# Chapter 2

# Australia Country Report

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# CHAPTER 2

# Australia Country Report

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## 1. Background

Australia is the sixth largest country in the world, with a land area of around 7.7 million square kilometres. It has diverse geography and climate and is divided into six states and two territories. Australia's population of around 22 million lives mostly in major cities or regional towns along the eastern and south-eastern coasts. Real gross domestic product (GDP) in 2009 was around US$535.2 billion (at constant 2000 US$ values[1]), which translates to around US$24,400 per person.

Australia has abundant, high quality and diverse energy resources, including both renewable and non-renewable sources. Australia has around 33 per cent of the world's uranium resources, 10 per cent of black coal resources and almost 2 per cent of gas resources Australia is overwhelmingly a net energy exporter. However, it is a net importer of crude oil and petroleum products. Coal is Australia's largest energy export earner, followed by crude oil and Liquefied Natural Gas (LNG). Australia accounts for around 28 per cent of world black coal trade—58 per cent of world metallurgical trade and 18 per cent of thermal coal trade. Since the late 1980s, Australia has emerged as one of the largest exporters of LNG to the Asia-Pacific region (BREE 2012).

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 517 years for brown coal, 128 years for black coal, 66 years for conventional gas, 175 years for coal seam gas and 134 years for uranium (BREE 2012).

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

In 2009, Australia's primary energy demand was around 138 million tonnes of oil equivalent (Mtoe). Coal accounted for about 39 per cent of primary energy demand, oil 35 per cent and gas 22 per cent. The remainder was sourced from renewable energy, including hydro, biomass, wind and solar.

In 2009, Australia produced about 245 TWh (terawatt-hours) of electricity. The majority of this was generated by coal (74 per cent), followed by gas (16 per cent), hydro (5 per cent) and oil (2 per cent). Other renewable sources accounted for about 3 percent of total electricity generation in 2009.

## 2. Modelling Assumptions

### 2.1. Population and Gross Domestic Product

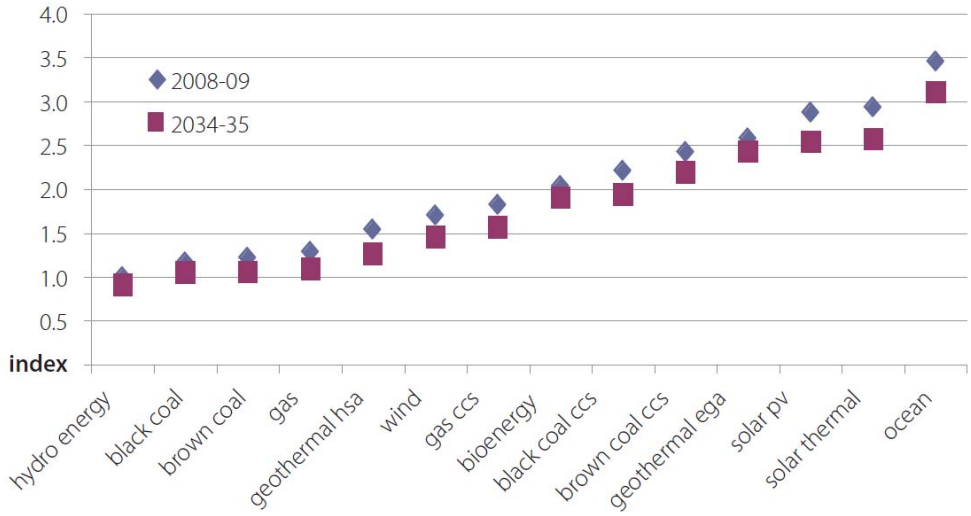
In the exercise to project Australia's energy consumption, production and trade (Syed and Penney 2011), it was assumed that annual average growth in population will moderate to around 1.4 per cent between 2009 and 2035, compared with the average annual growth of 1.3 per cent between 1990 and 2009.

Average annual growth in Australia's gross domestic product is assumed to remain fairly strong throughout the projection period, averaging about 2.8 percent per year between 2009 and 2035. A moderation in Australia's population and labour supply growth is expected to contribute to a gradual decline in GDP growth towards the end of the projection period. The Australian economy is expected to continue to shift away from energy-intensive industries, such as manufacturing, towards the services sector.

### 2.2. Electricity Generation Technologies

Australia has access to a range of electricity generation technologies. As new technologies are developed and costs fall, the technologies available for electricity generation in Australia is expected to increase.

**Figure 2-1. Index of Real Levelised Cost of Electricity Generation Technologies, Excluding Carbon Costs**




*Source:* Syed and Penney 2011.

It is assumed that over the medium term, coal and gas without carbon capture and storage will remain among the lowest technology cost options in Australia. Despite an expected decline in the cost of solar technologies in the future, the cost will remain relatively high in the short to medium term. The cost of geothermal technology has been shown to be competitive with other baseload technologies, although it is still at a demonstration stage in Australia. All of these are shown in Figure 2-1.

## 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 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.

In December 2011, the Australian Government released the Draft Energy White Paper, *Strengthening the Foundations for Australia's Energy Future*. Four main policy priorities are identified: (1) enhancing energy policy through regular evaluations, (2)

furthering competitiveness and efficiency in the energy market through reforms, (3) furthering the development of energy resources (with an emphasis on gas), and (4) promoting the transition towards clean energy technologies. The final Energy White Paper is expected to be released in mid-2012.

Australia has provided legislated support to renewable energy technologies via the Renewable Energy Target (RET) which mandates that 45,000 GWh of Australia's electricity supply will come from renewable energy sources by 2020. In January 2011, the RET scheme was separated into two components—the large scale Renewable Energy Target and the small scale Renewable Energy Scheme. Under the amended scheme, the interim targets for electricity generation will increase from 16,338 GWh in 2012 to 41,000 GWh in 2020. Households and small businesses are expected to provide the additional 4000 GWh required to meet the target.

The Clean Energy Future Plan was announced in July 2011. It targets the reduction of Australia's carbon emissions to 5 per cent below 2000 levels by 2020, and 80 per cent below 2000 levels by 2050. The plan transitions the previous Clean Energy Initiative and other Government programs into a comprehensive strategy to reduce Australia's greenhouse gas emissions including the introduction of a carbon price, the promotion of innovation and investment in renewable energy, encouraging energy efficiency and the creation of opportunities in the land sector to cut pollution. In November 2011, the Australian parliament passed the Clean Energy Act 2011, which establishes the structure of and process for introducing an economy-wide carbon price and the transition to an emissions trading mechanism. The carbon price will be introduced on 1 July 2012 and is to be fixed at A$23 a tonne $CO_{2\text{-}e}$, growing at 5 per cent a year until the transition to an emissions trading mechanism on 1 July 2015.

Australia has a number of programs and regulatory measures that promote energy efficiency. The National Strategy on Energy Efficiency (NSEE) was introduced in 2009 and aims to help businesses and households reduce their energy costs and carbon emissions through energy efficiency. The NSEE encompasses commercial buildings, residential buildings, appliances and equipment, industry and business, government, transport, skills, innovation, advice and education. The Energy Efficiency Opportunities (EEO) program under the NSEE came into effect in 2006 and is Australia's flagship initiative to improve energy efficiency in the industrial sector. It is

mandatory for corporations and electricity generators using more than 0.5 petajoules (PJ) of energy each year to undertake a detailed energy assessment, then identify and evaluate opportunities to improve their energy performance.

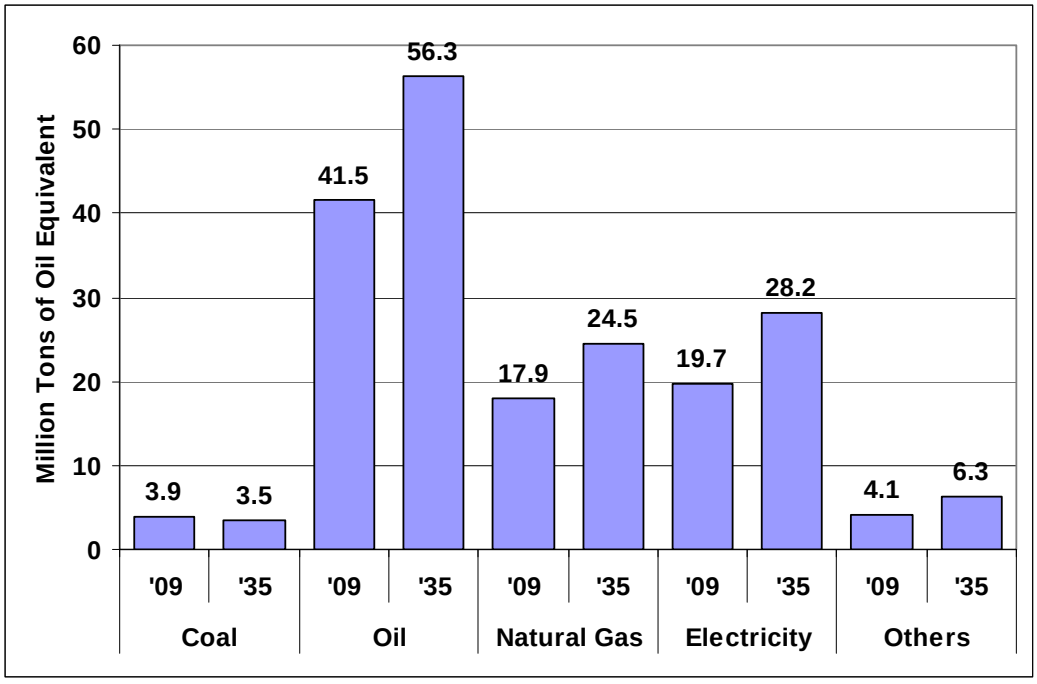
## 3. Outlook Results

The energy projections modelling provided the following results.

### 3.1. Total Final Energy Consumption

Oil (48 per cent) accounted for the largest share of final energy in 2009, followed by electricity (23 per cent) and gas (21 per cent). The transport and industry sectors are the largest users of final energy in Australia, accounting for about 35 Mtoe and 33 Mtoe, respectively, in 2009.

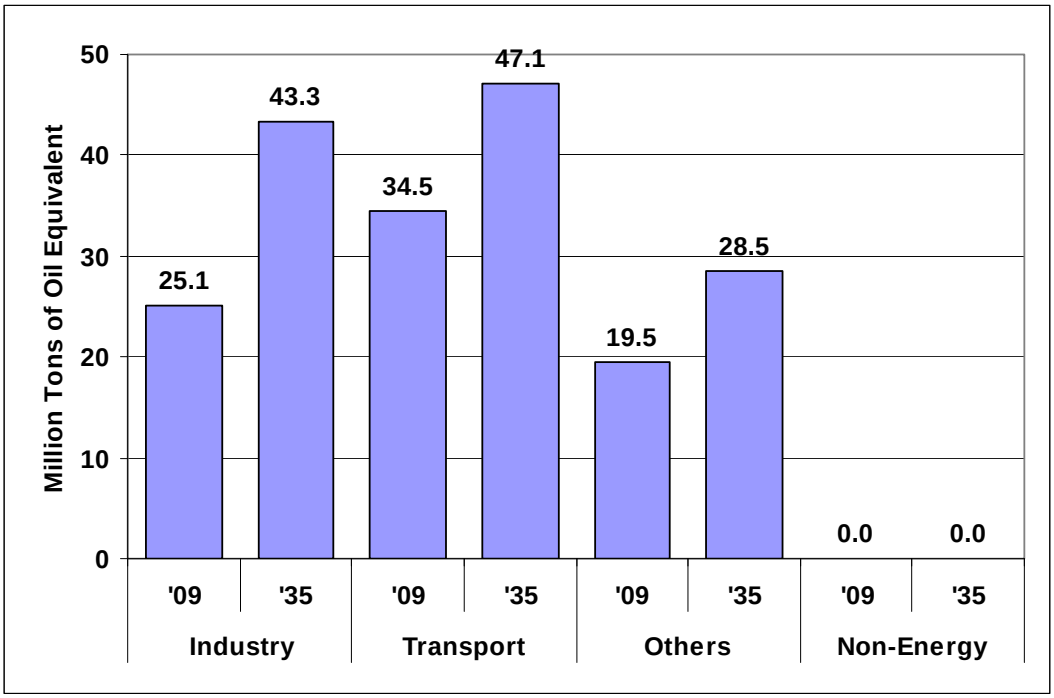
**Figure 2-2. Final Energy Consumption by Energy Type, 2009 and 2035**




Australia's total final energy consumption is projected to increase at an average annual rate of 1.2 per cent over the period 2009 to 2035 from about 87 Mtoe in 2009 to about 119 Mtoe in 2035. 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.

**Figure 2-3. Final Energy Consumption by Sector, 2009 and 2035**




Strong average annual growth in final energy consumption over the period 2009 to 2035 is expected in electricity (1.4 percent) and gas (1.2 percent). The strong growth in these energy types will contribute to the declining share of oil in final energy consumption over the projection period. The transport and manufacturing sectors are the major drivers of Australia's final energy consumption. This is expected to remain the case over the projection period. However, growth is expected to be stronger in less energy-intensive sectors.

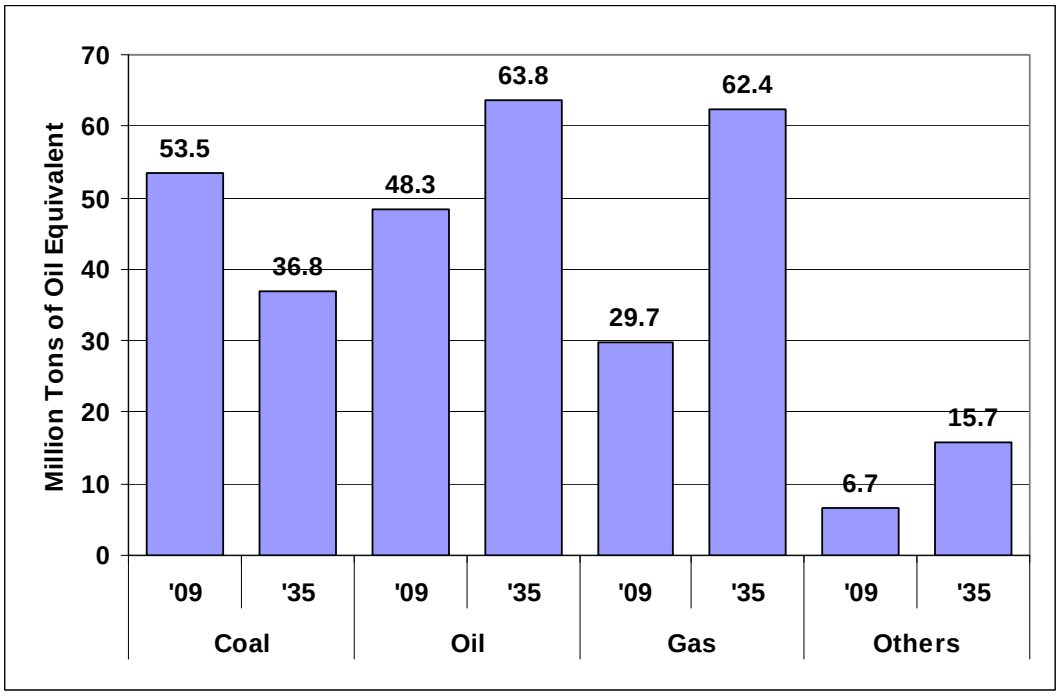
### 3.2. Primary Energy Consumption

Coal (39 per cent) accounted for the largest share of primary energy in 2009, followed by oil (35 per cent) and gas (22 per cent). Hydro and other renewable energy sources accounted for the remaining 5 percent of primary energy in Australia. Electricity generation, transportation and manufacturing accounted for around 89 per cent of Australia's total primary energy consumption in 2009.

The rate of growth in primary energy consumption is projected to slow over the

coming decade. This is a continuation of an ongoing trend that has been occurring since the 1960s driven by energy efficiency policies and structural change in the Australian economy. Australia's primary energy consumption is projected to increase at an average annual rate of about 1.0 per cent, from around 138 Mtoe in 2009 to 179 Mtoe in 2035 .

**Figure 2-4. Primary Energy Consumption by Source, 2009 and 2035**




Over the projection period, the relative share of each energy type is expected to change considerably in response to the changing policy environment. Gas is projected to exhibit the fastest growth, increasing by 2.9 per cent a year from 2009 to 62 Mtoe in 2035. This growth is driven by increased utilisation in electricity generation and the mining sector. Most of this growth will be at the expense of coal. The share of coal in the primary energy mix is projected to decline from 39 per cent in 2009 to 21 per cent in 2035. By contrast, the share of gas is projected to increase from 22 per cent in 2009 to 35 per cent in 2035.

The share of renewable energy is expected to grow considerably, supported by government policies encouraging investment in these technologies. The bulk of this increase is expected to come from bioenergy and wind energy.

The electricity generation, transportation and manufacturing sectors are projected to continue to be the major drivers of Australia's primary energy consumption.

## 4. Implications and Policy Recommendations.

Australia's economy is more energy and emission intensive than most developed countries, reflecting to a large extent its resource endowment and economic structure.

The projections indicate a significant transformation in the Australian energy landscape. The change is most prominent in the energy mix, with a shift away from coal towards lower emission technologies (such as gas and renewables) over the medium to longer term. This will require considerable investment in energy supply chains to allow for the larger scale integration of renewable energy and other emerging technologies.

Changes to market settings within the energy market framework will also help to further support this transition. A shift to cleaner technologies and improved energy efficiency will require a broad energy policy framework that supports investment in Australia. Timely adjustments to the policy framework will need to be made in response to emerging pressures/challenges and market developments as they arise.

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. The Clean Energy Future Plan will further impact on Australia's energy and emissions profile with the introduction of a carbon price and other measures to encourage greater take up of clean energy and energy efficiency technology. The full impact of which will take time to realise.

## References

BREE (2012) *Energy in Australia 2012*, Canberra, February.

Syed, A. and K. Penney. (2011) *Australian Energy Projections to 2034–35*, BREE report prepared for the Department of Resources, Energy and Tourism, Canberra, December.

# Chapter 3

# Brunei Darussalam Country Report

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# CHAPTER 3

# Brunei Darussalam Country Report

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## 1. Background

Brunei Darussalam is an independent sovereign constitutional Sultanate, headed by His Majesty Sultan HassanalBolkiah. Brunei Darussalam is situated on the north-east coast of Borneo Island in South-east Asia, occupying 1 percent, 5765 square kilometers, 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 percent 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 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 48,194[1]. Brunei Darussalam's GDP is projectedto grow at an average of 3.9 percent and the population growth at 2.1

[1] Asian Development Bank Key Indicators for Asia 2009.

percent[2].

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

- A first class education system to meet the requirements of a changing economy and one that encourages life-long learning.
- Top 10 in the world in living standards as defined by the Nations Human Development (UNHD) Index.
- A dynamic andsustainable 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 2007 was 2.03 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, 3396 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 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 otherhand policies pertaining to the use of renewable energy are still being studied. The

[2] UN population Data 2009.

[3] Department of Economic Planning and Development. Development Board, http://www.depd.gov.bn/productservice.html

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.

### *1.3.3. 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 1.7 Mtoe in 2009. The projected average annual increase in FEC from 2009 to 2035 is 2.1 percent. The projection is linked to GDP growth. The GDP is expected to grow at annual average rate of 4.3 percent over the period 2009-2035.

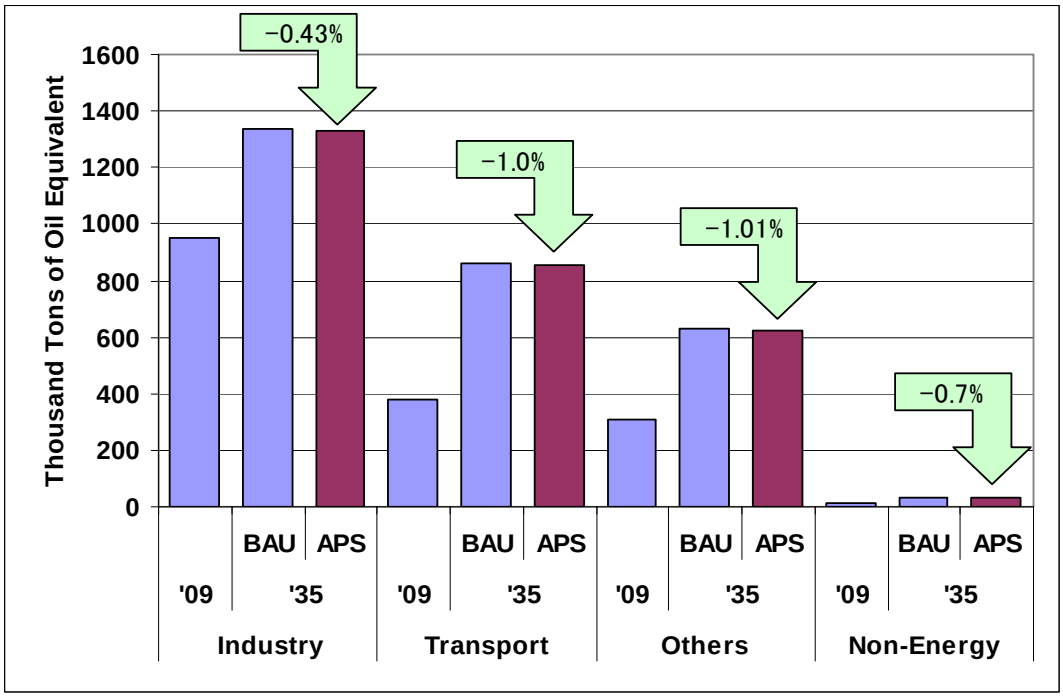
The transportation sector is expected to grow at an average annual growth of 3.2 percent. The FEC in the residential and commercial sectors[4] will also see a steady increase at 2.8 percent per year. This is in-line with the population increase of 2.2 percent per year and the increase in economic activities in the commercial sector.

For 2009, natural gas FEC reached 0.8 Mtoe corresponding to around 47.9 percent of the total energy consumed due to the increasing demand in domestic industries. The FEC for oil is 0.6 Mtoe in 2009 corresponding to around 35.2 percent of the total fuel consumed. By 2035, 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.

For this study, the model assumed that 1.0 percent electricity production is based on oil. The demand for electricity is expected to increase on average of 3.6 percent per year which also translates to an increase of 3.6 percent in oil consumption for the period 2020-2035.

