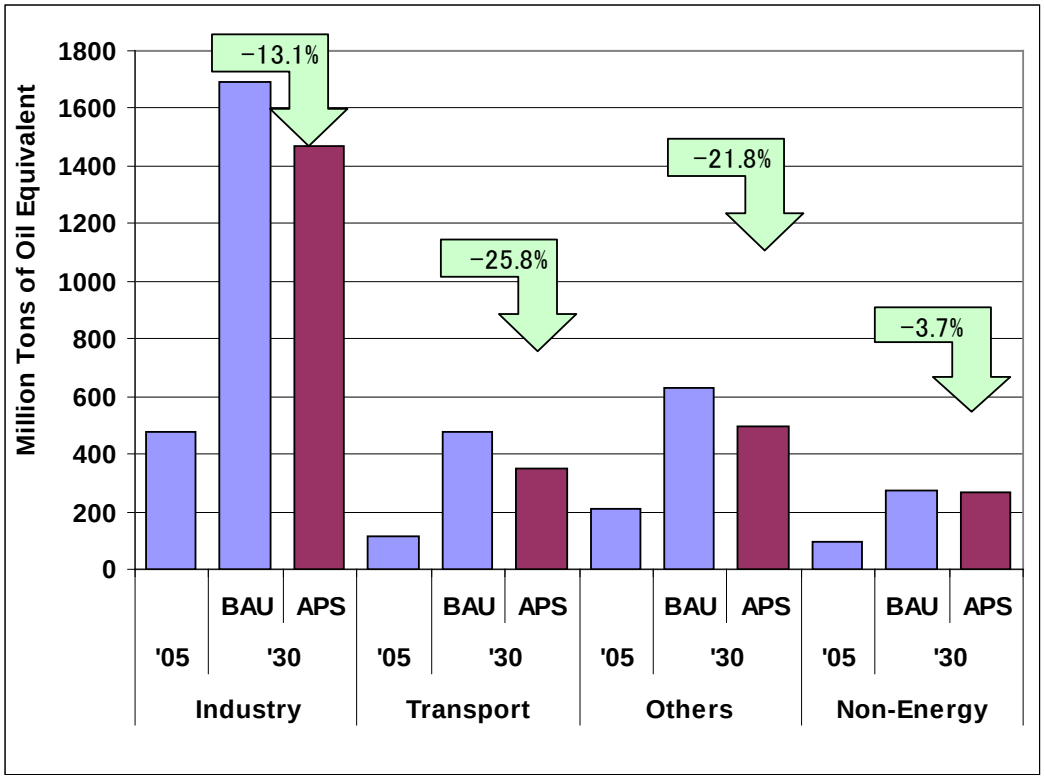
Final energy consumption from 2005 to 2030 is projected to increase at an average rate of 5.1 percent per annum. The consumption of the transportation sector is projected to grow the fastest with an annual average growth rate of 5.8 percent, followed by that of the industry sector at 5.2 percent. Energy consumption in the commercial and residential (others) sectors is projected to grow at an average annual rate of 4.5 percent.

By fuel, natural gas is projected to grow the fastest at 9.4 percent per annum over the period 2005 and 2030. Consumption of electricity and heat is projected to increase at an average annual rate of 5.9 and 5.5 respectively over the period 2005 to 2030. Oil consumption is projected to grow at 4.6 percent per annum over the same period.

Alternative Policy Scenario (APS)

In the APS, the final energy consumption is projected to increase at 4.3 percent per annum, lower than the BAU's, from 894 Mtoe in 2005 to 2,583 Mtoe in 2030, due to energy efficiency and conservation programs. Because of improvement in end-use technologies and the introduction of energy management systems, decline of energy consumption growth is expected in all sectors, particularly in the commercial, residential and transportation sectors. Figure II-11 shows the final energy consumption in China in 2005 and 2030 in both BAU and APS.

Figure II-11. Final Energy Consumption in China, BAU and APS



3.2 Primary Energy Demand

Primary energy demand in China is expected to continue grow but at a slower pace than it had in the past. It is also expected that growth in primary energy demand will be slightly slower than that of final energy consumption due to the improvement of efficiency in energy transformation sector.

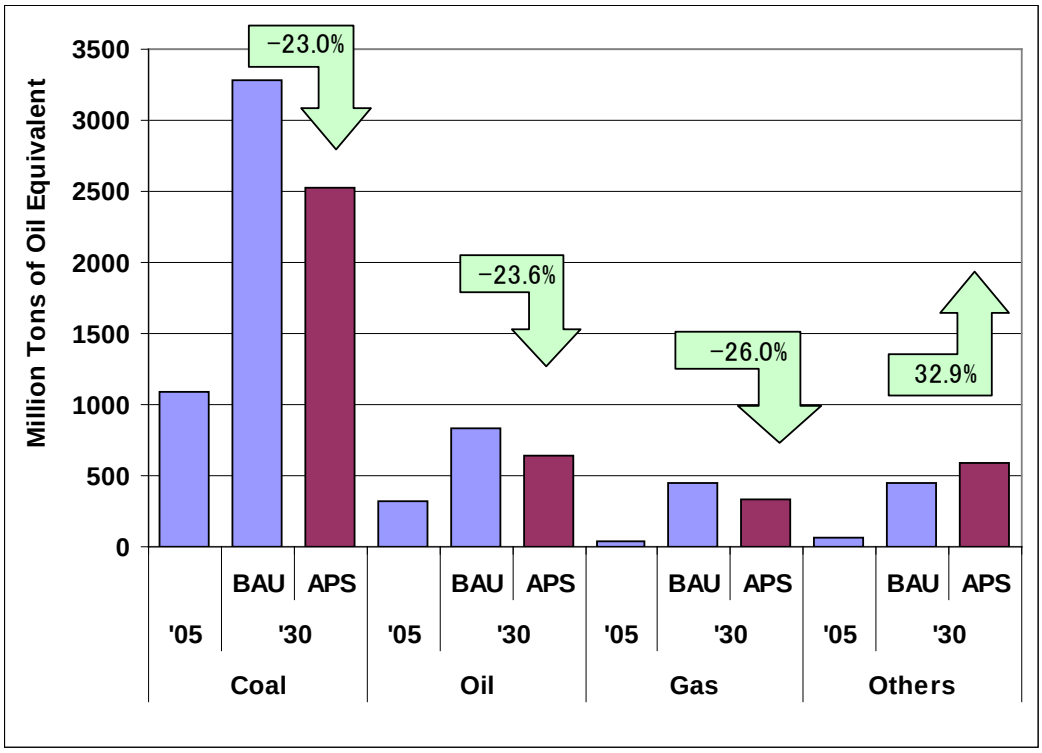
Business-as-Usual Scenario

In the BAU scenario, China's primary energy demand is projected to increase at an annual average rate of 4.9 percent per annum to 5,012 Mtoe in 2030. Coal will still constitute the largest share in total primary energy, but is expected to grow slightly slower than other fuels at an annual average rate of 4.5 percent. Consequently, the share

of coal in total primary energy is projected to decrease from 72.3 percent in 2005 to about 65.5 percent in 2030.

Natural gas and nuclear energy are expected to increase the fastest over the 2005 to 2030 period at similar annual average rates of 10.1 percent. Oil and hydro are projected to grow at lower rates of 4.0 and 3.6 percent per annum respectively in the same period. The share of natural gas is projected to increase from 2.7 percent in 2005 to 8.9 percent in 2030 whereas the share of nuclear will increase from 0.9 percent to 3.1 percent. The share of oil is projected to decrease from 21.2 percent in 2005 to 16.7 percent in 2030 and that of hydro is projected to decrease from 2.3 percent in 2005 to 1.6 percent in 2030.

Figure II-12. Primary Energy Demand by Source in China, BAU and APS



Alternative Policy Scenario

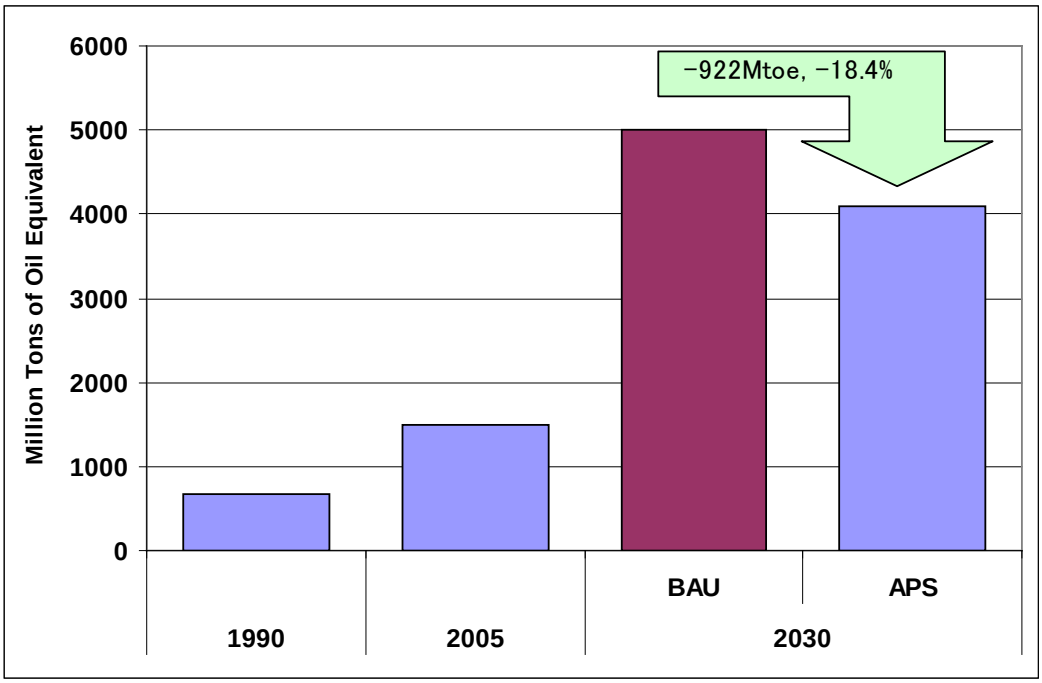
In the APS, the primary energy demand is projected to increase at 4.1 percent per annum, at a lower rate than the BAU's, between 2005 and 2030. By 2030, primary energy demand is expected to reach 4,090 Mtoe. The demands for coal, oil and gas are projected to increase over the 2005-2030 period but at lower rates than the BAU's (Figure II-12). The demands of these energy sources are projected to grow at annual average rates of 3.4 percent for coal, 2.8 percent for oil and 8.8 percent for natural gas between 2005 and 2030. The consumption mitigated in the APS is achieved by energy efficiency and conservation measures on the demand side. For nuclear, the annual average growth rate will be higher than that in the BAU scenario at 11.9 percent

between 2005 and 2030. The growth rate of hydro in the APS is expected to be the same as the BAU's.

3.3 Projected Energy Savings

It is estimated that the implementation of energy efficiency and conservation goals and action plans in China could reduce its primary energy demand in 2030 by about 922 Mtoe in the APS, relative to the BAU scenario. In the APS, China's primary energy demand is about 18.4 percent lower than the BAU's (Figure II-13).

Figure II-13. Total Primary Energy Demand in China, BAU and APS



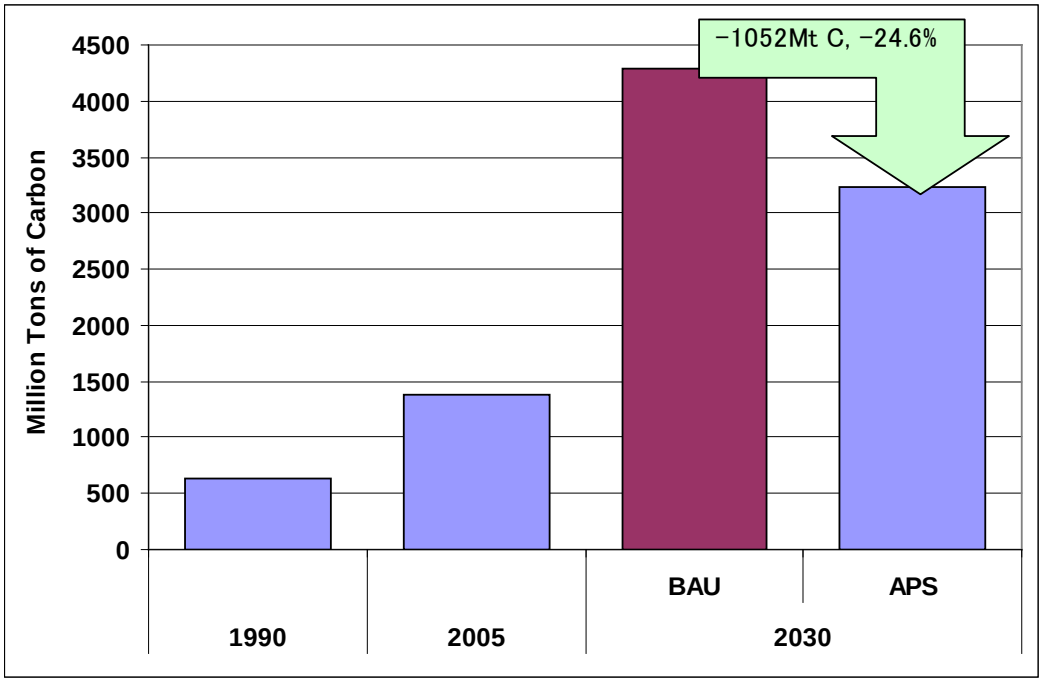
In terms of savings in final energy consumption, there is an estimated saving of 222 Mtoe in the industry sector, 122 Mtoe in the transportation sector and 138 Mtoe in the others sector in 2030 in the APS, relative to the BAU scenario.

3.4 CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 4.6 percent per annum from 1,384 million tons of carbon (Mt-C) in 2005 to 4,284 Mt-C in 2030 in the BAU scenario. This percentage increase is lower than that in primary energy demand (4.9 percent) over the same period. It indicates an improvement in the emission intensity.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected at 3.4 percent. This rate is also lower than the average annual growth rate in primary energy demand over the same period. The difference in the growth rates of CO_2 emissions between the APS and the BAU scenarios indicates that the energy saving goals and action plans of China are effective in reducing CO_2 emissions (Figure II-14).

Figure II-14. CO_2 Emission from Energy Consumption in China, BAU and APS



4. Implications and Policy Recommendations

As the world's largest developing country, it is paramount for China to eradicate poverty and improve quality of life. China is in the fast growth phase and its industrialization is in the mid-way. China's urbanization rate is low, less than 50 percent. If China maintains fast GDP growth, its energy demand, as well as the CO_2 emissions will increase in the long run.

China's energy demand and CO_2 emissions will increase but energy intensity (energy demand per unit GDP) and emission intensity (CO_2 emission per unit GDP) will decrease, because of the high growth rate in GDP. If sound EEC policies are implemented, China could reduce over one-sixth of its total primary energy consumption and about one-fourth of its CO_2 emissions in 2030. There is great potential for energy saving in China. About 50 percent of energy saving can be achieved by structural change of the economy. Development of tertiary industry may also reduce China's energy demand.

Energy saving and energy efficiency in industries were important in past 10 years. Shutdowns of small inefficient power plants, coal mines and small energy intensive industries like cement and steel plants were essential in improving China's industry structure. However, in the long run, energy efficiency in residential, commercial and transportation is more important in realising energy savings, given China's booming real estate market and automobile industry recently.

The Government may implement more market-based measures to motivate enterprises to take actions. Energy pricing mechanism reform, energy tax, carbon tax should be studied, and put in place as soon as possible. China should develop more energy efficiency standards and labelling to facilitate the development of a more energy efficient electrical appliances industry.

Chapter 6

India Country Report

Naoko Doi
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June 2011

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India

Ms. Naoko Doi

1. Background

India is a country in South Asia with a land area of 2,973 thousand square kilometres. It had a population of around 850 million in 1990 which grew at an annual average rate of 1.7 percent per year reaching 1,095 million in 2005. Its gross domestic product (GDP) in 1990 was US$270 billion which grew at an average annual rate of 6.0 percent to reach US$645 billion in 2005. India's GDP components are: 55 percent services, 27 percent industrial and 18 percent agricultural. GDP per capita stood at about US$600 in 2005.

India's total primary energy demand was 380 million tons of oil equivalent (Mtoe) in 2005. Demand grew at an average rate of 4.9 percent per year since 1990. By fuel in 2005, coal represented the largest share at 54.6 percent, followed by oil at 33.0 percent. Coal is mainly consumed for power generation and industry. The remaining shares were: natural gas (8.4 percent), hydro (2.3 percent), nuclear (1.2 percent) and others (0.5 percent). Compared to 1990, the share of coal decreased marginally. On the other hand, the shares of natural gas, oil and nuclear energy increased. Conversely, there was a decrease in the share of hydro.

India generated almost 700 terawatt-hours (TWh) of electricity in 2005. The annual average growth rate of electricity production has been growing at almost the same rate as GDP (6.1 percent) over the period 1990-2005. The share of generation from coal in 2005 amounted to 68.9 percent while the remaining shares are: hydro (14.6 percent), natural gas (8.8 percent), oil (4.0 percent), nuclear (2.5 percent) and others (1.2 percent).

2. Modelling Assumptions

In this report, India's GDP is assumed to grow at an average annual rate of 8.1 percent from 2005 to 2030. Population, on the other hand, is projected to increase by 1.2 percent per year from 2005 to 2030.

With regards to future electricity supply, the shares of electricity from gas-fired and nuclear power plants are projected to increase to 2030 whereas the shares of coal, oil, hydro and others are expected to decrease.

India's energy saving goals could be attained through the implementation of energy efficiency programs in power generation and final energy sectors. For the industry sector, energy savings are expected from improvements in the highly energy-intensive industries and in inefficient small plants. In the residential and commercial sectors, 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 improving fuel economy but also through more effective traffic management.

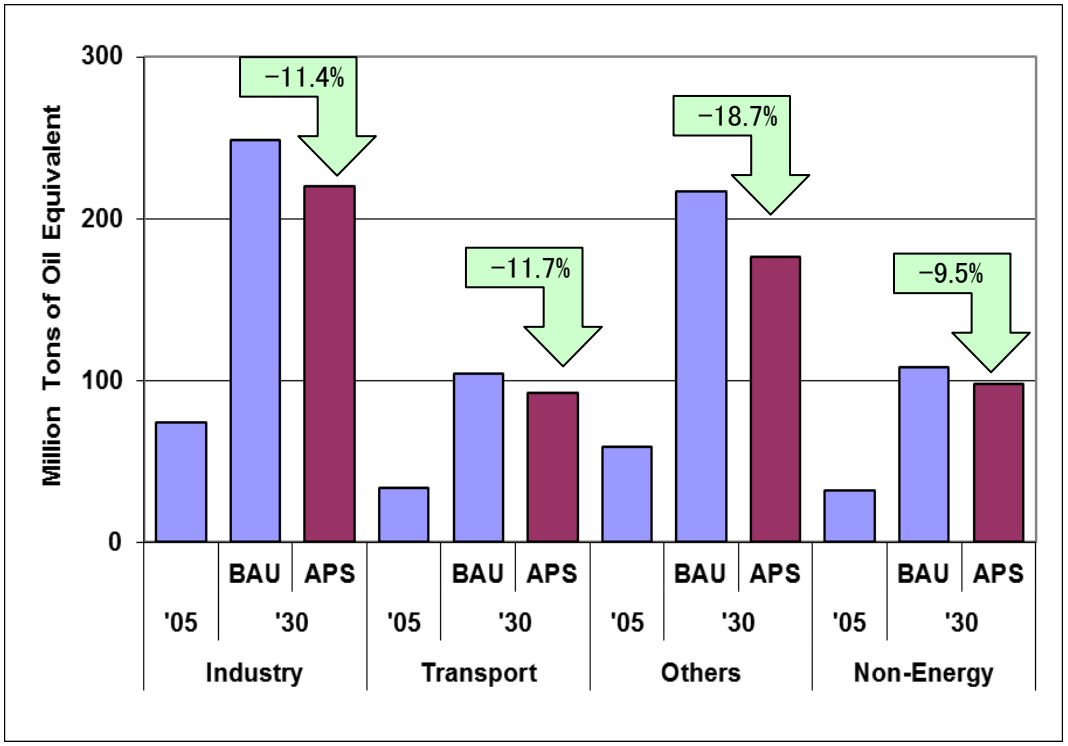
3. Outlook Results

3.1. Total Final Energy Consumption

India's final energy consumption experienced a growth of 3.5 percent per year from 117.7 Mtoe in 1990 to 198.4 Mtoe in 2005. The residential and commercial (others) sectors grew at 4.2 percent per year, and the transport sector grew at 1.6 percent per year between 1990 and 2005. The industrial sector grew at 2.9 percent per year over the same period. The non-energy sector grew the fastest over the 1990-2005 period at 7.0 percent per year.

Oil was the most consumed product having a share of 44.2 percent in total final energy consumption in 1990, which increased to 51.6 percent in 2005. The share of electricity, which was 15.5 percent in 1990, increased to 20.4 percent in 2005. Coal's share decreased from 35.5 percent in 1990 to 20.3 percent in 2005. Similarly, the share of natural gas experienced an increase from 4.8 percent in 1990 to 7.5 percent in 2005.

Figure II-15. Final Energy Consumption by Sector in India, BAU and APS



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 5.0 percent per year from 198 Mtoe in 2005 to 677 Mtoe in 2030. The consumption of the others sector is projected to grow the fastest with an annual growth rate of 5.3 percent per year followed by the industry and non-energy sectors, both at 5.0 percent per year over the period 2005-2030. The transport sector is projected to increase at 4.6 percent per year during the same period.

By fuel type, electricity is projected to grow the fastest at 7.3 percent per year over the period 2005-2030. Natural gas is projected to increase at the second highest rate of 4.7 percent per year through 2030. Following this, oil is projected to grow at an annual rate of 4.3 percent.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a lower rate than the BAU's at 4.4 percent per year from 198 Mtoe in 2005 to 585 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 others and transportation sectors due to improvements in end-use technologies and the introduction of energy management systems (Figure II-15).

3.1. Primary Energy Demand

Primary energy demand in India grew at a higher rate than the final energy consumption at 4.9 percent per year from around 185 Mtoe in 1990 to 380 Mtoe in 2005. Among the major energy sources, the fastest growing fuels were natural gas and nuclear energy. Natural gas demand grew at an average annual rate of 7.6 percent while nuclear grew at 7.2 percent per year 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 2.4 percent respectively. The "Others" energy source had a growth rate of 20.1 percent per year during the period but their collective share in total primary energy consumption was very small at 0.5 percent in 2005.

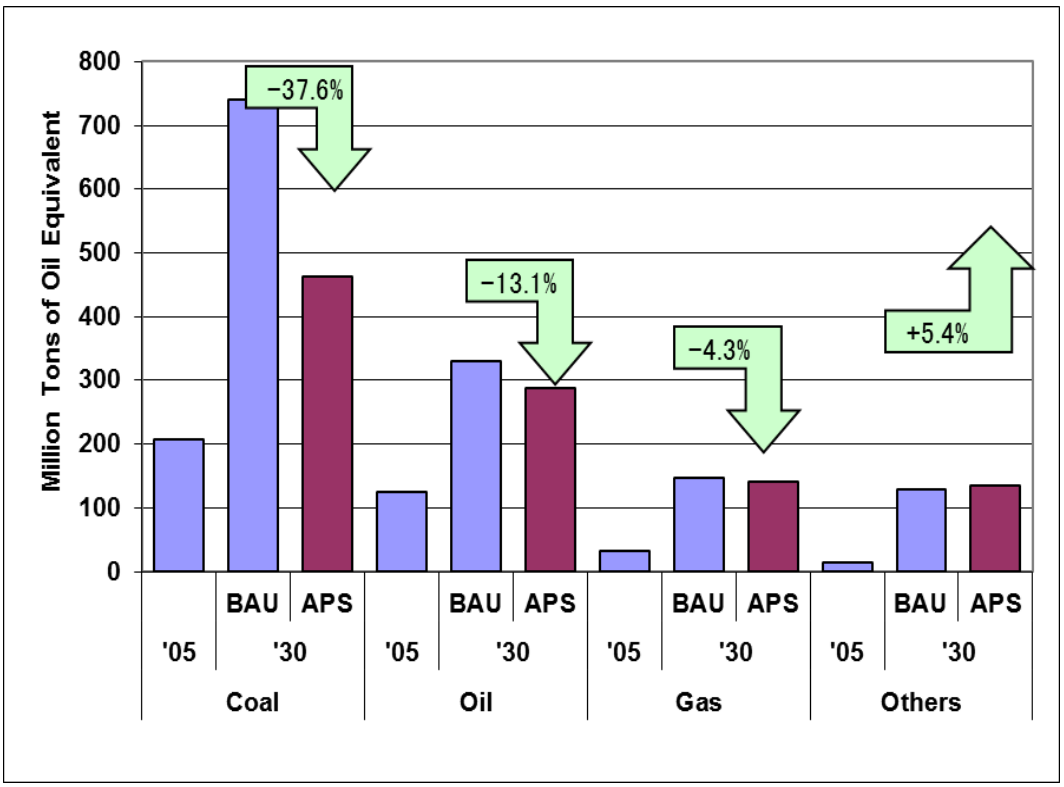
Business-as-Usual Scenario

In the BAU scenario, India's primary energy demand is projected to increase at an annual rate of 5.2 percent per year to 1,347 Mtoe in 2030. Nuclear energy is expected to grow the fastest at an annual average rate of 12.1 percent. Others, including solar and wind, is projected to increase at a fast annual rate of 8.7 percent through 2030, but its share remains small at 1.2 percent in 2030. Natural gas is projected to increase at 6.3 percent over the period 2005-2030.

Alternative Policy Scenario

In the APS, India's primary energy demand is projected to increase at a slower rate than in the BAU's at 4.1 percent per year from 380 Mtoe in 2005 to 1,026 Mtoe in 2030. Nuclear will be the fastest growing fuel at 12.0 percent per year followed by natural gas at 6.1 percent per year. Oil, coal and hydro will grow at slower annual rates of 3.4 percent, 3.3 percent and 5.6 percent, respectively. The other energy will also make its mark in the primary energy demand mix and will grow at an average annual rate of 10.6 percent. Consequently, its share will increase from 0.5 percent in 2005 to 2.4 percent in 2030. Figure II-16 shows the future primary energy demand mix in both the BAU scenario and APS in 2005 and 2030.

Figure II-16. Primary Energy Demand by Source in India, BAU and APS

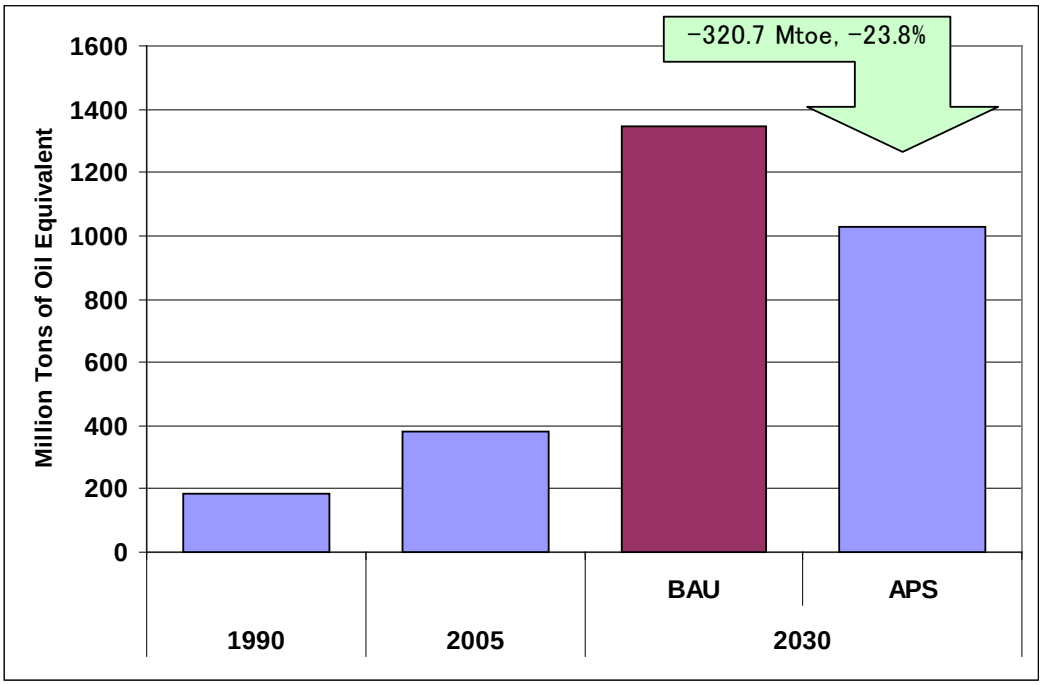


3.2. Projected Energy Saving

In 2030, the total primary energy savings that could be derived from the EEC goals and action plans of India would amount to 321 Mtoe, the difference between the primary energy demands of the BAU scenario and the APS. This is equivalent to 23.8 percent of India's primary energy demand in 2030 (Figure II-17) but just a little lower than the primary energy demand of India in 2005 (380 Mtoe).

In terms of savings in final energy consumption, there is an estimated saving of 28 Mtoe in the industry sector, 12.2 Mtoe in the transportation sector and 40.6 Mtoe in the others sector at 2030 in the APS, relative to the BAU scenario.

Figure II-17. Primary Energy Consumption in India, BAU and APS

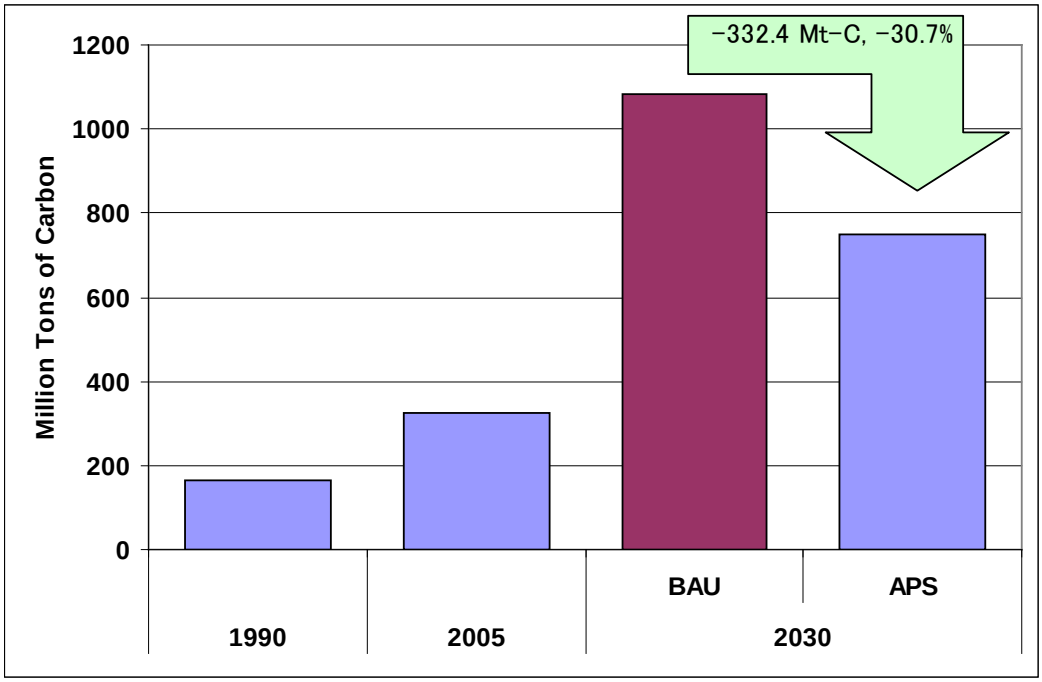


3.3. CO_2 Emissions from Energy Consumption

In the BAU scenario, CO_2 emissions from energy consumption are projected to increase by 4.9 percent per year from 324 Mt-C in 2005 to 1,084 Mt-C in 2030. 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 3.4 percent. The reduction in the growth rate of CO_2 emissions between the APS and the BAU scenario indicates that the energy saving goals and action plans of India are effective in reducing CO_2 emissions (Figure II-18).