[4] Residential and commercial consumption are grouped as “Others”

**Figure 3-1. 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 0.7 percent decrease is observed between the total FEC in 2035. 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 improvements in the transport sector. This correlates to improvement in the efficiency of internal combustion engines.

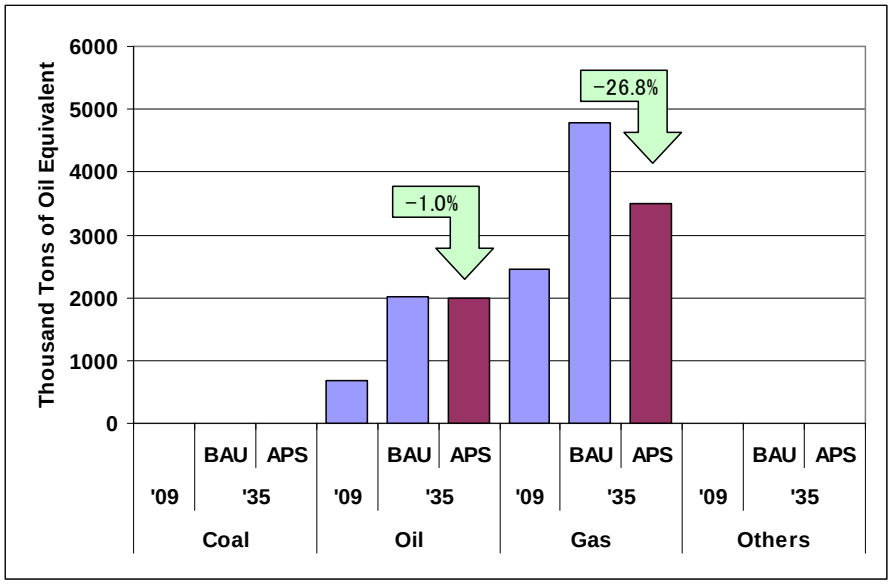
The shift in the energy mix may be changed if alternative energy sources are considered in the APS. It is appropriate to assume at this juncture that oil and gas remain as the main sources of energy as there was no strong indication of alternative energy policies to be implemented in the near future. 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) for 2009 is primarily sourced from natural gas at 78.3 percent. PES is expected to increase at an annual average rate of 3.0 percent per year for the period of 2009 to 2035, and in absolute values; from 3.1 Mtoe to 6.8 Mtoe. For this study, solar source is being included which is at 1.0 ktoe.

**Figure 3-2. Primary Energy Demand, BAU and APS**




PES for oil and natural gas is expected to increase at a rate of 4.3 percent and 2.6 percent, respectively. Brunei Darussalam will continue to be a net exporter of energy.

***Alternative Policy Scenario***

A significant decrease in PES is observed between the BAU and the APS in year 2035. The difference between the two scenarios is 1.3 Mtoe which corresponds to 19.1 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 11.8 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 2009, a total of 3575 GWh of electricity was generated and by 2035 8717.9 GWh of electricity will be needed. This corresponds to an average annual increase of 3.5 percent for the period 2009-2035. On the otherhand, an increase of 3.6 percent is expected for diesel generation for the period 2020-2035.

The model assumes low efficiency electricity generation. The efficiency is set only at 24.0 percent which implies that for 0.7 Mtoe or 8.7 GWh of electricity generated, approximately 3.1 Mtoe of natural gas is needed.

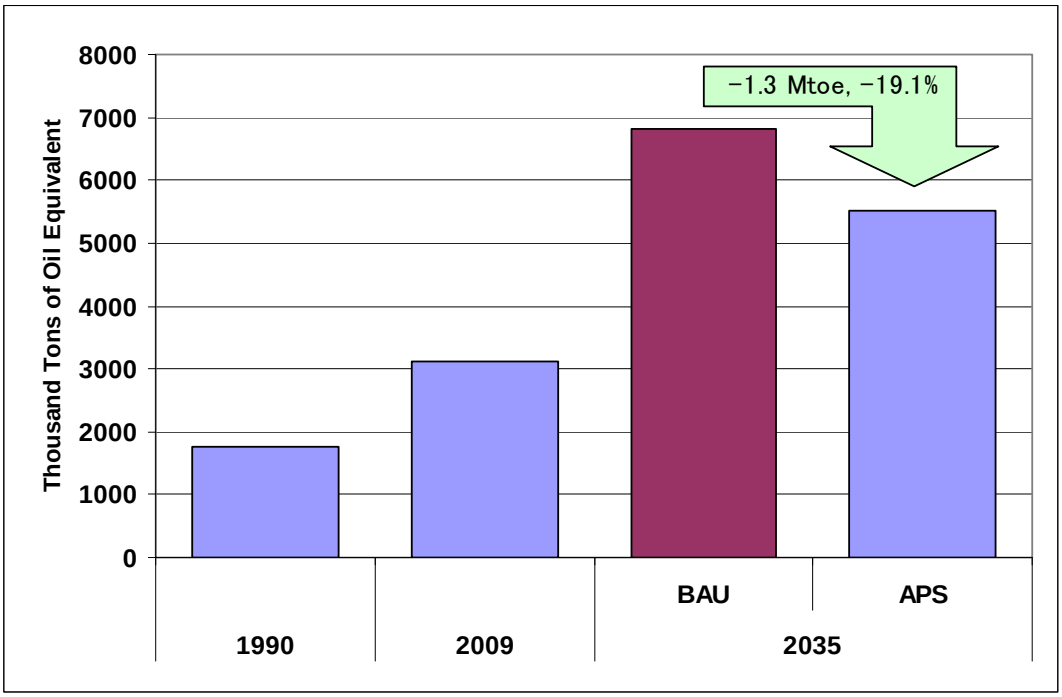
***Alternative Policy Scenario***

In the APS, efficiencies of natural gas power generation plants were improved to 40.0 percent while no improvement where assumed for diesel generators. Improvement of efficiencies for natural gas power plant produced a significant drop in natural gas consumption. Based on the results of the model, particularly in 2035, 8.6 GWh of electricity will only require 1.9 Mtoe of natural gas.

## 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 1.3 Mtoe, equivalent to 19.1 percent reduction from the BAU in the year 2035 (Figure 3-3).

**Figure 3-3. Evolution of Primary Energy Demand, BAU and APS**




## 2.5. Carbon Dioxide Emission

***Business-as-Usual Scenario***

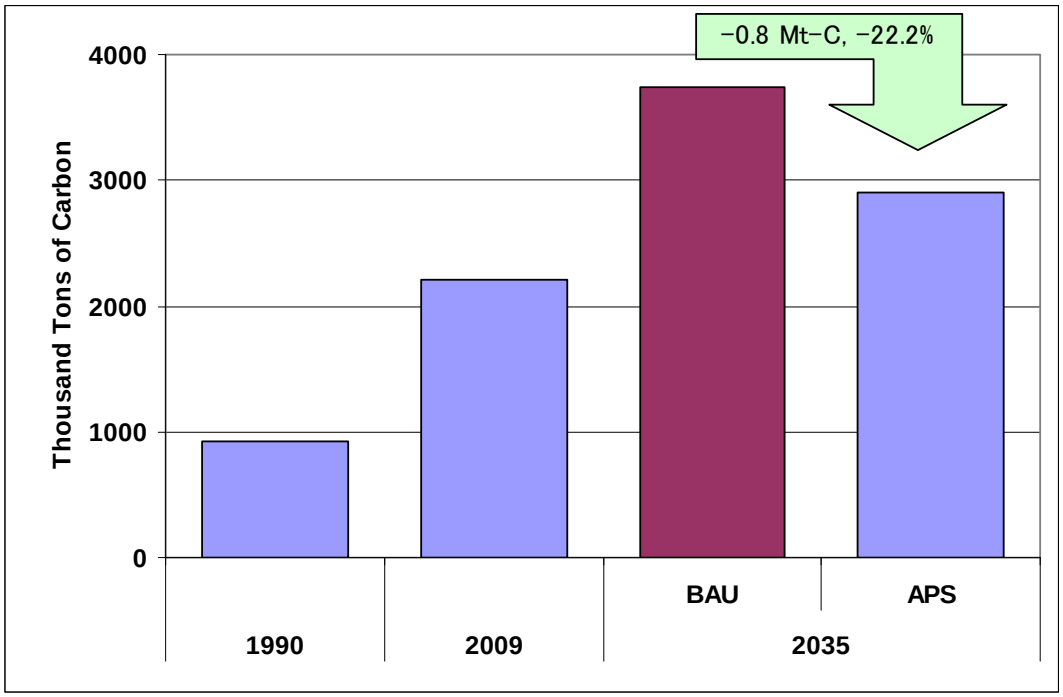
The percentage increase in carbon dioxide emission correlates strongly to the increase in total primary energy supply (TPES). This is expected because the energy mix for Brunei Darussalam is 99.0 percent dependent on fossil fuel. In 2009, the energy balance table shows 2.2 Mt-C, this increased at a steady rate of 2.0 percent per year to a value of 3.7 Mt C in year 2035.

***Alternative Policy Scenario***

In the APS, carbon dioxide emission decreased by 22.2 percent in 2035 as compared to BAU (Figure 3-4). Results of the study showed that a total of 2.9 Mt C will be emitted in 2035. 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 0.5 t-

C/toe. This is because no significant amount of non-fossil fuel was introduced in the APS.

**Figure 3-4. $CO_2$ Emission from 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 336.8 toe/Million 2000 US$ in BAU to 272.4 toe/Million 2000 US$ in the APS for the year 2035.

The BAU and the APS only placed emphasis on EEC. The result is significant showing significant reduction in carbon dioxide emission (22.2 percent) and TPES (19.1 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 placed in motion such as adopting energy efficiency and conservation (EEC) techniques and technologies within the nation. Having only oil and natural gas for its main sources for energy, it is also imperative for Brunei Darussalam to intensify the EEC initiatives to further strengthen its energy efficiency guidelines and regulations as well as accelerating the adoption of the EEC best practices and advanced technologies.

# Chapter 4

# Cambodia Country Report

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# CHAPTER 4

# Cambodia Country Report

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## 1. Background

The Kingdom of Cambodia is located in the Lower Mekong region of Southeast Asia. It has an 800 km border with Thailand in the west, with Lao PDR in the north, and Viet Nam in the east. The physical landscape is dominated by lowland plains around the Mekong River and the Tonle Sap Lake. Of the country's area of 181,035 $km^2$, approximately 49 percent remains covered by forest. There are about 2.5 million hectares of arable land and over 0.5 million hectares of pasture land. The country's gross domestic product (GDP) in 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 1303 ktoe while its final energy consumption stood at 1007 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 65 MW had been installed to date. Commercial quantities of coal have also been discovered in Cambodia but no official figures on recoverable reserves are available currently.

# 2. Modelling Assumptions

## 2.1. GDP and Population

In forecasting energy demand to 2035, it is assumed that the GDP of Cambodia will grow at an annual rate of 7.5 percent. Its population on the other hand is projected to grow at 1.7 percent per year resulting to a growth rate of GDP per capita of 5.1 percent per year up to 2035.

## 2.2. Electricity Generation

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

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

## 2.3. Energy Efficiency and Conservation Policies

Cambodia's energy efficiency and conservation programs aims to achieve an integrated and sustainable program that will facilitate energy efficiency improvements in the major energy consuming sectors and help prevent increased and wasteful fuel 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.
- Improving energy efficiency in industries in cooperation with UNIDO and MIME to be implemented in the 4 sectors namely, rice mill, brick kiln, rubber refinery, and garment.

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

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Cambodia's final energy consumption (not including biomass) grew at an average annual rate of 9.0 percent from 1995 to 2009. This growth was driven by the industrial sector which grew at a rapid rate of 33.0 percent during the ten-year period. The other sector which comprises the residential and commercial sectors grew at an average rate of 15.7 percent annually while the transportation sector had a more modest annual growth rate of 2.2 percent. In terms of energy, petroleum products comprise more than

95.0 percent of total final energy consumption with electricity supplying the rest.

***Business-as-Usual (BAU) Scenario***

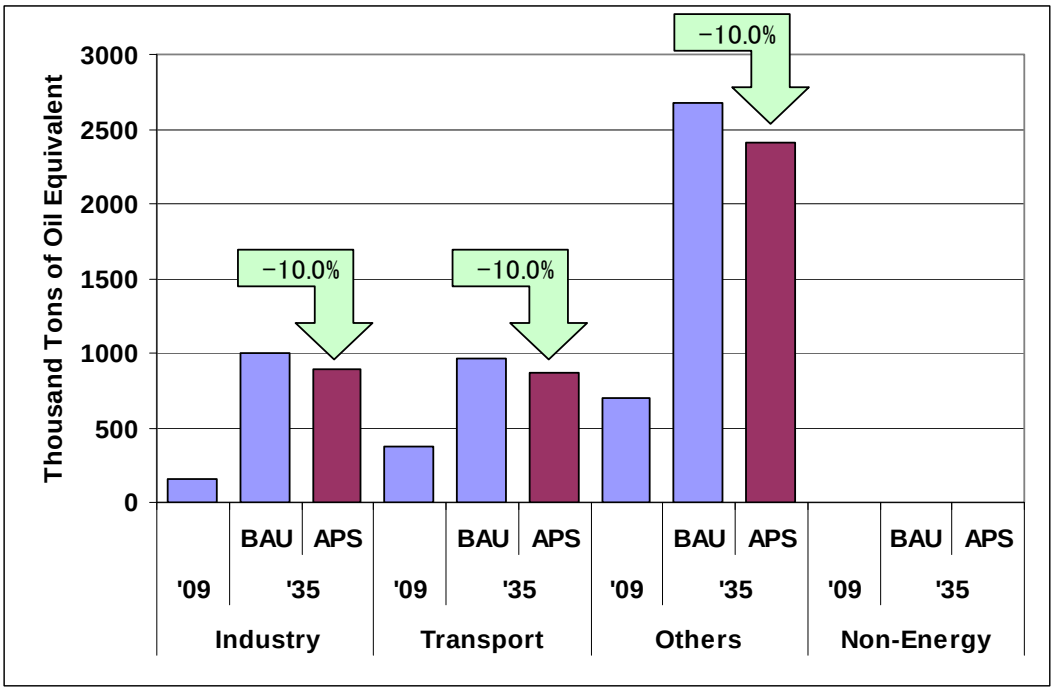
Cambodia's final energy consumption is projected to grow at an average annual rate of 5.2 percent for the period 2009 to 2035. The industrial sector is expected to have the highest growth rate of 7.2 percent per year followed by the residential/commercial sector at 5.3 percent. Meanwhile, the transportation sector is expected to grow by 3.8 percent over the same period. 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 7.6 percent per year while the demand for petroleum products will grow by 4.5 percent yearly up to 2035. Coal consumption started in 2008 and is projected to more than double by 2035.

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to grow at a slower rate of 4.8 percent per year over the 2009-2035. 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 6.8 percent, 3.3 percent and 4.9 percent, respectively. The growth in electricity consumption will also be slower at 7.2 percent per year while that of oil will be 3.9 percent per year. The difference in the demand in the BAU and APS are shown in Figure 4-1.

**Figure 4-1. Final Energy Demand by Sector, BAU and APS**



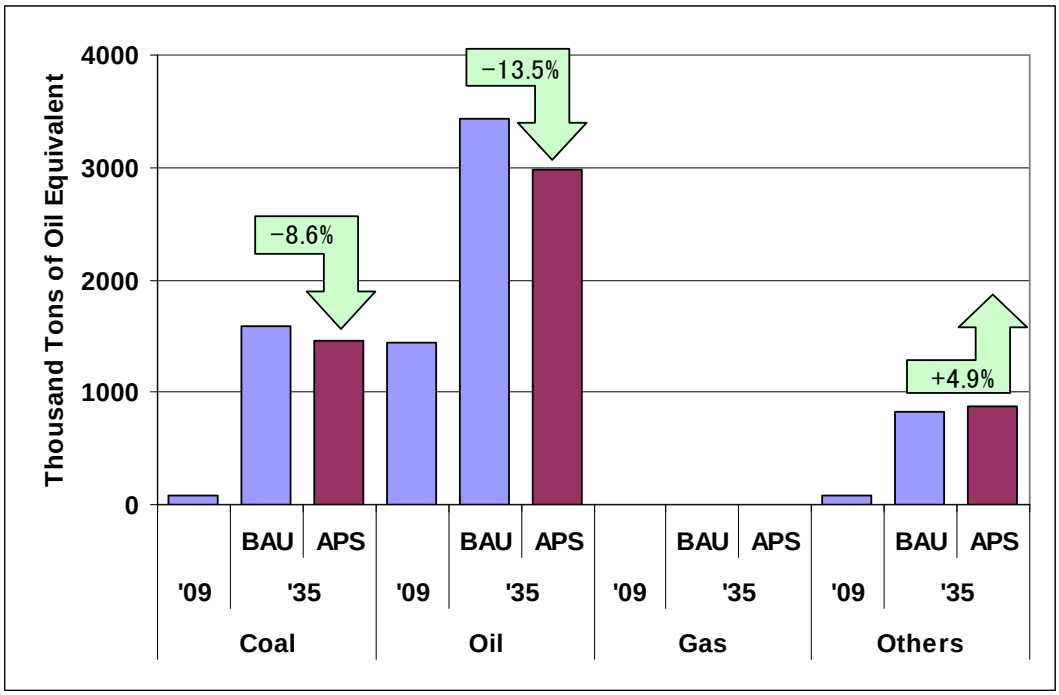

### 3.2 Primary Energy Demand

Cambodia's primary energy demand grew at an average annual rate of 8.9 percent from 1995 to 2009. 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 2009 to 2035, the country's primary energy demand is projected to grow at an average annual rate of 5.1 percent in the BAU scenario. Given the rapid growth in electricity demand of 7.6 percent annually, hydro electricity production will increase on average by 24.0 percent per year to 2035. This high growth in hydro electricity is projected although coal and natural gas are also being considered as future sources 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 3.4 percent.

**Figure 4-2. Primary Energy Demand by Source, BAU and APS**




***Alternative Policy Scenario***

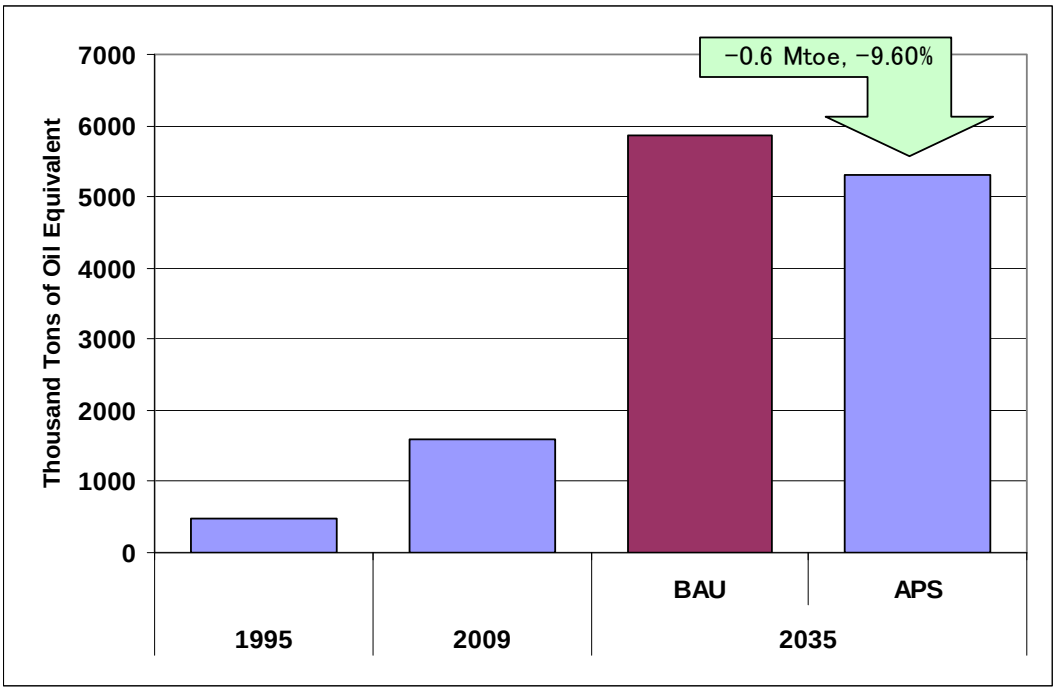
In the APS, primary energy demand will increase at a slower rate of 1.7 percent per year. Hydroelectricity generation will also be at a slower rate of 23.6 percent per year. The differences in the primary energy demand by source in the BAU and APS are shown in Figure 4-2.

### 3.3 Projected Energy Savings

The initial estimates of the impacts of sectoral energy efficiency actions plan will result to a reduction in primary energy demand of 560.9 ktoe from BAU to APS. This is equivalent to a 9.6 percent primary energy savings by 2035. Figure 4-3 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 99.7 ktoe in the industrial sector, 96.4 ktoe in the transport sector and 267.4 ktoe in the others sector

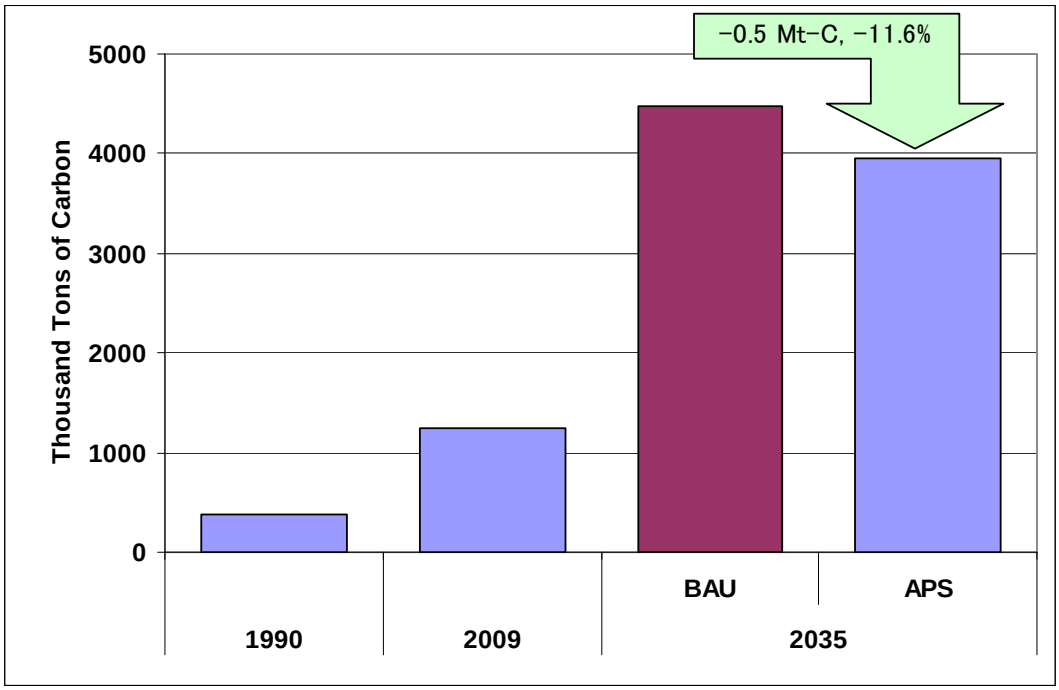
**Figure 4-3. Total Primary Energy Demand, BAU and APS**




### 3.4 $CO_2$ Emissions from Energy Consumption

Based on the above projections, $CO_2$ emissions in Cambodia in the BAU will increase from 1.3 million tonnes of carbon (Mt C) in 2009 to 4.5 Mt C in 2035 at an average annual rate of 5.0 percent, slightly lower than the growth rate of primary energy demand. In the APS, the growth rate will be lower at 4.5 percent (Figure 4-4).