Figure II-18. CO_2 Emission from Energy Combustion in India, BAU and APS



Chapter 7

Indonesia Country Report

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June 2011

This chapter should be cited as
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Indonesia

Ms. Cecilya Laksmiwati Malik

1. Background

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

Indonesia covers an area of 1,910,931 square kilometres and is the world's 16th largest country in terms of land area. The 2010 population census showed that Indonesia's population has reached 237.6 million people, and it is still the world's fourth most populous country. Its average population density is 124 people per square kilometre.

Indonesia's real gross domestic product (GDP) in 2005 was almost US$210 billion (constant 2000 US$). From 1990, it has grown at an average rate of 4.4 percent per year to 2005. GDP per capita in 2005 was around US$900 dollars while in 1990 it was only US$600.

Indonesia is richly endowed with natural resources. The country was previously an OPEC member, and thus important to the world's energy markets. However, as it become a net importer of oil, the country would benefit more from lower oil prices, putting it at odds with other OPEC members, who favour higher prices. As prices continue to increase, Indonesia decided to leave OPEC at the end of 2008. Indonesian crude oil proven reserves were 9 billion barrels in 1986 but this has since declined to 5 billion barrels in 1996 and further down to 4.2 billion barrels in 2005. In 2008, the proven crude oil reserves was around 3.7.billion barrels

Indonesia is also the world's largest liquefied natural gas (LNG) exporter. Its natural gas proven reserves were 2.27 trillion cubic metres (TCM) in 1986 and these declined slightly in 1996 to 2.05 TCM. In 2005, the proven reserves increased to 2.75 TCM and 3.2 TCM (around 112 trillion cubic feet) in 2008. Indonesia is also a coal exporter with proven coal reserves of around 4.3 billion tonnes at end of 2008.

In addition to fossil energy resources, Indonesia's non-fossil energy resources include hydro, geothermal, biomass and other renewables such as solar and wind. For hydro, the estimated potential is around 75 GW while for geothermal its potential is 27 GW.

Indonesia's total primary energy demand was 135.1 Mtoe in 2005. By fuel, oil represented the largest share at 49.0 percent, followed by natural gas at 22.6 percent and coal at 18.8 percent. The remaining share of about 9.6 percent represents hydro, geothermal and others.

Indonesia has 28.9 GW of installed electricity generating capacity and generated about 127.4 terawatt-hours (TWh) of electricity in 2005. The state electricity company of Indonesia, PT PLN PERSERO, owns and operates generation plants of about 23.9 GW in 2005 composed of: 42 percent oil, 20 percent coal, 22 percent gas, 14 percent hydro and 2 percent geothermal.

2. Modelling Assumptions

The GDP growth rate used in this report primarily reflects historical growth rates and incorporates projections from the World Bank which account for the potential impacts of the global economic crisis. Indonesia's GDP growth rate was 6.3 percent in 2007 and this slowed down 6.0 percent in 2008. In 2009, the International Monetary Fund expected annual growth in GDP to slow further to 2.5 percent. However, the World Bank expected a higher growth rate of 4.5 percent in 2009 which is projected to increase further to 5.5 percent in 2010. At early 2010, the government announced that the 2009 GDP growth was 4.5% which is similar to that of World Bank. Early 2011, the central bureau of statistics (BPS) announced that the GDP growth for 2010 could reach 6.1% due to the high export for mining products and non-oil and gas products.

In this report it is assumed that annual GDP growth will reach 6 percent in 2010 and will continue to increase to 6.5 percent between 2010 to 2020 and slow down to 6.2 percent between 2020 to 2030. Thus, on average the assumed annual growth in Indonesia's GDP from 2005 to 2030 is around 6.2 percent. This rate is lower than the projected growth used in the National Energy Planning Blueprint of 6.5 percent per year. However, this reflects the current global economic crisis which is also affecting economic growth in the East Asia Summit (EAS) region.

Population growth is assumed to increase at an average of 1.1 percent per year from 2005 to 2030. This is still the same assumption as last year study because it is in line with the projections of the Central Bureau of Statistics (BPS) of Indonesia. This assumption is higher than the 2008 UN assumption of 0.9% per year over the 2005-2030 periods. Growth is assumed to be slightly faster from 2005 to 2010 and 2010-2020 at 1.2 percent per year, tapering off to 0.9 percent per year from 2020-2030.

With regards to future electricity supply, Indonesia will increase its usage of coal as part of the Government Crash Program for power generation. On the First Phase of the program an additional 10,000 megawatts (MW) of coal fired electricity capacity will be built by 2010. In addition the Government is also embarking on the Second Phase where additional capacities will be mainly coming from geothermal energy and other renewable energy sources. This is in line with the projected increasing share of renewable in the future electricity supply mix in response to the renewable portfolio standard (RPS).

In the Medium Term Plan (RPJM) 2010-2014, the target for geothermal total installed capacity will be 4.6 GW by 2014. However, due to the issues in feed in tariff and mitigation risks, there were delays from the developers in constructing the geothermal

plants which already have won tender. In this regard, the study assumed that total installed capacity of 4 GW will be achieved only by 2030.

Supply from gas fired power plants is also expected to increase. However, improvements to gas supply infrastructure are required. In contrast, generation from oil fired power plants are assumed to decrease significantly. Beyond 2018, nuclear is also assumed to be a part of the future electricity supply mix in Indonesia. This is deferred from the original plan in 2017. As a result of this deferral nuclear power plants are only assumed to be available in the APS as in the last year's study.

The National Energy Policy 2005-2025 stated that the goal for energy savings is to achieve GDP energy elasticity of less than 1 by 2025. This means that energy demand growth should be less than the corresponding GDP growth. At the ECTF meeting in Da Lat, Vietnam, Indonesia submitted only the goals and action plans for EE&C. No specific energy saving targets was submitted. Since last year's study energy saving target was considered high when compared to the current energy conservation potential, this year's study assumed more moderate energy saving targets for the APS scenario.

The current energy conservation potential as indicated in the Government's Blueprint for Energy Efficiency and Conservation published in 2006 (RIKEN 2006) and that of this year and last year's study is shown below in Table II-1.

Table II-1. Energy Conservation Potential to 2020

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

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

3. Outlook Results

3.1. Total Final Energy Consumption

Indonesia's final energy consumption increased at an average annual rate of 4.7 percent over the 1990 to 2005 period from 45 Mtoe to 91 Mtoe. The transport sector had the highest growth rate during this period at 5.8 percent per year. Final energy consumption in industry and other sectors (mainly consisting of the residential and commercial), grew at slower rates of 5.0 percent and 4.5 percent per year, respectively over the period 1990-2005. Oil still plays a major role in the country's final energy consumption. Its share in total final energy consumption however, shows a decreasing trend, from 63

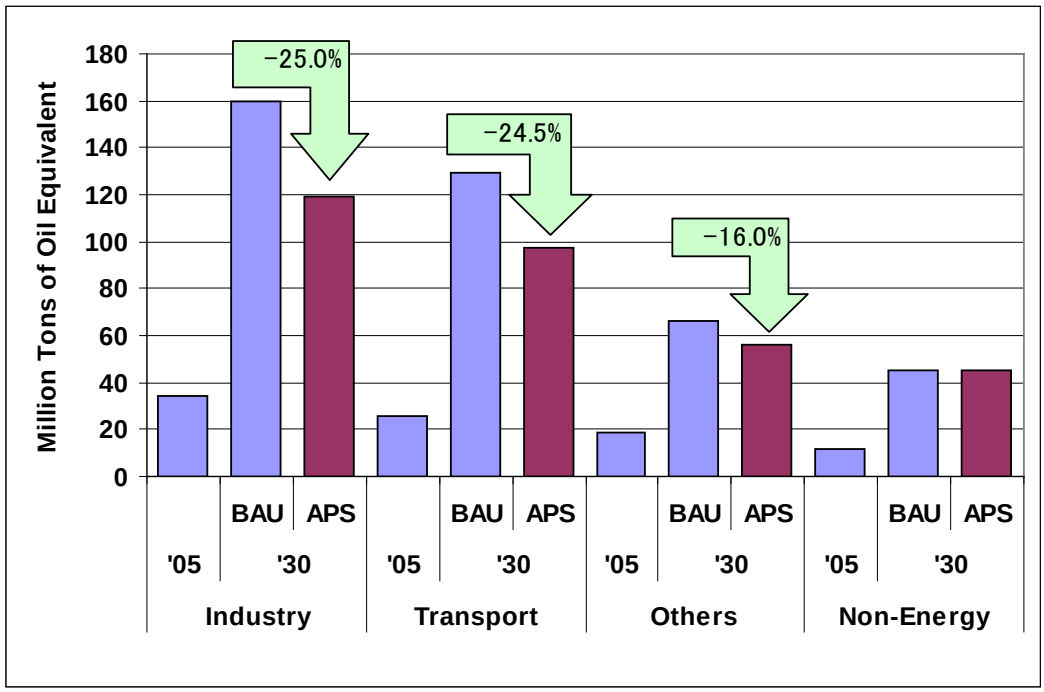
percent in 1990 to 57 percent in 2005. Natural gas was the second most consumed product in 2005 followed by coal and electricity.

Business-as-Usual (BAU) Scenario

Given the projected economic and population growth, final energy consumption from 2005 to 2030 is projected to grow at an average rate of 6.1 percent per year in the BAU scenario. This is mainly due to the rapid increase in the consumption of the transportation sector which is still heavily dependent on oil. Consumption by the industry and other sectors are projected to grow at slower annual rates of 6.3 percent and 5.1 percent respectively. The use of natural gas as a feedstock is included in industry sector demand.

By fuel type, the consumption of coal, oil, natural gas, and electricity is projected to increase over the 2005-2030 period. Coal and electricity are assumed to grow faster than natural gas and oil at average annual rates of 8.7 and 7.6 percent respectively. Consumption of natural gas and oil is projected to increase at average annual rates of 6.3 and 5.2 percent, respectively over 2005-2030.

Figure II-19. Final energy Consumption by Sector in Indonesia, BAU and APS



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 5.2 percent per year to 2030. That is, from 91 Mtoe in 2005 to 319 Mtoe in 2030. This slower rate of increase in the APS, relative to the BAU scenario, is projected to be the result of the government program for energy efficiency and conservation 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 by 5.5 percent per year as compared to 6.7 percent per year in the BAU over the period 2005-2030. Slower rates of growth in energy consumption will also be experienced across all sectors in the APS relative to the BAU scenario.

Figure II-19 shows the final energy consumption in 2005 and 2030 in both the BAU and APS.

3.2. Primary Energy Demand

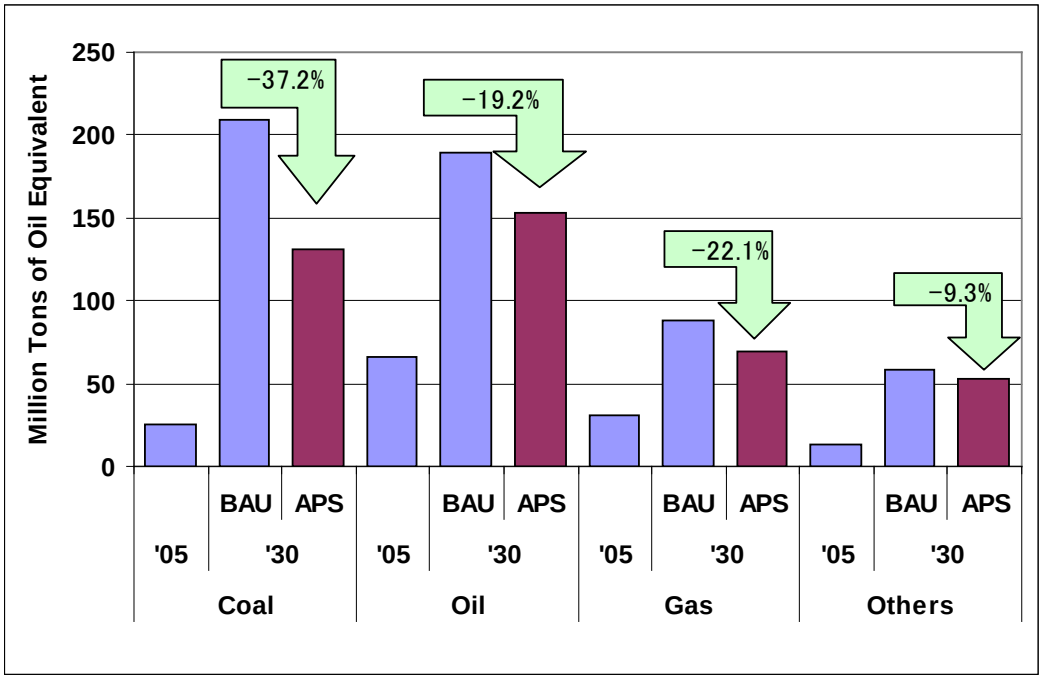
Primary energy demand in Indonesia grew faster than final energy consumption at about 5.8 percent per year from 58 Mtoe in 1990 to 135 Mtoe in 2005. Among the major energy sources, the fastest growing fuels between 1990 and 2005 were coal and geothermal energy. Coal consumption grew at an average annual rate of 13.2 percent while geothermal energy grew at 12.7 percent. Oil consumption increased slower at 4.5 percent per year while natural gas consumption grew at 3.4 percent per year. Hydro energy had a growth rate of 3.0 percent during the period but its share in the total remained small at 0.7 percent in 2005.

Business-as-Usual Scenario

In the BAU scenario, Indonesia's primary energy demand is projected to increase at an annual average rate of 5.7 percent to 544.5 Mtoe in 2030. Coal and geothermal are projected to continue to grow at the fastest rate. The growth in the demand for these energy sources are expected to accelerate to 8.8 percent and 6.3 percent per year respectively over the period 2005-2030. This is in line with the government's First and Second phases of the accelerated program to develop 10,000 MW of coal and geothermal power plants by 2020.

Consumption of hydro is projected to grow faster than natural gas and oil at an average of 4.5 percent per year over the period 2005-2030, though its share in the total will remain below 1 percent. Meanwhile, the share of natural gas are in the total primary energy demand is expected to decline from 22.6 percent in 2005 to 16.2 percent in 2030. Oil consumption is projected to increase at an annual average rate of 4.3 percent over the period 2005-2030 with a declining share in total primary energy demand from 49.0 percent in 2005 to 34.7 percent in 2030. There is assumed to be no uptake of nuclear in the BAU scenario. Thus, other renewable energy is projected to increase in the future primary energy supply mix as cleaner fuel alternatives to oil. However, their share in the total fuel mix is projected to remain small.

Figure II-20. Primary Energy Demand by Source in Indonesia, BAU and APS



Alternative Policy Scenario

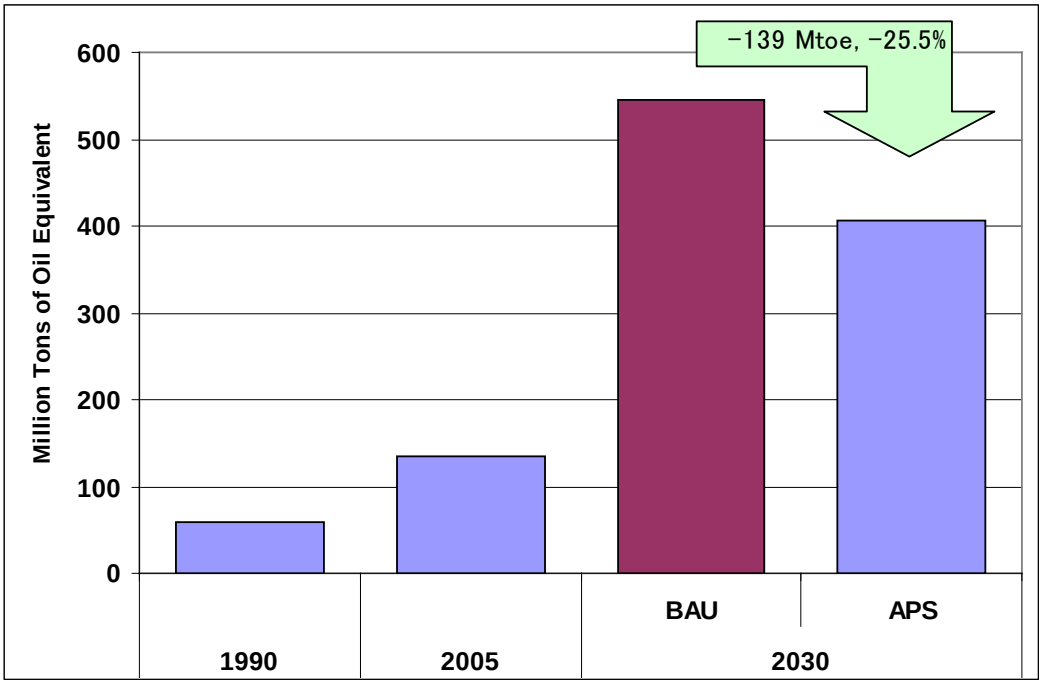
In the APS, primary energy demand is projected to increase at a slower rate, relative to the BAU scenario, at 4.5 percent per year to almost 406 Mtoe in 2030. All fuels are still projected to experience positive average annual growth rates. However, these will be slower than in the BAU scenario. These decreases in consumption relative to the BAU scenario are mainly due to energy efficiency and conservation measures on the demand side.

3.3. Projected Energy Savings

The energy savings (the difference between primary energy demand in the BAU scenario and the APS) that could be achieved through the energy efficiency and conservation goals and action plans of Indonesia are about 139 Mtoe in 2030 (Figure II-21). This is more than Indonesia's energy consumption in 2005 of around 91 Mtoe.

In terms of final energy consumption savings, there is estimated to be a saving of almost 40 Mtoe in the industry, 32 Mtoe in the industry sector and around 11 Mtoe in the residential/commercial (other) sector by 2030 in the APS, relative to the BAU scenario.

Figure II-21. Total Primary Energy Demand in Indonesia, BAU and APS

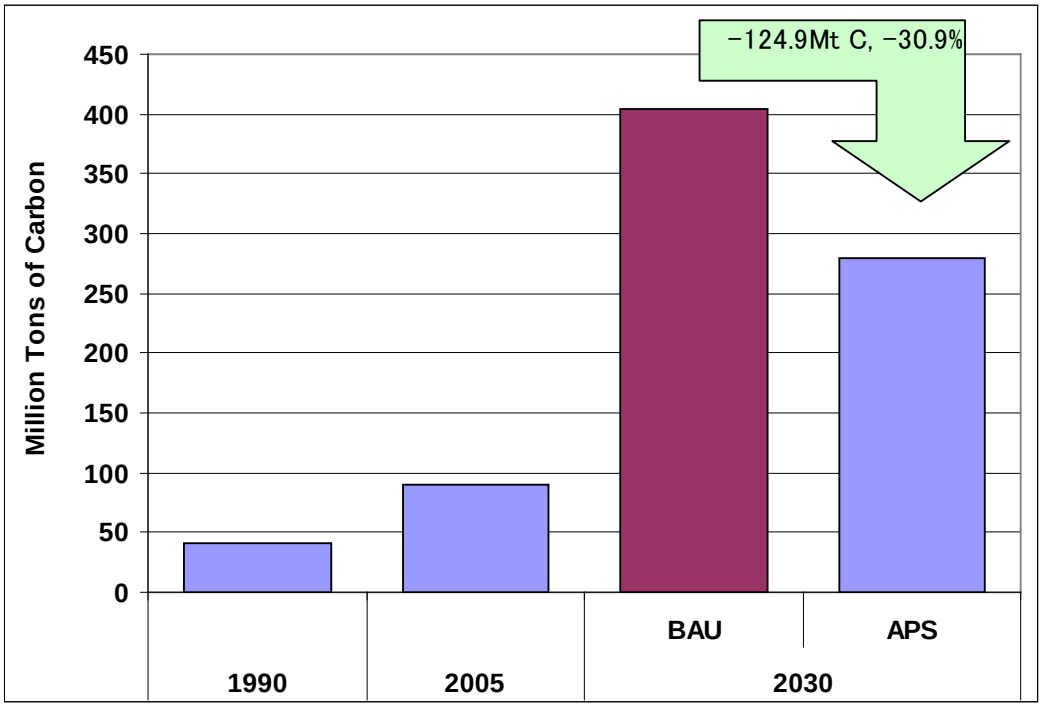


3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an average annual rate of 6.2 percent from around 91 million tons of carbon (Mt C) in 2005 to 404 Mt C in 2030 in the BAU scenario (Figure II-22). This increase is driven by the increasing use of carbon intensive fuels, particularly in the use of coal for power generation and industry, as well as oil in the transport sector.

In the APS, the annual average growth in CO_2 emissions from 2005 to 2030 is expected to be lower than in the BAU scenario at 4.6 percent, lower by 30.9 percent compared with BAU scenario. This lower growth rate is the result of 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 25.5 percent. This indicates that the energy saving goals and action plans of Indonesia are also very effective at reducing growth in CO_2 emissions. The Government committed to reduce CO2 emission in 2025 by 26 percent without international assistance and 41 percent with international assistance. This study result in almost 31 percent CO2 emission reduction by 2030.

Figure II-22. CO_2 Emissions from Energy Combustion in Indonesia, BAU and APS



4. Implications and Policy Recommendations

As a developing country, Indonesia's primary energy intensity (TPES/GDP) has been increasing since 1990. In the future, it is expected that there will be more improved and efficient energy technologies to be 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 0.4 percent while in the APS the projected average annual rate of decline is 1.6 percent.

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

The transport sector which is the main consumer of oil in the country will be crucial to achieving energy savings. The savings in oil consumption between the BAU scenario and the APS could reach around 24-25% percent in 2030 by introducing more efficient vehicles and boilers in the transport and industrial sectors, respectively. Developed countries in the region such as Japan and Australia should increase efforts to introduce newly improved technologies to developing countries as early as possible.

The New and Renewable Energy and Energy Conservation (EBTKE) Directorate General of the Ministry of Energy and Mineral Resource, established in 2010, will play

an important role in enhancing the EEC and renewable energy programs. The energy efficiency and conservation blueprint (RIKEN) of 2006 need to be revised to include specific energy saving target of the sectors with detailed action plans to achieve the targets.

Chapter 8

Japan Country Report

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Japan

Mr. Yu Nagatomi

1. Background

Japan is a small island nation in Eastern Asia. It consists of several thousand islands spanning across a land area of approximately 377,914 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) of about US$ 4,980 billion (constant 2000 prices) in 2005. Its population was about 128 million people with a per-capita income of US$ 38,972 in 2005.

Japan possesses a modest amount of indigenous energy resources and imports almost all of its crude oil, coal and natural gas requirements to sustain economic activity. In the end of 2010, proven energy reserves included around 44 million barrels of oil, 738 BCF of natural gas. In the end of 2009, proven reserves of coal was 345 Mt.

Japan's total primary energy demand was 517.8 Mtoe in 2005. By fuel, oil represented the largest share at 47.0 percent, coal was second at 21.2 percent, followed by nuclear energy (15.3 percent), natural gas (13.6 percent) and others represented the remainder. In 2005, net imports of energy accounted for about 86 percent of the total primary energy demand. With limited indigenous energy sources, Japan imported almost 99 percent of oil, 99 percent of coal and 96 percent of gas.

Japan is the world's largest importer of coal: steam coal for power generation, pulp and paper and cement production and coking coal for steel production. Domestic demand for natural gas is met almost entirely by imports of LNG. Natural gas is mainly used for electricity generation, followed by reticulated city gas and industrial fuels. In 2005, primary natural gas supply was 70.6 Mtoe.

Japan has 274 GW of installed electricity generating capacity and generated about 1,090 TWh of electricity in 2005. The generation amount by energy type is broken-down as: thermal (coal, natural gas and oil) at 62 percent, nuclear (28 percent), hydro (7 percent), geothermal, solar and wind taking up the remainder.

2. Modelling Assumptions

In this outlook, Japan's GDP is assumed to grow at an average annual rate of 1.4 percent from 2005 to 2030. Growth is projected to slow down from 2005 to 2010 at 0.7 percent per year due to the recent economic recession. However, GDP is projected to be strong and at an average of 1.5 percent per year from 2010 to 2030. The industry structure, with the maturing of society and economy, will increasingly become service oriented. Population growth, on the other hand, will be decreasing by about 0.4 percent per year from 2005 to 2030 due to the declining birth rate. Japan's population is projected to decrease from 128 million in 2005 to 115 million in 2030. Infrastructure

development and expansion of manufacturing industry will be saturated and productions of crude steel, cement and ethylene will gradually decrease. The number of automobile will also be decreasing.

Fourteen additional nuclear power plants are assumed to be constructed by 2030 and the utility rate is expected to grow through 2030. The capacity of hydro power plants would be around 70 percent of the potential that would translate to an increase in capacity by 2030. Supply from oil-fired power plants is projected to decrease while that of nuclear power is expected to increase. Generation capacity of natural gas-fired power plant is expected to be more than that of other fossil fuels because natural gas is less carbon intensive.

Japan's energy saving goals would be attained through 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 sectors, 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 efficiency improvements 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 300.1 Mtoe in 1990 to 346.9 Mtoe in 2005. The residential/commercial (others) sector had the highest growth rate during this period at 2.0 percent per annum followed by the transportation sector with 1.1 percent. Consumption in the industry sector decreased at a slow pace of 0.4 percent per annum over the period 1990-2005. Oil was the most consumed product, having a share of 61.3 percent in 1990 and 57.8 percent in 2005. Electricity was the second most consumed product.

Business-as-Usual (BAU) Scenario

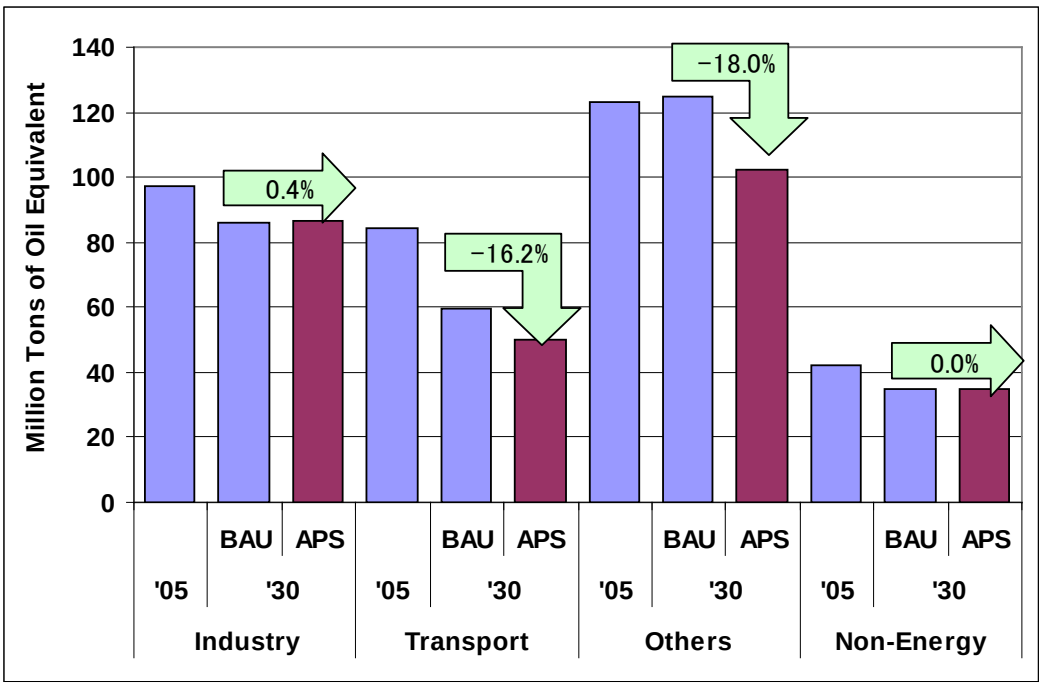
With the projected weak economic growth and population decline, final energy consumption from 2005 to 2030 is projected to decline at an average rate of 0.5 percent per annum in the BAU scenario. This is also driven by the projected decline in the consumption of industry and transportation sectors, caused by improvement of energy efficiency. The consumption in the others sector is, however, projected to grow at an average annual rate of 0.1 percent between 2005 and 2030.

By fuel type, consumption of coal and oil is projected to decrease at an average annual rate of 0.2 and 1.8 percent, respectively, between 2005 and 2030. Consumption of natural gas and electricity is projected to increase, at 1.3 and 0.7 percent per annum, respectively, over the same period.

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to decline at a higher rate of 0.9 percent per annum from 346.9 Mtoe in 2005 to 273.4 Mtoe in 2030. The largest decline of 2.1 percent per annum will be found in the transportation sector due to the top-runner program and aggressive energy management systems. Japan will continuously improve energy efficiency, especially, in the transportation section. Energy efficient automobiles such as hybrid vehicles, electric vehicles and plug-in hybrid electric vehicles will be introduced. The energy efficiency in the industrial and service sectors will improve as well. The energy efficiency in the steel and cement sectors will drop. It will be difficult to improve energy efficiency drastically because the capacity factors will be decreasing and more renewable energy will be used. The sectoral final energy consumption in the BAU and APS are shown in Figure II-23.

Figure II-23. Final Energy Consumption by Sector in Japan, BAU and APS



3.2. Primary Energy Demand

Primary energy demand in Japan grew at a higher rate than the final energy consumption at 1.1 percent per annum from 436.6 Mtoe in 1990 to 517.8 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 3.2 percent while nuclear energy grew at 2.8 percent over the period 1990-2005. Oil consumption declined by 0.2 percent per annum over the same period. Geothermal energy had a respectable growth rate of 4.4 percent during the period but its share in total primary energy demand was minimal at 0.6 percent in 2005.

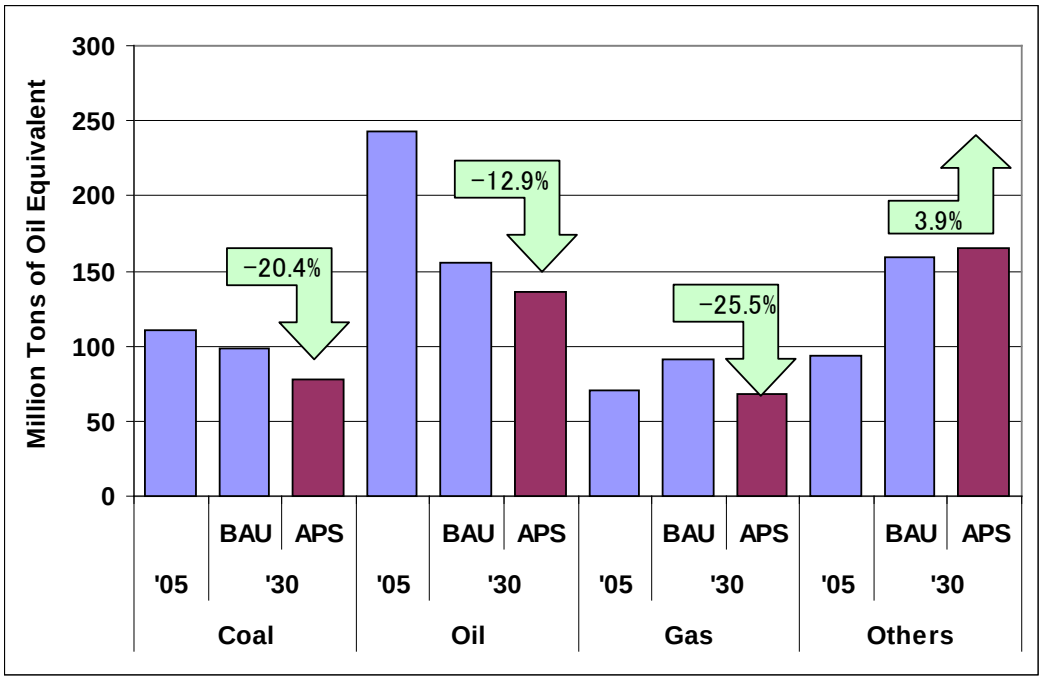
Business-as-Usual Scenario

In the BAU scenario, Japan's primary energy demand is projected to decline at an average annual rate of 0.1 percent per annum from 517.8 Mtoe in 2005 to 503.5 Mtoe in 2030. This decline is due to the reduction of coal and oil use at annual average rates of 0.5 percent and 1.8 percent, respectively, over the period 2005-2030. The shares of coal in 2005 and 2030 are projected to decrease from 21.2 percent in 2005 to 19.5 percent in 2020 and that of oil will decline from 47.0 percent to 30.9 percent. Natural gas and nuclear energy consumption will, however, increase at average annual rates of 1.0 percent and 2.3 percent, respectively, over the period 2005-2030.