**Figure 4-4. $CO_2$ Emission from Energy Consumption, BAU and APS**




## 4. Implications and Policy Recommendations

In 2009, Cambodia's per capita consumption of commercial energy of 0.1 toe/person are among the lowest in EAS at only 10 percent 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. One of the pressing needs in Cambodia is the improvement of the reliability of electricity supply. When this is attained, energy consumption per capita is expected to further increase.

However, there are proven ways to minimise the growth of energy consumption without affecting economic growth. One of these proven ways is energy efficiency and conservation. In this regard, the Government needs to craft an energy efficiency plan and encourage the efficient use of energy with appropriate support on energy efficient technologies and renewable energy technologies. International support should be considered if necessary. This is a very important activity that will certainly need the strong support and commitment of the Cambodian government.

# Chapter 5

# China Country Report

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# CHAPTER 5

# China Country Report

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## 1. Background

### 1.1 Natural Condition and History

The People's Republic of China has an area of 9.6 million square kilometres and is situated in eastern Asia on the western shore of the Pacific Ocean. China's continental coastline extends for about 18,000 kilometres, and its vast sea surface is studded with more than 5000 islands. Due to its size, China's climate is 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 has more than 5000 years of history and is one of five countries with a great ancient civilization. The People's Republic of China was founded on 1 October 1949. Today, China is implementing reforms and opening up its economy, and has established a socialist market economy, thereby charting the course for socialist modernization with Chinese characteristics.

### 1.2 Economy and Population

China's GDP in 2009 was around US$2762 billion (in 2000 US$ terms), which translates into a per capita income of around US$2100. China is the world's most populous country. It had a population of about 1332 billion in 2009. To mitigate population growth, China has implemented a family planning policy since the 1970s. China is experiencing a fast urbanization process, with around 51.2 percent of people

living in urban areas at the end of 2011.

### 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 largest coal producer and has the third largest coal reserves, with recoverable reserves of 114.5 billion tonnes. In 2011, China produced 3.52 billion tonnes of raw coal. China is still a major crude oil producer, with output of 204 million tonnes of crude oil in 2011. However, driven by very fast increases in China's oil demand, China became an oil importer in the 1990s. Approximately 60 percent of China's oil consumption is met by imported oil. China is also a large producer and exporter of energy intensive items. In 2011, it produced 826 million tonnes of finished steel and 2.09 billion tonnes of cement, and exported 49 million tonnes of finished steel.

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

In 1990, coal accounted for 79.8 percent of primary energy consumption while oil was 16.6 percent, natural gas almost 2 percent and hydro 1.6 percent. In 2009, coal was still a major fuel, but with a lower share of about 74 percent. The share of other energy sources increased from 1990 levels to 19 percent for oil, 4 percent for gas and 3 percent for hydro. Primary energy consumption in China increased at an average annual rate of around 6 percent from 663 Mtoe in 1990 to 2056 Mtoe in 2009. Energy intensity (primary energy demand per unit of GDP) declined from 1490 tonnes of oil equivalent per million US$ in 1990 to 744 tonnes of oil equivalent per million US$ in 2009.

Final energy consumption in China increased at a lower annual average rate of 5.3 percent from 463 Mtoe in 1990 to 1232 Mtoe in 2009. Coal accounted for 68.2 percent of final energy consumption in 1990 and 42 percent in 2009. In 1990, oil accounted for 18 percent of total final energy consumption. Oil consumption has increased rapidly at 8.0 percent per year between 1990 and 2009 leading to a significant increase in its share

to 27 percent in 2009. Electricity is also increasing in importance, with growth of 10.2 percent between 1990 and 209, which was higher than any of the other final energy sources. The share of electricity in final energy consumption has increased from 9.0 percent in 1990 to 21.4 percent in 2009.

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 55 percent in 2009. Conversely, the share of energy consumption in the residential sector declined from 31 percent in 1990 to 22 percent in 2009 because of relatively faster growth in the industry and transport sectors.

In China, coal-fired power generation accounted for around 71.3 percent of total electricity generation in 1990. By 2009, this share increased to 78.8 percent. The share of hydro was around 20 percent in 1990, but has since declined to 17 percent in 2009. Gas and oil, collectively, accounted for about 1.8 per cent of total generation in 2009. The share of nuclear power increased to about 1.9 percent in 2009.

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

## 2. Modelling Assumptions

### 2.1. Population and Gross Domestic Product

The model results for China have been developed by the Institute of Energy Economics, Japan. China's population increased from 1.14 billion in 1990 to 1.332 billion in 2009. Over the projection period, China's population growth is assumed to slow as a result of the one child policy. China's population is assumed to increase at average rate of 0.1 percent per year and reach 1.382 billion people by 2035.

China's economy grew at an average annual rate of 10.1 percent from US$ 445 billion in 1990 to about US$ 2762 billion in 2009. In this study, GDP is assumed to

grow at a slower rate of 6.3 percent per year to reach US$ 13,663 billion by 2035. Given the GDP and population assumptions, GDP per capita in China is assumed to increase from around US$ 2,100 per person in 2009 to US$ 9,900 per person in 2035.

## 2.2. Energy and Climate Change Policies

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

In last five years, China has achieved significant energy conservation, with energy intensity declining by over 19 percent. Many polluting and inefficient factories and equipment have been closed. Between 2006 and 2010, a number of small thermal power units with low energy efficiency with a total capacity of 72.1GW were shut down, and backward production capacities of over 330 million tonnes of cement per year, 68 million tonnes of steel were phased out. In 2010, hydropower generation was 72.1TWh, accounting for 17 percent of total 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 the end of 2010, the total installed capacity of hydropower was more than 213GW and the total installed capacity of wind power reached 41.83GW, ranking the first in the world.

In addition, have a number of other measures to encourage energy conservation including a campaign to get 10,000 enterprises to save energy and the introduction of vehicle fuel standards. New buildings are required to meet 50 percent energy saving standards so as to improve building energy efficiency; efficient fluorescent lamps have been widely promoted to enterprises and people; energy audits for factories are subsidized and 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 set a challenging goal for reducing 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 measures, market based measures and legal measures to promote energy

conservation, and it will continue to implement new policies. Energy intensity reduction goals will be assigned to provincial governments and progress will be announced publicly every year. In additional to conventional intensity targets, controlling total energy consumption is proposed.

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

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

# 3. Outlook Results

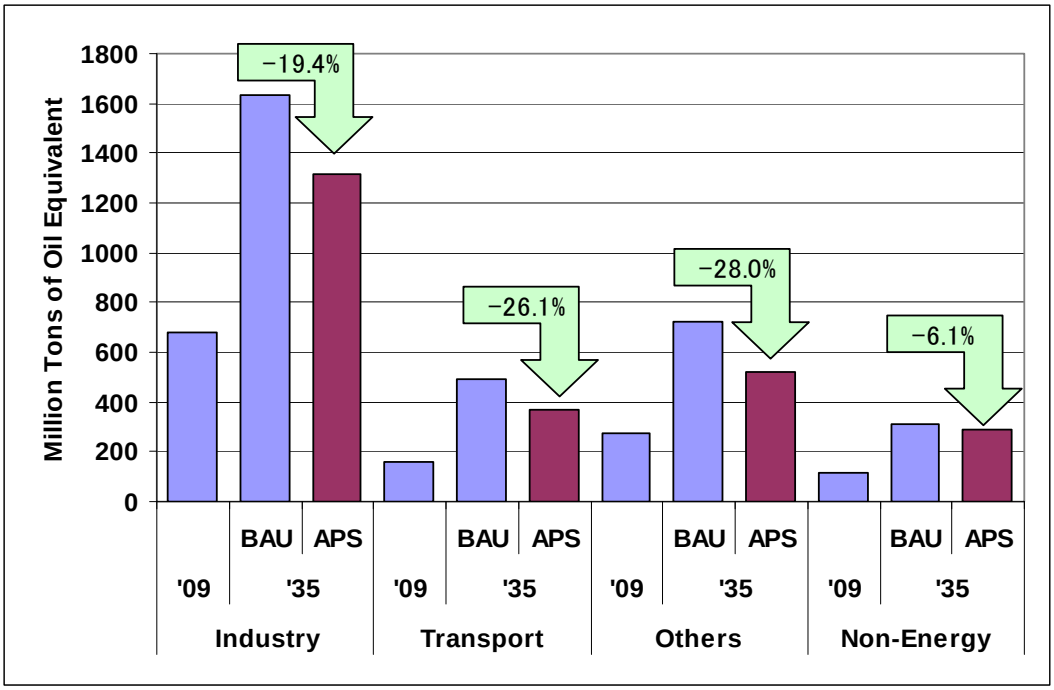
## 3.1. Total Final Energy Consumption

Between 2009 and 2035, growth in China's final energy consumption is projected slow reflecting lower assumed economic and population growth.

### *Business-as-Usual (BAU) Scenario*

Final energy consumption is projected to increase at an average rate of 3.7 percent per year between 2009 and 2035. The transportation sector consumption is projected to grow the fastest, increasing by 4.4 percent a year, followed by the commercial and residential (others) sectors at 3.8 percent. Energy consumption in the industry sector is projected to grow at an average annual rate of 3.4 percent.

**Figure 5-1. Final Energy Consumption, BAU and APS**




Natural gas is projected to exhibit the fastest growth, increasing by 8.0 percent per year between 2009 and 2035. Consumption of electricity and heat are projected to increase at an average annual rate of 4.3 percent and 4.8 percent, respectively over the same period. Oil is projected to grow by 3.6 percent per year to 2035.

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to increase by 2.7 percent per year, from 1232 Mtoe in 2009 to 2494 Mtoe in 2035, as a result of energy efficiency and conservation programs. An improvement in end-use technologies and the introduction of energy management systems is expected to contribute to slower energy growth in all sectors, particularly in the commercial, residential and transportation sectors. Figure 5-1 shows the final energy consumption in China in 2009 and 2035 in both BAU and APS.

### 3.2. Primary Energy Demand

Primary energy consumption in China is projected to grow at a slower pace than in the past. It is also expected that growth in primary energy demand will be slightly slower than final energy consumption because of improved efficiency in the energy transformation sector.

***Business-as-Usual Scenario***

In the BAU scenario, China's primary energy consumption is projected to increase at an annual average rate of 3.6 percent per year to 5198 Mtoe in 2035. Coal will still constitute the largest share in total primary energy, but its growth is expected to be slower, increasing by 3 percent a year. Consequently, the share of coal in total primary energy is projected to decline from 73.8 percent in 2009 to 62.9 percent in 2035.

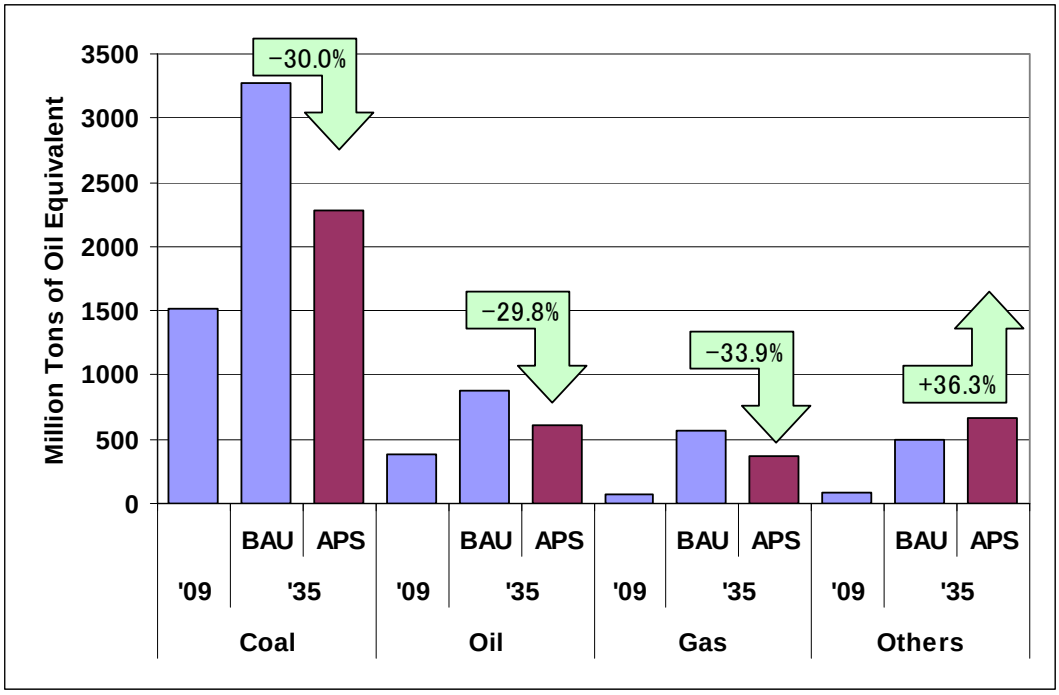
Nuclear energy is projected to exhibit the fastest growth between 2009 and 2035, increasing at an annual average rate of 9.0 percent, followed by natural gas at 8.1 percent. Oil and hydro are projected to grow at lower rates of 3.3 and 1.8 percent per year, respectively. The share of natural gas is projected to increase from 3.7 percent in 2009 to 10.8 percent in 2035 whereas the share of nuclear will increase from 0.9 percent to 3.3 percent. The share of oil is projected to decline from 18.5 percent in 2009 to 16.8 percent in 2035 and hydro is projected to decline from 2.6 percent in 2009 to 1.6 percent in 2035.

***Alternative Policy Scenario***

In the APS, primary energy consumption is projected to increase by 2.5 percent per year between 2009 and 2035. By 2035, primary energy consumption is projected to reach 3944 Mtoe. The rate of growth is projected to be slower under the APS relative to the BAU (Figure 5-2). By energy source, coal is projected to increase by 1.6 percent a year, oil by 1.9 percent a year and natural gas by 6.4 per cent a year. For nuclear, the annual average growth rate will be higher than the BAU, increasing by 10.6 percent a year between 2009 and 2035. The growth rate of hydro in the APS is expected to be

almost the same as the BAU at 1.9 percent per year. The consumption mitigated in the APS is achieved through energy efficiency and conservation measures on the demand side.

**Figure 5-2. Primary Energy Demand by Source, BAU and APS**




### 3.3. Projected Energy Savings

It is estimated that the implementation of energy efficiency and conservation goals and action plans in China could reduce primary energy demand in 2035 by about 1254 Mtoe under the APS, relative to the BAU scenario. In the APS, China's primary energy demand is about 24 percent lower than the BAU (Figure 5-3).

In terms final energy consumption, there is an estimated saving of 317 Mtoe in the industry sector, 129 Mtoe in the transportation sector and 203 Mtoe in the others sector in 2035 under the APS, relative to the BAU scenario.

**Figure 5-3. Total Primary Energy Demand, BAU and APS**

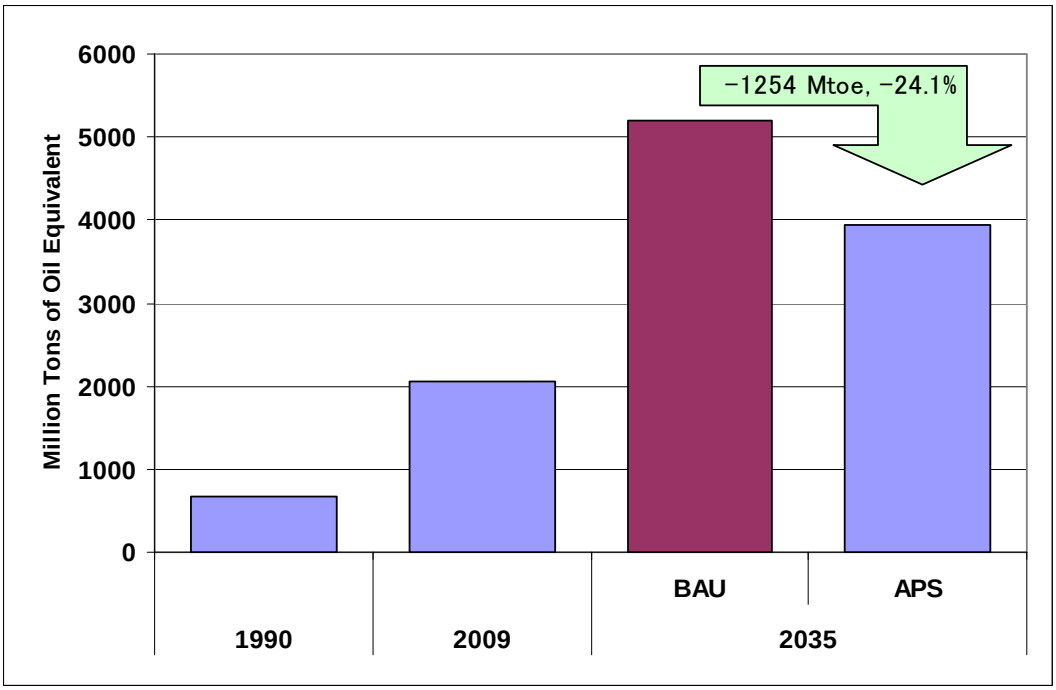
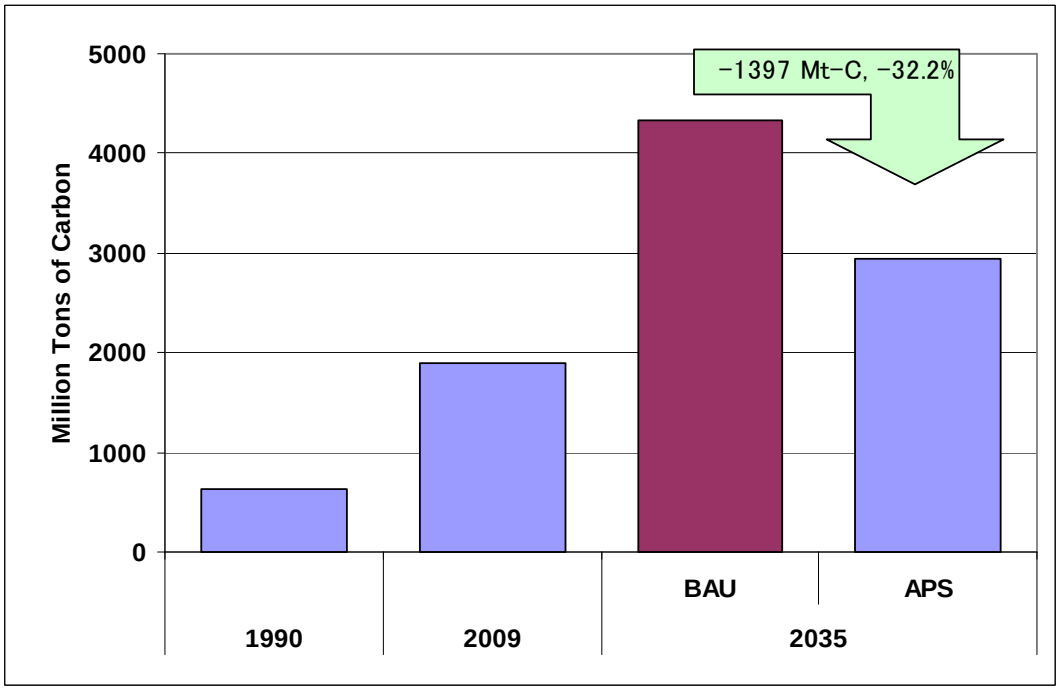



**Figure 5-4. $CO_2$ Emission from Energy Consumption, BAU and APS**




## 3.4. $CO_2$ Emissions from Energy Consumption

$CO_2$ emissions from energy consumption are projected to increase by 3.2 percent per year from 1901 Mt-C in 2009 to 4340 Mt-C in 2035 under the BAU scenario. This percentage increase is lower than that in primary energy demand (3.6 percent) over the same period, indicating an improvement in the emissions intensity of the Chinese economy.

In the APS, the annual increase in $CO_2$ emissions between 2009 and 2035 is projected to be 1.7 percent. This rate is also lower than the average annual growth rate in primary energy demand over the same period. The difference between the APS and the BAU $CO_2$ emissions growth rates indicates that the energy saving goals and action plans of China are effective in reducing $CO_2$ emissions (Figure 5-4).

## 4. Implications and Policy Recommendations

In the past three decades, China has made great efforts on energy conservation and achieved great success. As the world's largest developing country, it is paramount for China to remove poverty and improve life quality. China is in a fast growth phase and its urbanization rate is low, at less than 50 percent. If China maintains fast GDP growth, its energy demand and $CO_2$ emissions will increase in the long run.

While China's energy demand and $CO_2$ emissions will increase, the energy intensity (energy demand per GDP) and emission intensity ($CO_2$ emission per GDP) will decrease because of the high GDP growth rate. If sound energy efficiency and conservation policies are implemented, China could reduce its total primary energy consumption by more than one-sixth and $CO_2$ emissions by about one-fourth by 2035. There is great potential for energy saving in China, with around 50 percent of this achievable through structural change of the economy. The development of tertiary industry may also reduce China's energy demand.