Alternative Policy Scenario

In the APS, the projected primary energy demand will decline at a higher rate of 0.6 percent per annum to 446.6 Mtoe in 2030, 71.2 Mtoe lower than the demand in 2005. Coal, oil and natural gas will decrease at average annual growth rates of 1.4 percent, 2.3 percent and 0.2 percent, respectively. These decreases are mainly due to energy efficiency and conservation measures in the demand side. Primary energy demand by source in 2005 and 2030 in BAU and APS are shown in Figure II-24.

Figure II-24. Primary Energy Demand by Source in Japan, BAU and APS



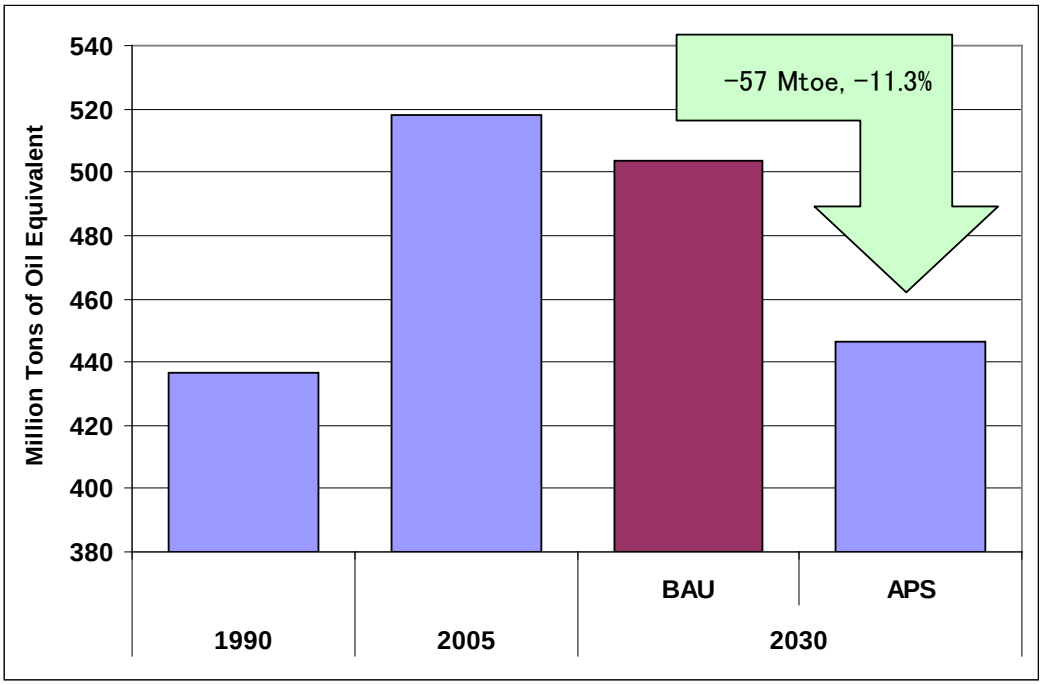
3.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Japan are 57.0 Mtoe, the difference between the primary energy demand, in BAU and in APS.

This is equivalent to 11.3 percent reduction of Japan's BAU consumption in 2030 (Figure II-25).

In terms of saving in final energy in the APS, relative to the BAU, there is an estimated saving of 22.5 Mtoe in the others sector, 9.6 Mtoe in the transportation sector in 2030. The energy savings in transportation achieved from 2005 to 2030 are 25.0 Mtoe and 34.6 Mtoe in the BAU and APS respectively, due to the use of more efficient vehicles.

Figure II-25. Primary Energy Consumption in Japan, BAU and APS

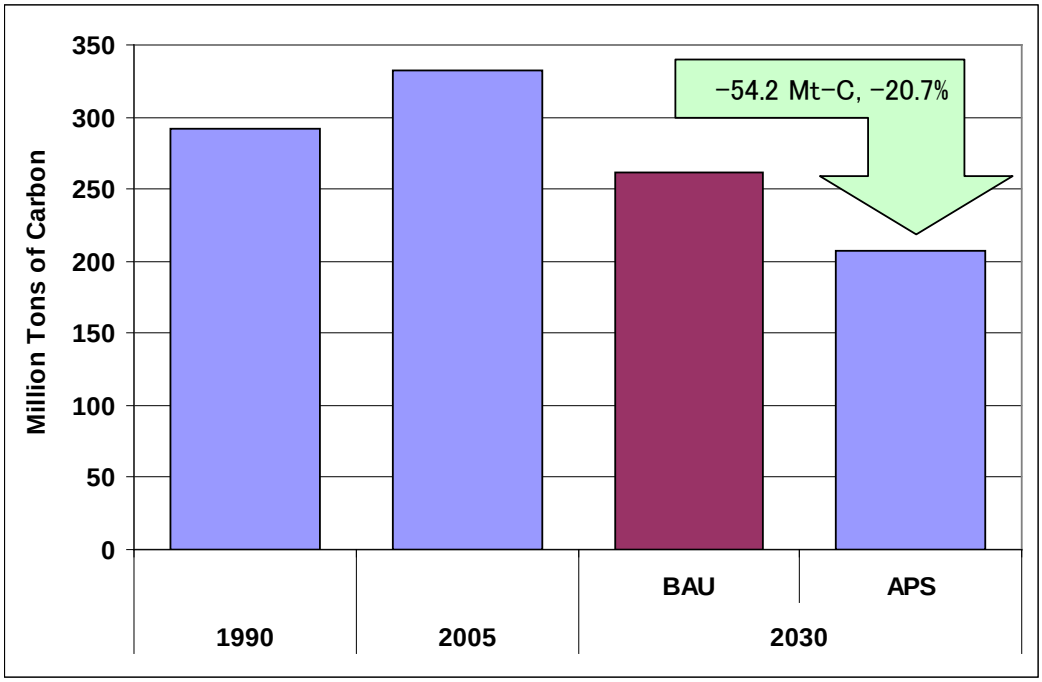


3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to decrease at average annual rates of 0.9 percent from 332 Mt-C in 2005 to 262 Mt-C in 2030 in the BAU scenario. This decrease is larger than the primary energy demand's. Japan will use more less-carbon intensive fuels.

In the APS, the CO_2 emissions from 2005 to 2030 are projected to decline at an average annual rate of 1.9 percent. This decrease rate in CO_2 emissions is also higher than that in the primary energy demand (0.6 percent). In addition, CO_2 emissions in 2030 are projected to be lower than the 1990 level in the APS (Figure II-26). This indicates that the energy saving goals and action plans of Japan are very effective in reducing CO_2 emissions.

Figure II-26. CO_2 Emission from Energy Combustion in Japan, BAU and APS



4. Implications and Policy Recommendations

Japan's primary energy intensity has been declining 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 significant improvement in energy efficiency might also be driven by the situation that Japan imports most of the energy for its energy demand.

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 on reducing GHG emissions by half from 2005 to 2050. However, to achieve the result, Japan should effectively implement its policies on energy efficiency such as the top-runner program. In addition, as the leader in the world in energy efficiency, Japan should introduce such successful policies to other countries as early as possible. By doing this, Japan is able to contribute more in reducing global energy consumption. This would not only benefit Japan economically but also reduce global energy consumption.

Therefore, Japan should not only look at its own market when developing energy efficiency policies but also look at the world market as a whole. Reducing global energy consumption would prolong use of available energy.

In addition, this result is similar with last year's, and doesn't include the aftermath of the earthquake in March 2011. Political change could occur but the changes were not modelled in this study. ERIA's result considers METI's projection in 2010. The current government reduction target is 25% from 1990 to 2020. If this target is accomplished by

domestic efforts, policy options may include deployments of more nuclear power plants, CCT and CCS and renewable energy, especially, solar power in the residential sector and heat pump system.

Chapter 9

Republic of Korea Country Report

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June 2011

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Republic of Korea

Dr. Soo-Il Kim

1. Background

The Republic of Korea is located in the southern half of the Korean Peninsula and has a 238 km boundary with North Korea. It occupies 98,480 square kilometres and includes about 3,000 mostly small, uninhabited islands. Korea is a mountainous country with lowlands accounting for only 30 percent of the total land area. The climate is temperate, with heavy rainfall in summer. Korea has a population of 48 million, about 85 percent of which live in urban areas. Korea has experienced tremendous economic growth over the last decades. After impressive growth, gross domestic product (GDP) plunged by -7 percent in 1998, but has since rebounded. The economy is dominated by manufacturing, particularly of electronic products, passenger vehicles and petrochemicals. Agriculture, forestry and fishing made up only 3 percent of total GDP in 2003.

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

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

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

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

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

2. Modelling Assumptions

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

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

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

3. Outlook Results

3.1. Total Final Energy Consumption

Korea's final energy consumption experienced a high growth of 5.6 percent per annum from 72 Mtoe in 1990 to 163 Mtoe in 2005[7]. The industry sector including non-energy had the highest growth rate during this period at 6.9 percent per annum followed by the transportation sector with 6.0 percent. Consumption in the residential/commercial/ public (other) sector grew at a relatively slow pace of 3.1 percent per annum. Oil was the most consumed product having a share of 59.9 percent in 1990, decreasing to 56.3 percent in 2005. Coal was the second most consumed product in 1990 but in 2005 electricity was the second most consumed product.

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

Business as Usual (BAU) Scenario

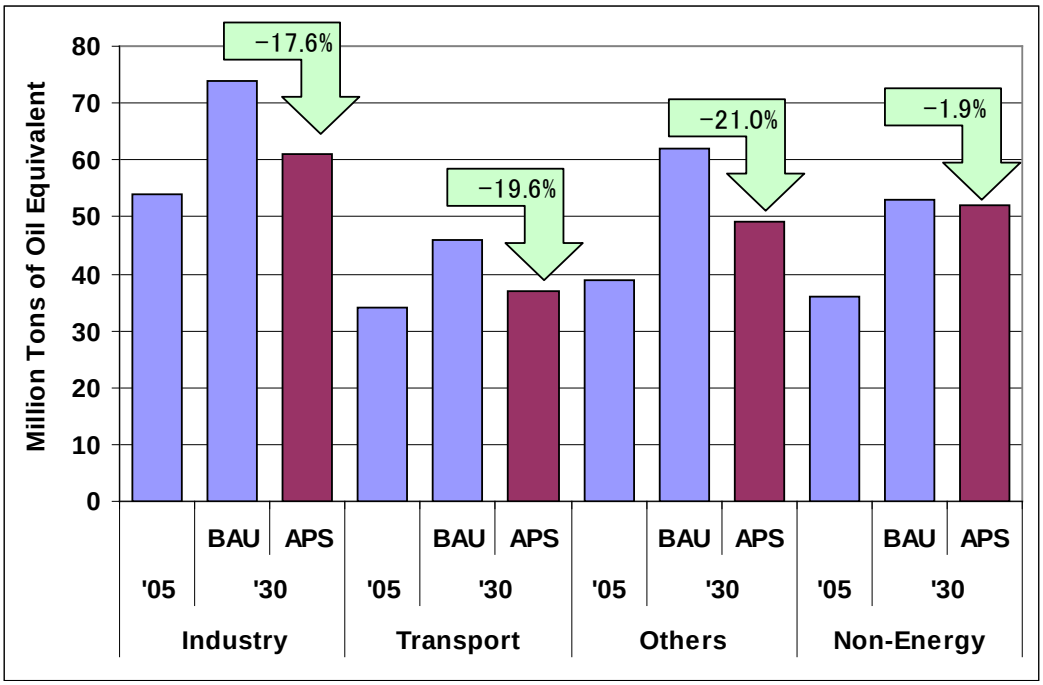
With projected low economic and population growth, final energy consumption from 2005 to 2030 is projected to increase at a low average rate of 1.5 percent per annum in the BAU scenario. This is mainly due to the projected decline in the growth of energy consumption in the industry and transportation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

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

Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to increase at a rate of 0.8 percent per annum from 163 Mtoe in 2005 to 199 Mtoe in 2030. The residential and commercial (other) sector is projected to have the fastest average annual consumption growth at 0.9 percent over the period 2005-30. Energy consumption in the transportation sector is projected to increase at the rate of 0.3 percent per cent per annum over the same period. Declines in the rate of growth are expected across all sectors, relative to the BAU scenario (Figure II-27).

Figure II-27. Final Energy Consumption by Sector in Korea, BAU and APS



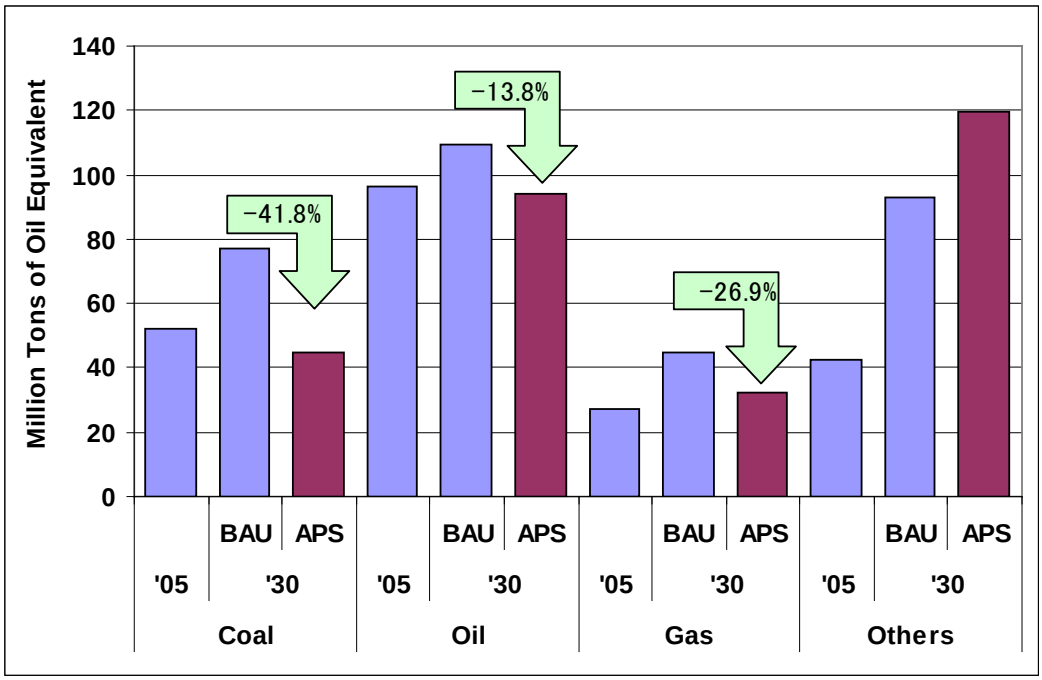
3.2. Primary Energy Demand

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

Business as Usual Scenario

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

Figure II-28. Primary Energy Demand by Source in Korea, BAU and APS



Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a lower rate of 1.2 percent per annum to 291 Mtoe in 2030. Coal will decline on average by 0.6 percent per year while oil will decrease at 0.1 percent per year over the period 2005-2030. Consumption of natural gas is projected to increase at an annual average rate of 0.7

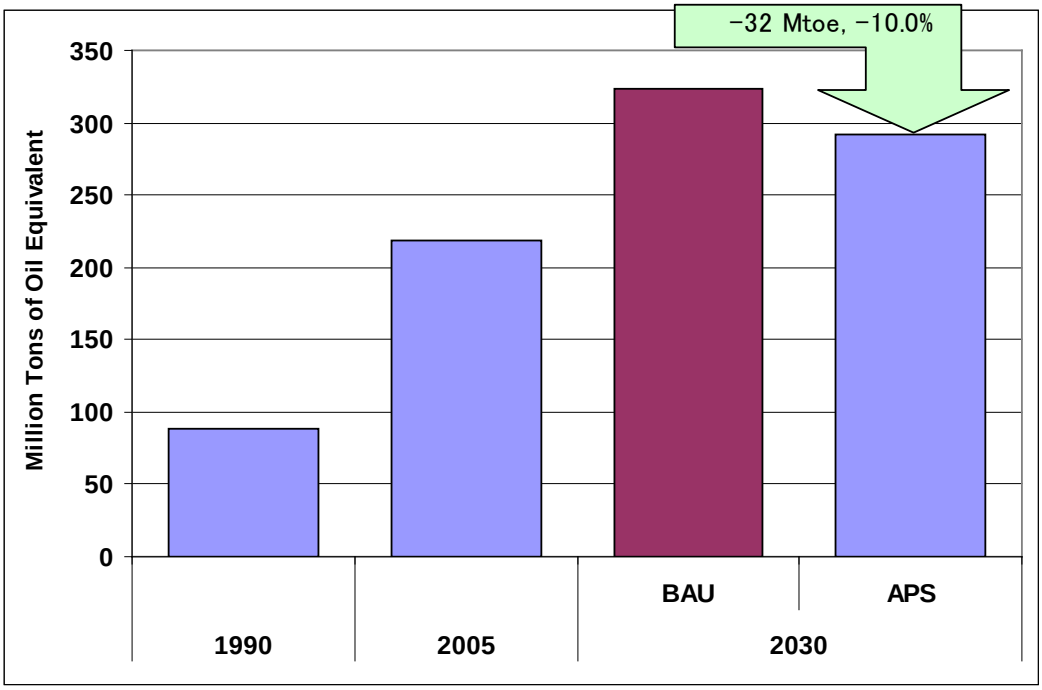
percent (Figure II-28). Energy efficiency and conservation measures on the demand side mainly contribute to the reduction in consumption growth.

3.3. Projected Energy Saving

The energy savings that could be derived from the energy saving goals, action plans and policies of Korea is 32.2 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2030 (Figure II-29). This is equivalent to 14.7 percent of Korea's consumption in 2005.

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

Figure II-29. Evolution of Primary Energy Demand in Korea, BAU and APS

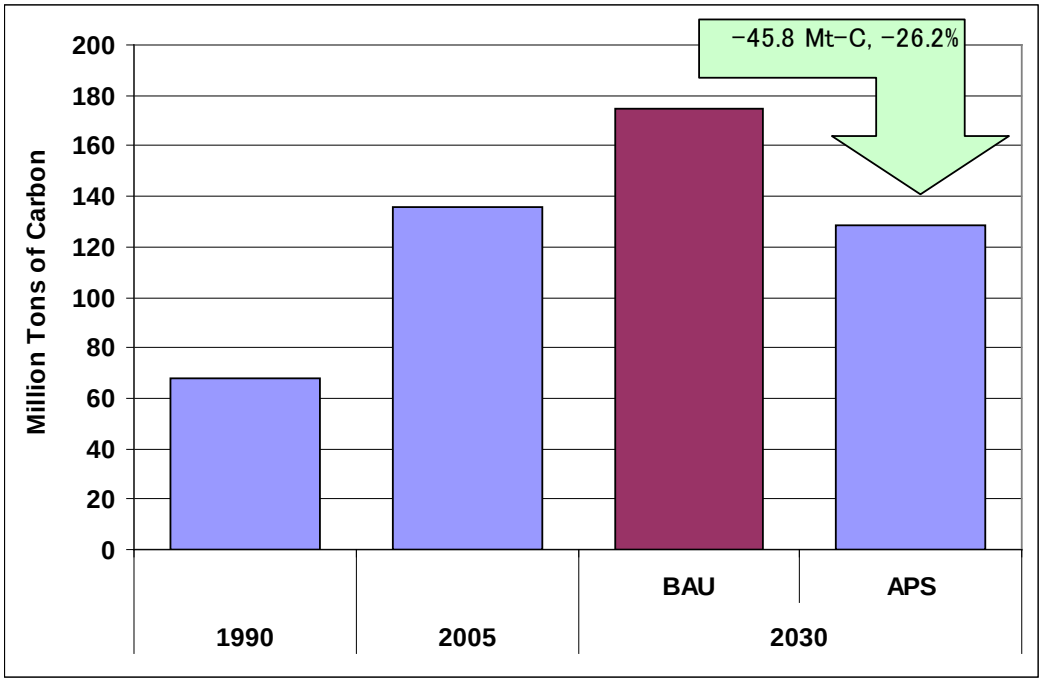


3.4. CO_2 Emissions from Energy Consumption

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

In the APS, CO_2 emissions are projected to decrease at an annual average rate of 0.2 percent from 2005 to 2030. This indicates that the energy saving goals and action plans of Korea are very effective in reducing CO_2 emissions (Figure II-30).

Figure II-30. Evolution of CO_2 Emission in Korea, BAU and APS



4. Implications and Policy Recommendations

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

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

Chapter 10

Lao PDR Country Report

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June 2011

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Lao PDR

Mr. Khamso Kouphokham

1. Background

Lao People's Democratic Republic (Lao PDR) is a small country in Southeast Asia. It is a landlocked country located in the middle of the Southeast Asia peninsula. It has borders with five countries namely China in the north, Vietnam in the east, Cambodia in the south, Thailand and Myanmar in the west. Lao PDR has a total area of 236,800 square kilometres and about 70% of that is covered by mountains. Lao PDR has a population of 5,873,616 people in 2007 with the female population accounting for a little bit more than 50% of the total. The average population density is 25 people per square kilometre. Laos consists of 17 provinces. Its capital city, Vientiane, has a population of 725,820 people in 2007.

Since Lao PDR had changed its economic policy to an open door policy in 1986, Lao economy has been progressing and expanding rapidly. The Gross Domestic Product (GDP) in 2007 increased by 7.9% from the previous year. GDP stood at about US$ 2,388 million at constant 2002 prices and about US$ 4,112 million in nominal terms. Per capita GDP was about US$ 700. The economy has been gradually changing from agriculture-oriented to a wider range of activities such as services and industry. In 2007, the services sector accounted for 38.4% while the agriculture sector had only 30.8% of GDP. The industry sector also increased rapidly due to investments in mineral and hydropower sectors. Even though in 2007 it has contributed only 26% to the GDP, it is projected to take a bigger share in the GDP within 5 years.

Laos's total primary energy demand in 2010 was 1.1 MTOE. The country's primary energy demand mix consists of four types of energy such as coal, oil, hydro, and biomass. As biomass and charcoal are excluded in this study, hydro was becoming the dominant energy supply at 911.0 KTOE sharing a 79.6 percent in the total primary energy demand. Oil came second at 678.0 KTOE with a 59.2 percent share in the total primary energy demand. Oil is imported from Thailand and Vietnam. Oil is mainly used in the transportation sector. The third energy type that used in the primary energy is coal. In 2010, it was consumed 111.0 KTOE. Also in the same year, Laos exported around 48.5 percent of its electricity to neighbouring countries.

Lao PDR is rich in hydro resources and in view of the low electrification ratio, rapidly increasing demand for electricity, and increasing power production for export, development of the country's hydropower potential is being promoted. The Lao Government plan has a target of increasing electrification ratio from 59 percent in 2007 to 70 percent in 2010 and 90 percent in 2020. This plan is among the priorities of the government to eradicate the country's poverty. According to Mekong River Commission Study conducted in 1995, Lao PDR has the potential of 23,000 MW. Up to 2007, only 3% of this potential has been developed with a total installed power capacity was 673 MW. The total power supply of the country is nearly 100% from hydro power source. In 2007, Lao PDR has produced 3,374 GWh of electricity. From the total power

generation, more than 66 percent or 2,230 GWh was exported to Thailand while and the 39 percent or 1,311 GWh was supplied domestically. The export figure is projected to increase sharply because by the year 2020, Lao PDR has agreed to export of 7,000 MW and 5,000 MW of electricity to Thailand and Viet Nam, respectively, to help these neighbouring countries fulfil their power requirement. The power source for the export is mainly from the hydropower except for one coal thermal power plant, Hongsa Lignite Power Project. This project alone has an installed capacity of 1,800 MW. At present, there are more than 50 hydropower sites planed to be developed for that export. These hydropower projects are being developed jointly between the Lao Government and foreign investors.

Since the Ministry of Energy and Mines has been established in 2006, energy policy gained a lot of attention and has been developing in more complexity. In the past, it focussed solely on the power sector but now it covers most of energy types and energy related activities. Lao PDR's energy policy aims to develop the energy sector toward sustainability and environmental compatibility. This is brought about by the cooperation of the Ministry of Energy and Mines in cooperation with ASEAN, other countries and international agencies. Many lessons and experiences learned from overseas have been incorporated into the policy.

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 1.7 percent. However the country will experience the decreasing population growth rate of 1.6 percent from 2005 to 2010.

With regards to future electricity supply, Lao PDR will continue to use hydro and coal as primary energy for generating electricity. Power generation from coal with installed capacity of 1,800 MW will only be available after 2015, as the country will be commissioning its first coal thermal power plant in Hongsa by 2015. However, this will only 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 and bio-fuel programs. The energy conservation program aims for a 10 percent reduction in final energy consumption by the year 2030. For the bio-fuel program, the government planned to increase a share of bio-fuel in the total oil consumption to 10 percent by 2020.

3. Outlook Results

3.1. Total Final Energy Consumption

Lao PDR's final energy consumption in 2005 was 0.5 Mtoe growing at an average annual rate of 4.5 percent from 0.2 Mtoe in 1990. The industry sector had the highest growth rate during this period at 23.8 percent per annum followed by the other sectors

(mostly residential and commercial) at 7.6 percent per annum. The transportation sector shares 63.3 percent of the total consumption in 2005. In terms of energy types in 2005, oil was the most consumed product having a share of 74.2 percent followed by electricity which accounted for 19.2 percent.

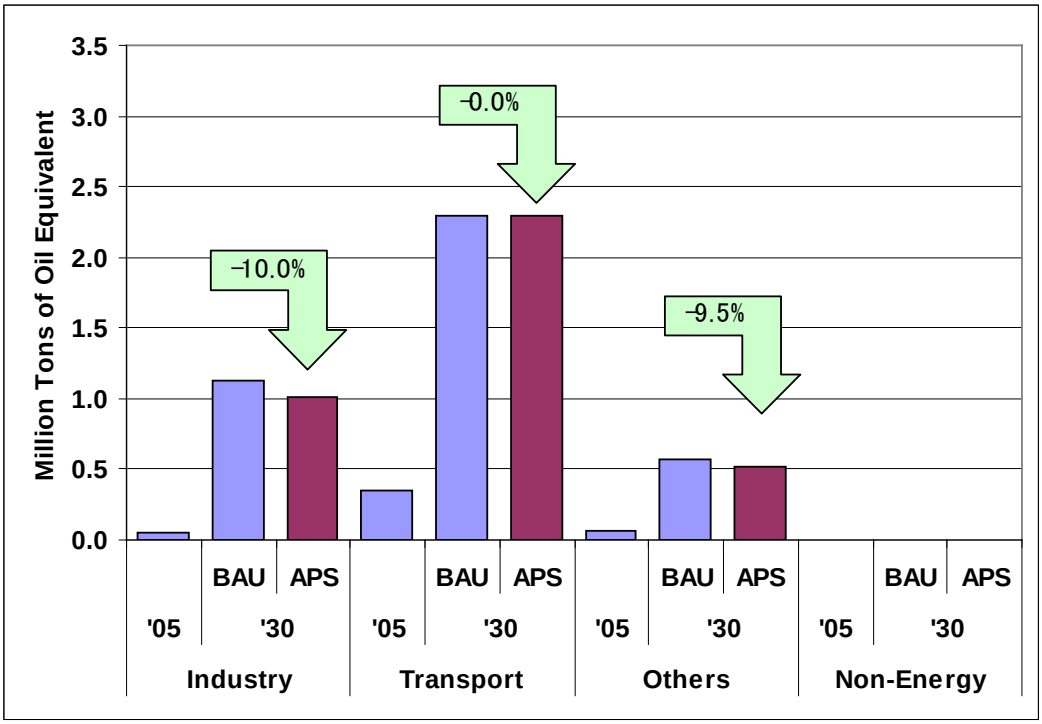
Business-as-Usual (BAU) Scenario

From 2005 to 2030, Lao PDR will experience high growth of energy consumption in all sectors. The industry sector will have the highest growth rate of 12.9 percent followed by the transportation sector at 8.7 percent. The final consumption of the other sectors will have a moderate growth rate of 6.7 percent.

Alternative Policy Scenario (APS)

In the APS, the growth of final energy consumption will be slightly lower than that of the BAU. This is due to a number of energy efficiency measures to be implemented up to 2030. With reduction of 10 percent of total final energy consumption, the total final energy consumption is expected to be lower from 4.0 MTOE in BAU to 3.8 MTOE in APS (Figure II-31).

Figure II-31: Final Energy Consumption in 2005 and 2030, BAU vs. APS



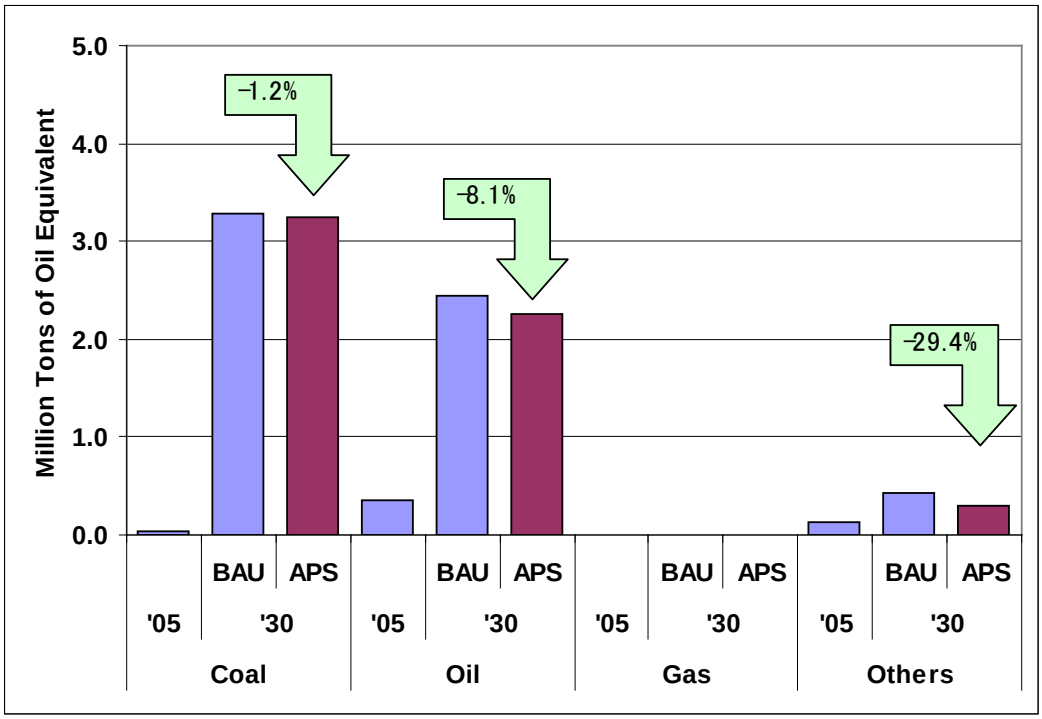
3.2 Primary Energy Demand

The primary energy demand of Lao PDR grew at an average annual rate of 4.4 percent from 1990 to 2005. Hydro grew the fastest during the period with an average annual rate of 10.2 percent due to many hydro plants that had been built to export electricity to Thailand. On the other hand, oil demand increased at an annual growth rate of 2.8 percent.