Energy saving and energy efficiency improvement in industry will be important over the next 10 years. The closure of small inefficient power plants, coal mines and small energy intensive industries like cement and steel plants was essential in improving China's industry structure. However, in the long run, energy efficiency in the residential, commercial and transportation sectors is more important in addressing energy saving

given China’s booming real estate market and automobile industry in recent years.

The Government may implement more market-based measures to motivate enterprises taking actions. Accordingly, energy pricing mechanism reforms, energy taxes and carbon taxes should be studied, and put in place as soon as possible. China should also develop more energy efficiency standards and labelling to facilitate development of energy efficient electric appliance market.

# Chapter 6

# India Country Report

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June 2012

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# CHAPTER 6

# India Country Report

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## 1. Background

India is located in South Asia and has a land area of 2973 thousand square kilometres. It had a population of around 850 million in 1990 which grew at an annual average rate of 1.6 percent per year to reach 1155 million in 2009. India's GDP increased at an average annual rate of 6.3 percent from US$271 billion in 1990 to US$867 billion in 2009. The services and industrial sectors are the largest contributors to India's GDP.

India's total primary energy consumption was 512 Mtoe in 2009. In 2009, coal represented the largest share of primary energy at 55.8 percent, followed by oil at 31.2 percent. Coal is mainly consumed for power generation and by industry. The remaining shares were: natural gas (9.6 percent), hydro (1.8 percent), nuclear (0.9 percent) and others (0.8 percent). Compared with 1990, the share of coal and oil decreased marginally. Conversely, the share of natural gas increased.

India generated almost 900TWh of electricity in 2009. The annual average growth in electricity generation between 1990 and 2009 was almost as high as growth in GDP. The share of generation from coal in 2009 amounted to 68.5 percent, natural gas (12.4 percent), hydro (11.9 percent), oil (2.9 percent), nuclear (2.1 percent) and others (2.2 percent).

## 2. Modelling Assumptions

India's GDP is assumed to grow at an average annual rate of 8.3 percent from 2009 to 2035 while population is assumed to increase by 1 percent a year.

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

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

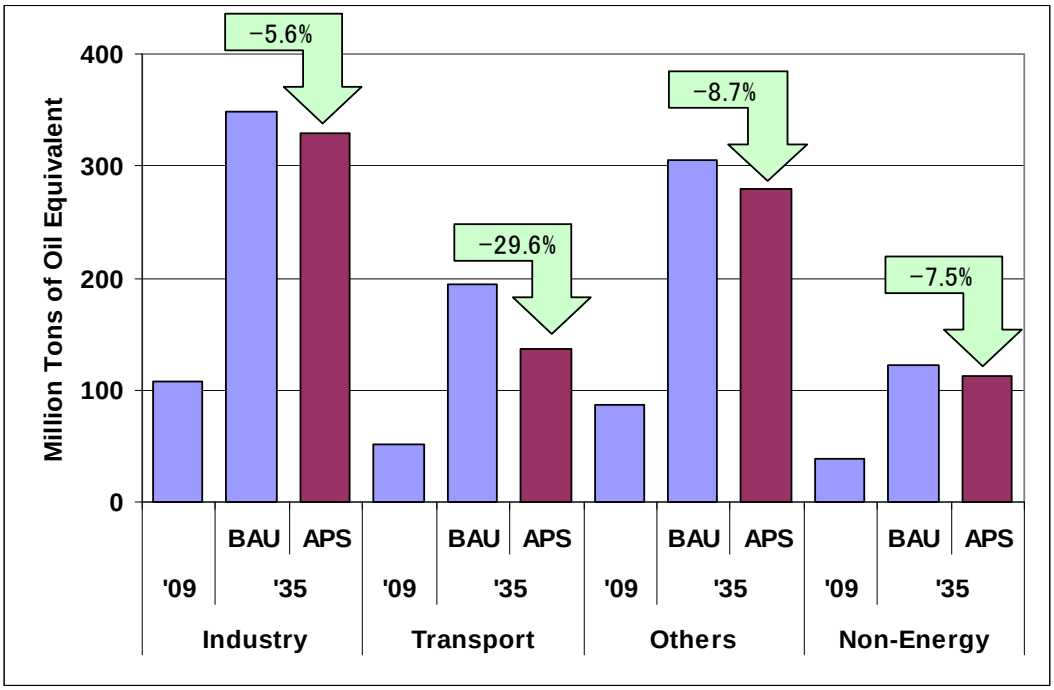
## 3. Outlook Results

### 3.1. Total Final Energy Consumption

India's final energy consumption grew by 4.7 percent per year from 118.2 Mtoe in 1990 to 285.2 Mtoe in 2009. Between 2009 and 2035, the residential and commercial (others) sectors grew by 5.5 percent per year, the industry sector by 4.4 percent a year and the transport sector by 3.4 percent per year. The non-energy sector had the fastest growth, increasing by 6.5 percent a year.

Oil was the most consumed product with a share of 44.5 percent of total final energy consumption in 1990, which increased to 45.2 percent in 2009. The share of electricity was 15.4 percent in 1990 and increased to 21.2 percent in 2009. The share of coal declined from 35.4 percent in 1990 to 26.0 percent in 2009. Similarly, the share of natural gas increased from 4.8 percent in 1990 to 7.4 percent in 2009.

**Figure 6-1. Final Energy Consumption by Sector, BAU and APS**




***Business-as-Usual (BAU) Scenario***

With assumed strong economic growth and a rising population, final energy consumption is projected to increase at an average rate of 4.8 percent per year from 285 Mtoe in 2009 to 970 Mtoe in 2035. The strongest growth is projected to occur in the transport sector, increasing at 5.2 percent a year between 2009 and 2035. Strong growth is also expected in the other (4.9 percent a year), industry (4.6 percent a year and non-energy (4.5 percent a year) sectors.

Electricity is projected to have the fastest growth, increasing by 7.1 percent per year over the period 2009-2035. Oil is projected to increase at the second highest rate of 4.7 percent per year, followed by natural gas (3.8 percent a year).

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to increase at a slower rate of 4.3 percent per year from 285 Mtoe in 2005 to 857 Mtoe in 2035 because of energy efficiency and conservation programs. The slower growth in consumption is expected

to occur across all sectors, especially in the others and transportation sectors reflecting improvements in end-use technologies and the introduction of energy management systems.

### 3.1. Primary Energy Consumption

Primary energy consumption in India grew at a higher rate than the final energy consumption, increasing by 5.6 percent per year from around 183 Mtoe in 1990 to 512 Mtoe in 2009. Among the major energy sources, the fastest growing were natural gas and nuclear energy. Natural gas consumption grew at an average annual rate of 8.4 percent while nuclear grew by 6.0 percent per year. Coal, oil and hydro consumption increased but at slower annual average rates of 5.5 percent, 5.1 percent and 2.1 percent, respectively. "Others" increased by 19.6 percent a year, but from a very small base - their collective share in total primary energy consumption was 0.8 percent in 2009.

***Business-as-Usual Scenario***

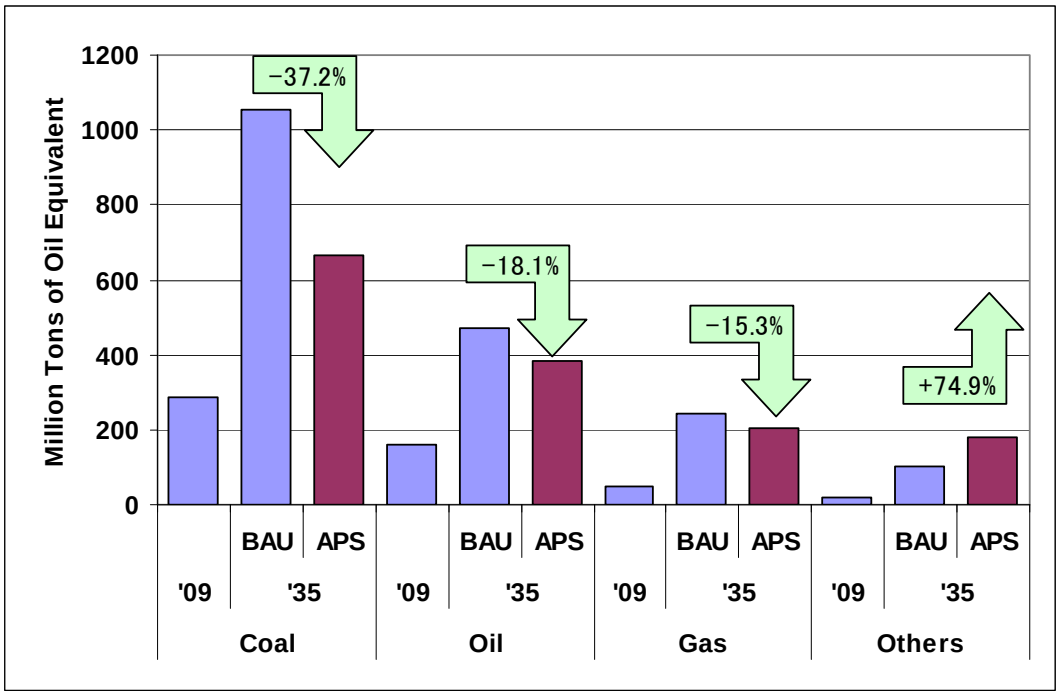
In the BAU scenario, India's primary energy consumption is projected to increase at an annual rate of 5.1 percent per year to 1874 Mtoe in 2035. Nuclear energy is expected to grow the fastest at an annual average rate of 9.8 percent. Others, including solar and wind, is projected to increase by 7.3 percent a year through to 2035, but its share remains small at 1.3 percent. Natural gas consumption is projected to increase by 6.4 percent between 2009 and 2035.

***Alternative Policy Scenario***

In the APS, India's primary energy consumption is projected to increase at a slower rate of 4.1 percent per year from 512 Mtoe in 2009 to 1436 Mtoe in 2035. Nuclear will be the fastest growing energy source, increasing at 13 percent per year, followed by natural gas at 5.7 percent per year. Oil, coal and hydro will grow at slower annual rates of 3.5 percent, 3.3 percent and 3.7 percent, respectively. Other energy will also make its mark in the primary energy mix, increasing by 9.5 percent a year. Consequently, its

share will increase from 0.8 percent in 2009 to 2.9 percent in 2035. Figure 6-2 shows the future primary energy consumption mix in both the BAU scenario and APS in 2009 and 2035.

**Figure 6-2. Primary Energy Consumption by Source, BAU and APS**

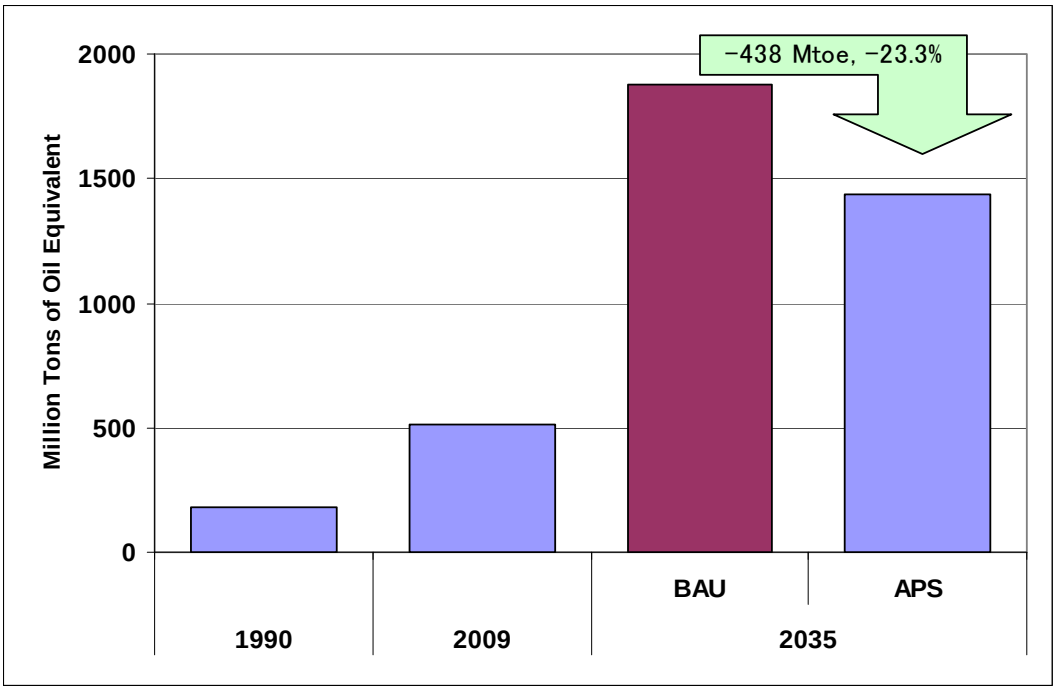



### 3.2. Projected Energy Saving

In 2035, total primary energy savings that could be derived from the energy efficiency and conservation goals and action plans in India amount to 438 Mtoe, the difference between primary energy consumption under the BAU scenario and the APS. This is equivalent to 23.3 percent of India's primary energy consumption in 2035 (Figure 6-3).

In terms final energy consumption, there is an estimated saving of 19.5 Mtoe in the industry sector, 57.4 Mtoe in the transportation sector and 26.6 Mtoe in the others sector in 2035 under the APS, relative to the BAU scenario.

**Figure 6-3. Primary Energy Consumption, BAU and APS**

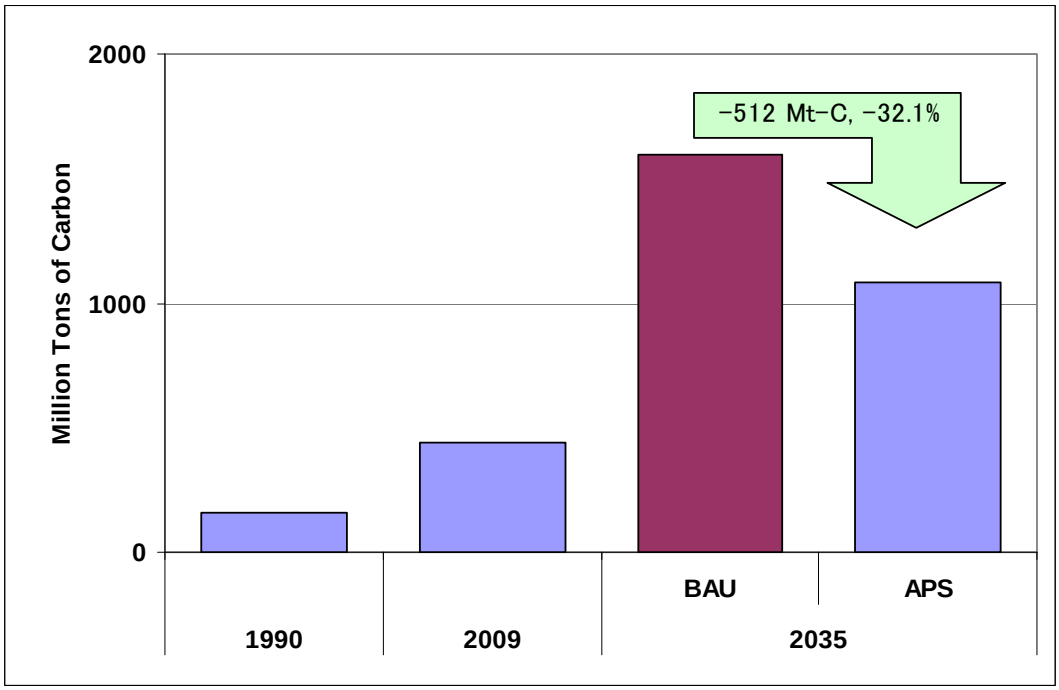



### 3.3. $CO_2$ Emissions from Energy Consumption

In the BAU scenario, $CO_2$ emissions from energy consumption are projected to increase by 5.0 percent per year from 443 Mt-C in 2009 to 1593 Mt-C in 2035. The projected growth in emissions is less than the projected growth in primary energy consumption reflecting the expected increased use of less carbon intensive energy sources in India.

In the APS, the annual increase in $CO_2$ emissions from 2009 to 2035 is projected to be 3.5 percent. The lower growth rate between the APS and the BAU scenario indicates that the energy saving goals and action plans of India are effective in reducing $CO_2$ emissions (Figure 6-4).

**Figure 6-4. $CO_2$ Emission from Energy Combustion, BAU and APS**




## 4. Implications

- Industry will account for 50% of the incremental energy use to 2035, energy efficiency programs should be focused in this sector
- Coal will still be dominant in 2035, use of domestic coal for secure supply as well as more efficient technologies such as IGCC, USC, etc. would be necessary
- There are huge potential savings in the power sector. Advance technologies for power generation should be used
- Decrease distribution losses by using better technologies
- On the demand side of electricity, reform of pricing mechanism would also be needed

# Chapter 7

# Indonesia Country Report

**Cecilya Laksmiwati Malik**
Energy Policy Planning Expert (Former Senior Scientist and Researcher of BPPT), Indonesia.

June 2012

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# CHAPTER 7

# Indonesia Country Report

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## 1. Background

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

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

Economic growth in Indonesia in 2011 was the fastest since before the Asian financial crisis as rising investment and domestic spending countered a slowdown in export demand due to Europe's debt crisis. Real GDP grew at almost 6.5 percent in 2011 after a revised 6.2 percent gain the previous year (2010). In 2011, Indonesia's real GDP was US$ 292 billion (constant 2000 US$) while in 2009 it was just around US$260 billion (constant 2000 US$). From 1990, GDP has grown at an average rate of 4.6 percent per year to 2009. GDP per capita in 2009 was around US$1100 dollars while in 1990 it was only US$600.

Indonesia is richly endowed with natural resources. It was previously an OPEC member, and thus important to the world's energy markets. However, as it became a net importer of oil it had a preference for lower oil prices, putting it at odds with other OPEC members who favour higher prices. As prices continued to increase, Indonesia decided to leave OPEC at the end of 2008. Indonesian crude oil proven reserves were 11.6 billion barrels in 1980, declining to 9 billion barrels by 1988. Since then, Indonesia's oil reserves continued to decline reaching 5.4 billion barrels in 1990 and 4.2 billion barrels in 2009. As of January 2012, proven crude oil reserves are estimated at around 3.7.billion barrels.

Indonesia is the world's largest liquefied natural gas (LNG) exporter. Its natural gas proven reserves were 2.9 trillion cubic metres (TCM) in 1990 and these declined slightly in 2005 to 2.5 TCM. Proven reserves increased to 3.0 TCM in 2009 and 3.2 TCM (around 110 trillion cubic feet) in 2010. Indonesia is also a coal exporter with proven coal reserves of around 5.5 billion tonnes at the end of 2010.

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

Indonesia's total primary energy consumption was 135.1 Mtoe in 2005 and 154 Mtoe in 2009. Oil represented the largest share of primary energy consumption in 2009 at almost 43.9 percent, followed by natural gas at 16.1 percent and coal at 24.0 percent. The remaining share of about 16.0 percent represents hydro, geothermal and others.

Indonesia has 35GW of installed electricity generating capacity and generated 155.5TWh of electricity in 2009. The state electricity company of Indonesia, PT PLN PERSERO, owns and operates generation plants with a combined capacity of about 25.6GW in 2009 composed of: 75.0 percent oil, 6.0 percent coal, 3.7 percent gas, 13.7 percent hydro, and 1.6 percent geothermal. There are also wind and solar power plants but the capacity is still small.

## 2. Modelling Assumptions

Indonesia's GDP growth was only 4.5 percent in 2009, slowing from the previous year's growth of 6.0 percent. By 2010, GDP growth reached 6.14 percent because of high export demand for mining products and non-oil and gas products. In early 2012, the Indonesian Bureau of Statistics (BPS) announced that GDP growth will continue to increase and is expected to reach 6.7 percent in 2012.

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

Population growth is assumed to increase at an average of 0.9 percent per year between 2009 and 2035. This is lower than the assumption used in previous study (1.1 percent per year) which was based on the assumptions of the National Energy Council. The current assumption is in line with the 2008 UN assumption of 0.9 percent growth per year between 2005 and 2030.

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

Supply from gas-fired power plants is also expected to increase. However, improvements to gas supply infrastructure are required. In contrast, generation from oil-fired power plants are assumed to decline significantly. Last year's study assumed that nuclear will become part of the future electricity supply mix in Indonesia from 2018 onwards. This was deferred following the incident at the Fukushima nuclear power station in Japan in March 2011 As a result of this deferral, nuclear power plants are only assumed to be available in the APS after 2020. In this regard, the study will

include nuclear after 2020 with 2 units each with a capacity of 1000MW. The number of nuclear plants to be built by 2035 was limited to a maximum of 3 units with a total combined capacity of 3000MW.

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

**Table 7-1. Energy Conservation Potential to 2020**

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

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

## 3. Outlook Results

### 3.1. Total Final Energy Consumption

Indonesia's final energy consumption increased at an average annual rate of 4.8 percent between 1990 and 2009 period, increasing from 45 Mtoe to 110 Mtoe. The industrial sector had the highest growth rate during this period at 6.2 percent per year. Final energy consumption in the transport and other sectors (mainly consisting of the residential and commercial), grew at slower rates of 5.7 percent and 3.5 percent per year, respectively over the same period. Oil still plays a major role in the country's final energy consumption, but its relative importance has been declining with its share falling from 63 percent in 1990 to 51 percent in 2009. Coal was the second most consumed product in 2009 followed by natural gas and electricity.

***Business-as-Usual (BAU) Scenario***

Given the assumed economic and population growth, final energy consumption is projected to grow at an average rate of 7.1 percent per year between 2009 and 2035 in the BAU scenario. This strong growth stems from the rapid increase in energy consumption in 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 7.0 percent and 6.3 percent, respectively. The use of natural gas as a feedstock is included in industry sector demand.