Business-as-Usual (BAU) Scenario

Primary energy demand will increase from 0.5 MTOE in 2005 to 6.2 MTOE in 2030. Coal demand will increase sharply from 0.03 MTOE in 2005 to 3.3 MTOE in 2030 at an average annual growth rate of 27.9 percent because Laos will use coal for electricity generation from 2015 onwards. Hydro will increase at a lower rate of 7.7 percent compared with that of coal. It will increase from 0.3 MTOE in 2005 to 1.9 MTOE in 2030. Oil demand will rise at a faster pace than hydro from 0.4 MTOE in 2005 to 2.5 MTOE in 2030.

Figure II-32: Primary Energy Demand in 2005 and 2030, BAU vs. APS



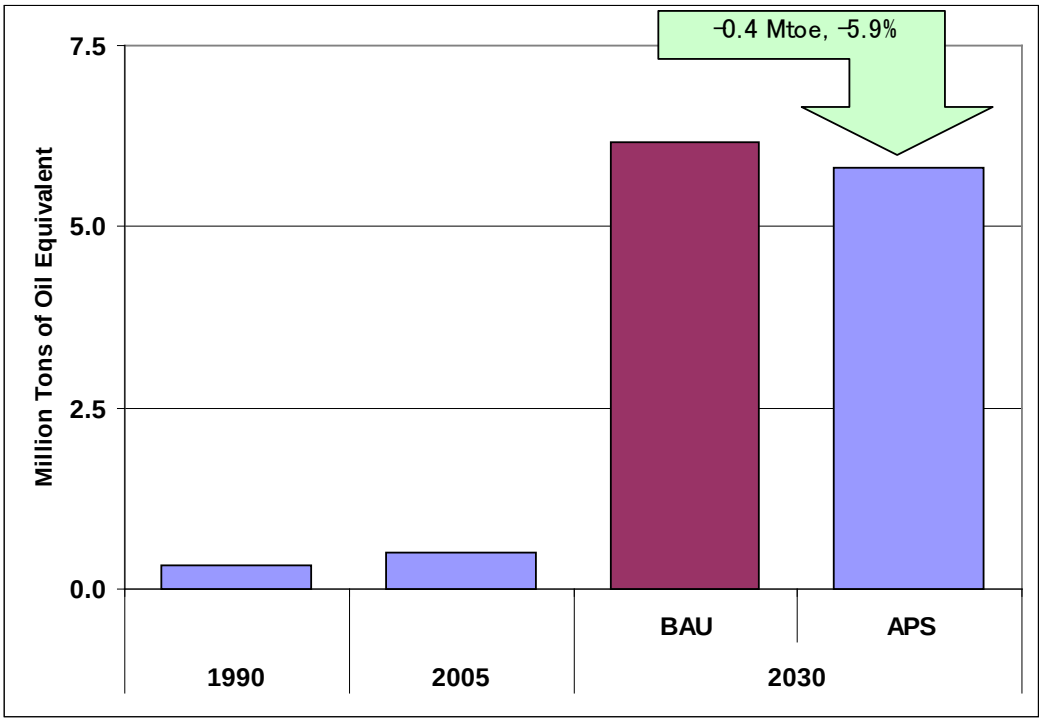
Alternative Policy Scenario

In the APS, the primary energy demand is expected to grow at a lower than that of the BAU scenario. It is projected to grow by 10.8 percent per year to 5.8 MTOE, lower than the 6.2 Mtoe of the BAU. Coal will increase at the same rate as in the BAU and will account for 56.0 percent share in the primary energy demand. Oil demand will grow at an average annual growth rate of 7.9 percent from 2005 to 2030 with an absolute values of 0.3 MTOE to 2.3 MTOE in 2005-2030 (Figure II-32).

3.3 Projected Energy Savings

Lao PDR will attain energy savings through the implementation of the proposed Energy Conservation and Bio-fuel programs. The programs aim a 10 percent reduction in final energy consumption and a 10 percent increase of bio-fuel in oil consumption by the year 2030. By implementing these programs Lao PDR will save about 0.2 Mtoe (equivalent to 4.2 percent) of final energy and 0.4 Mtoe (equivalent to 5.9 percent) of primary energy (Figure II-33) in 2030.

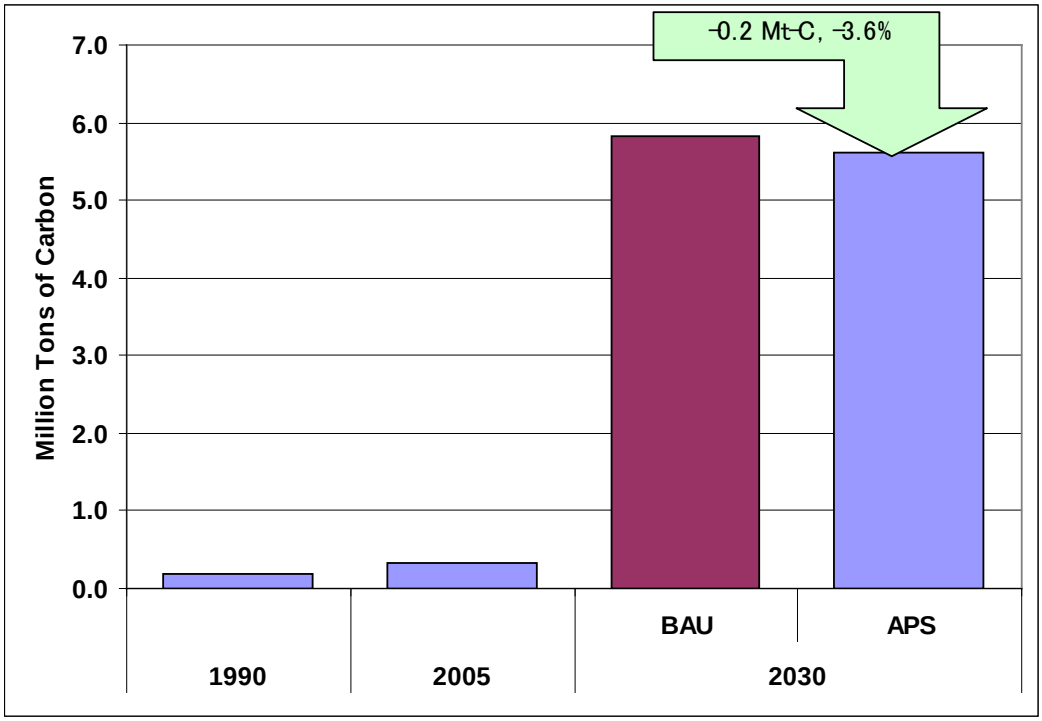
Figure II-33: Evolution of Primary Energy Demand, BAU vs. APS



3.4 CO_2 Emissions

In this outlook, if Lao PDR successfully implements the proposed energy conservation and bio-fuel programs, its CO2 emissions will be reduced by 0.2 Mt-C, around 3.6 percent reduction compared with the BAU scenario.

Figure II-34: CO_2 Emission in Energy Consumption, BAU vs. APS



4. Implications and Policy Recommendations

In this outlook, Lao PDR will experience increasing primary energy and final energy consumption. This is because Laos will continue to have a high GDP growth which is expected to be around 7.5 percent. Most sectors will require more energy.

In order to increase energy savings, Lao PDR has to be more active in implementation of the energy efficiency and conservation programs. The programs may initially focus on raising public awareness on energy efficiency and conservation. This can help all sectors to better understand the importance and necessity of implementing the EEC activities. Importantly, the programs should be supported by many detailed measures in the short, medium and long term periods. At the same time, the government should also provide the necessary information and know–how in best practices on EEC to the people.

Chapter 11

Malaysia Country Report

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June 2011

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Malaysia

Mr. Zaharin Zulkifli

1. Background

Malaysia is located in Southeast Asia. Its 330,242 square kilometers of territory consists of Peninsular Malaysia and the Sabah and Sarawak States on the island of Borneo. Malaysia has a tropical, humid climate with temperatures averaging 86°F (30°C). The total population of Malaysia was 25.3 million in 2005. Gross Domestic Products (GDP) grew at an average of 6.2 percent per year from 1990 to 2005. After the downturn in 2009, the Malaysian economy experienced a strong resumption of growth in 2010 with an expansion of 7.2 percent. Growth was driven mainly by robust domestic demand, with strong expansion in private sector activity. Meanwhile, the public sector continued to support the domestic economy through implementation of programmes to further enhance the country's infrastructure and the public sector delivery system.

Over the past few decades, Malaysia has enjoyed a rapidly growing economy – developing physical and human infrastructure to the point that it is now transitioning from a middle income country to a high income country focussing increasingly on the production of high value goods and services. The energy sector is seen as being of critical importance to future economic development. It is considered fundamental to the efficient and effective development of a modern economy as well as to the security and welfare of society more generally. As such it is imperative that Malaysia's energy supplies be assured as it embarks of the next stage of its economic and social development.

Malaysia is well endowed with conventional energy resources such as oil, gas, and coal, as well as renewable such as hydro, biomass and solar energy. As of January 2010, reserves included 20.56 billion of barrels oil equivalent (bboe) of crude oil and natural gas and 1,938.4 million tons of coal. At the current level, Malaysia is a net energy exporter. Crude oil, LNG and petroleum products contributed 14.9 percent of the economy's export earnings in 2010 or RM 94.67 billion. Malaysia is the world's second largest producer of crude palm oil. A local study carried out in 2004 estimated that in 2002, 362 palm oil mills in the country processed about 59.8 million tonnes of fresh fruit bunches (FFB) and produced 11.9 million tonnes of crude palm oil (CPO). The by-product from mill processing generated about 22.6 million tonnes solid waste from the empty fruit brunches (EFB) and 41.9 million tonnes of palm oil mill effluent (POME). Malaysia being an equatorial country has an irradiance level, well suited for photovoltaic (PV) generation. The investigations of PV installations in Malaysia use a modified tilt angle as 30° is not optimum for locations around the Equator. Near horizontal tilt is more favourable and installations will normally have about 5° to 15° tilt angle to be efficient and still allow the PV system to be follow the roof slope.

The Malaysia Government has identified three principal energy goals as being instrumental in guiding the future development of the energy sector. First is the supply objective to ensure the provision of adequate, secure and cost-effective energy supplies

by developing indigenous energy resources (renewable and non-renewable). Second is the utilization objective to promote the efficient utilization of energy and discourage wasteful and non-productive patterns of energy consumption. And third is the environmental objective to minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

With economic growth rate of 6.2 percent per annum from 1990 until 2005, Malaysia final energy consumption grew at 7.3 percent per annum in the same period. Majority of fuel consumed were oil, natural gas and electricity. In terms of sectoral usage, the industrial and transport sectors were the major consumers of energy in Malaysia. In 2005, Malaysia generated 84.8 terawatt hours (TWh) of electricity. Natural gas continued to remain the main fuel source for electricity generation with a share of 64.9 percent followed by coal at 26.1 percent oil at 2.9 percent in 2005. In 2009, Malaysia had 24 gigawatts (GW) of installed generation capacity.

2. Modelling Assumptions

The projections of growth rates of future GDP are based on study carried out by the Economic Planning Unit (EPU) under the Prime Minister's Office of Malaysia. The GDP growth rates by sub-sectors are very useful and important to forecast better results for energy supply and demand in the future. Most of all the demand equations for Malaysia used GDP as the key factor to determine future projections. The assumed GDP growth rates are shown in Table II-2.

Table II-2. GDP Growth Assumption in Malaysia to 2030

Year	GDP (%)	Industrial GDP (%)	Commercial Sector GDP (%)	Manufacturing GDP (%)	Agricultural GDP (%)
2007-2010	0.83	-0.22	1.62	-1.10	1.12
2011-2015	4.57	4.85	4.36	5.60	4.64
2016-2020	4.72	5.06	4.47	5.56	4.70
2021-2025	4.15	4.48	3.89	4.98	4.08
2026-2030	3.62	3.96	3.37	4.45	3.50

Source: Economic Planning Unit, Study to Formulate a New Energy Policy for Malaysia, August 2009

Beside future GDP growth rates, the annual average population growth was also considered as one of main key drivers for future energy demand growth. The assumption of future growth rates of population was obtained from the Department of Statistics Malaysia and is shown in Table II-3.

Table II-3. Population Growth Assumption in Malaysia

Year	Growth Rate
1990 – 2005	2.30%
2005 – 2010	2.30%
2010 – 2020	2.30%
2020 – 2030	2.10%

Source: Department of Statistics Malaysia (2009)

As part of the government's initiative to ensure security of energy supply and at the same time to conserve the environment and promote green technology, the introduction of feed-in-tariff (FiT) is an effort towards that direction. With a lot of renewable energy source potential, Malaysia can fully utilise its resources by converting them into electricity. The implementation of FiT will promote and make sure that renewable energy supply can be part of future generation mix of Malaysia. Furthermore, the Government target of reducing 40 percent of the CO_2 emission intensity by 2020 from the 2005 level could become reality. The introduction of biodiesel in the market gradually by region starting June 2011 is one of the other actions to meet the target. Utilization of biomass in the country was not only for the power sector but also can be benefit the transport sector. The 2,400 MW Bakun dam is expected to commercially produce its first 300 MW in July 2011. This definitely will increase hydro share in the fuel mix of Malaysia. As part of alternative energy option, nuclear power was also considered to be a part of the future supply mix for power generation from around 2023.

Malaysia's energy saving goals are expected to be attained through the implementation of energy efficiency programs in all energy consuming sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies as well as aggressive energy efficiency efforts. Various incentives, tax exemptions and government fund or soft loan were already in place to encourage private sectors to invest in energy efficiency products and services. Mandatory appointment of energy manager in industry that consume more than 3,000 MWh in six months is to make sure that energy intensive industries will shift or undertake energy efficiency measures. In the residential and commercial sectors, the utilization of more efficient electrical appliances is projected to induce savings, in addition to energy management systems. Star labelling and rating on major electrical appliances will help consumer to choose more efficient electrical products. Moreover, the building sector has become an important sector potentially in reducing energy consumption. Standards, such as Green Building Index (GBI) that is already introduced in Malaysia, will help to reduce the electricity consumption in the building sector. In the transport sector, efficiency improvements will be achieved through the use of biodiesel, so as to reduce dependency on oil and curb CO_2 emissions. Electric vehicles were introduced recently to individual users to help reducing oil consumption in the transport sector. A roadmap on electric vehicle is now being prepared by the Government to identify action plans and measures that should be in place to realising the increase in electric vehicles in the country. Under the Greater Kuala Lumpur plan, the new route of Mass Rapid Transportation (MRT) is

now being undertaken by the Government to expand the public transportation network in Klang Valley.

Details of assumptions in respective scenarios mentioned are listed below:

Energy Efficiency and Conservation (EEC) Scenario

1. 10% reduction in final energy consumption of the industrial sector from 2011 until 2030
2. 10% reduction in commercial sector from 2011 until 2030
3. 10% reduction in residential sector from 2011 until 2030
4. Fuel switching from motor gasoline to electric train in public sector
    - In 2010, the electric consumption in trains will be at 12 ktoe and 20 ktoe in 2020
5. Fuel switching from motor gasoline to electric vehicle in transportation sector
    - In 2011, there will be 50 EV in road and gradually increase to 1000 EV in 2030
    - Assuming, motor gasoline per vehicle is about 0.00139 ktoe or 1,473 litre per year, in 2030, potential reduction of motor gasoline in transportation sector is about 1.39 ktoe

Renewable Energy Scenario:

Energy Source	2015	2020	2025	2030
Biomass (MW)	300	800	1,190	1,340
Biogas (MW)	100	240	350	410
Mini-hydro (MW)	290	490	490	490
Solar (MW)	55	175	399	854
Municipal Solid Waste (MW)	200	360	380	390
Biodiesel	5% of diesel will be replaced by biodiesel starting 2011			

Note: The numbers in MW are cumulative installed capacity.

Nuclear Energy Scenario: 2,000 MW installed for power generation in 2023.

All of the above assumptions are used in the APS. Therefore, the APS has combined assumptions for energy efficiency and conservation, renewable energy development and nuclear energy use.

3. Outlook Results

3.1. Total Final Energy Consumption

Malaysia's final energy consumption experienced a high growth of 7.3 percent per annum from 12.8 Mtoe in 1990 to 36.7 Mtoe in 2005. The industry sector had the highest growth rate during this period at 7.5 percent per annum followed by the others sector, growing at 7.3 percent. The transportation sector grew at 7.1 percent per annum

from 1990 to 2005 and the non-energy sector grew at 7.0 percent in the same period. Analysis by fuel type shows that, in 2005, oil dominated the share with 57.5 percent followed by natural gas at 19.3 percent and electricity at 19.1 percent. Coal that was mainly consumed by cement industry was at 3.4 percent of share and remaining 0.2 percent shared by others.

Business-as-Usual (BAU) Scenario

With the projected continuous economic growth of 4.6 percent per annum and population growth of 1.8 percent per annum, the final energy consumption from 2005 to 2030 is also projected to grow at an average rate of 3.8 percent per annum in the BAU scenario. The highest growth rate is expected to occur in the non-energy sector at 4.9 percent per annum. This was in line with the Government announcement that PETRONAS will construct a US$ 20 billion (RM 60 billion) integrated refinery and petrochemicals complex in Southern Johor to be commissioned by end-2016. The project, known as the Refinery and Petrochemicals Integrated Development (Rapid), is at the detailed feasibility study stage and will comprise a crude oil refinery, a naphtha cracker that would produce about three million tonnes of ethylene, propylene, C4 and C5 olefins per year and a petrochemicals and polymer complex that would produce differentiated and highly-specialised chemicals.

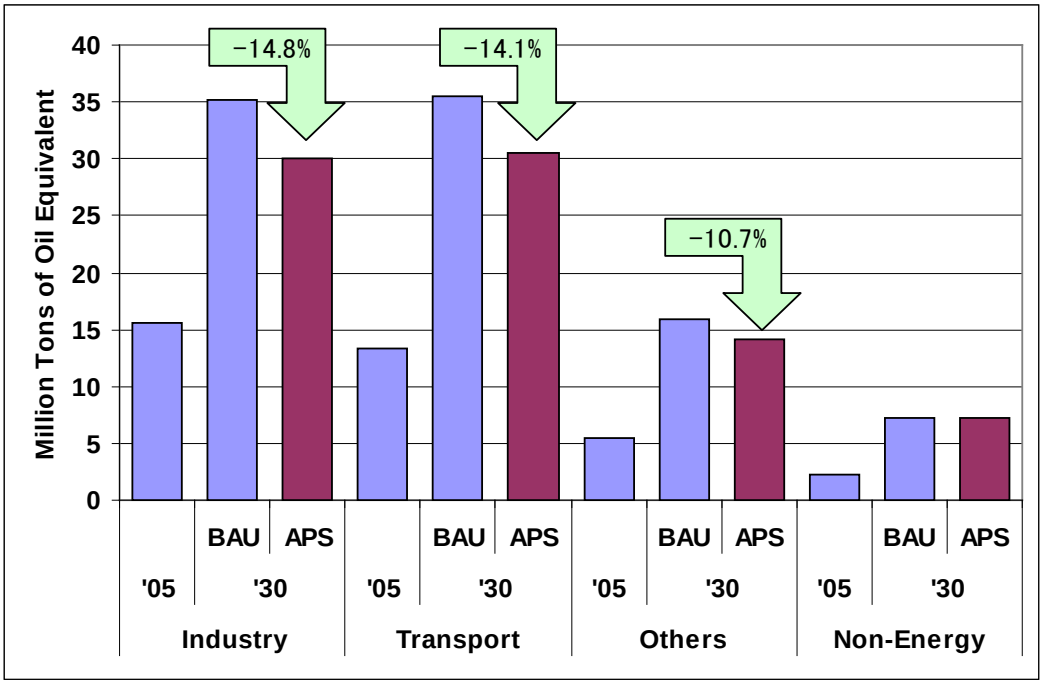
As the lower GDP growth affects the growth rates of the industry and transportation sectors, the others sector is likely to increase by 4.3 percent per annum from 2005 to 2030. This was followed by the transportation sector at 4.0 percent per annum and the industry sector at 3.3 percent per annum. The lower growth rates of GDP compared to others was anticipated by higher GDP growth from the services sector.

Analysis by fuel type shows that natural gas will be expecting to increase at the highest rate per annum of 5.3 percent from 2005 to 2030. This was followed by electricity at 4.5 percent per annum and coal 3.4 percent per annum. The “Others” fuel, which is biomass, is expected to increase at 3.1 percent per annum and oil at 3.0 percent per annum.

Alternative Policy Scenario (APS)

In the APS, growth in final energy consumption will be slightly lower compared with that of the BAU scenario at 3.3 percent per annum from 2005 to 2030. The slower rate of increase in the APS is projected to be the result of improvements in manufacturing technologies, as well as efforts in improving energy efficiency, particularly in the industrial sector. Improvement of public transportation and introduction of electric vehicle will also contribute to the lower growth of oil in the transportation sector. From 2005 to 2030, the transportation sector will be expecting to increase by 3.3 percent per annum compared to 4.0 percent per annum in BAU scenario. In the residential and commercial sectors, the growth rate of energy consumption is projected to have a lower growth rate at 3.9 percent per annum in the APS as compared to 4.3 percent per annum in the BAU scenario. It is due to lower growth of electricity, especially in the building segment. The growth rate of energy consumption in the non-energy sector will remain the same in the APS relative to the BAU scenario (Figure II-35).

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



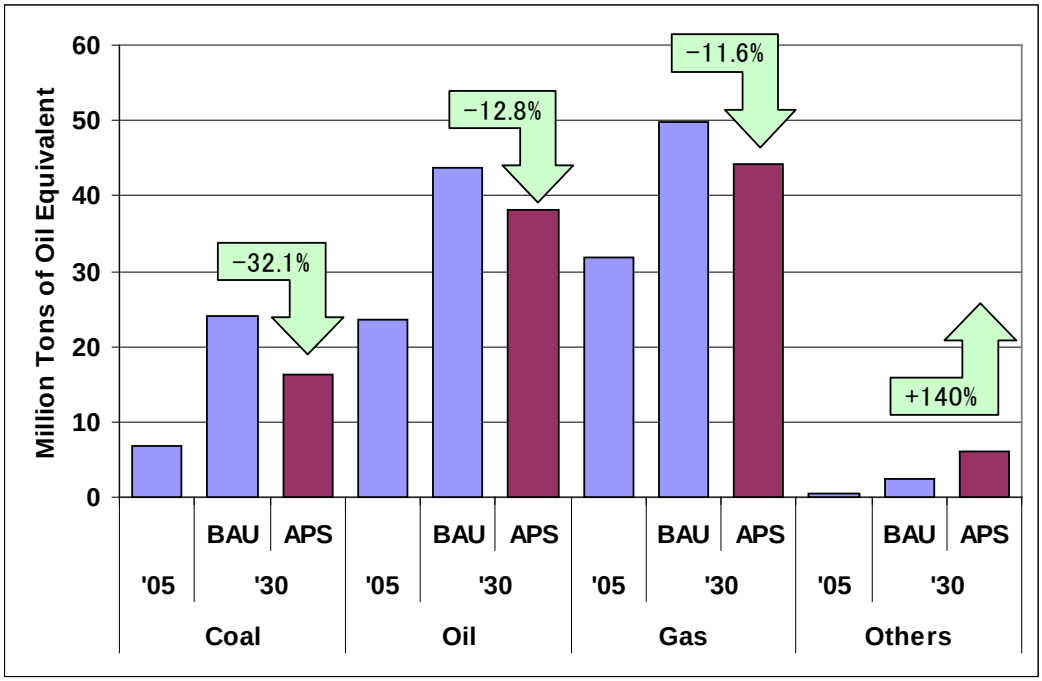
3.2. Primary Energy Consumption

Primary energy consumption of Malaysia grew at an annual average rate of 7.7 percent per year from 20.6 Mtoe in 1990 to 62.8 Mtoe in 2005. Among the major energy sources, the fastest growing energy sources were coal and natural gas, increasing at average annual rates of 13.4 percent and 10.8 percent, respectively between 1990 and 2005. Oil and others grew at lower average annual rates of 4.4 percent and 2.4 percent over the same period. Hydro grew at average annual growth rate of 1.8 percent from 1990 to 2005.

Business-as-Usual Scenario

In the BAU scenario, Malaysia's primary energy consumption is projected to increase at an annual growth rate of 2.6 percent over the period 2005-2030 to 120.1 Mtoe in 2030. Over the same period (2005-2030), others, which is biomass, is projected to be the fastest growing fuel, will increase at an average annual rate of 6.9 percent followed by hydro and coal at 6.2 percent and 5.2 percent respectively. Oil is projected to remain a dominant fuel in primary energy sources and its demand is projected to increase at an annual average rate of 2.5 percent between 2005 and 2030. Natural gas will be expecting to increase at 1.8 percent per annum in the same period. The share of oil in primary energy demand is projected to decrease slightly from 37.5 percent in 2005 to 36.4 percent in 2030. However, the share of coal is projected to grow higher from 10.9 percent in 2005 to 20.0 percent in 2030. Natural gas share will be expecting to be lower in 2030 at 41.5 percent compared to 50.8 percent in 2005.

Figure II-36. Primary Energy Consumption by Source in Malaysia, BAU and APS



Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower pace than in the BAU scenario at 2.1 percent per annum from 62.8 Mtoe in 2005 to 104.5 Mtoe in 2030. Others will be growing the fastest at 13.2 percent per annum followed by hydro at 6.4 percent between 2005 and 2030. The implementation of FiT in power generation has a big impact to the primary energy demand in 2030 as more renewable energy will be expected. However, oil and natural gas will have lower growth rates of 1.9 percent and 1.3 percent, respectively (Figure II-36). The decline in the growth rate is mainly achieved as a result of energy efficiency and conservation measures on the demand side as well as the decline of dependency on fossil fuels. Nuclear power, as one of the future energy options, is also projected to increase in the future primary energy demand mix, because it is an energy supply with zero carbon emission. In terms of share, oil and natural gas shares will respectively dropped from 2005 levels in 2030. However, others type of fuels such as coal, hydro, others and nuclear will grow gradually in 2030.

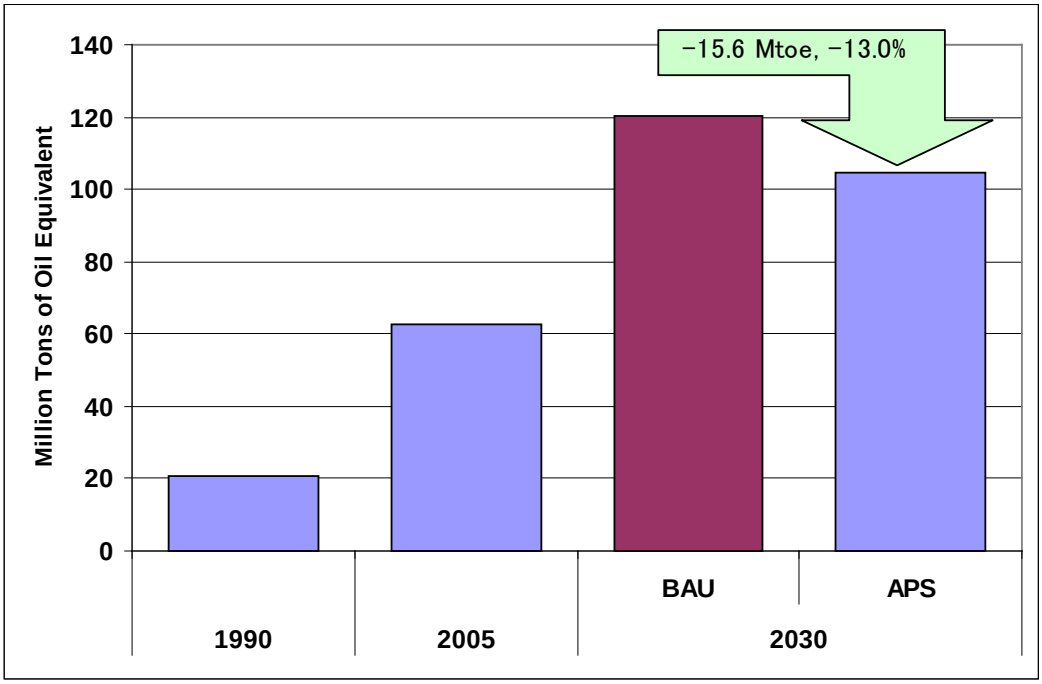
3.3. Projected Energy Savings

The energy savings that could be achieved under the APS, relative to the BAU scenario, as a result of energy efficiency efforts in industrial and commercial sectors and fuel switching in transportation sector are estimated at about 16 Mtoe in 2030 (Figure II-37).

Based on the assumption on the improvement of energy usage in industry, transport and commercial sectors, the total saving that can be achieve is about 13 percent in 2030. The

above savings in energy in 2030 consist of savings of 5.2 Mtoe in the industry sector, 5.0 Mtoe in the transport sector and 1.7 Mtoe in the others sector.

Figure II-37. Total Primary Energy Consumption in Malaysia, BAU and APS

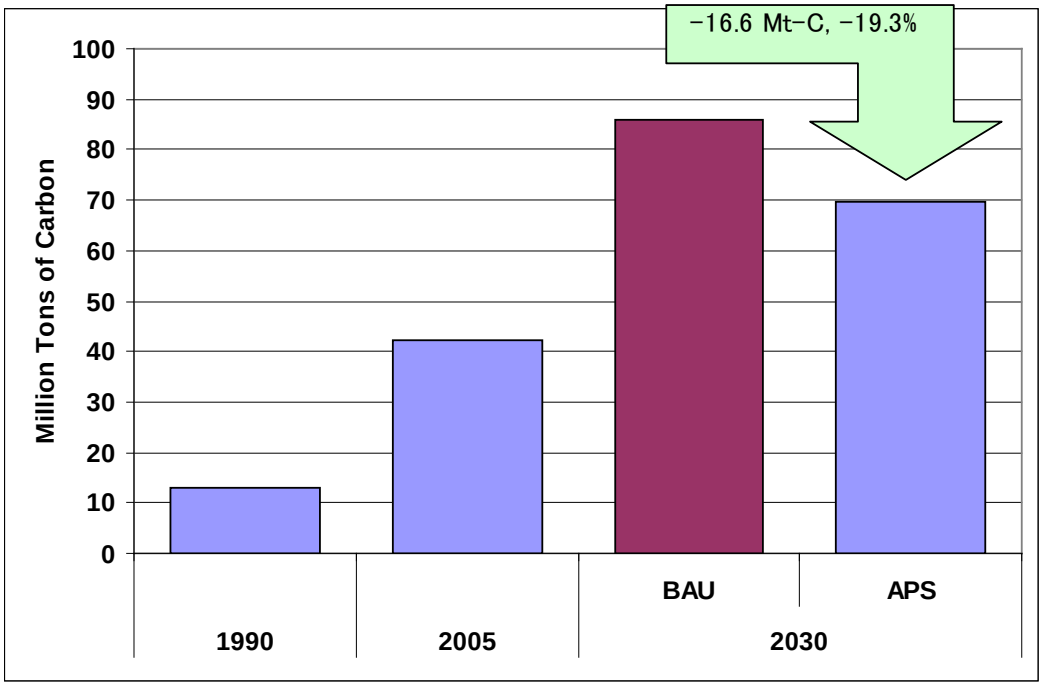


3.4. $C0_2$ Emissions from Energy Consumption

Total carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 2.9 percent per annum from 2005 to 2030. In 2005, the CO2 emissions level was at 42.4 million tons of carbon (Mt-C) and it is expected to increase to 86.1 Mt-C in the BAU scenario.

In the APS, the annual increase in CO_2 emissions from 2005 to 2030 will be lower than in the BAU scenario at 2.0 percent per year, which is fairly consistent with the growth in primary energy demand. The reduction in $C0_2$ emissions in the APS is 16.6 Mt-C or 19.3 percent relative to the BAU scenario. It is caused by a significant decrease in coal consumption for power generation in the APS, relative to the BAU scenario, as the coal demand is being substituted by natural gas and other clean energy sources, such as nuclear and renewable energy. Furthermore, reduction of energy use in the industry and transport sectors also reduces the CO_2 emissions. This indicates that Malaysia's energy saving effort and renewable energy action plans would be effective in reducing $C0_2$ emissions.

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



4. Conclusions

In the BAU scenario, it is expected that Malaysia's primary energy intensity will decrease by 1.9 percent per annum from 2005 to 2030. As such, in APS scenario, the primary energy intensity is projected to decrease by 2.4 percent per annum in the same period. The reduction of primary energy intensity indicates effectiveness of the energy saving measures undertaken by Malaysia in promoting energy efficiency and renewable energy. The reduction is also contributed by programmes and activities under the Green Technology Policy, which promote investments in green technology products and services in the private sector.

To make sure Malaysia have secure energy supply and at the same time conserve the environment, various initiatives have been undertaken by the Government, such as The Tenth Malaysia Plan (2010-2015), New Economic Model, Economic Transformation Programme and others. This will be the short, medium and long term planning for Malaysia economy that definitely affecting the energy sector in the country. To achieve the target of reducing CO2 emission intensity by 40 percent from the 2005 level in 2020, the Government will study very seriously any feasibility in reducing the energy demand and at the same time promote new technology in green business. Programmes and promotions on awareness campaign among Malaysians are now being implemented to ensure that people will foresee the benefit of green practices in their daily life.

Chapter 12

Myanmar Country Report

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Myanmar

Ms. Cecilya Laksmiwati Malik

1. Background

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

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

The population of Myanmar grew at 1.2 percent per year between 1990 and 2005 to 48 million in 2005. Myanmar's gross domestic product (GDP) was US$ 13.3 billion in 2005 and its GDP per capita grew from US$ 0.1 thousand in 1990 to US$ 0.3 thousand in 2005. With the objectives of enhancing economic development in Myanmar, the Five-Year Short-Term interval plans have been formulated and implemented during the years 1992 to 2011. The first (1992-1995), second (1996-2000) and third plans (2001-2005) achieved average annual growth rates in GDP of 7.5 percent, 8.5 percent and 12.8 percent respectively. The last five-year plan (2006-2010) has been formulated to achieve an average annual growth rate of 12.0 percent in GDP.

Myanmar's total primary energy consumption was 4.7 million tons of oil equivalent (Mtoe) in 2005. By fuel, oil represented the largest share at 40.4 percent; gas was second at 38.3 percent, followed by hydro with 6.4 percent. Natural gas is mainly used for electricity generation and in industry. Myanmar has 1,650 megawatts (MW) of installed generation capacity and generated about 6.0 terawatt-hours (TWh) of electricity in 2005. In 2005, thermal (coal, natural gas and oil) and hydro accounted for 50.2 percent and 49.8 percent of total electricity generation respectively.

1.1. The National Efficiency Policies

The Myanmar Energy policy in general strives towards maintaining the status of energy independence by increasing indigenous production of available primary energy resources through intensive exploration and development activities. It also addresses electric power as the main driving power source for economic development and the need to generate and distribute in terms of volume, density and reliability. It also advocates the utilization of water resources, a renewable energy resource for generating of electricity to save non-renewable sources of energy such as fossil fuels for alternative and future use. Energy Efficiency and Conservation is emphasized in order to save energy through effective energy management and to reduce energy consumption so as to minimize harmful environmental impacts. Encouragement is made to utilize new and

renewable energy sources, especially solar and wind which are abundant under Myanmar's climatic condition. It also accepts the fact that utilization of traditional energy sources such as fuel-wood and charcoal still needs to be practiced. Regulatory and anticipatory actions are necessary for the sustained harvesting of this primary energy source.

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

- Disseminate knowledge about EE&C to communities and way forward to easy use local renewable energy resources instead of fossil fuel.
- Create workshop and seminar regarding the EE&C for public awareness.
- Market promotion in energy efficient equipments and labelling of energy saving materials such as air-condition, motor & pump, electric appliances etc.
- Encourage the private sector to implement the EE&C programs by means of volunteer basis and award programme.
- Financial assistance on transferring advanced technology.
- Adoption of best practices is an effective action plan for energy saving in transport, residential & commercial sectors.
- To be considered EE&C in both demand and supply sides of electricity.
- There should proper policy measures and action plans to achieve energy savings targets.

1.2. Action Plan

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

Table II-4. Energy Efficiency Initiatives in Myanmar

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

2. Modelling Assumptions

2.1. GDP and Population

In this report, Myanmar's GDP is assumed to grow at an average annual rate of 9.6 percent from 2005 to 2030. Growth was strong from 1990 to 2005 at 11.5 percent per year. Average annual growth in GDP is projected to be 11.8 percent per year from 2005 to 2010, 9.8 percent per year from 2010 to 2020 and 8.3 percent per year between 2020 and 2030. Population is assumed to increase by about 1.7 percent per year from 2005 to 2030.

1.1. Electricity Generation

The share of electricity from hydro is projected to increase while the shares of oil, coal and natural gas are expected to decrease due to the Government's plan of developing and harvesting the abundant hydropower resources. Generation from natural gas power plants is expected to remain fairly constant through 2030 in the BAU scenario. In contrast, output from hydro power plants is projected to increase to export electricity in and after 2020. Reflecting the increasing efficiency of new technologies, the thermal efficiency of gas-fired power plants in Myanmar is expected to increase from 19.3 percent in 1990 to 27.7 percent in 2030.

1.1. Energy Saving Goals and Action Plans

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

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

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

- In the industrial sector, improve energy efficiency by 10 percent against BAU and reduce energy related greenhouse gases by 2020.
- In the transport sector, have biofuel (E85, biodiesel) fuel substitution of at least 8 percent by 2020.
- Increase the total installed power capacity of renewable energy to 15-20 percent

(around 18%) by 2020.
- Improve energy efficiency in the commercial/residential sector by 5-8% (around 7%) by 2020.

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

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

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

- In industry, gradual replacement of low efficiency equipment with higher efficiency ones will be encouraged.
- In the transportation sector, the state will encourage fuel switching in the transport sector to bio-fuels and natural gas as alternative fuels. The state also aims to achieve energy saving through exploiting more efficient transportation networks including road, waterways, rail, air and seaway and develop high-capacity transportation with greater volume capacity for freight and passenger. Improvement in fuel efficiency in the transport sector is also considered.
- In the residential and commercial sectors, the following are the measures that will be implemented:

    - Encourage the use of alternative energy and improvements in energy efficiency in existing buildings in the public and private sectors.
    - Promote the use of higher energy efficient appliances and energy savings equipment in the residential and commercial sectors.
    - Launch the use of bio-diesel (B 100) in rural communities.

- In the electricity sector, the following measures that will be implemented are:

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

3. Outlook Results

3.1. Total Final Energy Consumption

Total final energy demand in Myanmar increased by about 10.7 percent per year from 1.0 Mtoe in 1990 to 4.7 Mtoe in 2005. The 'others' sector, which comprises the commercial, residential and agricultural sectors, was the fastest growing sector with an average annual growth of 22.5 percent between 1990 and 2005. Average annual growth in the transport sector was about 7.5 percent over the period 1990-2005. The non-energy sector grew the slowest at 7.2 percent per year over the same period. By fuel type, oil was the most consumed product in 1990 having a share of 58.5 percent in the total final energy demand of the country. Its share decreased to 37.2 percent in 2005 due to the rapid increase of natural gas consumption from 0.2 Mtoe in 1990 to 2.2 Mtoe in 2005.

Business-as-Usual (BAU) Scenario

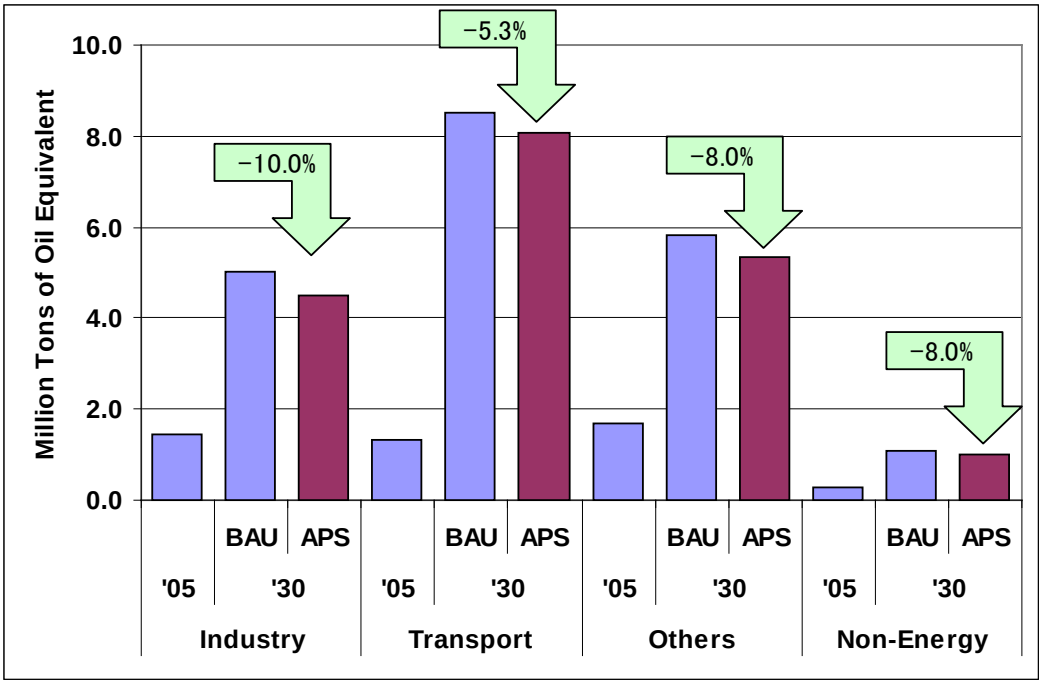
Using the socio-economic assumption stated above, final energy demand in Myanmar is projected to grow at an annual rate of 6.0 percent from 2005 to 2030 in the BAU scenario. Final energy demand is projected to grow the fastest to 2030 in the transportation sector with annual average growth of 7.7 percent. In the industry and others sectors, consumption is projected to grow similar at an annual average rate of 5.1 percent.

Natural gas is projected to remain a dominant fuel source in total final energy demand in 2030 but with a lower share of 40.4% percent as compared to 2005. From 2010 onwards, natural gas share will continue to decrease and reach 40.4% in 2030. Alternately, oil became the dominant fuel with share increasing to 46.5 percent in 2030 from 39.6 percent in 2010. Coal is projected to have an annual average growth rate of 6.5 percent in the period 2005-30 driven by the projected growth in industrial GDP. The share of coal will increase from 2.4 percent in 2005 to 2.7 percent in 2030 in the BAU scenario. Electricity demand will grow slower than oil and coal at an average annual growth rate of 6.2 percent per year over the 2005-2030 period. Its share will increase from 6.7 percent in 2005 to 6.9 percent in 2030.

Alternative Policy Scenario (APS)

In the APS, the growth in final energy demand is projected to grow at a lower average annual rate of 5.7 percent as compared to the 6.0 percent annual growth in the BAU. The reason for the slower growth rate is the result of technological improvement in manufacturing processes and the reduction of final energy demand of electricity and oil in the other sectors. Figure II-39 shows the sectoral final energy demand in Myanmar in the BAU and APS.

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



3.2. Total Primary Energy Demand

Primary energy Consumption in Myanmar grew at an average annual rate of 6.2 percent from 1.9 Mtoe in 1990 to 4.7 Mtoe in 2005. Among the major energy sources, the fastest growing were coal and hydro with average annual growth rates of 13.1 percent and 7.4 percent, respectively. Natural gas consumption grew at an average annual rate of 5.9 percent over the period 1990-2005. Oil consumption increased at the slowest rate of 4.5 percent per year over the same period.

Oil and gas dominate the primary energy consumption mix in 2005 with respective shares of 40.4 percent and 38.3 percent.

Business-as-Usual (BAU) Scenario

In the BAU scenario, Myanmar's primary energy consumption is projected to increase at an annual average rate of 6.5 percent per year to 22.4 Mtoe in 2030. Hydro is expected to grow at an annual average rate of 7.2 percent followed by oil at 6.8 percent over the period 2005-2030. This rapid increase of hydro is in line with the Government's plan on expanding hydroelectricity for export purposes which is reflected in the 'Others' primary energy demand.

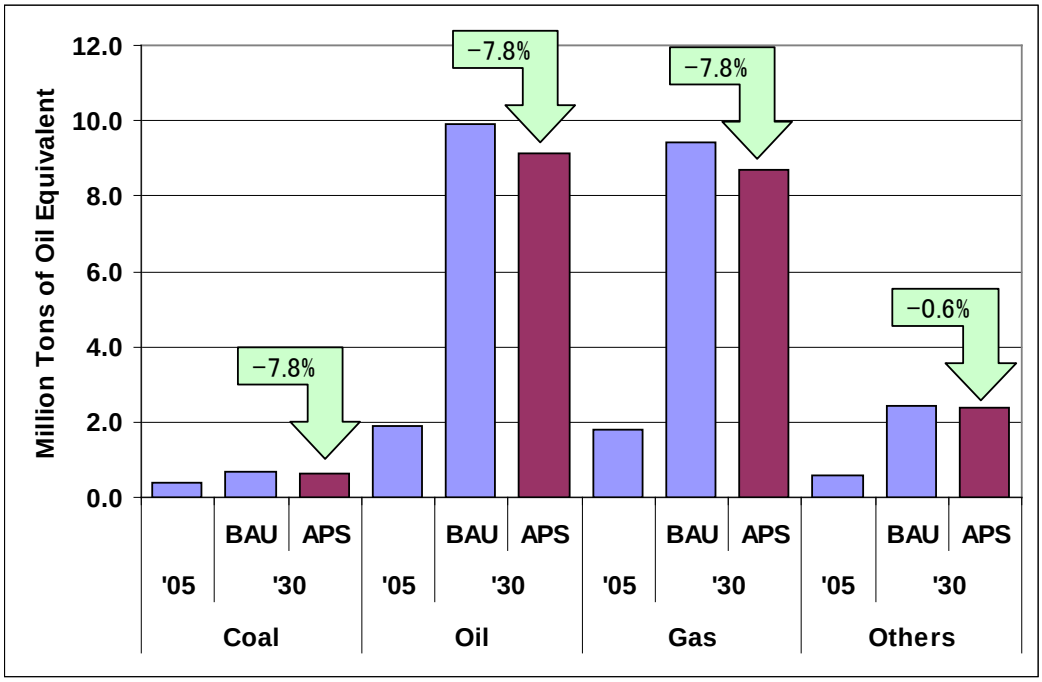
The share of hydro in the total primary energy mix of Myanmar will increase to 7.6 percent in 2030. However, since hydro will mainly be for electricity export, domestically, oil and gas will continue to dominate the primary energy mix through

2030. The shares of oil and gas will respectively increase further to 44.1 percent and 42.0 percent by 2030. Coal, on the other hand, will have a declining share from and 8.5 percent in 2005 to 3.1 percent in 2030.

Alternative Policy Scenario

In the APS, Myanmar's primary energy consumption is projected to increase at a slightly lower rate than the BAU's at 6.1 percent per year from 4.7 Mtoe in 2005 to 20.9 Mtoe in 2030. Hydro will be the fastest growing fuel at 16.3 percent per year followed by oil and gas at the same rate of 6.5 percent per year between 2005 and 2030. Coal is expected to grow at lower annual rate of 2.0 percent over the same period. Figure II-40 shows the future primary energy consumption mix in both the BAU scenario and APS.

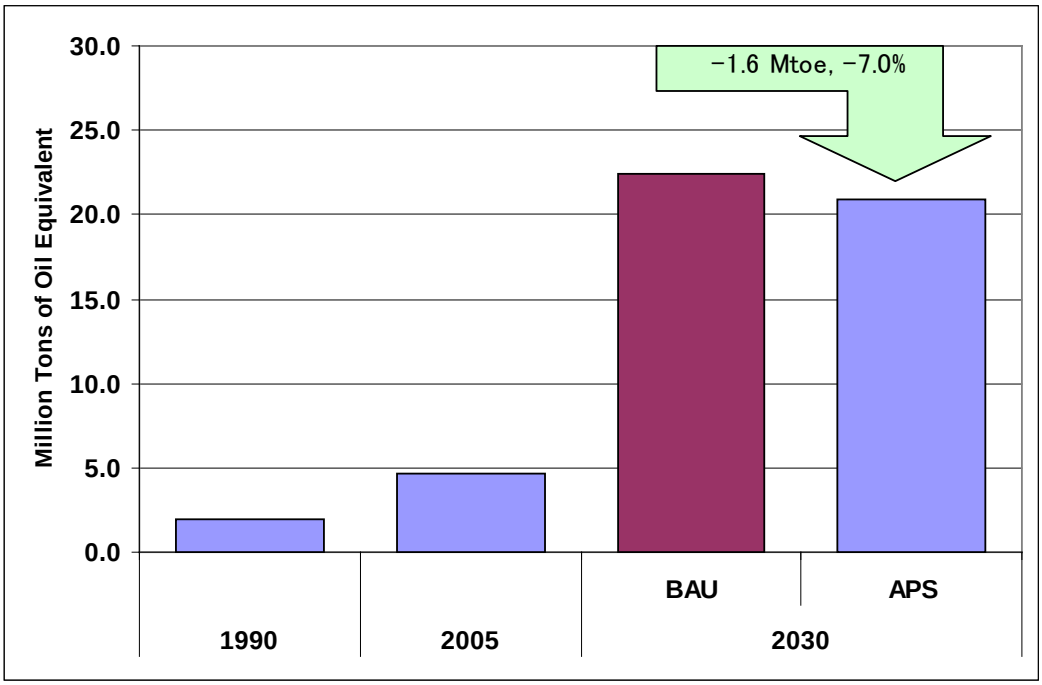
Figure II-40. Primary Energy Demand by Source in Myanmar, BAU and APS



3.3. Projected Energy Savings

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

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

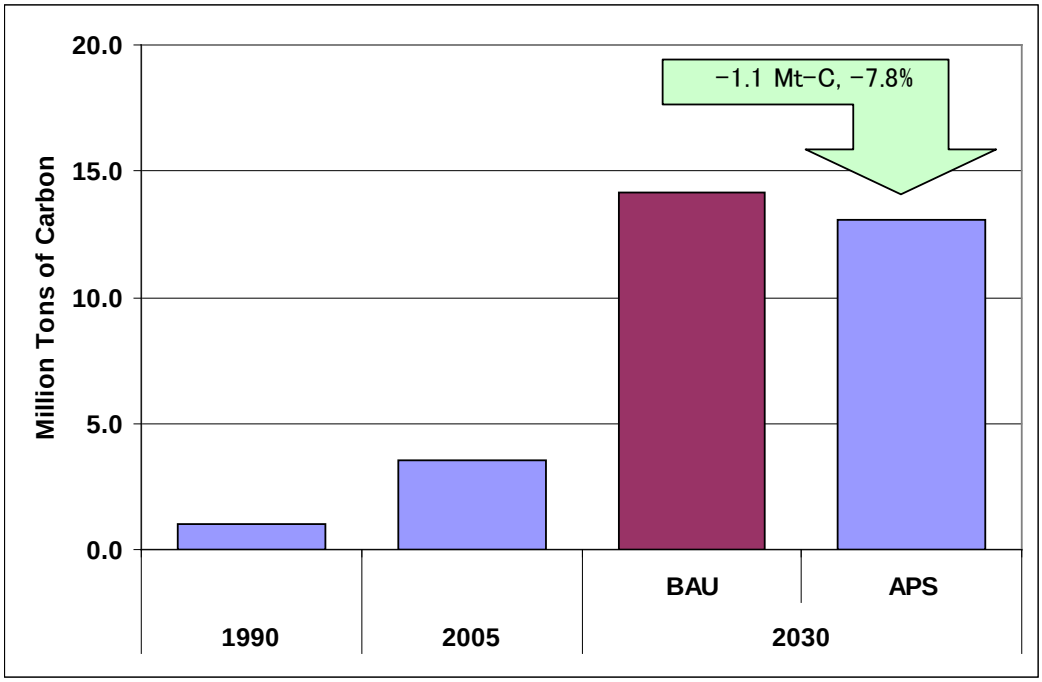


Future saving in energy could be due to saving in primary energy consumption in the residential, commercial, transportation and industrial sectors. In this regard, Myanmar has implemented a range of energy efficiency and conservation goals and action plans which target on energy savings in all sectors of the economy and in cooperation with both the private and public sectors. There is an estimated saving of 1.6 Mtoe in 2030 in the APS, relative to the BAU scenario. This is equivalent to 7.0 percent of the primary energy consumption in 2030 in the BAU scenario. Myanmar has plans to decrease the growth in primary energy consumption by implementing a range of energy efficiency and conservation measures on the demand side.

3.4. CO_2 Emissions

In the APS, the energy efficiency policy of Myanmar is projected to reduce growth in CO_2 emissions from energy consumption. At 2030 in the APS, CO_2 emissions from energy consumption are projected to reach about 13.1 million tons of carbon (Mt-C) which is about 7.8 percent below the BAU level.

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



4. Implications and Policy Recommendations

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

Myanmar should increase adoption of energy efficient technologies to further mitigate growth in energy consumption and should also diversify energy availability. The energy saving will be targeted in the residential, commercial, transport and industry sectors.

Chapter 13

New Zealand Country Report

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June 2011

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New Zealand

Ms. Naoko Doi

1. Background

New Zealand is an island nation in the Pacific about 2000 km southeast of Australia. It consists of two main islands (the North Island and South Island), and a number of smaller, mostly uninhabited outer islands. The land area is approximately 269,000 square kilometres, making it smaller than Japan or Italy, but larger than the United Kingdom. Most of New Zealand is hilly or mountainous and has a mild temperate climate. The population is currently about 4.3 million. Although there is some light and heavy industry, foreign trade is heavily dependent on agriculture, tourism, forestry, and fishing. In 2005, New Zealand had a gross domestic product (GDP) of about US$62 billion, or about US$14,900 per capita. While the latter figure is lower than those of many OECD countries, New Zealand tends to be ranked high in international quality-of-life surveys.

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

New Zealand's total primary energy demand was around 15.2 million tons of oil equivalent (Mtoe) in 2005. By fuel, oil represented the largest share at about 39 percent, gas was second at about 21 percent, followed by hydro, coal and geothermal, each with around 13 percent. New Zealand obtains about 30 percent of its primary energy supply from renewable sources, including hydro, geothermal, woody biomass, and wind.

In 2006, electricity generation accounted for 55 percent of New Zealand's domestic coal use, with most of the remainder used for making steel or in other industrial processes. Electricity generation also accounted for 56 percent of gas use, petrochemicals for 15 percent, and other industrial use for 20 percent while commercial and residential use accounted for most of the remainder. Reticulated natural gas is only available on the North Island. Transport accounted for an estimated 86 percent of New Zealand's oil consumption. In the transportation sector, New Zealand heavily depends on private road vehicles and air transport, with oil providing 99 percent of New Zealand's transport energy.

New Zealand had 8.8 gigawatts (GW) of installed generating capacity which generated about 43 terawatt hours (TWh) of electricity in 2005. The generation by energy type is broken down as: hydro at 54.4 percent, thermal (coal and gas) 35.7 percent, geothermal 7.4 percent, with wind and wood accounting for most of the remainder. Oil is used in electricity generation only as a minor source peaking supply.

2. Modelling Assumptions

In this outlook, New Zealand's GDP is assumed to grow at an average annual rate of 2.0 percent between 2005 and 2030. Population will increase by 22 percent by 2030, relative to 2005 levels.

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

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

The New Zealand government has agreed to implement an emissions trading scheme and has set a target for 90 percent of electricity to be generated from renewable sources by 2025. The government also maintains a range of programmes to promote energy efficiency at home and work, as well as the development and deployment of sustainable energy technologies. The Alternative Policy Scenario (APS) presented here assumes the abovementioned policies are implemented successfully.

3. Outlook Results

3.1. Total Final Energy Consumption

New Zealand's final energy consumption experienced a growth of 1.6 percent per year from 8.8 Mtoe in 1990 to 11.3 Mtoe in 2005. Oil was the most consumed energy source having a share of 44.6 percent in 1990 and increasing to 52.8 percent in 2005. Electricity was the second most consumed energy source.

Business as Usual Scenario

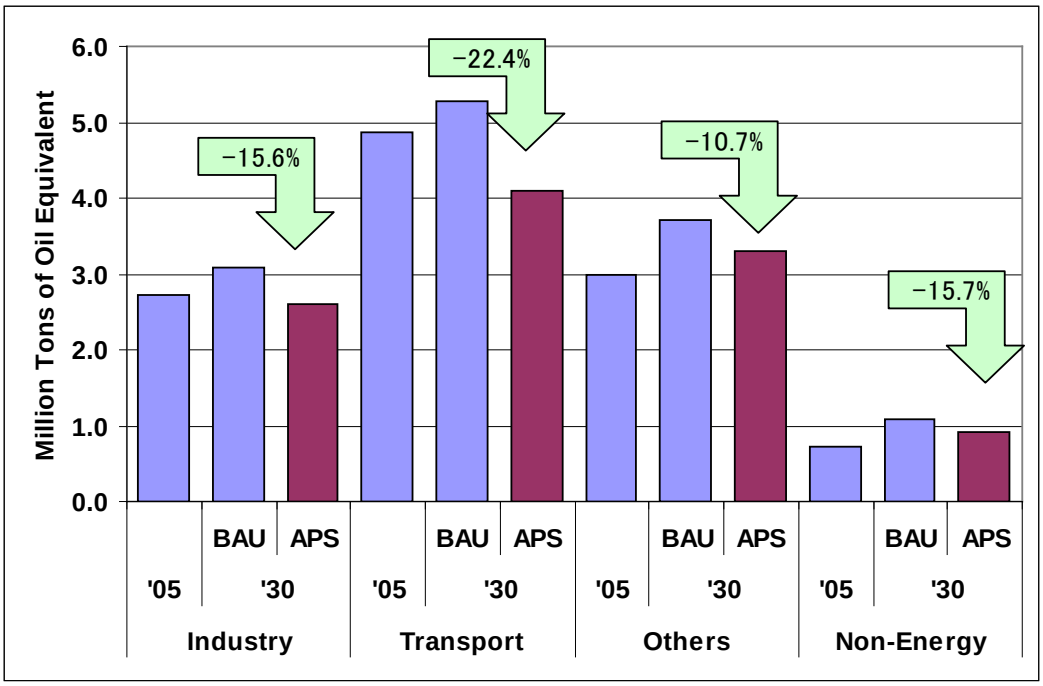
In the BAU scenario, final energy consumption from 2005 to 2030 is projected to grow at an average rate of 0.6 percent per year. The "Others" sector (primarily residential and commercial) will have the highest growth rate at 0.9 percent per year, and the industrial sector will have the second highest growth rate at 0.5 percent per year. The transport sector consumption is projected to increase at a slow pace of 0.3 percent.

By fuel type, final consumption of coal will increase at an average rate of 1.2 percent per year. Final consumption of oil and gas will increase by 0.2 and 0.9 percent per year respectively, while electricity will increase by 0.9 percent per year.

Alternative Policy Scenario

In the APS, final energy consumption will decrease at a rate of 0.1 percent per year from 11.3 Mtoe in 2005 to 10.9 Mtoe in 2030. Energy use in the transport sector will drop by an average of 0.7 percent per year, reflecting a shift to more energy efficient vehicles, particularly electric vehicles. Energy use in the 'Others' sector will increase by 0.4 percent per year, reflecting increased use of efficient appliances at the residential and commercial sectors. The sectoral final energy consumption in New Zealand in 2005 and 2030 in the BAU and APS is shown in Figure II-43.

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



3.2. Primary Energy Demand

Primary energy demand in New Zealand grew at a rate of 1.5 percent per year from 12.2 Mtoe in 1990 to 15.2 Mtoe in 2005. The fastest growing primary fuel in percentage terms was coal at 3.9 percent per year, reflecting growing electricity demand. The fastest growing primary fuel in absolute terms was oil from 3.5 Mtoe in 1990 to 5.9 Mtoe in 2005, reflecting the rapid growth in transport energy demand. Natural gas declined at an average annual rate of 1.3 percent, reflecting the decrease in gas production from the Maui gas field. Geothermal consumption grew from 1.6 Mtoe in 1990 to 2.0 Mtoe in 2005 at an annual rate of 1.6 percent for electricity generation. Hydroelectricity production was more or less unchanged.

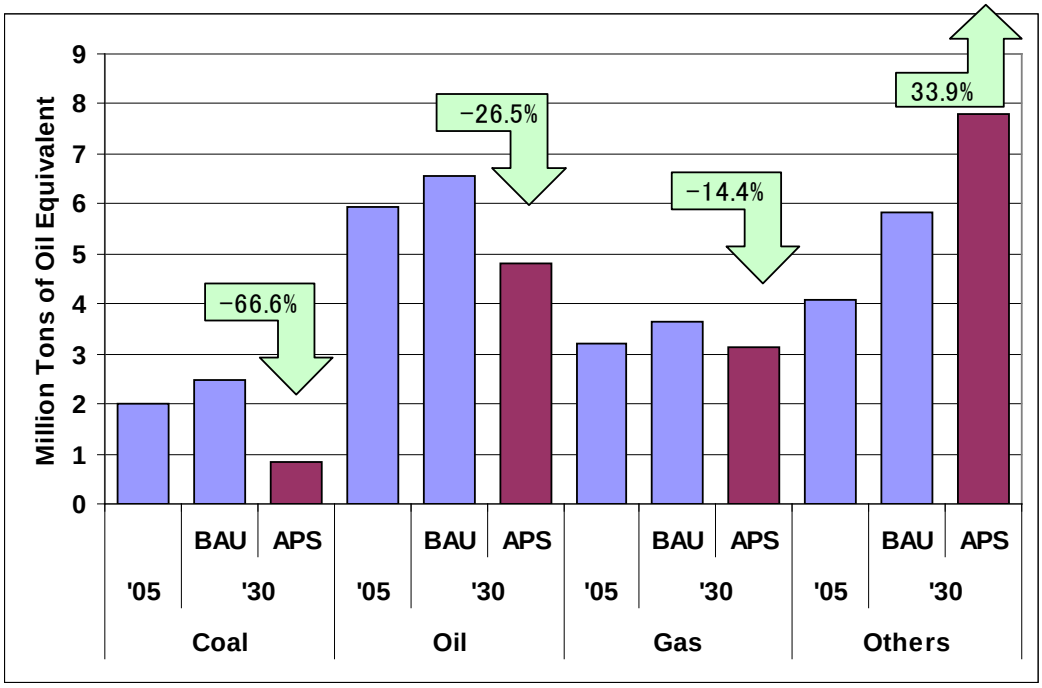
Business as Usual Scenario

In the BAU scenario, New Zealand's primary energy demand will grow at an annual rate of 0.8 percent per year to 18.5 Mtoe in 2030. To the incremental growth of primary energy demand between 2005 and 2030, geothermal contributes the most, accounting for 40 percent, followed by oil at 19 percent. This growth is mainly due to continued increases in oil consumption at an annual rate of 0.5 percent. "Others" primary energy will grow by 7.5 percent per year, reflecting mainly the expected growth in wind power.