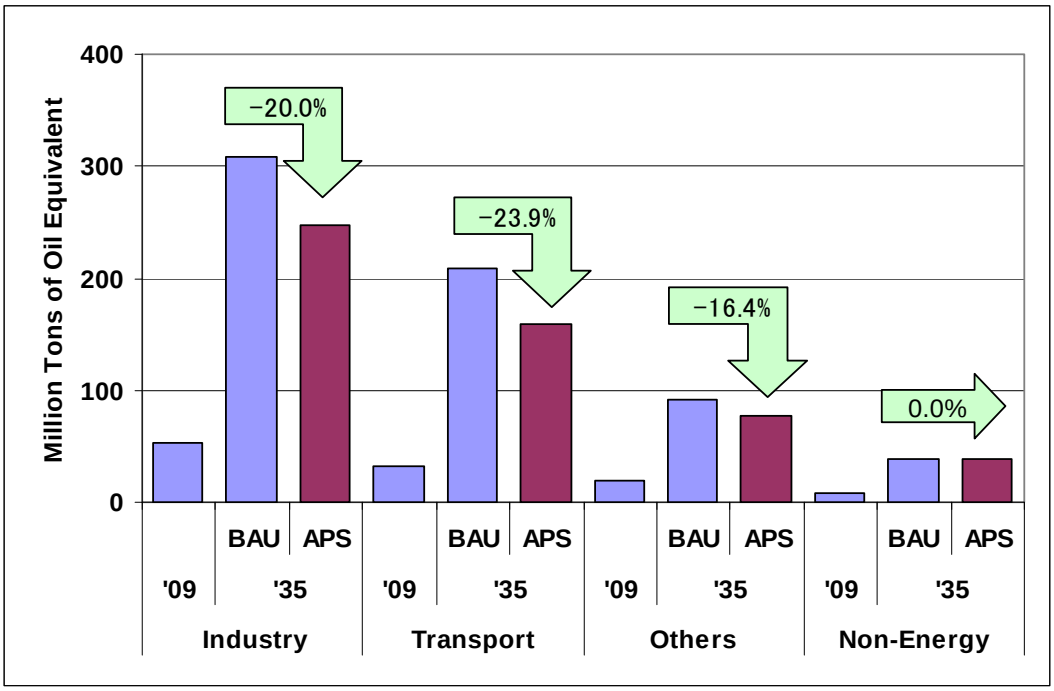
The consumption of coal, oil, natural gas, and electricity is projected to increase over the period 2009-2035. Coal and electricity are assumed to grow faster than natural gas and oil at average annual rates of 8.3 and 7.9 percent, respectively. Consumption of natural gas and oil is projected to increase at an average annual rate of 7.2 and 6.3 percent, respectively between 2009 and 2035. Other final energy is largely consumption of biomass in the industrial sector. In households, biomass is mainly used as a non-commercial fuel.

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to increase at a slower rate than in the BAU scenario, increasing at an average rate of 6.2 percent per year from 110 Mtoe in 2009 to 522 Mtoe in 2035. Slower growth under the APS, relative to the BAU scenario, is projected across all sectors as a result of the government program for energy efficiency and conservation, particularly in the transport sector. The growth rate of energy consumption in the transport sector is projected to increase by 6.4 percent per year compared with 7.6 percent per year in the BAU.

Figure shows the final energy consumption by sector in 2009 and 2035 in both the BAU and APS.

**Figure 7-1. Final energy Consumption by Sector, BAU and APS**




## 3.2. Primary Energy Demand

Primary energy demand in Indonesia grew faster than final energy consumption at about 5.3 percent per year from 58 Mtoe in 1990 to 154 Mtoe in 2009. Among the major energy sources, the fastest growing fuels between 1990 and 2009 were coal and geothermal energy. Geothermal energy consumption grew at an average annual rate of 16.3 percent while coal grew at 12.6 percent a year. Oil consumption increased at a slower rate of 3.7 percent per year while natural gas consumption grew at 1.6 percent per year. Despite the relatively slow growth in natural gas consumption, it still accounts for a relatively large proportion of primary energy consumption.

***Business-as-Usual Scenario***

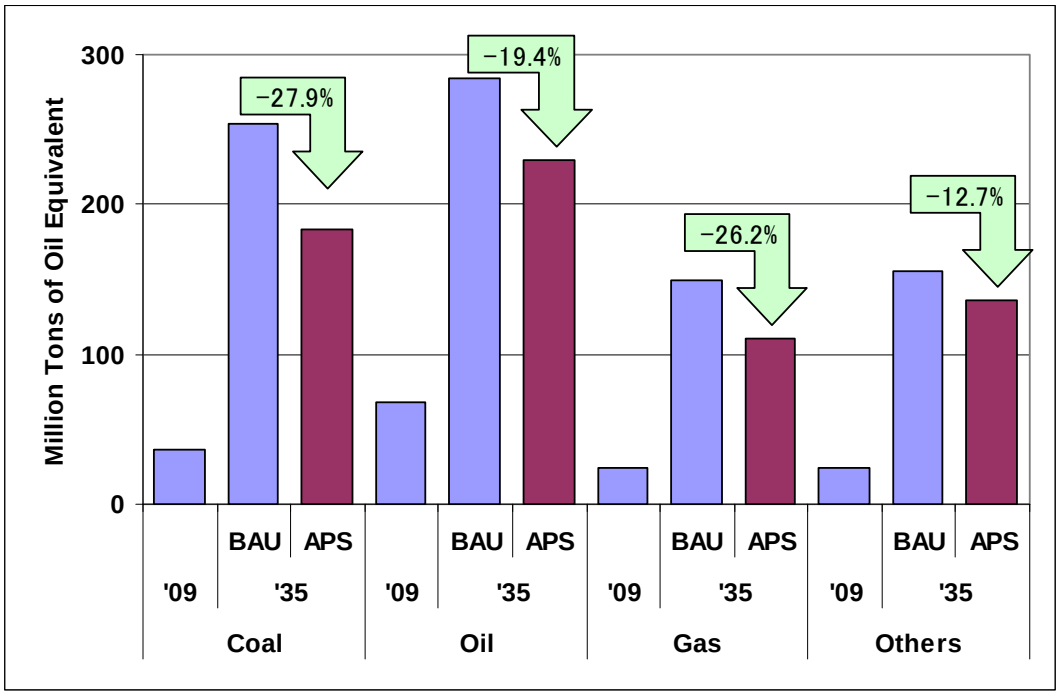
In the BAU scenario, Indonesia's primary energy consumption is projected to increase at an annual average rate of 6.8 percent to 843 Mtoe in 2035. Coal is projected to continue to grow at a fast rate, increasing by 7.7 percent per year over the period 2009-2035. Geothermal energy is also expected to increase strongly over the 2009-2035 period, but will be slower than the growth witnessed over the past 19-years because of difficulties expanding exploration in protected forest areas. In addition, exploration will also become more expensive as the areas to be explored become smaller and are increasingly located in difficult terrains such as those in the eastern part of Indonesia. The growth rate of geothermal energy consumption until 2035 is projected to be 6.7 percent per year.

Hydro, on the other hand, will increase at a faster rate between 2009 and 2035 compared with that over the period 2000-2009. This is because more hydro plants will be built in the future such as in East Kalimantan. Consideration is being given to building more run-of river type hydro rather than reservoir type. The average annual growth rate of hydro will be 10.7 percent per year between 2009 and 2035. Although the growth of hydro will be the fastest, its share in the total primary energy mix will be below 2 percent.

Oil consumption is projected to increase at an average annual rate of 5.7 percent over the period 2009-2035, with its share of total primary energy consumption declining from 44 percent in 2009 to 34 percent in 2035. Natural gas consumption is expected to increase faster than oil at an average rate of 7.2 percent per year. The share of natural gas in the total mix will be around half of that of oil by 2035. By contrast, in 2009, it was slightly less than one-third of oil's share indicating the increasing role of natural gas in the future.

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 the uptake of cleaner alternatives to oil increases. However, their share in the total energy mix is projected to remain small.

**Figure 7-2. Primary Energy Demand by Source, 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 5.7 percent per year to almost 660 Mtoe in 2035. All energy sources are projected to experience positive average annual growth rates. However, these will be slower than in the BAU scenario. The lower consumption relative to the BAU scenario reflect energy efficiency and conservation measures on the demand side.

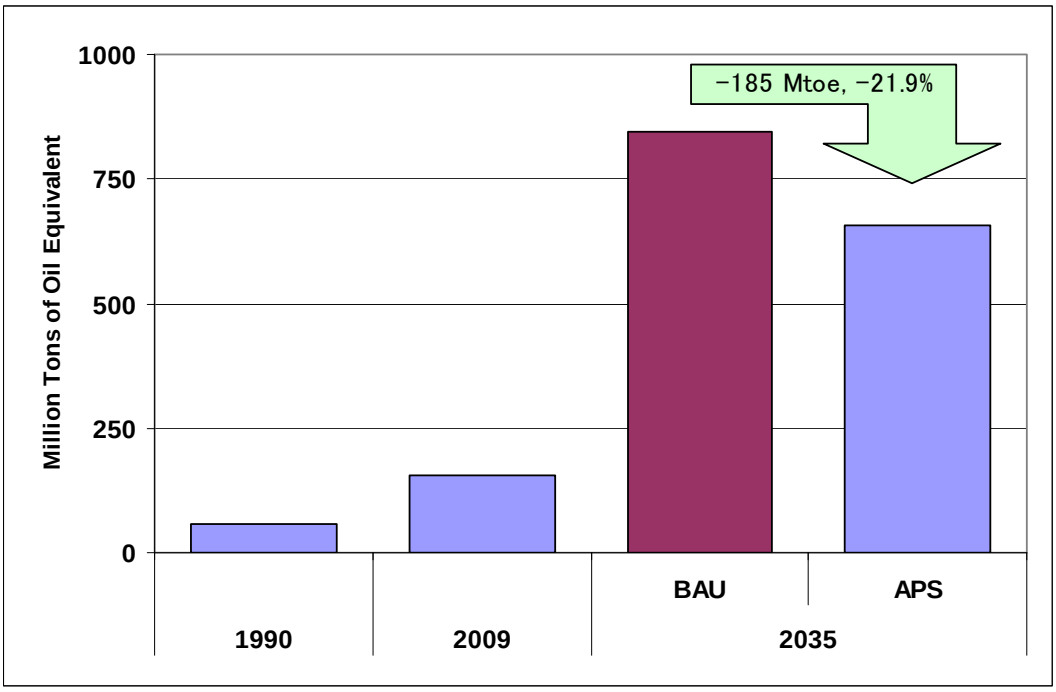
### 3.3. Projected Energy Savings

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 almost 185 Mtoe in 2035 (Figure 7-3). This is more than Indonesia's energy consumption in 2009 of around 154 Mtoe.

In terms of final energy consumption savings, there is estimated to be a saving of almost 62 Mtoe in the industry sector, 50 Mtoe in the transport sector and around 15 Mtoe in the residential/commercial (other) sector by 2035 under the APS, relative to the

BAU scenario.

**Figure 7-3. Total Primary Energy Demand, BAU and APS**



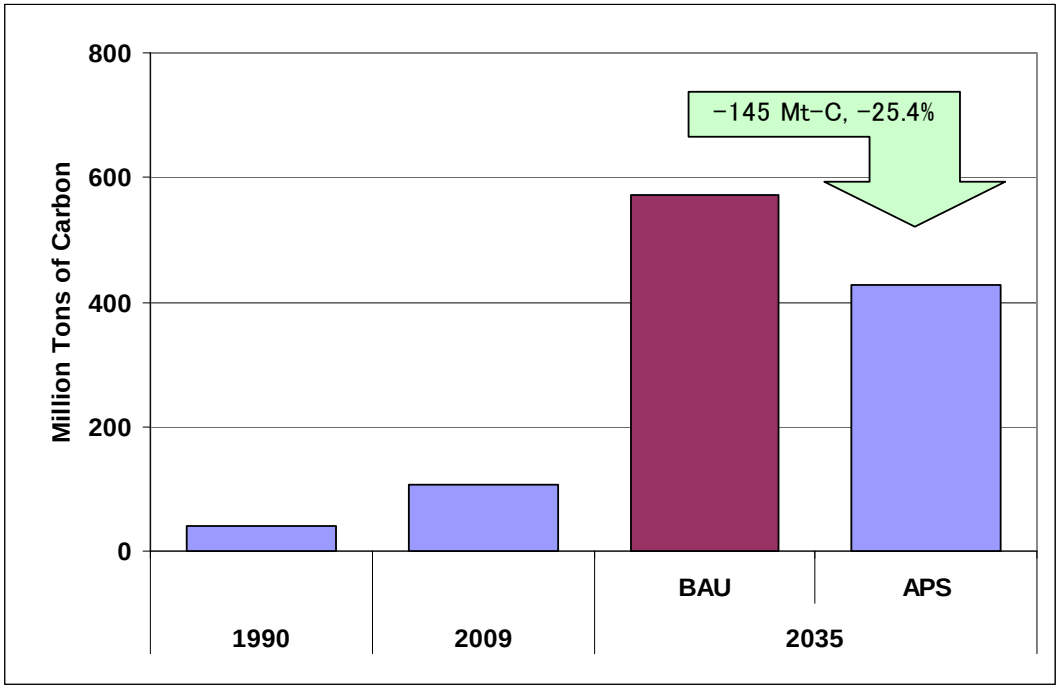

### 3.4. $CO_2$ Emissions from Energy Consumption

$CO_2$ emissions from energy consumption are projected to increase at an average annual rate of 6.7 percent from around 107 Mt-C in 2009 to 573 Mt-C in 2035 in the BAU scenario (Figure 7-4). This is driven by the increasing use of carbon intensive fuels, particularly the use of coal for power generation and in industry, as well as oil in the transport sector.

In the APS, the annual average growth in $CO_2$ emissions from 2009 to 2035 is expected to be 25.4 percent lower than in the BAU scenario, increasing at 5.5 percent a year. This lower growth rate is the result of an expected significant decline in coal consumption in the power sector in the APS, relative to the BAU scenario. The growth in emissions is projected to be slower than the growth in primary energy, indicating that the energy saving goals and action plans of Indonesia will be effective in reducing $CO_2$ emissions. The Government has committed to reduce $CO_2$ emissions in 2025 by 26 percent without international assistance and 41 percent with international assistance.

This study result is still below the committed target. Thus, more stringent energy saving and renewable targets need to be in place to achieve the committed $CO_2$ reduction targets.

**Figure 7-4. $CO_2$ Emissions from Energy Combustion, 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 greater utilisation of efficient energy technologies both by energy producers and consumers. Thus, as Indonesia's economy grows, it is projected that primary energy intensity will decrease. In the BAU scenario it is projected to decline at an average annual rate of 0.7 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 period 2009-2035 in both of the scenarios. This can be easily achieved if the energy efficiency and conservation programmes are implemented extensively

throughout the country.

The transport sector, which is the main consumer of oil in the country, will be crucial to achieving energy savings. The savings in oil consumption between the BAU scenario and the APS could reach around 22 percent in 2035 by introducing more efficient vehicles and boilers in the transport and industrial sectors, respectively. Developed countries in the region such as Japan and Australia should increase efforts to introduce newly improved technologies to developing countries as early as possible.

The 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 energy efficiency and conservation and renewable energy programs. The energy efficiency and conservation blueprint (RIKEN) of 2006 had been revised to include specific energy saving target of the sectors with detailed action plans to achieve the targets. However, the issuance of this document still awaits National Energy Policy approval from the Parliament. Nevertheless, the range of sectoral savings targets in the previous RIKEN has been applied in the study.

To enhance further reductions in $CO_2$ emissions the following actions are proposed:

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

- Renewable Energy Development
  - Improve the transparency and awareness of government support mechanisms to encourage investment in the sector, particularly geothermal energy and other renewable energy sources

# Chapter 8

# Japan Country Report

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June 2012

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# CHAPTER 8

# Japan Country Report

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## 1. Background

Japan is a small island nation in Eastern Asia. It consists of several thousand islands spanning 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 GDP of about US$4815 billion (in 2000 US$ terms) in 2009. Its population was about 128 million people with a per-capita income of US$37,766 in 2009.

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. At the end of 2010, proven energy reserves included around 44 million barrels of oil and 738 billion cubic feet of natural gas. At the end of 2009, proven reserves of coal were 345 million tonnes.

Japan's total primary energy consumption was 469.5 Mtoe in 2009. Oil represented the largest share at 42.7 percent, coal was second at 21.6 percent, followed by natural gas (17.2 percent), and nuclear energy (15.5 percent). In 2009, net imports of energy accounted for about 87 percent of Japan's total primary energy consumption. With limited indigenous energy sources, Japan imported almost 99 percent of its oil, 99 percent of its coal and 96 percent of its 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

natural gas consumption 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 2009, primary natural gas consumption was 80.7 Mtoe.

Japan has 281GW of installed electricity generating capacity and generated about 1041 TWh of electricity in 2009. Generation is comprised of thermal (coal, natural gas and oil) at 63 percent, nuclear (27 percent) and hydro (7 percent), with geothermal, solar and wind taking up the remainder.

## 2. Modelling Assumptions

Japan's GDP is assumed to grow at an average annual rate of 1.4 percent between 2009 and 2035. Growth is assumed to recover from the recent economic recession, increasing at an average rate of 1.9 percent a year between 2009 and 2020 before slowing to 1 percent a year between 2020 and 2035. With the maturing society and economy, the economic structure will increasingly become service oriented.

Population growth is assumed to decline by about 0.5 percent per year between 2009 and 2035 because of the declining birth rate. Japan's population is assumed to decline from 128 million in 2009 to 111 million in 2035. Infrastructure development and the expansion of manufacturing will be saturated and production of crude steel, cement and ethylene will gradually decrease. Vehicle ownership will also decline.

According to the current Strategic Energy Plan, 14 nuclear power plants were assumed to be constructed by 2035 and the utilisation rate was expected to grow through 2035. But the future of nuclear power is unclear following the accident at the Fukushima-daiichi nuclear power plant. Supply from oil-fired power plants is projected to decline. Generation capacity of natural gas-fired power plant is expected to increase because of its relatively low emissions profile.

Japan's energy saving goals are expected to be attained through the implementation of energy efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from improvements in manufacturing technologies. In the residential and commercial 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 grew by 0.2 percent per year from 300.1 Mtoe in 1990 to 313.6 Mtoe in 2009. The residential/commercial (others) sector had the highest growth rate during this period at 1.3 percent per year, followed by the non-energy sector with 0.8 percent. Between 1990 and 2009, consumption in the industry sector declined by 1.2 percent per year. Oil was the most consumed product, having a share of 61.3 percent in 1990 and 54.7 percent in 2009. Electricity was the second most consumed product.

### *Business-as-Usual (BAU) Scenario*

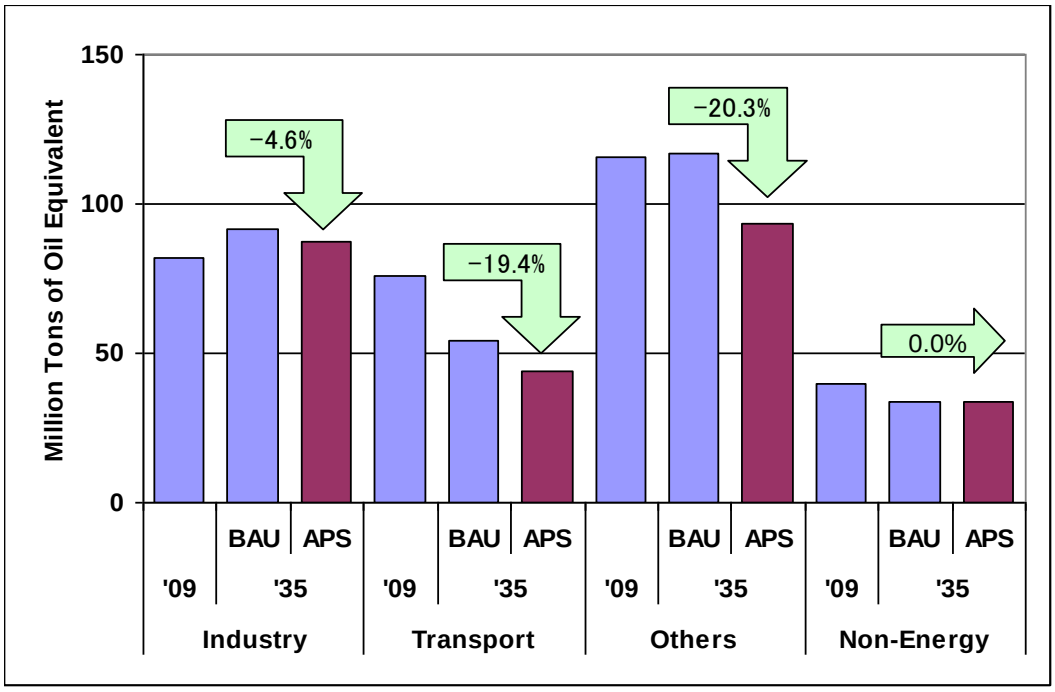
With assumed weak economic growth and a declining population, final energy consumption is projected to decline at an average rate of 0.2 percent per year between 2009 and 2035 in the BAU scenario. This is also driven by the projected decline in the consumption of the industry and transportation sectors, underpinned by improved energy efficiency. Consumption in the others sector is projected to grow at an average annual rate of 0.1 percent between 2009 and 2035.

Consumption of coal and oil is projected to decrease at an average annual rate of 0.4 and 1.2 percent, respectively, between 2009 and 2035. Consumption of natural gas and electricity is projected to increase, at 4.0 and 1.2 percent per year, respectively, over the same period.

*Alternative Policy Scenario (APS)*

In the APS, final energy consumption is projected to decline by 0.7 percent per year from 313.6 Mtoe in 2005 to 258.5 Mtoe in 2035. The largest decline is expected to occur in the transportation sector, falling by 2.1 percent per year because of the top-runner program and aggressive energy management systems. Japan will continuously improve energy efficiency, especially in the transportation sector. Energy efficient automobiles such as hybrid vehicles, electric vehicles and plug-in hybrid electric vehicles will be introduced. The energy efficiency of the industrial and service sectors will improve as well. Energy efficiency in the steel and cement sectors will decline. It will be difficult to improve energy efficiency drastically because capacity factors will be falling and more renewable energy will be used. The final energy consumption by sector in the BAU and APS are shown in Figure 8-1.

**Figure 8-1. Final Energy Consumption by Sector, BAU and APS**




## 3.2. Primary Energy Consumption

Primary energy consumption in Japan grew at a higher rate than the final energy

consumption at 0.4 percent per year from 436.6 Mtoe in 1990 to 469.5 Mtoe in 2009. Among the major energy sources, the fastest growing 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 1990-2009. Oil consumption declined by 1.2 percent per year over the same period. Geothermal energy had a respectable growth rate of 2.8 percent during the period but its share in total primary energy demand was small at 0.6 percent in 2009.

After the Great East Japan Earthquake, the future of nuclear is uncertain. The Japanese government aims to reduce the dependence on nuclear power. Different assumptions about operating plant life have been used in the BAU and APS, with a longer life assumed under the APS. The BAU expected the commissioning of 2 new plants and the plants will be operating for 40 years. The APS has 2 new plants and 60 years operation.

***Business-as-Usual Scenario***

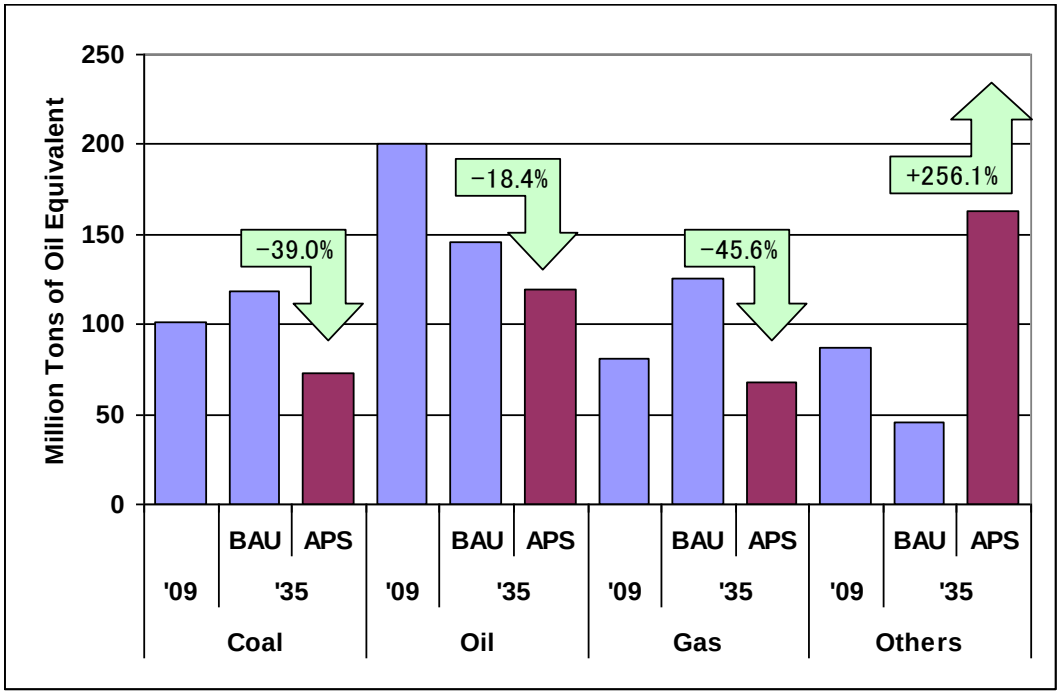
In the BAU scenario, Japan's primary energy consumption is projected to decline at an average annual rate of 0.3 percent per year from 469.5 Mtoe in 2009 to 435.9 Mtoe in 2035. This decline stems from the reduction of oil use, declining at annual average rate of 1.2 percent over the period 2009-2035. The share of coal in 2009 and 2035 is projected to increase from 21.6 percent in 2009 to 27.2 percent in 2035 and that of oil will decline from 42.7 percent to 33.6 percent. Natural gas consumption is projected to increase at average annual rate of 1.7 percent, but nuclear energy consumption will decline at average annual rate of 4.2 percent over the period 2009-2035.

***Alternative Policy Scenario***

In the APS, the projected primary energy consumption will decline by 0.4 percent per year to 422.5 Mtoe in 2035, 47 Mtoe lower than the consumption in 2009. Coal, oil and natural gas consumption are projected to decline at average annual growth rates of 1.3 percent, 2.0 percent and 0.6 percent, respectively. This slower growth is the result of energy efficiency and conservation measures on the demand side. Primary energy

consumption by source in 2009 and 2035 in BAU and APS are shown in Figure 8-2.

**Figure 8-2. Primary Energy Consumption by Source, BAU and APS**

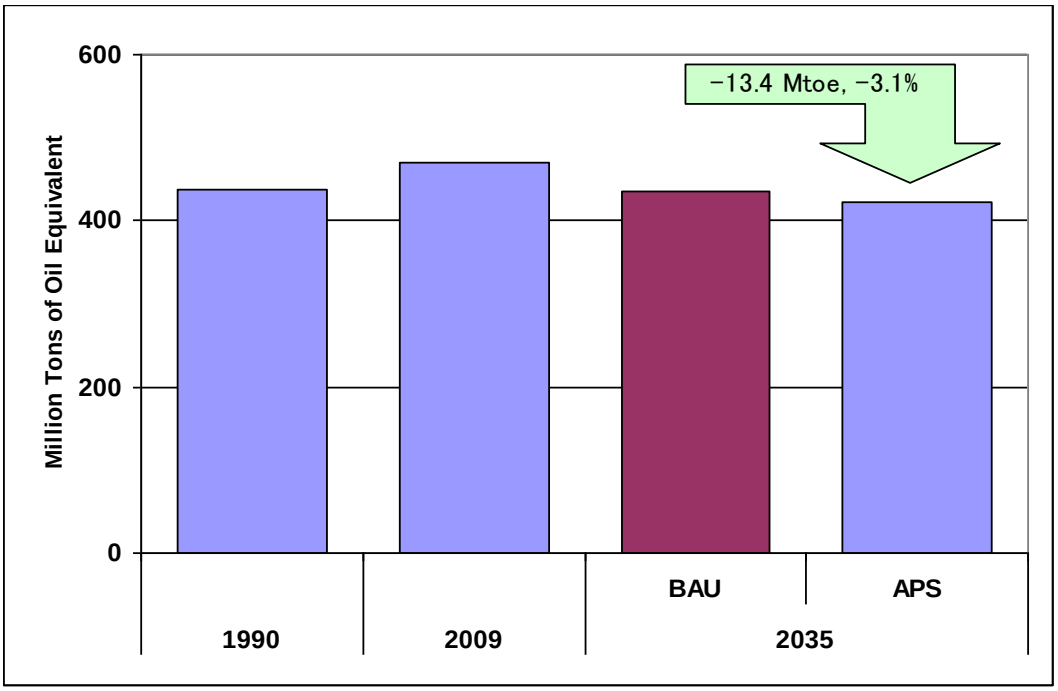



### 3.3. Projected Energy Saving

The energy savings that could be derived from the energy efficiency and conservation goals and action plans of Japan are 13.4 Mtoe, the difference between the primary energy consumption in the BAU and APS. This is equivalent to a 3.1 percent reduction compared with the BAU consumption 2035 (Figure 8-3).

In terms of final energy, there is an estimated saving of 23.7 Mtoe in the others sector and 10.5 Mtoe and 10.5 Mtoe in the transportation sector in 2035. Energy consumed in the transportation sector will decline by 30.2 Mtoe in the BAU and 40.7 Mtoe in the APS because of the the use of more efficient vehicles and a declining vehicle stock.

**Figure 8-3. Primary Energy Consumption, BAU and APS**

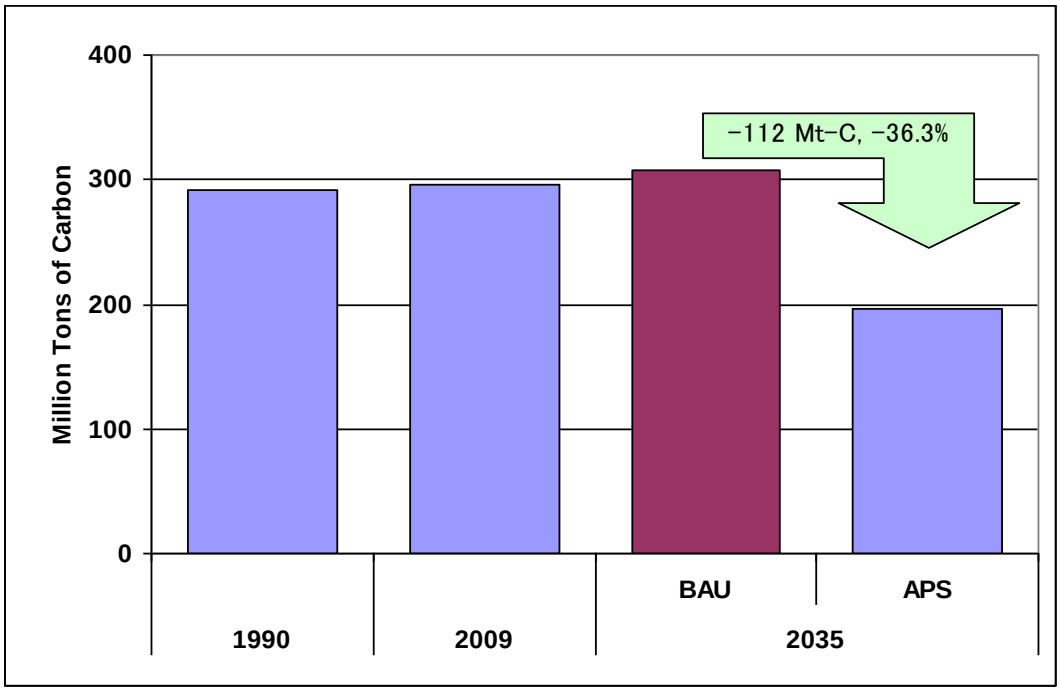



### 3.4. $CO_2$ Emissions from Energy Consumption

$CO_2$ emissions from energy consumption are projected to decrease at an average annual rate of 0.2 percent from 295 Mt-C in 2009 to 308 Mt-C in 2035 in the BAU scenario. This growth is faster than primary energy consumption, indicating the greater use of less-carbon intensive fuels.

In the APS, the $CO_2$ emissions from 2009 to 2035 are projected to decline at an average annual rate of 1.6 percent. In addition, $CO_2$ emissions in 2035 are projected to be lower than the 1990 level in the APS (Figure 8-4). This indicates that the energy saving goals and action plans of Japan are very effective in reducing $CO_2$ emissions.

**Figure 8-4. $CO_2$ Emission from Energy Combustion, 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 has been supported by the enormous improvements in energy efficiencies in both supply side and demand side technologies developed in Japan. The significant improvement in energy efficiency is also encouraged by its import dependency.

In the APS, $CO_2$ emissions in 2035 are projected to be lower than the 1990 level. This indicates that Japan could meet its target of reducing GHG emissions by half between 2005 and 2050. However, to achieve the result, Japan should effectively implement its policies on energy efficiency such as the top-runner program. In addition, as a world leader in energy efficiency, Japan should share its knowledge and experience with other countries. By doing this, Japan is able to contribute to reducing 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 the use of available energy.

After the Great East Japan Earthquake, the future of nuclear is uncertain. The Japanese government aims to reduce its dependence on nuclear. It is important to conduct analysis to assess the effect of Japanese government policy regarding nuclear energy.

The current government emissions reduction target is 25 percent from 1990 to 2020. If this target is accomplished by domestic efforts, policy options may include the deployment of more nuclear power plants, clean coal technology and carbon capture and storage 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 2012

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# CHAPTER 9

# Republic of Korea Country Report

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## 1. Background

The Republic of Korea is located in the southern half of the Korean Peninsula and has a 238 kilometre boundary with North Korea. It occupies 98,480 square kilometres and includes about 3000, mostly small, uninhabited islands. Korea is a mountainous country with lowlands accounting for only 30 percent of the total land area. The climate is temperate, with heavy rainfall in summer. Korea has a population of 49 million, about 85 percent of which live in urban areas. Korea has experienced tremendous economic growth over the past few 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 electronic products, passenger vehicles and petrochemicals. Agriculture, forestry and fishing made up 3 percent of total GDP in 2010.

Korea has no domestic oil resources and only a very small amount of natural gas has been produced locally. It has indigenous anthracite coal resources, but imports most of its coal, which is bituminous coal. As a result Korea is an energy importer - it is the world's second largest importer of liquefied natural gas (LNG).

Although total primary energy consumption is dominated by oil and coal, nuclear power and LNG also supply a significant share of the country's primary energy. Total primary energy consumption increased by 4.8 percent a year between 1990 and 2009. The strongest growth occurred in natural gas (13.8 percent) and nuclear (5.6 percent). Oil use increased at a relatively slower 3.2 percent a year.

Total final energy consumption (TFEC) in 2009 was 147.8 Mtoe, increasing at an average annual rate of 4.4 percent from 1990. The industry sector accounted for 27 percent of final energy consumption in 2009, followed by others (28 per cent) and transportation (20 percent). Consumption of natural gas in the industry sector has grown eight-fold in the last decade and oil accounts for a relatively large share of industry consumption.

In 2009, generators in Korea produced 451.6TWh of electricity, with coal and nuclear combined providing more than three-quarters of Korea's electricity. Natural gas accounted for 15.6 percent of generation in 2009. Total electricity consumption grew at an average annual rate of 8 percent over the period 1990-2009. When broken down by fuel, coal, natural gas and nuclear have grown by an average annual rate of 13.9 percent, 11.0 percent and 5.6 percent, respectively over the period 1990-2009.

## 2. Modelling Assumptions

Korea's GDP grew at an average annual rate of 5 percent from 1990 to 2009. In this report, Korea's GDP is assumed to grow at an average annual rate of 3.4 percent from 2009 to 2035. Following the global recession in 2009, economic growth in Korea is expected to recover to 4.3 percent per year from 2009 to 2020, tapering off to 2.7 percent per year from 2020 to 2030.

Korea is expected to continue to rely heavily on coal and nuclear energy for base load generation. Gas-fired electricity generation is projected to increase between 2009 and 2035, while oil-fired generation is projected to decline. Generation from hydro sources is projected to remain relatively stable. There is projected to be strong growth in electricity generation from wind energy driven by the renewable portfolio standard (RPS).

Korea's energy saving goals can be attained through the implementation of energy efficiency programs in all energy consuming sectors. In the industry sector, energy savings are expected from 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 the 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 exhibited growth of 4.4 percent per year from 65 Mtoe in 1990 to 148 Mtoe in 2009[1]. The non-energy sector had the highest growth rate during this period at 9.4 percent per year followed by the industry sector with 3.9 percent. Consumption in the residential/commercial/public (other) sector grew at a relatively slow pace of 2.9 percent per year. Oil was the most consumed product having a share of 67.3 percent in 1990, declining to 53.9 percent in 2009. The relative share of coal in the final energy mix declined between 1990 and 2009, with electricity increasing its share to be the second most consumed product.

***Business as Usual (BAU) Scenario***

With assumed low economic and population growth, final energy consumption in Korea is projected to increase at a low average rate of 0.8 percent per year between 2009 and 2035 under the BAU scenario. This largely stems from the slow growth in energy consumption in the transportation sector. The strongest growth in consumption is projected for the industry sector, increasing at an average annual rate of 1.1 percent between 2009 and 2035.

Consumption of oil, natural gas and electricity is projected to increase at average annual rates of 0.1, 1.4 and 1.7 percent, respectively over the period 2009-2035.

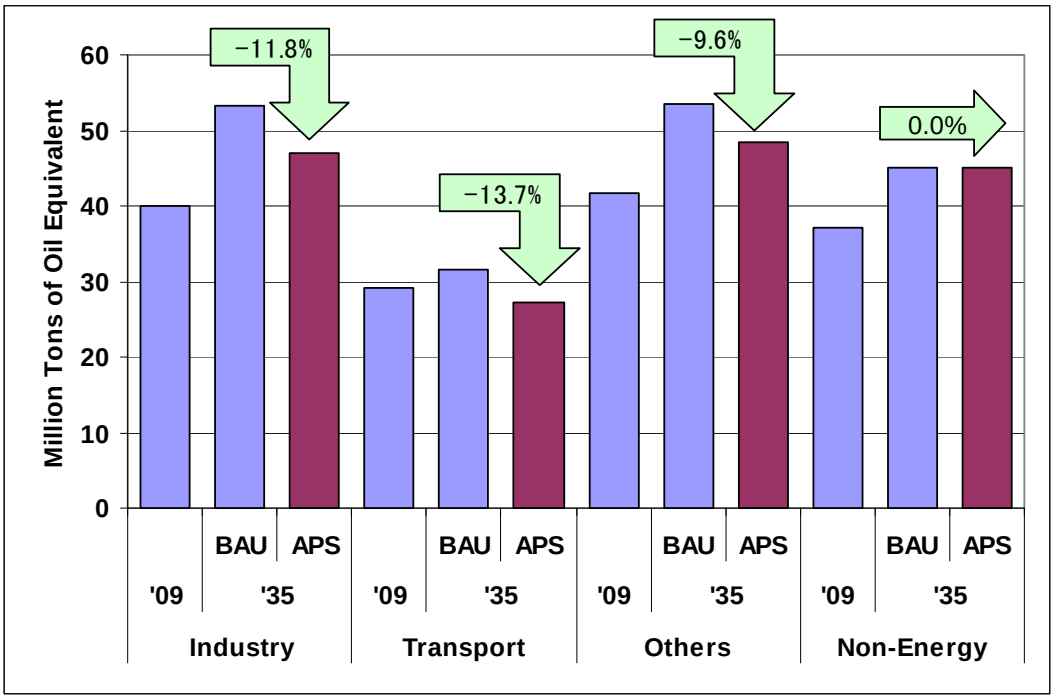
[1] The outlook results are based on the net calorific values as converted by IEEJ from original data submitted by the Republic of Korea.

Consumption of coal is projected to decline by 0.7 percent per year reflecting a shift toward the increased use of natural gas by industry in order to reduce carbon emissions.

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to increase at 0.5 percent per year from 148 Mtoe in 2009 to 168 Mtoe in 2035. The Non-energy sector is projected to have the fastest average annual consumption growth, increasing by 0.8 percent a year between 2009 and 2035. Energy consumption in the transportation sector is projected to decline by 0.3 percent per year over the same period. The rate of growth is much slower across all sectors relative to the BAU scenario (Figure 9-1).

**Figure 9-1. Final Energy Consumption by Sector, BAU and APS**



### 3.2. Primary Energy Demand

Primary energy demand in Korea grew at an average rate of 4.8 percent per year from 92 Mtoe in 1990 to 227 Mtoe in 2009. Among the major energy sources, the fastest growing were natural gas and nuclear energy. Natural gas consumption grew at an average annual rate of 13.8 percent while nuclear energy grew at 5.6 percent between 2009 and 2035. Oil and coal consumption increased by 5.0 and 3.2 percent per year, respectively over the same period.

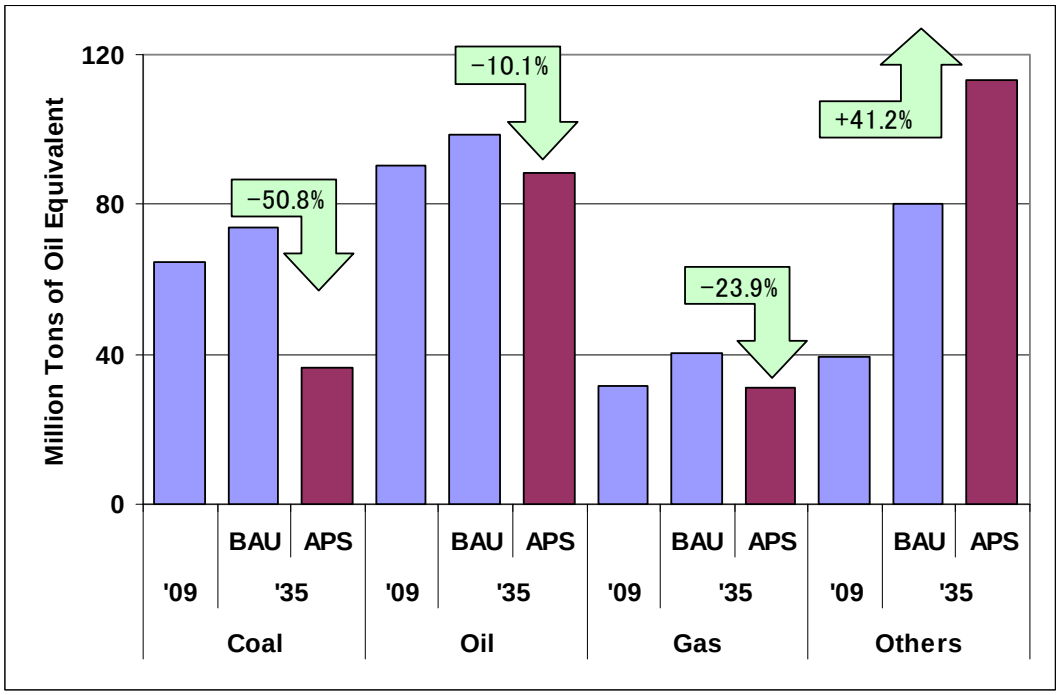
***Business as Usual Scenario***

In the BAU scenario, primary energy demand in Korea is projected to increase at an annual average rate of 1.0 percent per year to 293 Mtoe in 2035. With the exception of nuclear, growth in all the energy sources is projected to be relatively slow. Nuclear energy consumption is projected to increase at an average annual rate of 2.4 percent over the period 2009-2035. The growth in nuclear will largely be at the expense of oil, with the share of oil declining from 40 percent in 2009 to 34 percent in 2035.

***Alternative Policy Scenario***

In the APS, primary energy demand is projected to increase at a lower rate of 0.7 percent per year to 269 Mtoe in 2035. Coal will decline on average by 2.2 percent per year while oil and natural gas will decrease by 0.1 percent per year between 2009 and 2035 (Figure 9-2). Energy efficiency and conservation measures on the demand side will be the main contributors to the reduction in consumption growth.