Alternative Policy Scenario

In the APS, primary energy demand is projected to grow at a lower rate of 0.3 percent per year to 16.6 Mtoe in 2030. Considering the 15% conversion efficiency of geothermal in electricity generation, primary energy demand will be almost the same in 2030 as it was in 2005. Geothermal primary energy is expected to grow by 4.0 percent per year, while 'others' primary energy, which includes wind and biomass, is expected to grow by 7.4 percent per year (note that the 'Others' shown in Figure II-44 also includes hydro and geothermal). Oil and gas are expected to show modest declines of 0.8 and 0.1 percent per year respectively. Coal will show a significant decline of 3.5 percent per year. The apparent growth in hydro is largely due to the fact that 2005 was a relatively dry year.

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

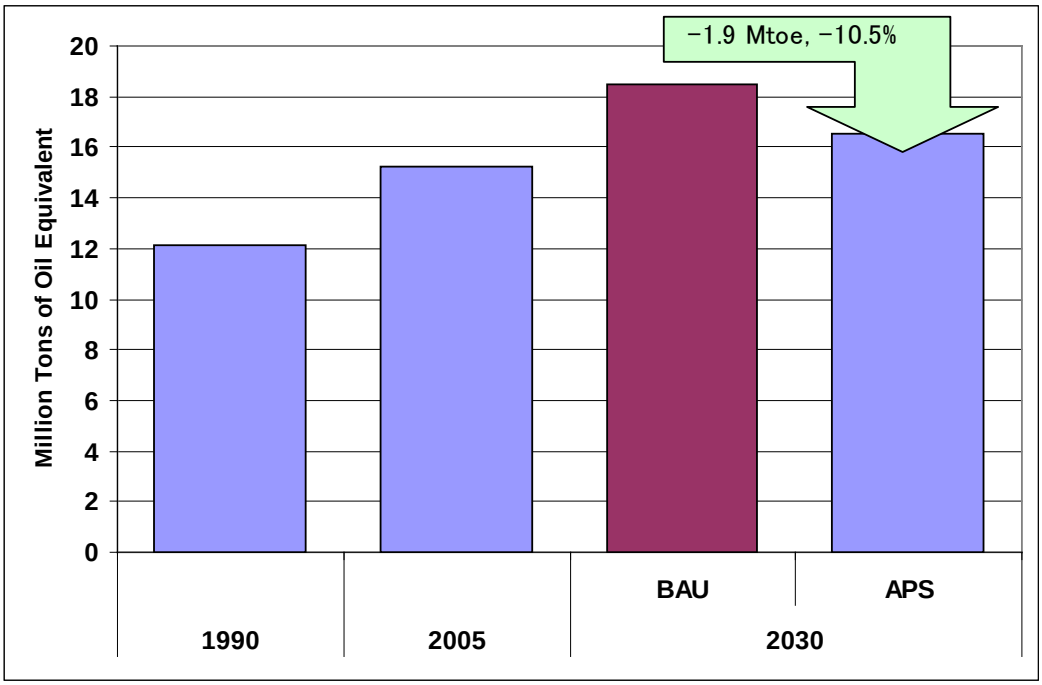


3.3. Projected Energy Savings

Under the APS, energy savings could amount to 1.9 Mtoe in 2030, the difference between the primary energy demands in the BAU scenario and the APS – 10.5 percent less than the BAU's in 2030 (Figure II-45).

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

Figure II-45. Total Primary Energy Demand in New Zealand, BAU and APS

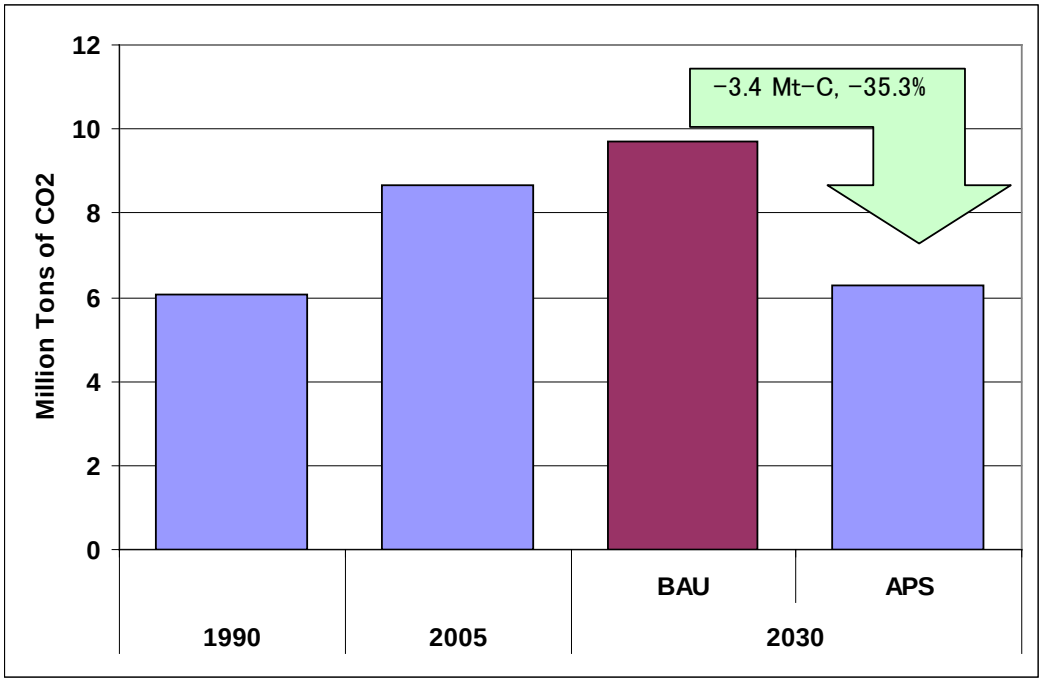


3.4. CO_2 Emissions

The carbon dioxide (CO_2) emissions in the BAU scenario will increase by 0.5 percent per year from 8.7 million tons of carbon (Mt-C) in 2005 to 9.7 Mt-C in 2030. This increase is roughly in line with the increase in primary energy demand other than geothermal and "Others".

In the APS, CO_2 emissions will decrease from 2005 to 2030 by 1.3 percent per year. Since primary energy demand, excluding geothermal, is more or less stable over this period. The decrease reflects the switch to renewable energy in electricity generation, and the switch automobiles to electric vehicles in the transport sector. Figure II-46 shows the CO_2 emissions from energy consumption in New Zealand from 2005 to 2030.

Figure II-46. CO_2 Emissions from Energy Combustion, BAU and APS



4. Implications and Policy Recommendations

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

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

New Zealand has many opportunities to improve energy efficiency, for example, through upgrading the poorly-insulated building stock and the inefficient vehicle fleet. The commercial building and industrial sectors also represent an area for energy efficiency improvements.

Growth in energy consumption in the transport sector has been slowed in recent years, mainly because of high fuel prices and a shift to smaller vehicles. Furthermore, reduction in emissions from the transport sector is possible through increased use of biofuels, and a switch to electric vehicles. Electric vehicles are a good match for New

Zealand given the high proportion of electricity generated from renewables, and relatively short average trips.

Chapter 14

Philippines Country Report

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Philippines

Ms. Lilibeth Tamayo Morales

1. Background

1.2. Socio-economic

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

Philippine economy posted a 7.3 percent increase in 2010, from a meager 1.1 percent growth in 2009, the highest growth ever recorded since the 8.8 percent during the high economic growth years of the Marcos Era. It likewise exceeded performance targets set by the government, as well as international and multi-lateral organizations.

Industry propelled the economy with a 12.1 percent growth backed by a revived manufacturing output and renewed construction projects in the private sector. The Services sector, constituting the bulk of real GDP (accounting for 49.7 percent share in 2010), further sustained the economy with a 7.1 percent increase attributed to hikes in revenues of domestic trade, finance and real estate sectors. On the other hand, the Agriculture, Fishery and Forestry (AFF) sector declined by 0.5 percent, as the production of major crops bore the brunt of the El Niño phenomenon that plagued the country in 2010. On the demand side, the 17.1 percent increase in investments and the 5.3 percent growth in consumer spending, supplemented by the country's double-digit growth in international trade, further stimulated the country's GDP growth.

The 2007 population was estimated at 86.4[8] million while GDP per capita was about US$1,100 in the same year.

1.3. Policy

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

[8] Based on 2007 Philippine Census of Population.

Another key component in the country's strategy on energy security is the need to take hold of the opportunities in energy efficiency and conservation measures. The DOE will continue to take the lead in increasing public interest on the use of energy-efficient technologies and conservation practices. The government's energy efficiency and conservation campaign will maximize opportunities in different economic sectors.

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

Given the importance of energy as a prerequisite in meeting basic human needs and services, the DOE along with its attached agencies, is proud of the following major achievements:

Renewable Energy (RE)

In pursuit of the country's energy security agenda, the DOE, pursues an environment conducive for private sector participation for the accelerated development of RE. The passage of Republic Act No. 9513 or Renewable Energy Act of 2008 establishes policy and program framework to advance RE resources and technologies, and increase its utilisation. Section 27 (b) of the law and section 31 (a) of the Implementing Rules and Regulation s likewise mandate the DOE in consultation with its stakeholders to formulate and facilitate the implementation of the National Renewable Energy Program (NREP) to ensure that the policies, mechanisms and rules embodied in the RE Act are put into action. The NREP serves as the roadmap for the increased utilisation and application of renewable energy sources cognizant of technological development, economic cost, local acceptability and grid integration.

The formulation of NREP is anchored in the Philippine Energy Plan (PEP and the Energy Reform Agenda (ERA). The PEP is the government's energy plans and programs which also highlights the role of renewable energy in attaining higher energy self-sufficiency level and energy security and promoting sustainable development. On the other hand, the ERA which was crafted under the President's Aquino's administration for the period 2011-2016 with an overall vision of "Energy Access for More," outlines 3 major strategic pillars: (a) ensure energy security; (b) achieve optimal pricing, and (c) develop a sustainable energy system.

Alternative Fuels for Transport

<u>Biofuels</u>

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

The mandatory 1.0 percent biodiesel blend in all diesel fuel sold in the country in May 2007 was increased to 2.0 percent in February 2009 on a voluntary basis. On the other

hand, the country now enjoys an accelerated use of E10 (10 % bioethanol blend) as supplied by most of our gasoline retailers. For the year 2010 local production of biofuels slid down by 14.5 percent compared to its previous level of 124.8 ktoe. The sudden decline is due to the discontinued operation/production of a significant number of biofuels producers in the country mostly due to their inability to cope with market price competition. Out of the 12 accredited CME producers in the country, only eight (8) were operational during the year with an aggregate production capacity of 292.6 million litres. From among the bioethanol producers on the other hand, only San Carlos Bioenergy, Inc. operated for the first half of 2010 with a total capacity of 40 million litres.

Compressed Natural Gas (CNG)

As of December 2010, there are 40 compressed natural gas (CNG) public utility buses plying the Manila-Batangas-Laguna routes. In addition there are 21 CNG buses that had completed technical evaluation and testing.

Auto-LPG

In terms of using LPG as an alternative fuel for transport, over 18,731 taxis nationwide were now running on LPG which is complemented by 216 auto-LPG dispensing stations.

Promoting responsible use of energy

Early 2009, the DOE implemented the "Philippine Energy Efficiency Program" which was conceived after the 2008 Energy Summit for a calibrated phasing-out of inefficient technologies such as the shift from incandescent bulbs to energy efficient lighting system, among others. With funding support from Asian Development Bank (ADB), the project is designed to generate electricity savings of 534 GWh as well as deferred power capacity savings of 450 MW per year. It would also result in an environmental pollution reduction of 35 Gigagrams of CO2 avoidance per year.

Barangay Electrification

Rural electrification has been one of the government's priority thrust. The goal is to achieve barangay electrification by end of 2010. As of December 2010, the country's total electrification level has reached 99.89 percent with 41,930 barangays already with access to electricity out of the 41,975 (formerly 41,980) barangays. The targeted 41980 barangays which is based on the 2005 census were reduced to 41,975 due to the following reasons: the barangay is deserted; the barangay is on the permanent danger zone; the barangay was an informal settler on a private property; the barangay captain rejected the electrification project. All unenergized barangays are targeted for energization by 31 December 2011.

Managing Energy Costs

As the country continues to source its energy requirements from fuel imports, the economy remains vulnerable to the effects of high energy prices in the world market. At the height of the clamour for lowering electricity rates, the President signed Executive Order 796 on 21 May 2009 establishing the "Industry Competitiveness Fund", with an initial allocation of 1.6 billion pesos to cover discounts granted to various large customers.

1.4. Energy

The country's total primary energy supply in 2005 reached 33.8 Mtoe. Oil accounted for 44.6 percent of the total energy supply followed by geothermal which comprised 25.2 percent.

The country's total electricity generation in 2005 was 56.6 TWh. Generation from natural gas-fired power plants dominated the power generation mix providing 30.0 percent, while coal-fired power plants ranked second accounting for 27.0 percent or 15.3 TWh. Geothermal energy remained the 3rd largest provider of electricity with a 17.5 percent share in the generation mix in 2005.

2. Modelling Assumptions

The Philippine economy is projected to grow at a steady pace of 5.9 percent per annum during the projection period 2005 to 2030. This sustained growth is expected to be driven by the steady performance of the service sector and improved exports and agricultural output. Nonetheless, it will take a higher, sustained growth path to make appreciable progress given the Philippines' annual population growth rate of 1.4 percent from 2005 to 2030.

To meet the country's increasing demand for electricity, the Philippines will source its energy from coal, oil, natural gas, hydro and geothermal. The relatively low contribution of oil in the total fuel input for power generation may be attributed to the restraint in oil use due to the continuous volatility of oil prices in the international market – as such no new oil plants will be constructed and aging oil-fired power plants will be decommissioned. Further, the combined annual average share of renewable energy such as hydro, geothermal and other RE in the year 2005 constitute around more 30.0 percent of the total power generation and is expected to increase due to the implementation of policy mechanisms that will push the utilisation and development of the Renewable Energy Law.

Meanwhile, the intensified development and utilisation of alternative fuels for transport is seen as a continuing strategy to reduce the country's dependence on imported oil. It also cushions the impact of highly volatile petroleum prices on the economy as well as assisting in promoting clean and environmentally-friendly energy sources. The major alternative fuels being promoted are biofuels which include biodiesel (cocomethyl

esther) and bioethanol, autogas (LPG as transportation fuel), compressed natural gas (CNG), and electric vehicles.

Meanwhile, the energy saving goals of 10 percent reduction of annual final energy demand of the country will be achieved through a range of measures including intensified energy utilisation management programs in the commercial and industrial sectors, power plants and distribution utilities as well as the continuous use of alternative fuels and technologies. The information and education campaign being conducted by the Department of Energy (DOE) as well as the "Palit Ilaw Program[9]" also contribute to the energy saving goals.

3. Outlook Results

3.1. Total Final Energy Consumption

The Philippines' final energy consumption reached 11.0 Mtoe in 1990 to 18.5 Mtoe in 2005 at an average growth rate of 3.5 percent per annum. Over the period 1990-2005 energy demand in the residential/commercial (others) sector grew the fastest at 5.0 percent per annum followed by the transportation sector with average growth of 4.1 percent per annum. The industrial sector grew by 2.2 percent per annum. Oil remained the most consumed fuel with a share of 69.2 percent in 1990 which decreased to 65.4 percent in 2005.

Business as Usual (BAU) Scenario

Final energy consumption is expected to grow at an annual average rate of 5.0 percent in the BAU scenario over the period 2005 to 2030. This is due to increased activities in all sectors with the residential/commercial (others) sector growing the fastest at 6.5 percent per annum, followed by the transportation sector at an average rate of 4.7 percent per annum over the period 2005-2030.

In terms of fuel, natural gas consumption is projected to grow the fastest at an average rate of 11.6 percent per annum followed by electricity and others at an average rate of 6.4 percent per annum to 2030. Oil use will grow at an average annual rate of 4.4 percent, while coal will grow by 2.3 percent.

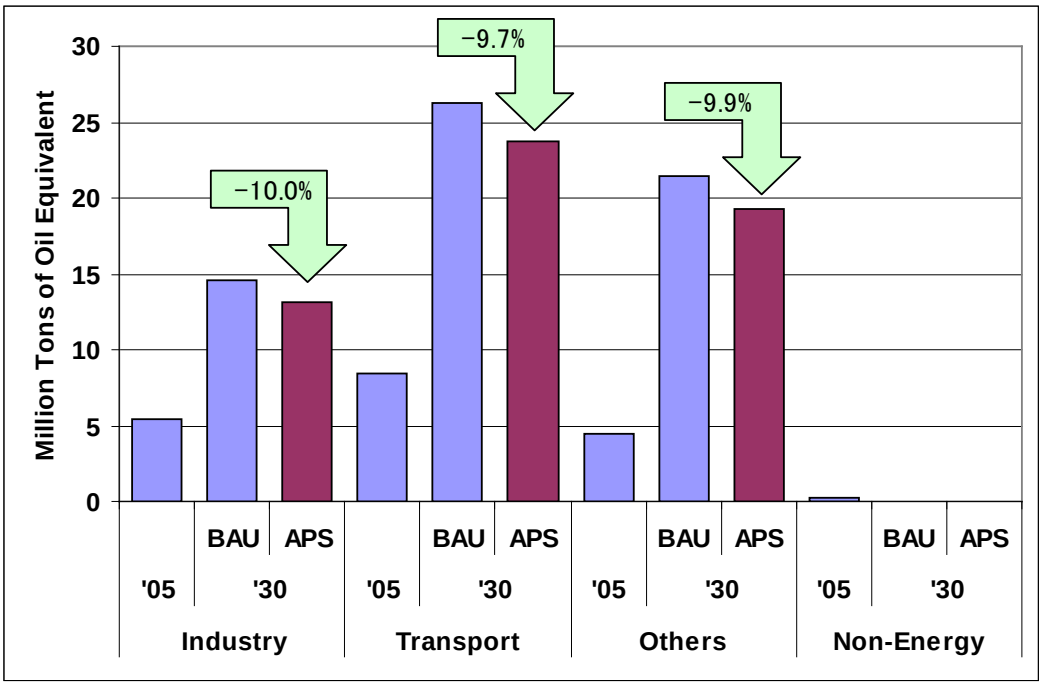
Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower average rate of 4.5 percent per annum from 18.5 Mtoe in 2005 to 56.2 Mtoe in 2030. All sectors will contribute to the increase with the residential/commercial (others) sector projected to have the fastest average annual growth at 6.0 percent between 2005 and 2030. The transportation sector is projected to follow with an annual growth of 4.2 percent over the same period. Meanwhile, the industry sector is expected to grow at an annual average

[9] A program to replace residential lighting with compact fluorescent lamp (CFL).

rate of 3.6 percent. The projected final energy consumption in the BAU and APS are shown in Figure II-47.

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



3.2. Primary Energy Demand

Primary energy demand in the Philippines grew at an annual average rate of 4.1 percent, from 18.6 Mtoe in 1990 to 33.8 Mtoe in 2005. Among the major energy sources, consumption of coal grew the fastest at 10.5 percent followed by geothermal at 4.0 percent per annum. Hydro followed next at 2.2 percent growth per annum, oil at 2.0 percent per annum and "others" (comprising of electricity, solar, wind and other sources of energy) at 1.7 percent per annum between 1990 and 2005. Oil which had the largest share in the total with 44.6 percent in 2005 grew at 2.0 percent per annum during the period 1990-2005.

Business as Usual (BAU) Scenario

In the BAU scenario, the Philippines' primary energy demand is expected to increase by 5.2 percent per annum from 33.8 Mtoe in 2005 to 120.4 Mtoe in 2030. Demand for all major energy sources is projected to increase with coal use growing the fastest at 7.9 percent per annum from 2005 to 2030. Natural gas is also expected to expand with a growth rate of 6.7 percent per year during the same period. Oil will remain as the major energy source at an annual average share of 35.6 percent and will grow at 4.0 percent per annum. This is followed by coal fuel with an annual average share of 25.4 percent having a growth rate of 7.9 percent over the period 2005 to 2030.

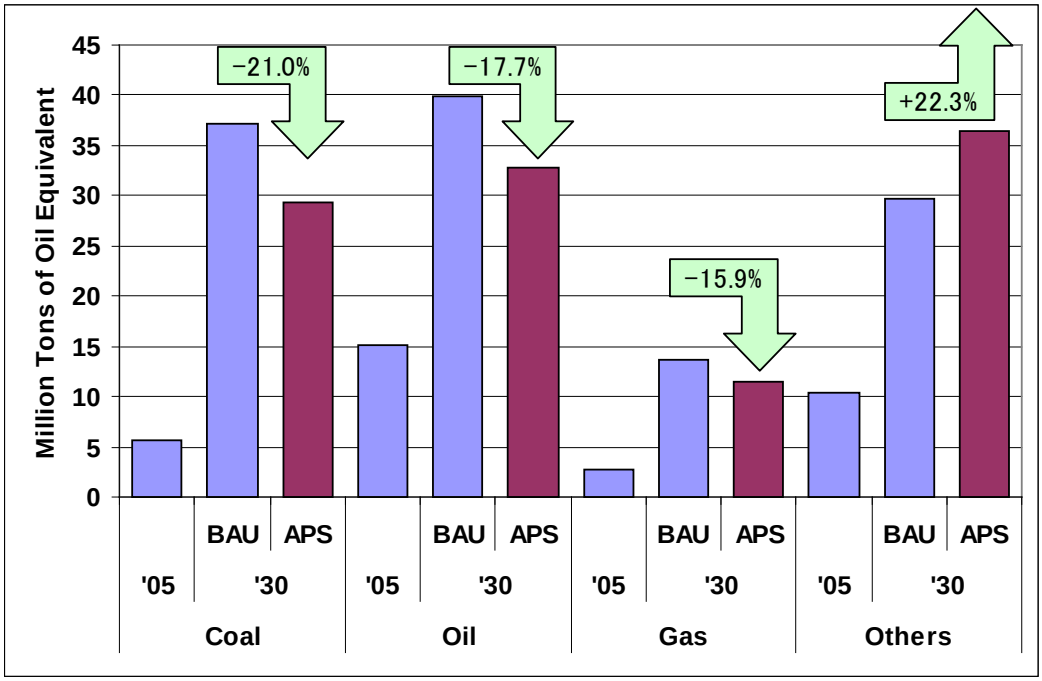
Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at an annual average rate of 4.8 percent increasing from 33.8 Mtoe in 2005 to 110.0 Mtoe in 2030. The shares of oil, coal, geothermal, and natural gas will be 29.9, 26.7, 19.0 and 10.4 percent respectively in 2030. Coal, natural gas, geothermal and oil are projected to have average annual growth rates of 6.9, 5.9, 3.7 and 3.2 percent respectively over the period 2005 to 2030.

Given the potentially severe impacts of climate altering greenhouse gases and skyrocketing crude oil prices, the Department of Energy has started a reassessment of nuclear energy as a long-term power option for the country. Thus in this study it is assumed that a nuclear power plant with 2,000 MW capacity is introduced in the year 2025 in the APS case. By 2030, 3.7 percent of total primary energy demand will be supplied by nuclear energy. The contribution of nuclear to total electricity generation will reach 15.8 TWh by 2030.

Figure II-48 shows the primary energy demand by source in the Philippines in 2005 and 2030 both in the BAU and APS.

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



3.3. Projected Energy Savings

In 2030 it is estimated that the EEC goals, action plans and policies of the Philippines could result in savings of 10.4 Mtoe which is the difference between primary energy

demand in the BAU scenario and the APS (Figure II-49). This level is about 30.6 percent of Philippines' consumption in 2005.

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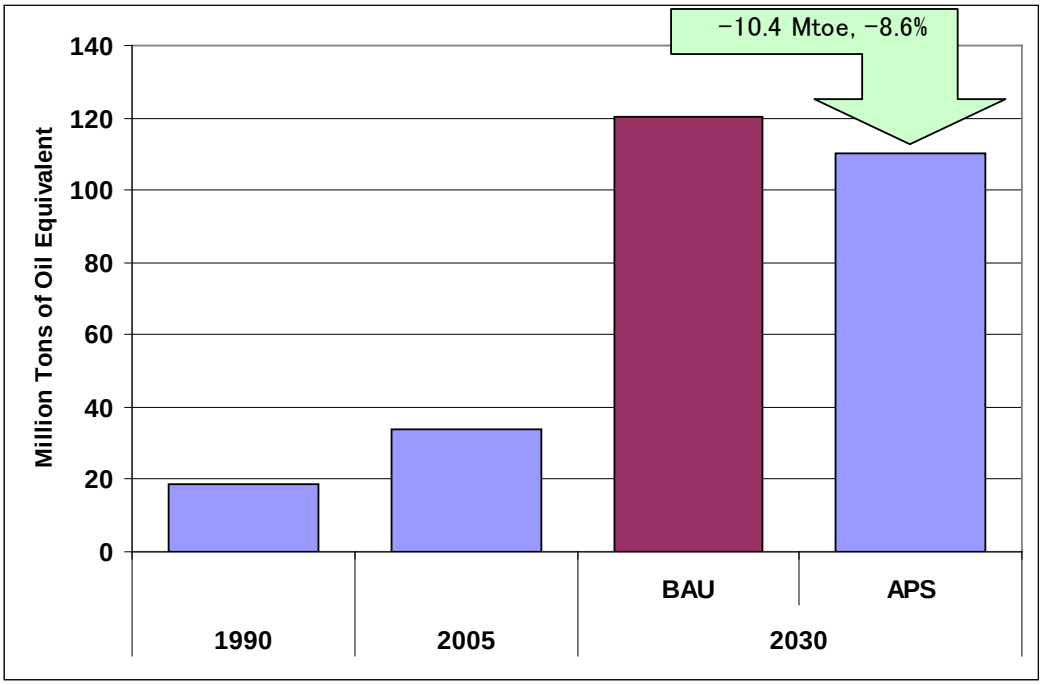
Figure II-49. Total Primary Energy Demand in the Philippines, BAU and APS

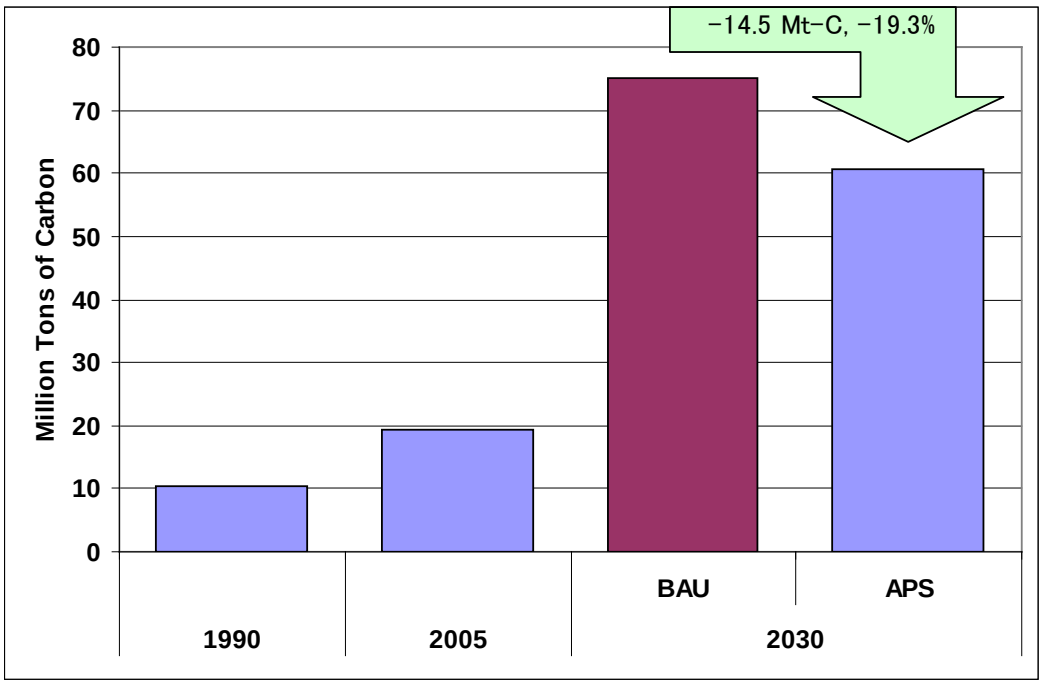


In terms of final energy consumption savings, the following savings were projected at 2030 in the APS, relative to the BAU scenario: residential/commercial (others) sector with 2.1 Mtoe, transport sector with 2.6 Mtoe and 1.5 Mtoe from the industry sector.

3.4. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase by 5.5 percent annually from 19.5 Mt-C in 2005 to 75.1 Mt-C in 2030 in the BAU scenario. However, in the APS, CO_2 emissions are projected to be reduced by almost 19.3 percent in 2030 relative to the BAU scenario (Figure II-50). This indicates that the energy saving goals, action plans and policies in the Philippines will be effective in reducing CO_2 emissions in the APS.

Figure II-50. CO_2 Emission from Energy Consumption in the Philippines



4. Implications and Policy Recommendations

In 2030 total final energy savings of 6.1 Mtoe could be achieved in the APS relative to the BAU. This is equivalent to a 9.9 percent reduction in total final energy consumption and an 8.6 percent reduction in the primary energy demand. The country's current policies on energy efficiency and conservation include: energy management activities conducted by the DOE such as spot checks on government agencies nationwide in compliance with Administrative Order No. 126 (Strengthening Measures to Address the Extraordinary Increase in World Oil Prices, Directing the Enhanced Implementation of the Government's Energy Conservation Program, and for other Purposes**)**, energy standards and labelling programs, energy audits of various commercial and industrial establishments, voluntary agreement programs, recognition awards and the various information and education campaigns (IEC) of the Department of Energy. In addition, the DOE is currently recently implementing "Philippine Energy Efficiency Program" which was conceived after the 2008 Energy Summit for a calibrated phasing-out of inefficient technologies such as the shifting from incandescent bulbs to energy efficient lighting systems, among others.

The continued improvement in the energy intensity of the Philippines to 2030 is expected to be driven in part by the country's changing economic structure to rely more on its service sector rather than on energy intensive industries. Responses to surging oil prices and their inflationary effects on the prices of basic commodities would also contribute to lowering the energy to GDP intensity level.

The government shall pursue its programs and projects that will further increase and enhance the utilisation of indigenous, clean and efficient alternative fuels. The full implementation of the Renewable Energy Act of 2008 to expand the utilisation and development of indigenous energy such as geothermal, hydro solar, wind and others will not only promote the use of clean energy but will also lessen country's need for energy imports. Additionally the use of alternative fuels that include CNG, autogas (LPG for transportation), biofuels and electric vehicles for transport will reduce the effects of continuous increases in the prices of crude oil in the world market as well as reduce greenhouse gas emissions. In addition, other technologies such as hydrogen and other forms of energy may be considered as an additional energy source in the future.

The country must set quantitative sectoral targets to achieve the overall energy savings. Evaluation of targets will be easier if it is done on a per sector basis.

The DOE should come up with policies on the transport and industrial sectors for these are the most intensive energy consuming sectors of the country.

Further, the DOE should increase research on alternative energy in cooperation with other government agencies like Department of Science and Technology (DOST), other concerned government agencies.

Finally, there is a need to pass the Energy Conservation Law to institutionalize energy conservation and enhance the efficient use of energy in the country for it to become a people's way of life.

Sources:

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Chapter 15

Singapore Country Report

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Singapore

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1. Background

Singapore is the most industrialized and urbanized country in Southeast Asia. It is totally dependent on oil and natural gas imports to satisfy its energy needs. It has a national energy policy framework to maintain a balance among policy objectives of economic competitiveness, energy security and environmental sustainability. [10] Singapore has a national target of improving energy intensity by 20 percent by 2020 and by 35 percent by 2030 from the 2005 level.[11] It also has a voluntary target of reducing carbon dioxide (CO_2) emissions by 16 percent from the baseline level in 2020.[12]

Singapore's Policy Initiatives

The National Environment Agency (NEA) of Singapore set up the inter-agency Energy Efficiency Programme Office (E2PO) in May 2007 to identify and implement measures to improve Singapore's energy efficiency in six priority areas, namely, power generation, industry, transport, buildings, the public sector and households.[13]

Since January 2008, registrable goods have had to carry energy labels under the Environmental Protection and Management Act (EPMA).[14] Currently, all household refrigerators, air-conditioners and clothes driers sold in Singapore must be energy labelled. Vehicle fuel economy labels are also affixed to vehicles at the point of sale. The mandatory energy labelling scheme will improve energy efficiency and mitigate growth of energy use in residential, commercial and transport sectors. In 2008, the NEA launched a "10% Energy Challenge" educational campaign to promote electricity saving in households.[15] It should be noted here that labelling standards and educational campaigns can facilitate energy conservation and efficiency improvements. However, it is not clear how effective they ultimately are. The efficacy of such campaigns depends on how responsive end-users are to these initiatives in education, labelling and the setting of standards.

The Building and Construction Authority (BCA) of Singapore launched the BCA Green Mark Scheme in January 2005 to promote environmental awareness in the construction and real estate sectors. Since April 2008, all new buildings and existing buildings

[10] National Energy Policy Report - Energy for Growth, The Ministry of Trade and Industry of Singapore, 2007.
[11] The Sustainable Development Blueprint, Singapore Government, 2009.
[12] Singapore to pledge 16% cut in gas emissions, Straits Times, 3 December 2009.
[13] Energy Efficiency Programme Office of Singapore, http://www.e2singapore.gov.sg/
[14] Ibid.
[15] Ibid.

undergoing major retrofitting works with a gross floor area above 2,000 square metres must meet Green Mark Certified standards. The BCA Green Mark Scheme promotes adoption of green building technologies and reduces the use of electricity in the commercial sector via efficiency improvements and conservation.[16] In the case of building standards, there are some uncertainties as to how effective such standards setting will be in the long run, even if one can make relatively detailed calculations about expected energy savings from engineering measurements.

Certificates of Entitlement (COEs) give Singaporeans the right to own a vehicle. COEs are integral to the Vehicle Quota System (VQS), a landmark scheme implemented to regulate the growth of vehicle population in Singapore. Under the VQS, vehicle annual growth rate is capped at 3 percent, given the constrained expansion of roads and highways in Singapore's urban environment. The actual compound annual growth rate of vehicle population from 1990 to 2008 was 2.8 percent per annum. From 2009 to 2011, the vehicle population growth rate has been capped at 1.5 percent per annum.[17]

The Government launched the Energy Efficiency National Partnership (EENP) programme in 2010 to help companies put in place energy management systems and implement projects to improve energy efficiency. From 2013, the Government will be introducing mandatory energy management requirements for large energy users, which consume more than 15 Gigawatt-hour (GWh) in the industry sector, under the Energy Conservation Act.

2. Modelling Assumptions

Two scenarios were developed to assess the energy saving potential of the energy efficiency and conservation policies in Singapore. The "Business As Usual" (BAU) scenario projects energy use and CO_2 emissions taking into consideration energy policies implemented up until end-2010, while the "Alternative Policy Scenario" (APS) projects energy use and CO_2 emissions in a case where there is higher uptake of energy efficiency and conservation policies. In this case, demand management policies are assumed to be more effective, as human behaviour is more "elastic" or responsive to such policies.

In 2007, the overall thermal efficiency of gas fired power plants was 41 percent. According to IEA, the average thermal efficiency of combined cycle gas turbine (CCGT) generators was 57 percent and that of conventional power plants was 41.1 percent.[18] We assumed that both the BAU and APS scenarios see improvements in the efficiencies of gas and thermal power plants. By 2030, gas-fired turbines will attain 45 percent efficiency, while thermal power plants will attain an efficiency of approximately 41 percent. In both scenarios, the share of electricity contributed by solar power reaches 5 percent by 2030.

[16] Ibid.
[17] Data for vehicle quota system COE quota computation, The Land Transport Authority of Singapore, http://www.lta.gov.sg/corp_info/doc/VQS_worksheet.pdf
[12.] Page 102 of Projected costs of generation electricity (2010 Edition), IEA.

Another assumption made is that gasoline consumption is linearly proportional to Singapore's car population. The Land Transport Authority (LTA) has capped the growth rate of vehicle at 1.5 percent from 2009 to 2011. Thereafter, we assume that the annual growth rate is as per historical levels.

In 2001, Green Energy Management (GEM) demonstrated a reduction of 60 percent in electricity consumption.[19] In the commercial sector, given our understanding of the vintage of building stock in Singapore, we assumed a reduction of electricity use by 10 percent relative to the BAS case in the BAU scenario, and by 20 percent in the APS. With reference to IEA's Energy Technology Transitions for Industry 2009,[20] the application of Best Available Technology (BAT) could reduce energy use in the industry sector by13-29 percent. Therefore, the energy saving potential in the industry sector is assumed to be a 5 percent and a 10 percent of the baseline's value in 2030 in the BAU and APS scenarios respectively.

3. Outlook Results

3.1 Total Final Energy Consumption

Singapore's total final energy consumption grew at a compound annual growth rate (CAGR) of 6.3 percent from 5 million tons of oil equivalent (Mtoe) in 1990 to 12.5 Mtoe in 2005. Electricity generation grew at 6.1 percent per annum from 15.7 Terawatt-hour (TWh) to 38.2 TWh in the same period. The primary fuel composition for electricity generation has changed dramatically over the past decade. Natural gas, which accounted for 28 percent of electricity generation in Singapore in 2001, grew rapidly to supply almost 75 percent of Singapore's electricity by 2005.[21] Currently, fuel oil use for thermal power generation is around 19.3 percent and is seen as a reasonable "balancing" alternative to a total dependence on natural gas.

Business-as-Usual (BAU) Scenario

The results of the model showed that total final energy consumption will grow by 3.1 percent. Figure II-51 shows that the industry sector will grow the fastest at 3.2 percent while consumption in the transport and others (residential and commercial) sector will almost have the same growth at around 2.8 percent per annum. Both in the BAU and APS the Energy Labelling Scheme, the EENP programme and BCA Green Mark Scheme retard the growth of energy use in the industry and others (which includes commercial and residential) sectors. Similarly, VQS in the country reduces energy use in the transport sector.

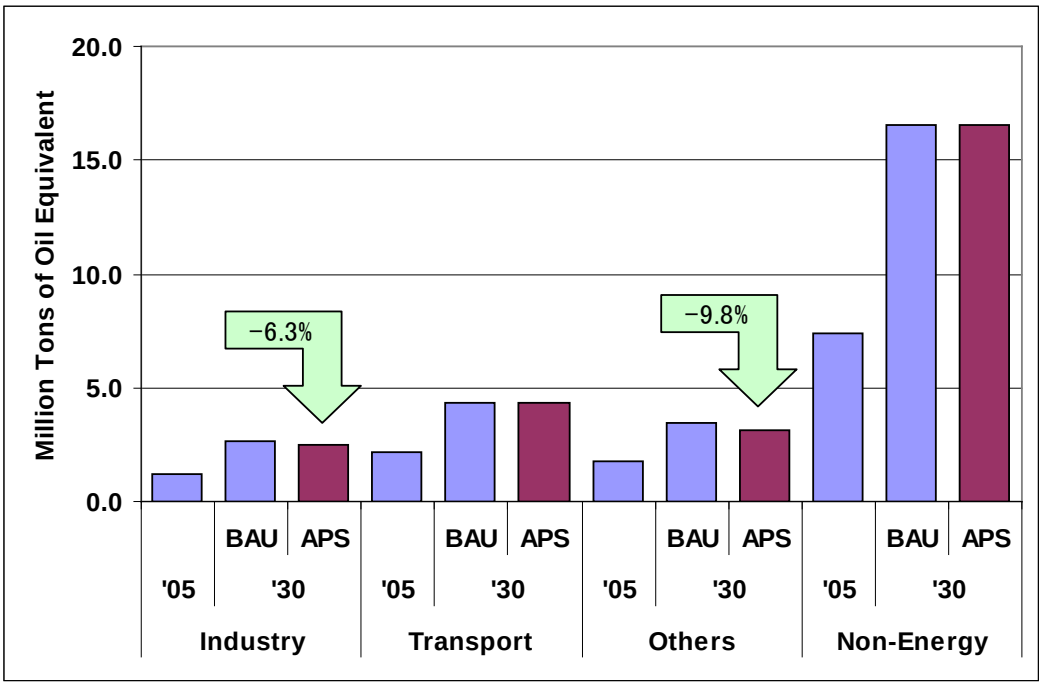
[19] National Energy Efficiency Committee, Case study: Green Energy Management at Grand Hyatt Singapore.
[20] Page 31 of Energy Technology Transitions for Industry 2009, IEA.
[21] Energy Statistics of Non-OECD Countries (2009 Edition), International Energy Agency, 2009.

Alternative Policy Scenario (APS)

Final energy consumption in the APS for the period 2005-2030 will grow by 3.0 percent per annum which is 1.9 percent lower compared with the BAU. Same with the BAU, the industry sector will grow the fastest in the APS at 2.9 percent followed by the transportation sector at 2.8 percent. From among the sectors, large improvement on the residential/commercial (others) sector can be realized at around 10.0 percent reduction in the energy consumption per annum.

On a per fuel basis, oil will still be the dominant fuel consumed with 79.2 percent share, electricity and natural gas followed at 20.0 and 0.8 percent, respectively. Meanwhile, an 8.5 percent improvement will be achieved on the use of electricity for the period 2005-2030.

Figure II-51. Final energy Consumption by Sector in Singapore, BAU and APS



3.2 Primary Energy Demand

Total primary energy demand grew at 6.1 percent per annum, from 11.4 Mtoe in 1990 to 27.7 Mtoe in 2005. Singapore's sole energy source in 1990 was oil, whose consumption increased rapidly from 11.4 Mtoe in 1990 to 21.8 Mtoe in 2005 at a growth rate of 4.4 percent per annum. Natural gas's share grew after the construction of pipelines for gas fired power plants, the first of which sourced gas from Malaysia in 1991, followed by two more recent pipelines from Indonesia. Consumption of natural gas increased from 0.4 Mtoe in 1992 to 5.9 Mtoe in 2007 at a growth rate of 20.7 percent per annum. To expand the country's import capability and sourcing options, Singapore will have an

operational LNG terminal with a throughput capacity of 6 million tonnes per annum by 2013.[22]

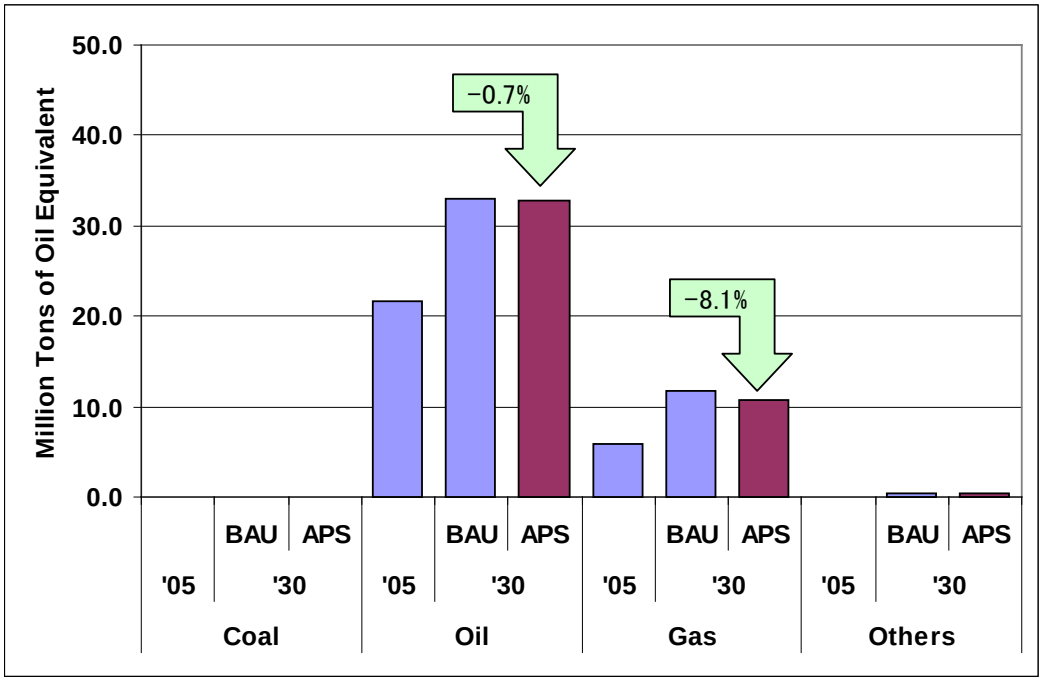
Business-as-Usual (BAU) Scenario

Primary energy demand in the BAU is seen to grow by 2.0 percent this is slower compared to the 3.1 percent growth of the total final energy consumption for the period 2005-2030. From among the energy sources, natural gas is seen to grow the fastest at 2.8 percent followed by oil at 1.7 percent. Regardless of a decreasing trend, oil will still be the primary energy source of the country with an average annual share of 73.3 percent followed by natural gas at 26.0 percent.

Alternative Policy Scenario (APS)

Results of the APS show that primary energy demand for the period 2005-2030 is expected to grow by 1.9 percent which is a 2.6 percent improvement as compared with BAU. Natural gas will have a slower growth rate of around 2.4 percent. Oil will still be the country's primary energy source with 74.7percent share followed by natural gas with 24.5 percent share.

Figure II-52. Total Primary Energy Demand in Singapore, BAU and APS



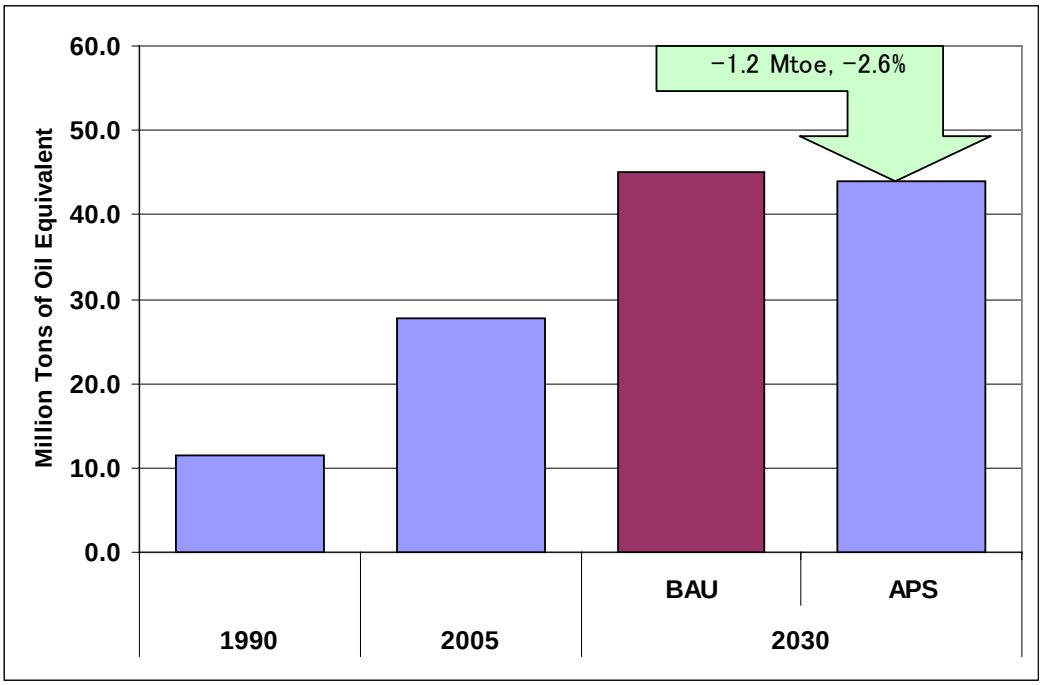
[22] Third Tank for Singapore's LNG Terminal on the Back of Strong LNG Uptake, Media Releases of the Energy Market Authority of Singapore on 2 November, 2010 (http://www.ema.gov.sg/news/view/227).

3.3 Projected Energy Savings

In 2030 it is estimated that the EEC goals, action plans and policies of the country could result in savings of 1.2 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure II-53). This level is about 9.3 percent of Singapore's consumption in 2005.

In terms of final energy consumption savings, the following savings were projected at 2030 in the APS, relative to the BAU scenario: industrial sector with 168.0 ktoe and the residential/commercial (other) sector 337.0 ktoe by 2030.

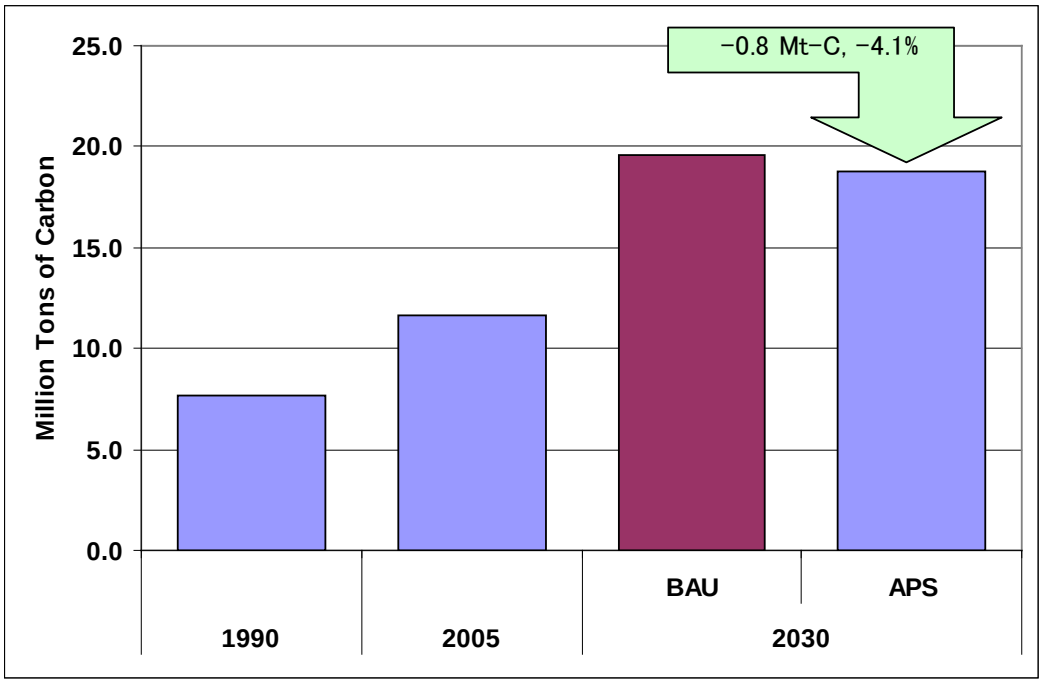
Figure II-53. Total Primary Energy Demand in Singapore, BAU and APS



3.4 CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an average annual rate of 2.1 percent, from 11.6 Mt-C in 2005 to around 19.6 Mt-C in 2030. In the APS, the annual average growth in CO_2 emissions from 2005 to 2030 is expected to be lower than in the BAU scenario at 1.9 percent.

Figure II-54. CO_2 Emissions from Energy Consumption in Singapore, BAU and APS



4. Implications and Policy Recommendations

The model results suggest that under the BAU scenario, Singapore's emission will reach 19.6 Mt-C in 2030. Once we include the policies implemented until the end of 2010 (in the BAU and APS scenarios), Singapore achieves carbon emission reductions within a range of 4.1 percent in 2030. The impetus for this reduction is provided by the myriad programs instituted by the government that seek to incentivize the use of less carbon-intensive fuels to improve energy efficiency. Despite the constraints posed by its small size and paucity of renewable energy sources, Singapore's long-term commitment to building a sustainable city will ensure that efforts at using energy efficiently and in an environmentally viable manner will continue to receive broad support.

Chapter 16

Thailand Country Report

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June 2011

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Thailand

Mrs. Supit Padprem

1. Background

Thailand is in the middle of the South East Asian mainland, with the Pacific Ocean on the south-east coast and the Indian Ocean on the south-west coast. Its land area is approximately 513,115 square kilometres, with great plains in the centre, mountainous areas up north and high-lands in the Northeast. It has a small economy with a gross domestic product (GDP) in 2005 of around US$157 billion. The population is currently 64 million with an income per capita of US$ 2,400.

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

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

In Thailand, natural gas is used as a major energy source for power generation. In 2005, primary natural gas supply was 25.9 Mtoe, around 72 percent was from domestic supply with the rest imported from neighbouring countries. Coal was mainly consumed for power generation and by industry. In addition it was also heavily used in cement and paper production.

Thailand has 26.5 gigawatts (GW) of installed power capacity and power generation was about 130.6 terawatt-hours (TWh) in 2005. The share of different fuel types in total electricity generation in 2005 was: thermal (coal, natural gas and oil) at 94.2 percent, hydro at 4.3 percent and geothermal, solar, small hydro and biomass making up the remainder.

2. Modelling Assumptions

In this report, Thailand's GDP is assumed to grow at an average rate of 4.0 percent per year from 2005 to 2030. Given the impacts of the world economic crisis on the Thai economy since the end of 2008, GDP growth between 2005 and 2010 will be slower than previously expected at about 3.7 percent per annum. Population growth is also

projected to be reasonably slow at around 0.5 percent per annum from 2005 to 2030, compared with average growth rate about 1.1 percent per annum during the period of 1990 till 2005.

For power generation in Thailand, coal and natural gas are projected to be the largest energy sources. Conversely, the shares of fuel-oil and diesel power plants are projected to decrease. Nuclear power and renewable fuels are projected to increase their shares in the energy fuel mix in the APS relative to the BAU scenario.

Thailand's energy saving goals can be achieved through the implementation of energy efficiency programs in all energy consumption sectors. In the industrial sector, improvements in technology development in manufacturing processes, along with efficiency labelling on appliances, should help improve energy efficiency. In the residential and commercial (other) sector, large energy savings are projected driven by programs to promote public awareness of energy efficiency and energy efficiency labelling. In the transportation sector, further development in the Bangkok metro area railway network will also contribute to energy savings. Significant improvements in energy efficiency in passenger vehicles are also expected to be achieved due to new developments in car technologies and introduction of the Eco car program.

Government policies will also continue to encourage the increased use of alternative fuels, such as nuclear power and biofuels. Reductions in the growth of CO_2 emissions are also expected to be achieved through the increased adoption of more energy efficient and lower emissions technologies. In particular, in the APS, nuclear power and renewable fuels in power generation are expected to help reduce CO_2 emissions from electricity generation. Gasohol and bio-diesel as oil alternatives are also expected to help curb CO_2 emissions from the transportation sector.

3. Outlook Results

3.1. Total Final Energy Consumption

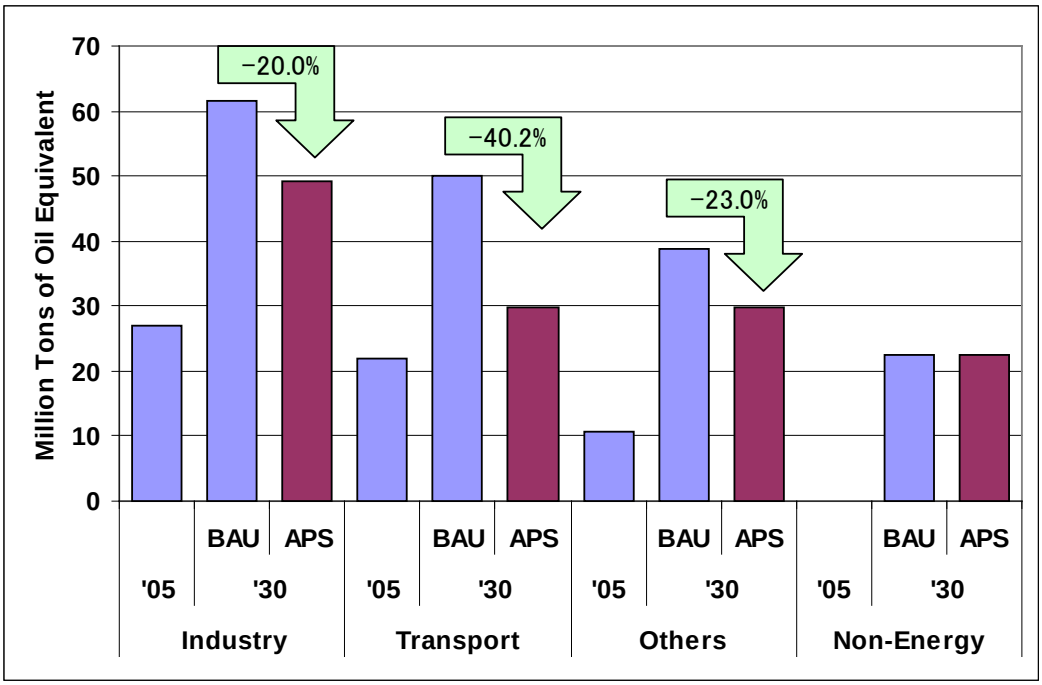
Between 1990 and 2005, Thailand's final energy consumption grew at a robust rate on average at 5.9 percent per annum from 25.4 Mtoe in 1990 to 59.7 Mtoe in 2005. The transportation sector was the largest consumer of final energy at 11.4 Mtoe in 1990. By 2005 the share of transport had declined from 45 percent in 1990 to 37 percent. Strong growth in the industrial sector of about 7.8 percent between 1990 and 2005 drove increases from 8.7 Mtoe in 1990 to 27.1 Mtoe in 2005. By 2005, the industrial sector had overtaken the transport sector as the largest consumer of final energy - its share in 2005 was about 45 percent. Oil remained the dominant energy source in the total final energy consumption since 1990. In 2005, oil accounted up to 36.4 Mtoe or about 61 percent share of the total final energy consumption. Electricity was the second largest energy source in the final energy consumption, accounting for 10.4 Mtoe or a 17.4 percent share in 2005.

Business-as-Usual (BAU) Scenario

Given moderate economic growth, (at an annual average rate of 4.0 percent,) and the low growth rate of population, (at an annual average rate of 0.5 percent), final energy consumption is projected to grow at a moderate rate of around 4.3 percent per annum during the period 2005-2030. The industry and the transportation sectors are projected to remain the largest consumers with the highest shares of consumption at 35.6 percent and 28.9 percent respectively in 2030.

By fuel type, oil is expected to remain the largest final energy source throughout the projection period. Growth in oil is projected to decline from 5.0 percent per annum during 1990-2005 to quite a low growth rate of 3.8 percent per annum during 2005-2030. In 2030, the shares of electricity, coal and natural gas in the final energy consumption are projected to increase to 20.8 percent, 12.5 percent and 3.4 percent respectively from the 2005 levels.

Figure II-55. Final Energy Consumption by Sector in Thailand, BAU and APS



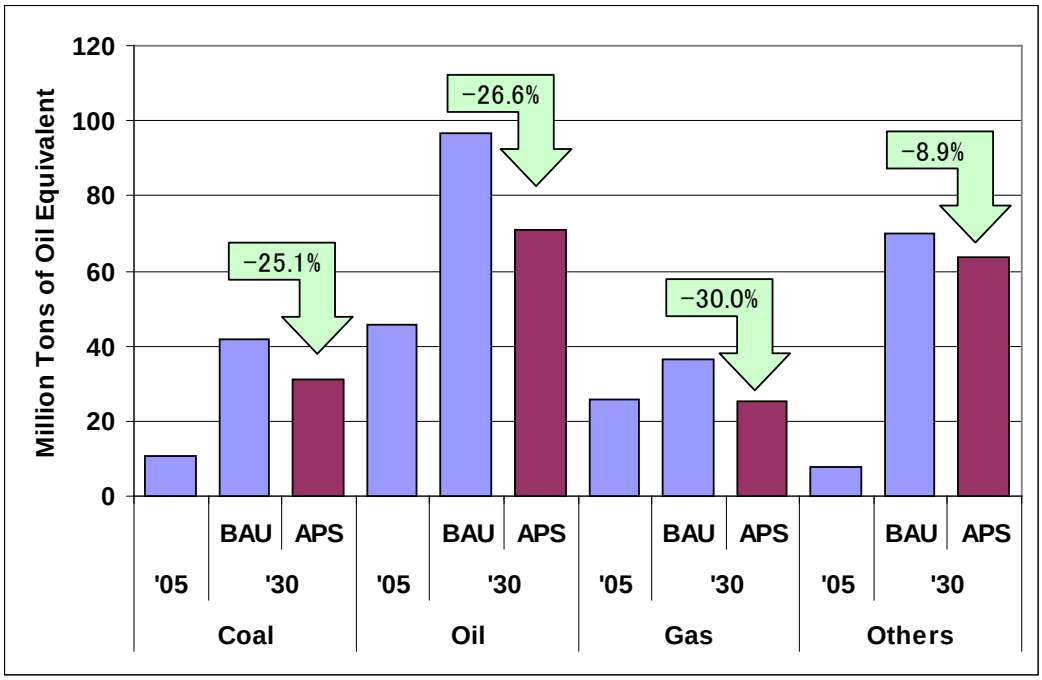
Alternative Policy Scenario (APS)

In the APS, final energy consumption is projected to grow only at 3.2 percent per annum, from 59.7 Mtoe in 2005 to 131.7 Mtoe in 2030, which is much slower than the BAU average annual growth rate of 4.3 percent. Specifically, the majority of energy savings will be achieved through energy efficiency improvement programs implemented in the industry and transportation sectors. Improvements will also be achieved in other sectors as shown in Figure II-55.

3.2. Primary Energy Demand

Primary energy demand grew reasonably fast at an average annual rate of 6.4 percent from 35.4 Mtoe in 1990 to 89.9 Mtoe in 2005 driven largely by fast economic development during 1990 and 1996. This growth in primary energy was achieved despite the severe economic crisis between 1997 and 1998 and a slow recovery during 1999 and 2005. In 2005, major sources of primary energy were oil, natural gas and coal with shares of 50.5 percent (45.4 Mtoe), 28.8 percent (25.9 Mtoe) and 11.8 percent (10.6 Mtoe) respectively. Although oil remained the largest source during 1990 and 2005, its share in the primary energy demand decreased from 55.7 percent in 1990 to 50.5 percent in 2005. Natural gas, which is mainly consumed in the power generation sector, became an important source of energy with its share in the primary energy demand increasing significantly from 16.0 percent in 1990 to 28.8 percent in 2005. The share of hydropower remained relatively constant at around 2 to 3 percent from 1990 to 2005.