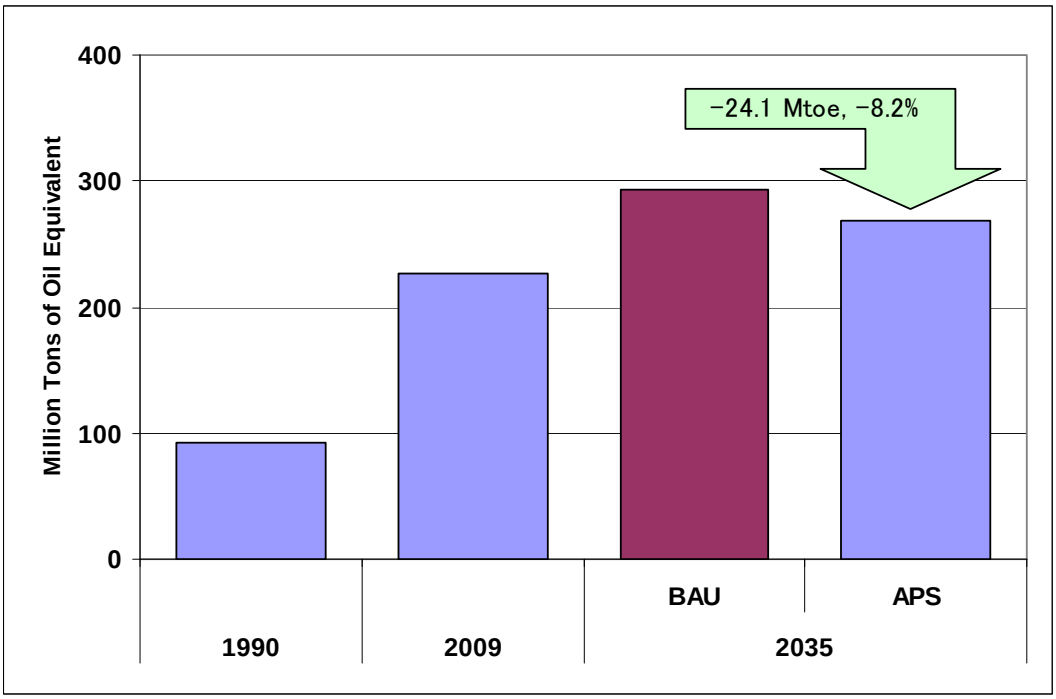
**Figure 9-2. Primary Energy Demand by Source, BAU and APS**




***Projected Energy Saving***

The energy savings that could be derived from the energy saving goals, action plans and policies of Korea is 24 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2035 (Figure 9-3). This is equivalent to 10.6 percent of Korea's consumption in 2009.

**Figure 9-3. Total Primary Energy Demand to 2030, BAU and APS**



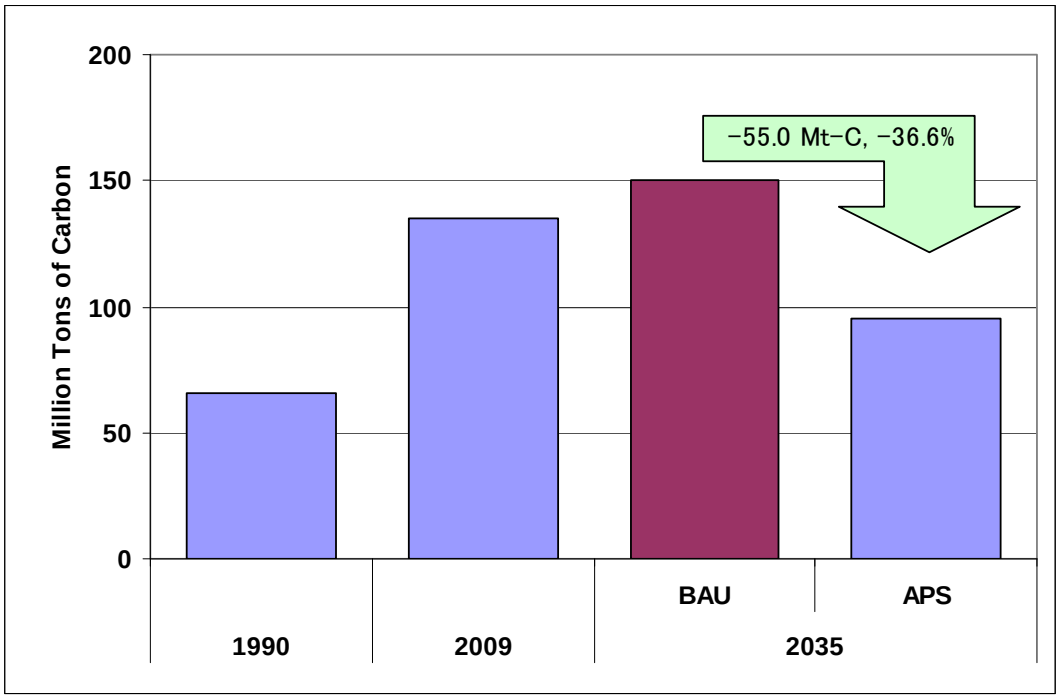

In terms of final energy consumption savings in 2035, there is estimated to be savings of 6.3 Mtoe in the industry sector, 5.1 Mtoe in the residential/commercial (other) sector and 4.3 Mtoe in the transportation sector.

### 3.3. $CO_2$ Emissions from Energy Consumption

Carbon dioxide ($CO_2$) emissions from energy consumption are projected to increase by 0.4 percent from 135.1 Mt C in 2009 to 150.4 Mt C in 2035 in the BAU scenario. This growth is slower than the growth in primary energy consumption 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 decline at an annual average rate of 1.3 percent between 2009 and 2035, indicating that the energy saving goals and action plans of Korea are likely to be very effective in reducing $CO_2$ emissions (Figure 9-4).

**Figure 9-4. $CO_2$ Emission from Energy Consumption, BAU and APS**




## 4. Implications and Policy Recommendations

Korea's total primary energy demand and final energy consumption in the 1990s increased at a faster rate than GDP as growth was driven by energy intensive industries. Since 1997, the contribution of these industries to Korea's GDP has declined, resulting in reduced energy intensity.

Korea has promoted the diversification of energy resources to reduce excessive external energy dependence and the substitution of energy to improve Korea's energy supply security. Korea's policy goals of encouraging conversion into a low energy consuming economic structure and implementation of policies harmonising energy, the economy, and the environment are expected to contribute to energy savings in the Korean economy.

# Chapter 10

# Lao PDR Country Report

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# CHAPTER 10

# Lao PDR Country Report

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## 1. Background

### 1.1 Socio-Economic Situation

Lao People's Democratic Republic (Lao PDR) is a small country in South East Asia. It is a land lock country which is located in the middle of the South East Asia peninsula. It has a border with five countries namely China in the North, Vietnam in the East, Cambodia in the South, Thailand and Myanmar in the West. Lao PDR has a total area of 236,800 square kilometres and about 70 percent of that is covered by mountains. Lao P.D.R has population of 6,127,910 people (2009) in which 3,070,013 people is female. The female population is accounted a little bit more than 50 percent of the total population. The average of the population density is 26 people per square kilometre. Laos consists of 17 provinces. Its capital city is Vientiane. It has population of 754,384 people.

Since Lao PDR had changed its economic policy to the opened door policy in 1986, the economy has been progressing and expanding rapidly. The Gross Domestic Product (GDP) in 2009 increased 7.5 percent from the previous year. It was accounted about US$ 3,421 million at the 2002 constant price. If it is estimated by activity at the current price it was about US$ 5,585 million and it per capita was about US$ 914. The economy has been gradually changing from agriculture oriented activities to a more wide range of activities such as service and industry. In 2009, the service sector has gained 38.7% while agriculture sector has had only 30.5% of the all GDP. The industry

sector also increased rapidly, because there are a lot of investments in mineral and hydropower sectors. Even though in 2009 it has contributed to the GDP only 24.5%, it was projected to take the bigger share in the GDP in the next 5 years.

## 1.2 Energy Supply-Demand Situation

Laos PDR's total primary energy demand in 2009 was 1.0 MTOE. The country's primary energy demand mix consists of four types of energy such as oil, hydro and coal. In 2009, electricity export reached 0.5 MTOE and accounted almost half of total energy consumed in the country. The export also accounted for 71.4% of total hydro power generation. The main fuel consumed in the country is oil products and is mainly used in the transportation sector. Since there is no refinery in Lao PDR, all of its oil product supply is imported from Thailand and Viet Nam. In 2009, Lao PDR imported 0.6 MTOE of oil products to supply the demand of transport and other sectors. Lao PDR's primary energy supply mix includes also coal. In 2009, 0.1 MTOE of coal was consumed in Lao PDR and mainly in industrial sector. In the future, coal demand is expected to increase as a coal power plant will start commercial operation.

The power sector plays a major role in the country's economy. Electricity became a source of revenue from abroad and at the same time as source of energy for economic activities. The electrification ratio in Lao PDR is 62% in 2009. According to the Lao PDR Government plan, the country will increase the electrification ratio to 70% in 2010 and 90% in 2020. This plan is among the priorities of the government to eradicate the country's poverty. Considering the increase of electricity demand in Lao PDR and the power production for export, optimisation of the power sector will be necessary for the future supply of electricity.

Luckily, Lao PDR is known as a rich country in terms of hydropower resources, because it has many rivers. According to the Mekong River Commission Study in 1995, Lao PDR has a potential hydropower resource of 23,000 MW. Up to 2009, Lao PDR has only developed 8.4% of the total potential with total installed power capacity reaching 1938 MW. Almost 100 percent of the total power supply comes from hydro power source.

In 2009 Lao PDR produced around 3366 GWh of electricity. From that, more than

57% (equivalent to 1921 GWh) was exported to Thailand and the remaining, consumed domestically. Power export is projected to increase sharply because the Government has made commitment to help its neighbouring countries to fulfil their power demand. By 2020, Lao PDR has agreed to export 7,000 MW to Thailand and 5,000 MW to Viet Nam. The power source for export is mainly from hydropower. There is, however, one thermal power plant known as Hongsa Lignite Power Project which will be constructed for export purposes. This project alone has the installed capacity of 1,800 MW. At present, there are more than 50 hydropower sites planed for the export target in 2020. These exporting hydropower projects are being developed jointly between the Lao PDR Government and foreign investors.

## 1.3 Energy Policies

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

### *1.3.1 Supply (Fossil, NRE, Nuclear, Bio fuels, etc)*

On the energy supply side, the Lao PDR Government has set up a number of measures and strategies to ensure the greater security of energy supply and promote sustainable development in the energy sector. The Government would like to provide sufficient energy for socio-economic development without shortage and disruption of energy supply. At the same time, the Government attempts to reduce the dependence on energy import and gradually diversify its energy supply. Now the renewable energy policy has been approved as a government decree. It aims to increase the share of renewable energy in total energy supply by 30% in 2020. This targeted obligation also

includes blending 10% of bio-fuels in the oil supply for the transportation sector. This policy will help the country to reduce oil import. For the nuclear energy policy, although there is no nuclear power plant to be developed in the medium term, the Government is attempting to build its personal capacity to be ready to cooperate with other countries and develop the nuclear power plants in the long term when it is necessary.

### *1.3.2 Consumption (Energy Efficiency and Conservation, etc)*

During the past decade, energy demand of Lao PDR increased significantly. In 1990, only 0.2 MTOE of energy had been consumed. In 2009, it increased to 1.0 MTOE and it is projected to grow to 5.4 MTOE by the year 2035. This requires a lot of investments in energy supply. In this regard, the country needs to use more its natural resources and to import more oil from abroad. These can cause negative impacts to the environment and increase greenhouse gas emission to the atmosphere. Therefore the Lao PDR Government as well as the Ministry of Energy and Mines are taking this energy consumption aspect into account seriously. One of the most effective measures and policies to minimize the associated issues, which the Government is currently promoting, is the Energy Efficiency and Conservation program. In this program, 10% reduction in energy consumption by 2020 in all sectors is being proposed to the Government. If it has been approved the specific measures and activities will be discussed and implemented in different sectors.

### *1.3.3 Energy Market Reforms, New Energy Policies under Consideration, etc*

To promote greater security and sustainable development in energy supply, the energy organization structures have been frequently reviewed and improved by the Government. Based on new developments in the country, suitable energy organizations are needed efficiently manage the energy sector. For example, the Department of Electricity is proposed to become the Department of Energy. Its mandatory responsibilities are proposed to accommodate a wide range of energy activities.

Moreover, the energy market has been opened up to private local and international investors. This strategy is aiming to promote competition and more investments in the energy industry. As a result, there are many new independent power producers (IPPs) that emerged to produce electricity for domestic and export requirements. Recently, Electricite du Laos, the state-owned power utility has been also divided into two companies: Electricite du Laos and Electricite du Laos-Generation (EdL-Gen).

# 2. Energy and $CO_2$ Emission Outlook

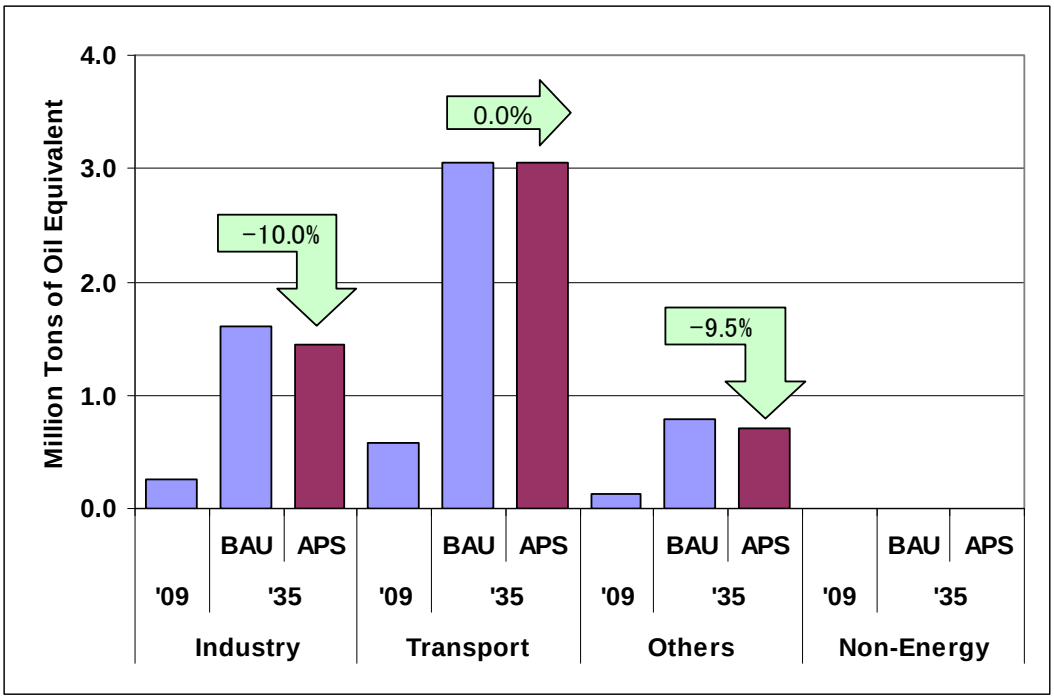
## 2.1 Final Energy Consumption

Lao PDR's total final energy consumption in 2009 was 1.0 MTOE growing at an average annual rate of 7.1 percent from 1990 of 0.2 MTOE. The industry sector had the highest growth rate during this period at 28.1 percent per year followed by the other sector at 12.4 percent per year. The other sector was responsible for 13.7 percent of the total consumption in 2009. In terms of energy types, oil was the most consumed product having a share of 63.7 percent followed by electricity which accounted for 18.7 percent.

***Business as Usual (BAU)***

From 2009 to 2035, Lao PDR will experience high growth in the total final energy consumption in all sectors. The industry sector will have the highest growth rate of 7.4 percent followed by the other sector at 7.1 percent. The final consumption of the transport sector will also have a high growth rate of 6.6 percent per year.

**Figure 10-1: Final Energy Consumption by Sector, BAU vs. APS**




***Alternative Policy Scenario (APS)***

In the APS, the growth of total final energy consumption (TFEC) will be slightly lower than in the BAU. This is due to the energy policy of the Lao PDR Government planned to be implemented in the near future. The policy includes an increase of the renewable energy share in total energy supply by 30% by 2020, 10% blend of bio-fuels in oil supply for the transportation sector and the reduction of 10% in energy consumption of all sectors. By implementing these measures, the TFEC is estimated to reduce from 5.4 MTOE in BAU to 5.2 MTOE in APS.

## 2.2 Primary Energy Consumption

The total primary energy consumption in Lao PDR increased from 0.2 Mtoe in 1990 to 1.0 Mtoe in 2009 at an average annual rate of 8.5 percent. Oil consumption increased at an annual rate of 6.6 percent on the average while hydro electricity production increased by 13.1 percent per annum on the average. Coal started to figure in the

primary energy mix in the late 2000's and had a 10.8 percent share in 2009.

**Figure 10-2: Primary Energy Demand, BAU vs. APS**

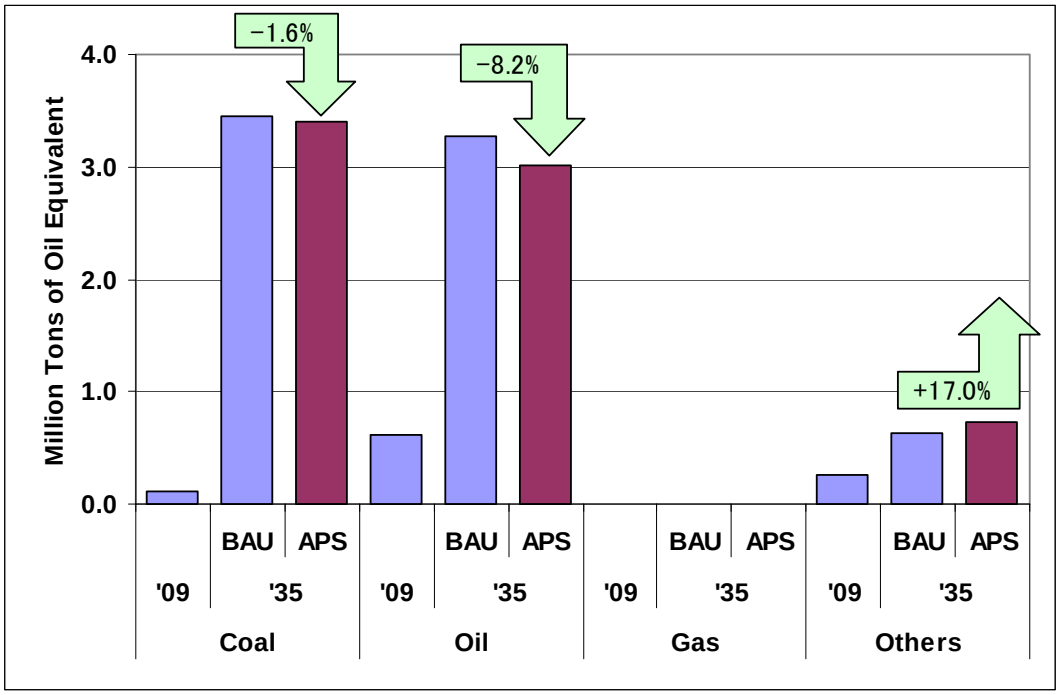
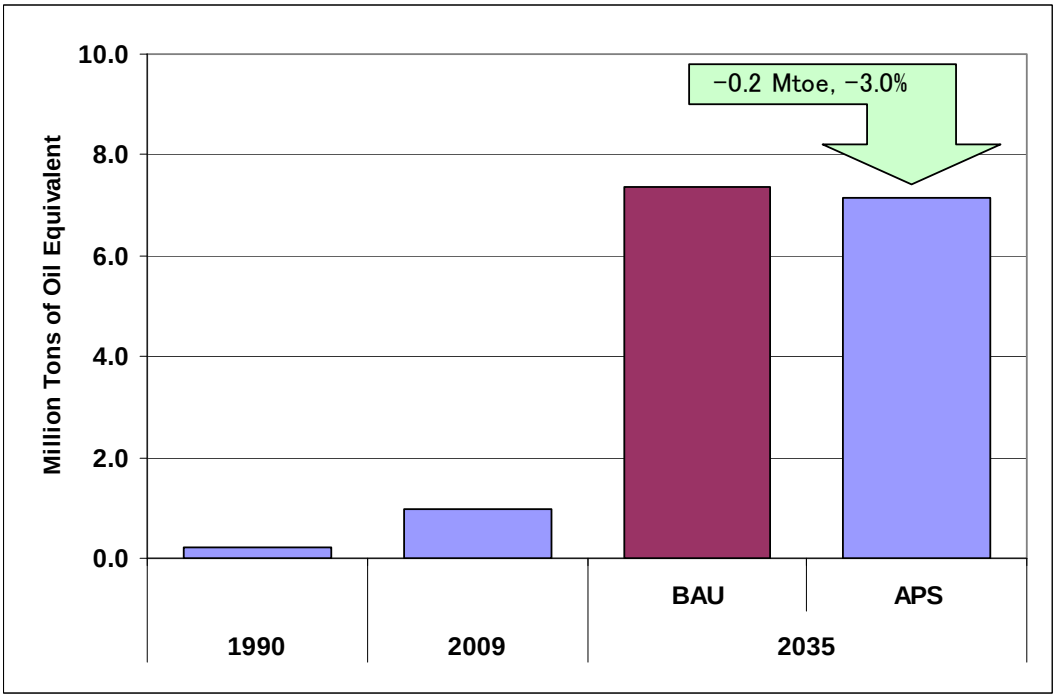



**Figure 10-3: Evolution of Primary Energy Demand, BAU vs. APS**



***Business as Usual (BAU)***

The total primary energy consumption or TPES of Lao PDR will grow at an average annual rate of 8.1 percent from 2009 to 2035 under the BAU scenario, reaching. 7.3 MTOE by 2035. Coal will grow at the fastest rate of 14.4% during the period due to development of one big and first coal power plant in the country, the Hongsa Lignite Power Plant which will be operated from 2015 onwards.

Hydro will also increase but at a lower rate compared with that of coal. It will increase from 0.7 MTOE in 2009 to 2.1 MTOE in 2035, at an average of 4.3 percent per year. Oil demand will rise at 6.7 percent per year on the average, from 0.6 MTOE in 2009 to 3.3 MTOE in 2035.

***Alternative Policy Scenario (APS)***

In the APS, the TPES will increase at an average rate of 8.0% throughout the projection period between 2009 and 2035. It is projected to increase from 1.0 MTOE in 2009 to 7.1 MTOE in 2035. If compared with BAU, the TPES in APS will be 4.3 percent lower or equivalent to 0.2 MTOE. The reduction in TPES resulted from the implementation of a number of energy strategies and measures as mentioned above.