Figure II-56. Primary Energy Demand by Source in Thailand, BAU and APS



Business-as-Usual (BAU) Scenario

In the BAU scenario, primary energy demand is projected to grow moderately at about 4.1 percent per annum from 2005 to 2030, reaching about 244.7 Mtoe in 2030. The highest average annual growth rate of 5.6 percent is expected for coal consumption with total amount reaching 41.8 Mtoe in 2030. Given very strong average annual growth in natural gas of 10.7 percent between 1990 and 2005, growth is expected to slow down to about 1.4 percent per year between 2005 and 2030. It is recognised that future strong

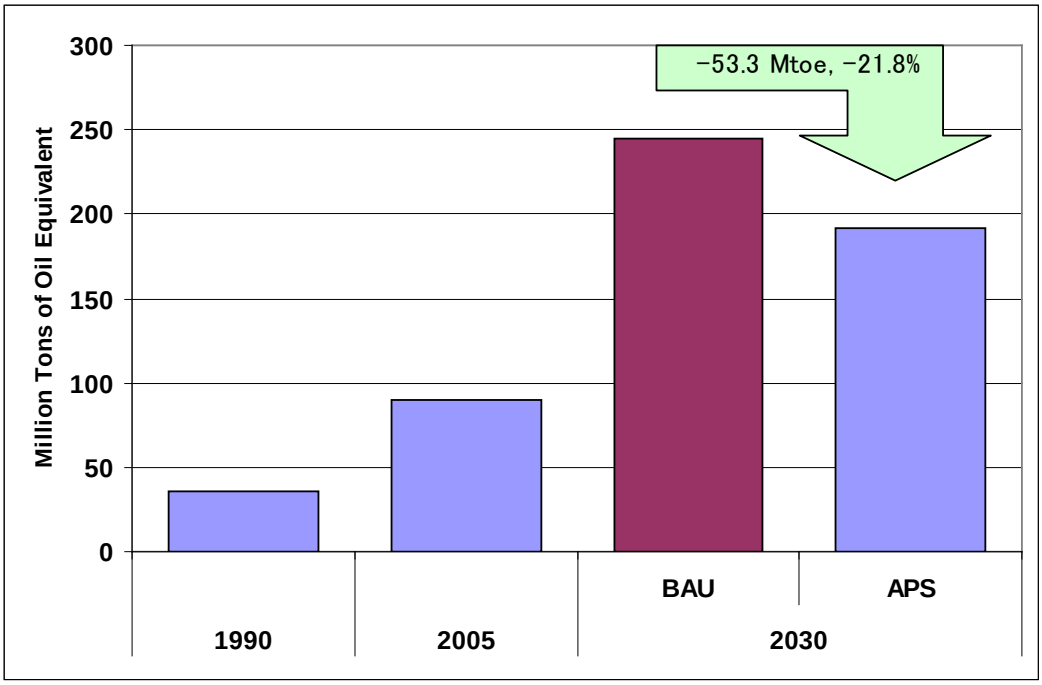
growth in natural gas consumption in power generation may be limited and it could be replaced by nuclear and other alternative fuels, according to the government plan.

Alternative Policy Scenario (APS)

In the APS, growth in primary energy demand is projected to be slower than in the BAU scenario at 3.1 percent per annum between 2005 and 2030 (compared with 4.1 percent in BAU) to reach 191.4 Mtoe in 2030. Primary energy demand is expected to be about 21.8 percent lower in the APS than in the BAU scenario in 2030 – an energy saving of about 53.3 Mtoe.

Natural gas is projected to decrease from 25.9 Mtoe in 2005 to 25.4 Mtoe in 2030, at an average annual rate of 0.1 percent. Oil is projected to increase from 45.4 Mtoe in 2005 to 71.0 Mtoe in 2030, at an average annual rate of 1.8 percent. These reductions in growth, relative to the BAU scenario, are mainly achieved through energy efficiency and conservation measures on the demand side. The differences in the projections between the two scenarios are shown in Figure II-56.

Figure II-57. Total Primary Energy Demand in Thailand, BAU and APS



3.3. Projected Energy Savings

The difference between primary energy demand in the BAU scenario and the APS at 2030 is 53.3 Mtoe (Figure II-57). This represents the potential energy savings that could be achieved if energy efficiency and conservation goals and action plans were implemented. This energy saving is equivalent to about 59.3 percent of Thailand's primary energy demand in 2005. Oil will contribute the most at about 25.7 Mtoe in

energy savings, while natural gas, as the second biggest, will contribute about 10.9 Mtoe.

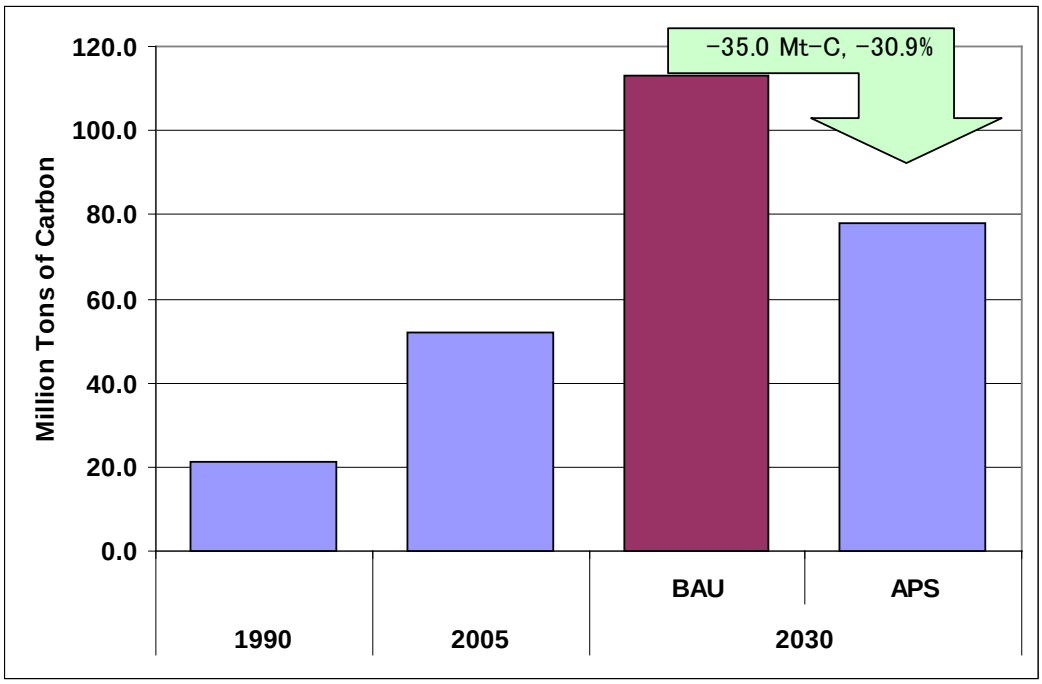
For the final energy consumption, the savings in the APS, relative to the BAU scenario in 2030, could reach 41.3 Mtoe. About 20.1 Mtoe of the saving is projected for the transport sector while the remaining 21.2 Mtoe would be that of the industrial sector (12.3 Mtoe) and others sector (8.9 Mtoe).

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 3.2 percent per annum on average from 52.1 Mt-C in 2005 to 113.1 Mt-C in 2030 in the BAU scenario. Thailand plans to promote the use of primary energy sources which are less carbon intensive, for example, nuclear and renewable fuels.

In the APS, the average annual growth in CO_2 emissions from 2005 to 2030 is projected to be about 1.6 percent, and emissions are projected to rise to 78.2 Mt C in 2030. The reduction in CO_2 emissions between the APS and BAU scenario highlights the range of benefits that can be achieved through energy efficiency improvements and savings via action plans (Figure II-58).

Figure II-58. CO_2 Emissions from Energy Consumption in Thailand, BAU and APS



4. Implications and Policy Recommendations

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

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

Improving energy efficiency will also help Thailand (which is an oil importer), to address the challenges faced by rising world oil prices. Thailand is committed to reducing the intensity of energy consumption, especially in oil, and is also looking for more sustainable energy sources and environmentally friendly fuels. It is recognised that the more Thailand saves energy, the less sensitive it will be to fluctuations in world energy prices and supply. It is wise and rational to try to be more self-sufficient and sustainable. Furthermore, Thailand realises that cooperation on energy savings is important and that all countries should respond.

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

Chapter 17

Vietnam Country Report

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June 2011

This chapter should be cited as
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Vietnam

Dr. Nguyen Quoc Khanh
Dr. Nguyen Minh Bao

1. Background

Vietnam lies in the centre of South East Asia. It has a total land area of about 331,111 square kilometres and a population of 83.1 million in 2005. Its GDP in 2005 amounted to US$ 44.8 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 539 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 45.4 percent, coal was second at 29.8 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 was mainly used in the industry sector with consumption in 2005 of 4.8 Mtoe, whereas gas was 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 59.9 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 7.6 percent from 2005 to 2030. Growth is projected to be at 7.7 percent per year from 2010 to 2020, slightly increasing to 7.8 percent per year from 2020-2030. Population growth, on the other hand, is projected to increase by 0.9 percent per annum from 2005 to 2030.

With regards to future electricity supply, the share of electricity from coal-fired power plants is projected to increase whereas the share of others is expected to decrease. Electricity import is expected to increase in particular from Lao PDR and China. The use of nuclear energy is projected to start in 2020 in view of Vietnam's recent nuclear power development plan. In the Business-As-Usual (BAU) scenario, the capacities of nuclear power are assumed to be at 1000 MW, 4000 MW and 6000 MW in 2020, 2025 and 2030, respectively.

Vietnam's energy saving goals are assumed to be between 3 to 5 percent of total energy consumption, equivalent to 5 MTOE in the period of 2006-2010, and 5 to 8 percent of total energy consumption, equivalent to 13.1 MTOE in the period of 2010-2015, in accordance with the country's national target on energy efficiency and conservation. Saving goals for subsequent period from 2015 to 2030 are assumed following the tendency in the previous periods.

The energy savings goals would be attained through the implementation of energy efficiency programs in the industry sector and in the residential and commercial sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies and introduction of energy management systems. In the residential and commercial sectors, efficient end use technologies and energy management systems are projected to induce significant savings.

Along with energy efficiency measures on the demand side, on the supply side, renewable energy technologies, particularly small hydro, wind and biomass are expected to come online intensively from 2010 in view of the recent master plan on renewable energy development. Concretely, electricity generating installed capacity from renewable energy would reach 4,900 MW by 2030 with small hydro contributing 2,400 MW, wind 2,100 MW and biomass 400 MW.

Vietnam has considered the use of biofuels to reduce dependency on oil and curb CO_2 emissions. According to decision 177/2007/QD-TTg of the Prime Minister approving the master plan on biofuel development until 2015 with perspective of 2025, 250 thousand tons and 1.8 million tons (both ethanol and biodiesel) are expected to produce in 2015 and in 2025, respectively.

3. Outlook Results

3.1. Total Final Energy Consumption

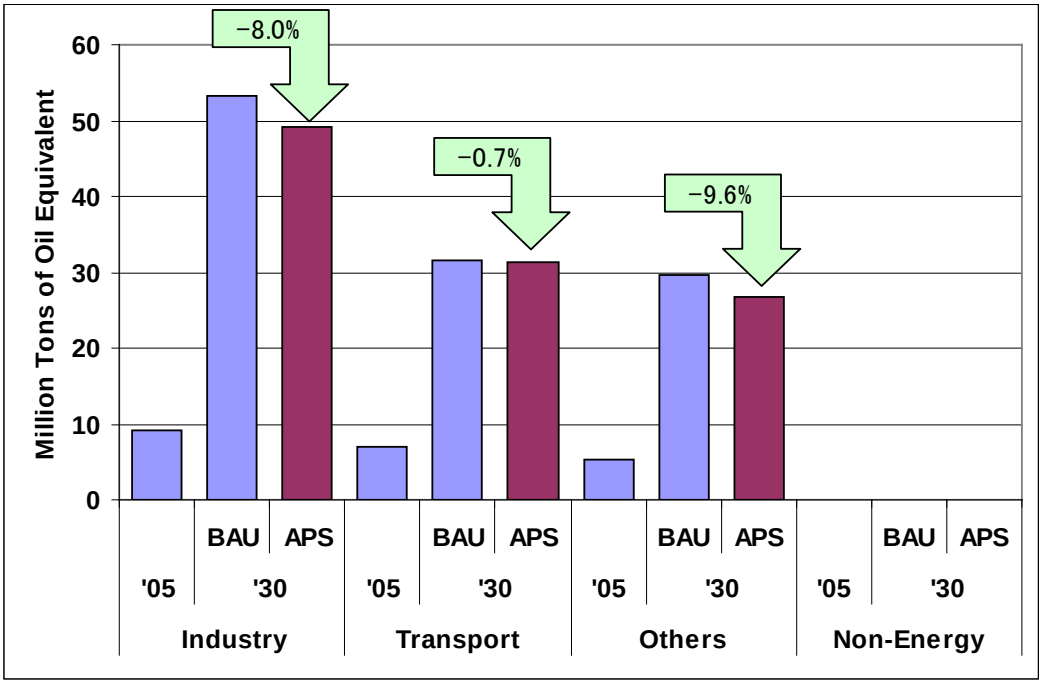
Vietnam's final energy consumption experienced a rapid growth of 11.5 percent per annum from 4.2 Mtoe in 1990 to 21.6 Mtoe in 2005. The industrial sector grew the fastest at 11.8 percent per annum followed by the residential/commercial (others) sector at 11.4 percent per annum between 1990 and 2005.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

Business-as-Usual (BAU) Scenario

With the projected strong economic growth and population increase, final energy consumption from 2005 to 2030 is projected to increase at an average rate of 6.9 percent per annum. The consumption of the industry sector is projected to grow the fastest with annual growth of 7.3 percent per annum followed by the residential/commercial (others) 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 6.2 percent over the period 2005-2030 (Figure II-59).

Figure II-59: Final Energy Consumption in 2005 and 2030, BAU vs. APS



By fuel type, natural gas is projected to grow the fastest at 13.9 percent per annum over the period 2005-30. Electricity is projected to have the second highest growth rate of 8.5 percent per annum over the same period. Consumption of coal and oil will increase at an average annual rate of 6.4 and 6.3 percent, respectively over the period 2005-2030.

Alternative Policy Scenario

In the APS, final energy consumption is projected to increase at a slower rate of 6.6 percent per annum from 21.6 Mtoe in 2005 to 107.3 Mtoe in 2030 due to energy efficiency and conservation programs. The decrease in the consumption growth rate is expected to occur particularly in the industrial sector and the residential/commercial (others) sector due to improvement in end-use technologies and the introduction of energy management systems.

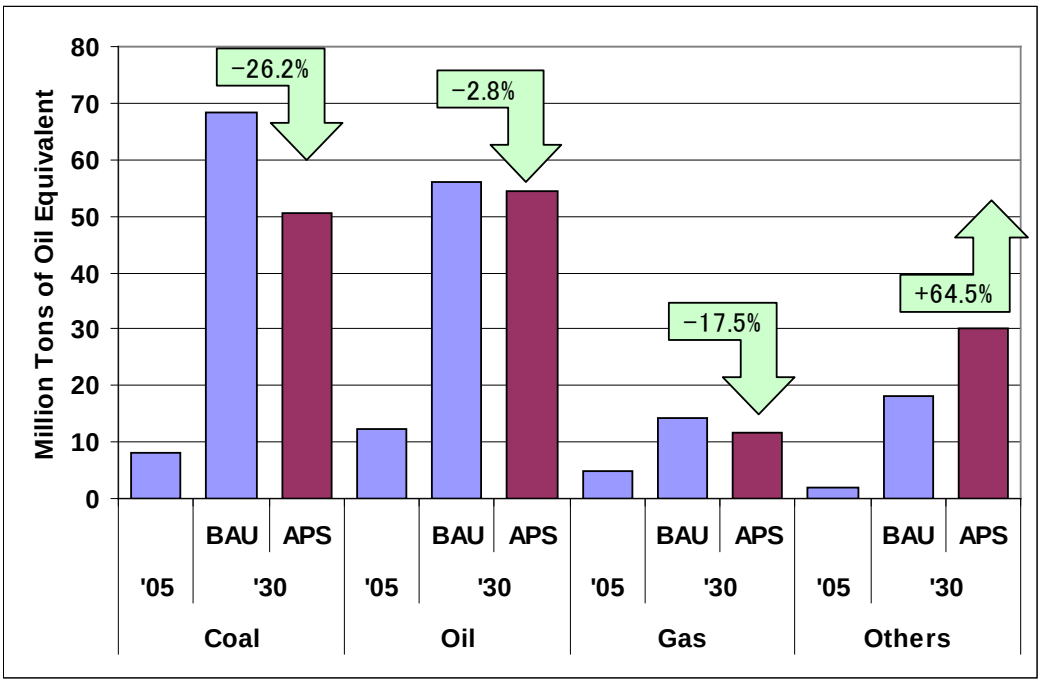
3.2. Primary Energy Demand

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 63.8 percent while oil and coal grew at 10.6 percent and 9.0 percent, respectively per annum over the period 1990-2005. Hydro energy had a respectable growth rate of 9.7 percent per annum during the period but its share in total primary energy demand remained small at 6.8 percent in 2005.

Business-as-Usual (BAU)Scenario

In the BAU scenario, Vietnam's primary energy demand is projected to increase at an annual rate of 7.2 percent per annum over the period 2005-2030 to 156.8 Mtoe in 2030. Coal is expected to grow the fastest at an annual average rate of 8.9 percent followed by oil and natural gas at 6.2 percent and 4.3 percent, respectively over the period 2005-30. The share of coal is projected to increase from 29.8 percent to 43.6 percent over the period 2005-2030 whereas the shares of oil and natural gas are projected to decrease from 45.4 percent to 35.7 percent and from 18.0 percent to 9.0 percent, respectively over the period 2005-30 (Figure II-60).

Figure II-60: Primary Energy Demand in 2005 and 2030, BAU vs. APS



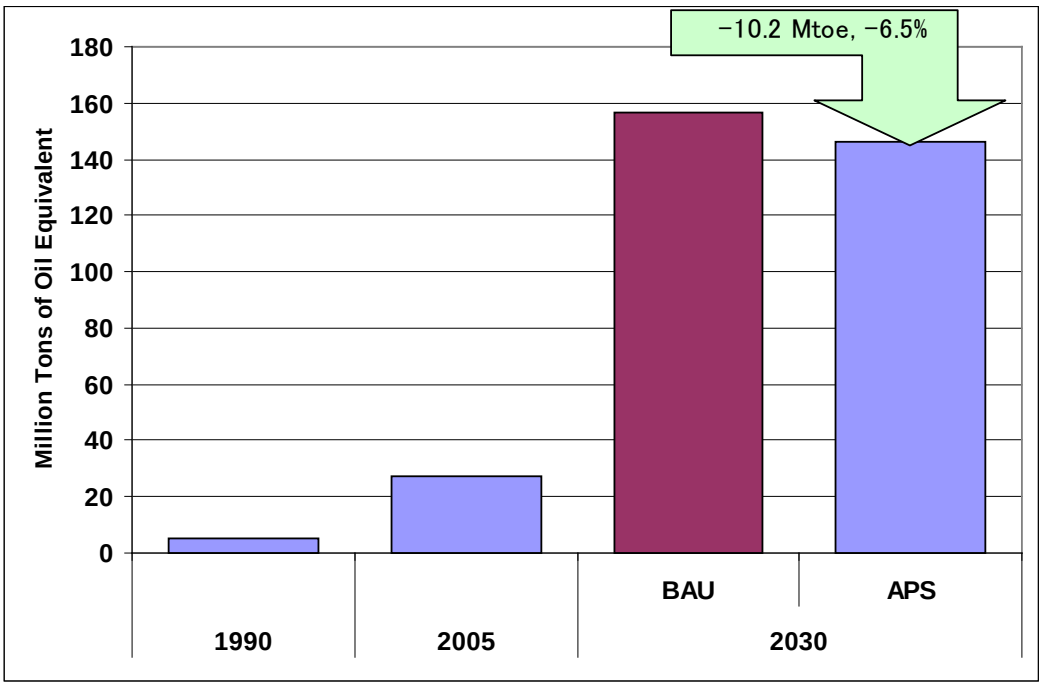
Alternative Policy Scenario

In the APS, primary energy demand is projected to increase at a slower rate of 7.0 percent per annum over the period 2005-2030 to 146.53 Mtoe in 2030. Coal, oil and natural gas are projected to grow at an average annual rate of 7.6 percent, 6.1 percent and 3.5 percent, respectively over the period 2005-2030. These decreases in consumption rates, relative to the BAU scenario, are due to energy efficiency and conservation measures on the demand side and the more aggressive use of renewable energy and nuclear energy on the supply side.

3.3. Projected Energy Saving

The energy savings that could be derived from the EEC goals and action plans of Vietnam would amount to 10.2 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS. This is equivalent to 6.5 percent of Vietnam's consumption in 2030 in the BAU (Figure II-61).

Figure II-61: Evolution of Primary Energy Demand, BAU and APS

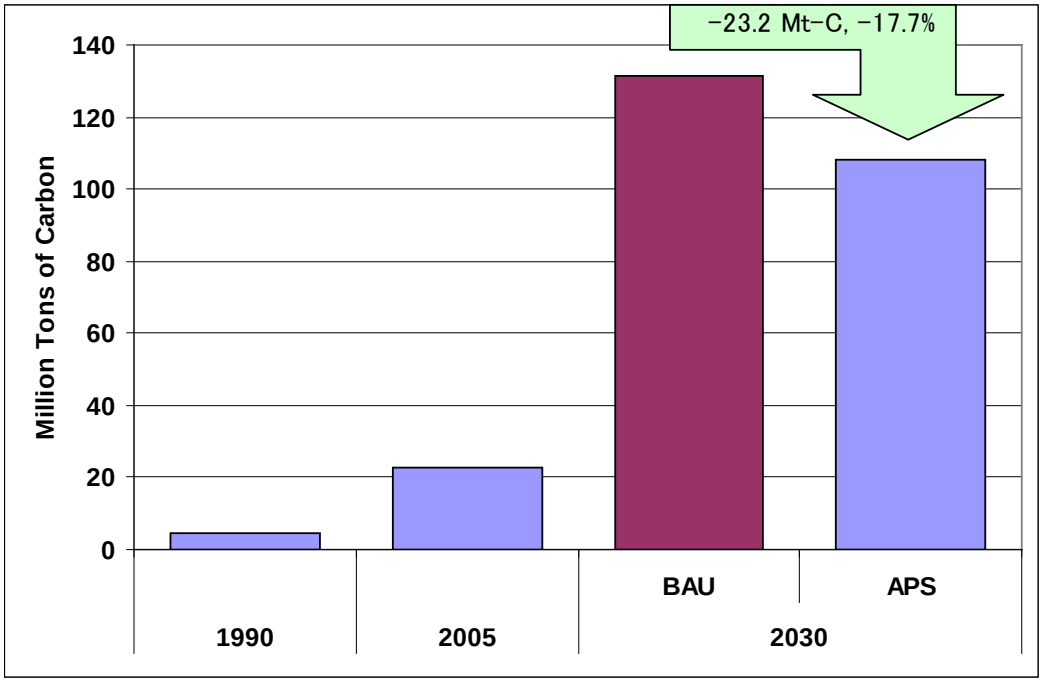


In final energy consumption, there is an estimated saving of 4.3 Mtoe in the industry sector, 2.8 Mtoe in the residential/commercial (others) sector and 0.2 Mtoe in the transportation sector in 2030 in the APS, relative to the BAU scenario.

3.4. CO_2 Emissions from Energy Consumption

CO_2 emissions from energy consumption are projected to increase by 7.2 percent per annum from 22.9 Mt-C in 2005 to 131.4 Mt-C in 2030 in the BAU scenario. In the APS, the annual increase in CO_2 emissions from 2005 to 2030 is projected to be 6.4 percent. The reduction in the growth rate of CO_2 between the APS and the BAU scenario which is around 17.7 percent indicates that the energy saving goals and action plans of Vietnam is very effective in reducing CO_2 emissions (Figure II-62).

Figure II-62: Evolution of CO_2 Emissions in Vietnam



4. Implications and Policy Recommendations

The above analysis shows that energy demand in Vietnam in the coming period (2010-2030) is expected to continue to grow at a significant rate, driven by economic growth, industrialization as well as increasing urbanization and population growth. Energy conservation measures could contribute in meeting such increasing demand in a sustainable manner. The energy intensity in Vietnam which is amongst the highest in the world indicates high saving potential. By implementing energy conservation measures not only energy security would be improved but also less environmental impact.

The energy savings that could be derived from the EEC goals of Vietnam are 10.2 Mtoe, equivalent to 6.5 percent of Vietnam's consumption in 2030. These goals would be attained through the implementation of energy efficiency programs in the industry sector and in the residential/commercial (others) sector. For the industry sector, energy savings are expected from improvements in manufacturing technologies and the introduction of energy management systems. In the residential and commercial sector, efficient end-use technologies and energy management systems are projected to induce significant savings.
To be able to implement these energy efficiency programs effectively and thus attain the EEC goals, in addition to those already mentioned in the action plan, the followings are recommended:

- **Gradual removal of subsidized energy prices:** low energy prices, especially to energy intensive industries (cement, fertilizer, pulp and paper**)** do not encourage

energy efficiency. As long as energy cost remains modest in the production cost, hardly any actions would be taken to save energy. To give an example, the weighted average retail electricity tariff in Vietnam in 2006 was only 870 Dong/kWh (5.5 US cent/kWh), which is about 2 US cent lower that the long run marginal cost (LRMC). Actually, the roadmap for energy price increase has been formulated but the actual increase so far did not keep pace with the required increased level. For example, electricity price increase at the beginning of 2010 just compensates the inflation rate in 2009.

- **More aggressive awareness raising campaigns**: Along with policy measures, awareness raising campaigns should be initiated. It is important that energy consumers understand well the benefits of energy saving to the society and themselves. Once they understand this, they would be happy to implement simple no-cost and low cost measures.

- **Support for large consumers to implement EEC measures**: For large consumers, supports in the implementation of EEC measures might be needed. These include training, financial assistance, etc. On the other hand, these consumers are requested to report energy consumption on an annual basis to Office of EEC for control and for formulation of EEC programs.

- **Promotion of ESCO:** It is infeasible that the energy consumers would carry out all EEC measures by themselves. There should be professional Energy Service Company (ESCO) in place to provide EEC services to them. These companies would provide energy auditing services, consultancy services on the financial aspects of EEC projects, and implement EEC projects for industrial and commercial customers, in some cases as an investor. In this regard, ESCO act as implementers of EEC policies and to some extent decides the success of an EEC action plan, and thus should be encouraged.

- **Collection of end-use energy consumption data**: Parallel to above measures, collection of end-use energy consumption data should be organized. It is clear that absence of detailed end-use energy consumption data can severely limit the availability of effective energy saving programs. For example, the potential of energy saving in the transport sector, one of the large energy consumers is not yet well evaluated in the present action plan, due to lack of detailed consumption data. Therefore, it is proposed that a comprehensive end-use energy consumption data collection campaign be carried out. To be able to do this on a regular basis, a data acquisition system should be created and the present data acquisition system of the general statistics of Vietnam which is collecting socio-economic data could be expanded for this function.

- **Restructuring of the economy:** The large difference of energy intensity of sectors might suggest a restructuring of the economy in the long run for the sustainable development of the country. The idea is energy intensive sectors that contribute less to the GDP might be reorganized and tertiary industry might be encouraged. As a hint, Table II-5 shows percentage of energy consumption of

sectors and their contribution to the GDP in 2003. Sectors in bold are those with low contribution to total VA in relation to their energy consumption.

- **Supply measures.** Along with measures on the demand side, attention should be paid to supply side. The technologies of existing power plants especially coal fired power plants in Vietnam are quite backward which should be improved and upgraded. Along with that, more attention should be focused on renewable energy as Vietnam possesses good potential for renewable energy. For example, wind energy by 2030 is set at 2100 MW while total capacity of projects in the pipeline exceeds 3500 MW.

- **Energy indicators to monitor implementation of action plan**: It is important that energy saving goal be clearly and transparently defined. For example, the overall energy saving should be defined in terms of a reduction in energy intensity. Likewise, transparent energy indicators should be established to monitor and evaluate the performance of EEC programs for formulation of follow-up activities.

- **Cooperation with countries with success in EEC**: 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. The cooperation might be in the formulation and implementation of a master plan on EEC or a concrete EEC project.

Table II-5: Percentage of energy consumption of sector in relation to their contribution to total VA

	Sector	% VA	% of intermediate expenditure for energy	% of energy consumed in total intermediate consumption	%energy consumed/ %VA
1	Cultivation	16.7%	3.7%	2.1%	0.13
2	Livestock	3.2%	2.3%	0.6%	0.19
3	Agricultural services	0.8%	22.9%	1.5%	1.91
15	Glass, ceramics	0.2%	13.1%	0.6%	2.48
16	**Brick and tiles**	**0.6%**	**16.9%**	**1.8%**	**3.28**
17	**Cement**	**0.7%**	**17.8%**	**3.8%**	**5.11**
18	Concrete	0.1%	7.3%	0.1%	1.14
19	Other construction materials	0.1%	10.0%	0.2%	1.52
20	**Pulp and paper**	**0.4%**	**14.3%**	**1.6%**	**4.01**
21	Processed wood	0.6%	7.0%	1.2%	1.87
22	**Basic chemicals**	**0.1%**	**19.4%**	**0.3%**	**2.78**
23	Fertilizer	0.4%	10.2%	0.6%	1.72
24	Pesticide	0.1%	3.5%	0.0%	0.40
25	Veterinary medicine	0.0%	0.7%	0.0%	0.07
26	Health medicine	0.3%	2.8%	0.1%	0.47
27	**Processed rubber**	**0.3%**	**13.3%**	**0.8%**	**2.34**
28	Soap and toilet preparation	0.4%	2.1%	0.2%	0.43
29	Plastic	0.6%	5.3%	0.6%	1.06
30	Paint and other chemicals	0.2%	4.1%	0.2%	0.84
31	Health instruments	0.1%	9.3%	0.1%	1.11
32	Home appliances	0.1%	3.3%	0.1%	0.60
33	Motor vehicles and bikes	0.6%	1.3%	0.3%	0.50
34	General purpose machinery	0.3%	3.2%	0.2%	0.72
35	Automobiles	0.8%	13.9%	1.5%	1.89
36	Electrical equipment	0.7%	2.2%	0.6%	0.77
37	**Non-ferrous and ferrous metal**	**0.8%**	**7.1%**	**2.4%**	**3.14**
38	Textiles	2.0%	3.7%	2.9%	1.45
39	Leather	1.3%	2.0%	1.1%	0.89
40	**Animal feeds**	**0.2%**	**7.1%**	**0.5%**	**2.77**
41	Printing activities and publishing	0.3%	1.6%	0.1%	0.32
42	Other physical goods	0.5%	3.6%	0.5%	1.08
43	Gasoline, lubricant and gas	0.1%	63.9%	0.7%	12.24
44	Electricity	3.0%	57.3%	6.7%	2.23
45	Water	0.2%	42.9%	0.3%	1.23
46	Construction	5.6%	5.2%	7.2%	1.29
47	Trade and repair services	10.3%	7.5%	6.0%	0.58
48	Hotel and restaurants	3.4%	21.7%	5.7%	1.68
49	Transportation	2.1%	48.8%	8.9%	4.18
50	Post and telecommunication	1.9%	6.2%	0.4%	0.21
51	Tourism	0.1%	9.3%	0.1%	0.65
52	Finance	1.1%	10.6%	0.5%	0.46
53	Other services	17.4%	14.8%	13.2%	0.76

Source: GSO (General Statistic Office), 2003. Input-Output table of Vietnam in 2000. Statistical Publishing House, Hanoi, Vietnam

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