**2.3 $CO_2$ Emission**

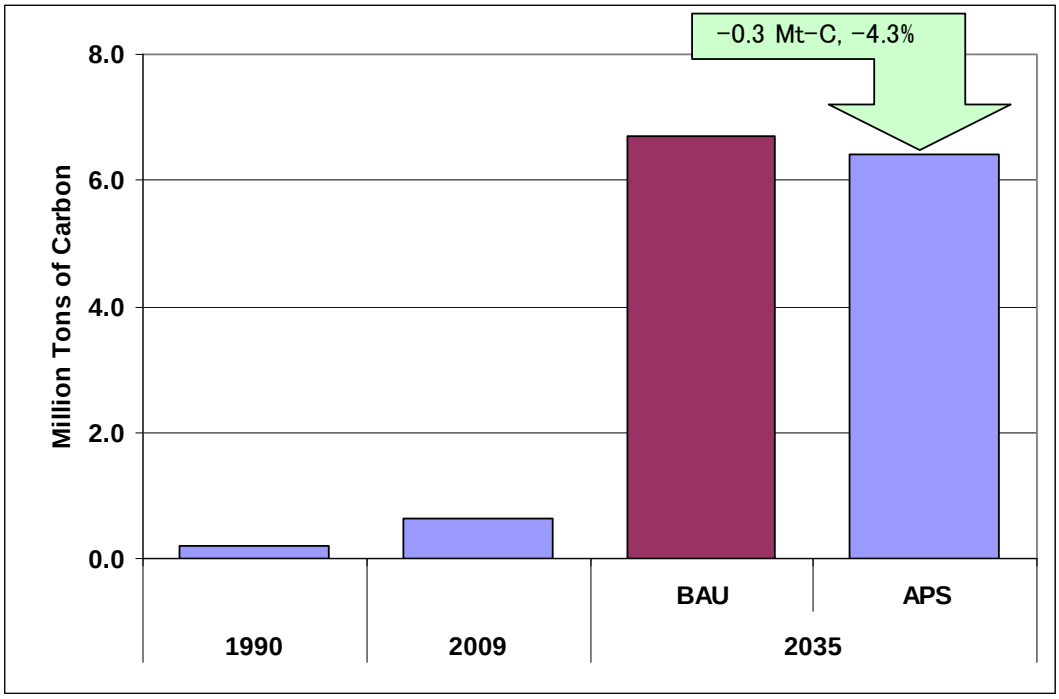
***Business as Usual (BAU)***

In the BAU, $CO_2$ emissions will increase from 0.6 Mt-C in 2009 to 6.7 Mt-C in 2035 at an average annual growth rate of 9.6 percent per annum. The high increase of $CO_2$ emission is due to the operation of a lignite power plant. Before the operation of this coal power plant, almost 100% of electricity generation in Lao PDR is from hydropower.

*Alternative Policy Scenario (APS)*

In the APS, the $CO_2$ emissions will be increasing but at a slower rate than the BAU case. The average annual growth rate of CO2 emission in the APS will be 9.4 percent, reducing the total CO2 emission to 6.4 Mt-C, roughly 4.3 percent lower than BAU.

**Figure 10-4: $CO_2$ Emission from Energy Combustion, BAU vs. APS**




## 3. Findings and Policy Implication

### 3.1 Findings

In this energy outlook, the GDP of Lao PDR is assumed to grow at an average annual growth rate of 7.6 percent from 2009 to 2035 while population growth is assumed to grow at an average annual growth rate of 1.6 percent. By the year 2035, if the three energy measures of the Government are implemented, the total primary energy

consumption will decrease from 7.35 MTOE in the BAU to 7.13 MTOE in APS.

Consequently, the energy intensity of the APS in 2035 will also be smaller than the BAU, almost 3 percent lower. The energy per capita of Lao PDR will also be 3 percent lower in the APS as compared to the BAU, i.e.: 0.75 toe/capita versus 0.77 toe/capita respectively.

The $CO_2$ intensity will increase over the 2009-2035 period for both BAU and APS. However, in 2035 the CO2 intensity of the APS will only reach 459 t-c/million 2000 US Dollar, 4.3 percent lower than that of the BAU.

### 3.2 Policy Implication

In this study, Lao P.D.R will get the energy savings mainly through the implementation of the government's renewable energy and energy conservation programs. The programs consist of an increase of the renewable energy share in total energy supply by 30% by 2020, input 10% of bio-fuels in oil supply for the transportation sector and the reduction of 10% in energy consumption of all sectors.

In order to have energy reduction both in Total Primary Energy Supply and Total Final Energy Consumption, as well as the reduction in $CO_2$ Emissions, Lao P.D.R should extend the implementation of the renewable energy and energy conservation programs until 2035. As the energy conservation programs are the most important in achieving the energy reduction, it should be proposed to be a National Policy. In the same time, there should be sound projects and programs to be implemented. In addition, the study on correlation between GDP and energy consumption should be carried out and energy statistics should be improved accordingly.

# Chapter 11

# Malaysia Country Report

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# CHAPTER 11

# Malaysia Country Report

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## 1. Background

Malaysia, located in South East Asia, comprises Peninsular Malaysia and the states of Sabah and Sarawak along with the Federal Territory of Labuan on the island of Borneo. The total area is 330,803 $km^2$ and contains a varied topography ranging from coastal areas to mountainous regions. Malaysia is bounded over by a coastline of 4800 km. The climate is tropical with mean daily temperatures of between 26°C to 28°C. Two monsoon periods occur between November-March and May-September. Rainfall is abundant, averaging 2000 mm to 4000 mm annually. Clouds cut off a substantial amount of direct sunshine. Malaysia receives about 6 hours of direct sunlight daily.

Total population was 28.3 million in 2010 and increased to 28.6 million in 2011 with increasing population density. About 68.4 percent of the population is within the 15-64 age brackets. The urbanization rate is expected to continue to increase. Life expectancy at birth also showed an upward trend. This improvement can be attributed to the extensive network of health care services in Malaysia, mainly provided by the government. Income per capita increased from RM 26,175 in 2010 to RM 28,725 in 2011. The GDP growth rate for the same period was approximately 5.1 percent. GDP for 2011 was made up as follows: services (57%), manufacturing (27%), agriculture, livestock, forestry and fishing (7%), mining and quarrying (6%), and construction (3%). Unemployment decreased to 3.3 percent in 2011 from 3.4 percent in 2010.

In Malaysia, the main thrust of energy policies is on the importance of ensuring adequate, secure and reliable supply of energy at affordable costs in addition to

promoting efficient utilisation of energy. Efforts to reduce dependency on petroleum products and environmental considerations are major objectives of more recent policies. In this context, renewable energy which is considered more environmentally friendly has been made the Fifth Fuel after oil, gas, coal and hydro.

The major energy policies implemented in the country are as follows:

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

Overall, the country has extensive electricity supply and even very remote rural areas in much of the peninsula are covered. Energy demand, particularly electricity demand can be expected to grow with population growth and economic growth. Electricity, its production, and supply forms an important part of the energy sector. Malaysia's energy needs in the past had been fulfilled with prudent energy policies. As the economy grows and incomes rise, per capita electricity use will increase. Therefore, Malaysia will have to decide today and invest in energy options that will guarantee reliable and affordable energy for the economy while at the same time limiting negative impacts on the environment and safeguarding long-term energy security.

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 2011, reserves included 5.858 billion barrels of crude oil and condensates, 89.988 tcf of natural gas and 1938.4 million tons of coal. In 2001, the Malaysian government launched the Small Renewable Energy Programme (SREP) programme to encourage and intensify the utilisation of renewable energy in power generation. Under this programme, small renewable energy power generation plants can sell up to 30 MW of electricity that has been generated to the utility through the Distribution Grid System. The renewable energy sources that have been identified under this programme are

biomass, biogas, solar, mini-hydro and solid waste. Up to April 2011, 15 SREP projects were in operation with a total generation capacity of 61.2 MW. The progress of SREP and the development of renewable energy in Malaysia have been generally slow due to a number of issues and barriers. Malaysia being an equatorial country has an irradiance level, well suited for photovoltaic (PV) generation. The Malaysian Building Integrated Photovoltaic (MBIPV) project is a national initiative by the Government in collaboration with the GEF and UNDP. The MBIPV project is implemented under the 9th Malaysia Plan (9MP) to promote widespread and sustainable use of PV in buildings in order to reduce the long term cost of building integrated photo voltaic (BIPV) technology in Malaysia. The project was officially launched in July 2005 and is too be implemented in five (5) years.

Energy is a key driver of the Malaysian economy. Increasingly, more recent policies have focussed on reducing dependency on petroleum products and environmental considerations while ensuring supply at affordable costs. The main sources of commercial energy supply in 2010 were natural gas (43.3%) and crude oil and petroleum products (34.3%). However, the share of coal and coke increased from 16.2 percent in 2009 to 20.3 percent in 2010 and only 2.2 percent came from the non-fossil source of hydropower in 2010. In terms of demand in 2010, 40.6 percent was for transportation, 31.2 percent for industrial purposes and 16.8 percent for commercial and residential use. In 2010, Malaysia generated 108.2 terawatt hours (TWh) of electricity. Natural gas continued to remain the main fuel source for electricity generation with a share of 53.0 percent followed by coal at 40.3 percent, hydro at 4.9 percent and oil at 1.8 percent. In 2010, Malaysia had 24 gigawatts (GW) of installed generation capacity.

## 2. Modelling Assumptions

One of the main drivers of the modelling assumption is GDP growth rates. The GDP growth rates for year 2009 until 2011 were based on actual data while for the 2012 was taken from the Ministry of Finance short term forecast. Based on study that was carried out by Economic Planning Unit (EPU) under the Prime Minister Office of

Malaysia, the assumption growth rates of future GDP was applied. The GDP growth rates by sub-sectors are very useful and important to predict better results for energy supply and demand in future. Most of all the demand equations for Malaysia were using GDP as the key factor to determine future projections. The assumption of GDP growth rates are found below:

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

| Year | GDP (%) | Industrial GDP (%) | Commercial Sector GDP | Manufacturing GDP (%) | Agricultural GDP (%) |
|---|---|---|---|---|---|
| 2009 | -1.6 | -2.3 | 3.1 | -9.3 | 0.6 |
| 2010 | 7.2 | 4.7 | 6.8 | 11.4 | 2.1 |
| 2011 | 5.1 | 2 | 6.8 | 4.5 | 5.6 |
| 2012 | 5.5 | 4.5 | 6.5 | 4.5 | 4.1 |
| 2013-2015 | 4.6 | 4.9 | 4.4 | 5.6 | 4.6 |
| 2016-2020 | 4.7 | 5.1 | 4.5 | 5.6 | 4.7 |
| 2021-2025 | 4.2 | 4.5 | 3.9 | 5 | 4.1 |
| 2026-2035 | 3.6 | 4 | 3.4 | 4.5 | 3.5 |

*Source*: Department of Statistics, Economic Planning Unit and Ministry of Finance

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

**Table 11-2: Population Growth Assumption to 2035**

| **Year** | **Growth Rate** |
|---|---|
| 2010-2015 | 1.57 |
| 2015-2020 | 1.43 |
| 2020-2025 | 1.29 |
| 2025-2030 | 1.15 |
| 2030-2035 | 0.99 |

*Source*: http://esa.un.org/unpd/wpp/unpp/Panel_profiles.htm

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

Improving energy efficiency is one of the most cost effective means of matching supply and demand. In Malaysia, there are additional reasons for focusing on energy efficiency. In residential sector regulatory instruments in the form of Minimum Energy Performance Standards (MEPS) and appliance labelling will be developed for major domestic appliances (including refrigerators and air conditioners). The fiscal instruments in the form of tax incentives for manufacturers and importers of energy efficient appliances will be used as an interim measure until such time as MEPS and labelling standards are ready to be implemented. In the commercial sector especially the building sector, energy efficiency performance standards will form part of the building standard for new buildings and for significant retrofits. Training programs for architects and building equipment specifications will be used as a means of helping improve the long term efficiency of building stock. While for industrial sector, educational or training initiatives aimed at industry, consultants and suppliers will be implemented as a means of fostering efficiently configured industrial systems. Furthermore, mandatory energy efficiency audits will be introduced as a means of identifying opportunities to improve energy efficiency performance in particular

applications. Barriers to development of co-generation (e.g. the ability to sell power to the grid) will be addressed as a means of facilitating its development. Under the Greater Kuala Lumpur plan, the new route of Mass Rapid Transportation (MRT) is now being undertaken by the Government to increase more public transportation in Klang Valley. The National Automotive Policy (NAP) was introduced on 22 March 2006 by the Ministry of International Trade and Industry (MITI) as the main thrust for the formulation of the strategic directions of the industry under the Third Industrial Master Plan (IMP3), 2006-2020. As transport is highlighted as one of the sector under the green technology policy, MITI launched the Review of National Automotive Policy (NAP) in early 2010 to review the existing NAP to foster more competitive market for local and international companies. In order to promote high value and green technology, the revised policy highlights the development of related Infrastructure to promote Hybrid and Electric Vehicles as the main agenda. The NAP Review assigns Ministry of Energy, Green Technology and Water to draw up a roadmap to develop the infrastructure for electric vehicles.

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

**Table 11-3: Energy Efficiency Assumptions**

| Scenarios | Assumptions |
|---|---|
| Energy Efficiency and Conservation (EEC) Scenario | 1. Potential reduction of 10% in industrial sector from 2011 until 2035 |
| | 2. Potential reduction of 10% in commercial sector from 2011 until 2035 |
| | 3. Potential reduction of 10% in residential sector from 2011 until 2035 |
| | 4. Fuel Switching from Motor Gasoline to Electric Train in public sector |
| | a. In 2010, the electric consumption in train will be at 12 ktoe and 20 ktoe in 2020 |
| | 5. Fuel switching from Motor Gasoline to Electric Vehicle in transportation sector |
| | a. In 2011, there will be 50 EV in road and gradually increase to 1000 EV in 2035 |
| | b. Assuming, motor gasoline per vehicle is about 0.00139 ktoe or 1,473 liter |
| | c. In 2035, potential reduction of motor gasoline in transportation sector is about 1.39 ktoe |

**Table 11-4: Additional Assumptions for the APS**

| Scenarios | Assumptions |
|---|---|
| Renewable Energy (RE) Scenario | 1. Biomass : Step(2015,330, 2020,800, 2025,1190, 2030,1340) |
| | 2. Biogas : Step(2015,100, 2020,240, 2025,350, 2030,410) |
| | 3. Mini Hydro : Step(2015,290, 2020,490, 2025,490, 2030,490) |
| | 4. Solar : Step(2015,55, 2020,175, 2025,399, 2030,854) |
| | 5. MSW : Step(2015,200, 2020,360, 2025,380, 2030,390) |
| | 6. Biodiesel |
| | a. 5% share of diesel will be replace by biodiesel in market starts 2011 |
| Nuclear (NUC) Scenario | 1. Step(2023,2000) |
| APS Scenario | EEC + RE + NUC |

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Malaysia's final energy consumption experienced a high growth of 5.9 percent per year from 12.8 Mtoe in 1990 to 38.0 Mtoe in 2009. The transportation sector had the highest growth rate during this period at 6.5 percent per year followed by the others sector, growing at 6.4 percent. The industrial sector grew at 4.4 percent per year from 1990 until 2009 and non-energy sector grew at 8.4 percent at the same period. Analysis by fuel type shows that in 2009, oil dominating the share with 57.6 percent followed by electricity at 21.8 percent and natural gas at 16.1 percent. Coal that was mainly consumed by cement industry was at 4.2 percent share and remaining 0.3 percent share by others.

***Business-as-Usual (BAU) Scenario***

With the projected continuous economic growth of 3.1 percent per year and population growth of 0.9 percent per year, final energy consumption from 2009 to 2035 is projected to grow at an average rate of 4.7 percent per year in the BAU scenario. The

highest growth rate is expected to occur in the others sector at 5.5 percent per year. This was driven by anticipated of growth of activity in commercial sector. The distribution of GDP by the service sector will be expected to increase in the long run.

The non-energy sector will be expected to grow at 3.7 percent per year from 2009 until 2035. This is in line with Government announcement that PETRONAS will construct a US$20bil (RM60bil) 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 would comprise a crude oil refinery, a naphtha cracker that would produce about three million tonnes of ethylene, propylene, C4 and C5 olefins and a petrochemicals and polymer complex that would produce differentiated and highly-specialised chemicals.

The transport sector will remain favourable with expected growth rate at 4.1 percent per year from 2009 until 2035. Similarly, the industrial sector is expected to have an increasing growth rate at 5.6 percent.

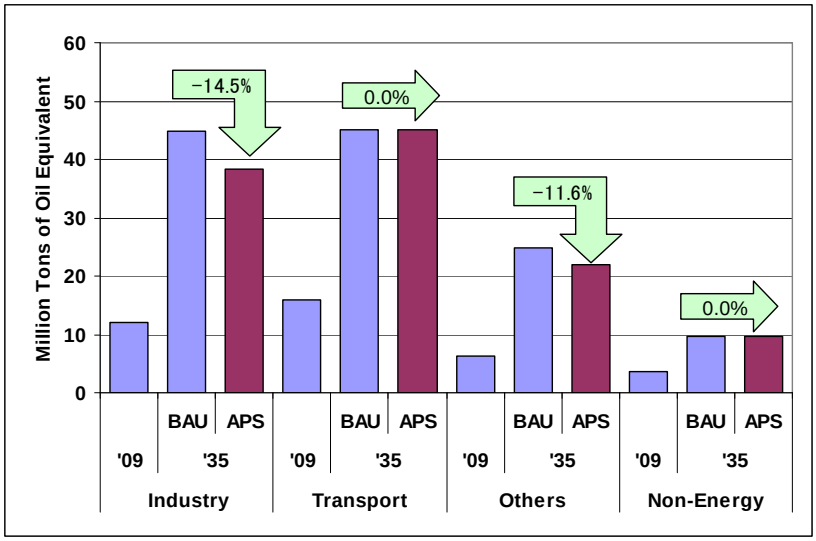
Analysis by fuel type shows that natural gas will be expected to increase at highest rate of 7.0 percent per year from 2009 until 2035, followed by electricity at 5.1 percent per year. Coal and oil products are expect to increase at 3.6 percent per year while "others" which is biomass, is expected to increase at 2.7 percent per year.

***Alternative Policy Scenario (APS)***

In the APS, growth in final energy consumption will be 4.3 percent, slightly lower compared to that of the BAU scenario from 2009 level until 2035. The slower rate of increase in the APS is projected to be the result of improvements in manufacturing technologies as well as efforts to improve energy efficiency, particularly in the industrial sector. However, there is no improvement on transportation sector as the APS scenario for the sector only concentrates on the fuel switching that is, from petrol to electricity and diesel to biodiesel. In the "others" sector, the growth rate of energy consumption is projected to have a lower growth rate of 5.0 percent per year in the APS as compared to 5.5 percent per year in the BAU scenario. This was due to lower growth of electricity consumption especially in the building sector by implementing energy efficiency

measures. The growth rates of energy consumption in non-energy sector will remain the same in the APS relative to the BAU scenario (Figure 11-1).

**Figure 11-1. Final Energy Consumption by Sector, BAU and APS**




### 3.2. Primary Energy Consumption

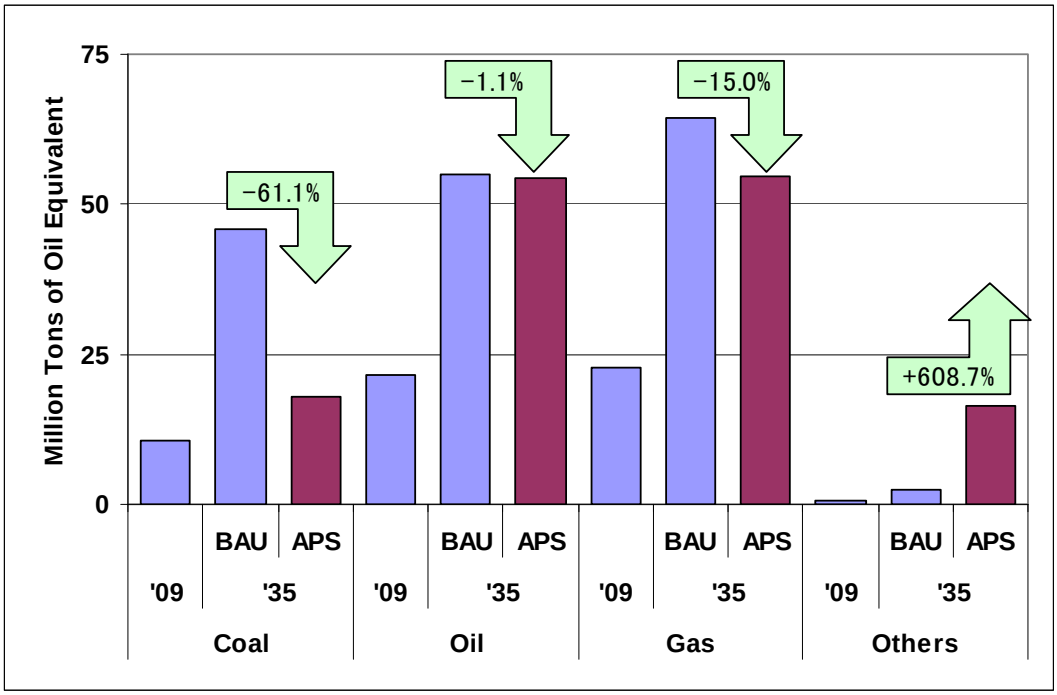
Primary energy consumption in Malaysia grew at an annual average rate of 5.3 percent from 20.6 Mtoe in 1990 to 55.4 Mtoe in 2009. Among the major energy sources, the fastest growing energy sources were coal and natural gas, increasing at average annual growth rates of 13.0 percent and 6.6 percent, respectively between 1990 and 2009. Oil and hydro grew at lower average annual growth rates of 3.0 percent during the same period.

***Business-as-Usual Scenario***

In the BAU scenario, Malaysia's primary energy consumption is projected to increase at an annual growth rate of 4.3 percent over the period 2009 to 167.4 Mtoe in 2035. Over the same period (2009-2035), coal is projected to be the fastest growing fuel increasing at an average annual growth rate of 5.8 percent followed by hydro and "others" at 4.1 percent and 4.7 percent, respectively. Natural gas is projected to remain the dominant fuel in primary energy consumption and its consumption is projected to

increase at an annual average growth rate of 4.1 percent between 2009 and 2035. The share of oil in primary energy demand is projected to decrease slightly from 38.8 percent in 2009 to 32.8 percent in 2035. However, the share of coal is projected to grow higher from 19.1 percent in 2009 to 27.3 percent in 2035. Natural gas share will be expected be lower in 2035 at 38.5 percent compared to 41.2 percent in 2009.

**Figure 11-2. Primary Energy Consumption by Source, BAU and APS**




***Alternative Policy Scenario***

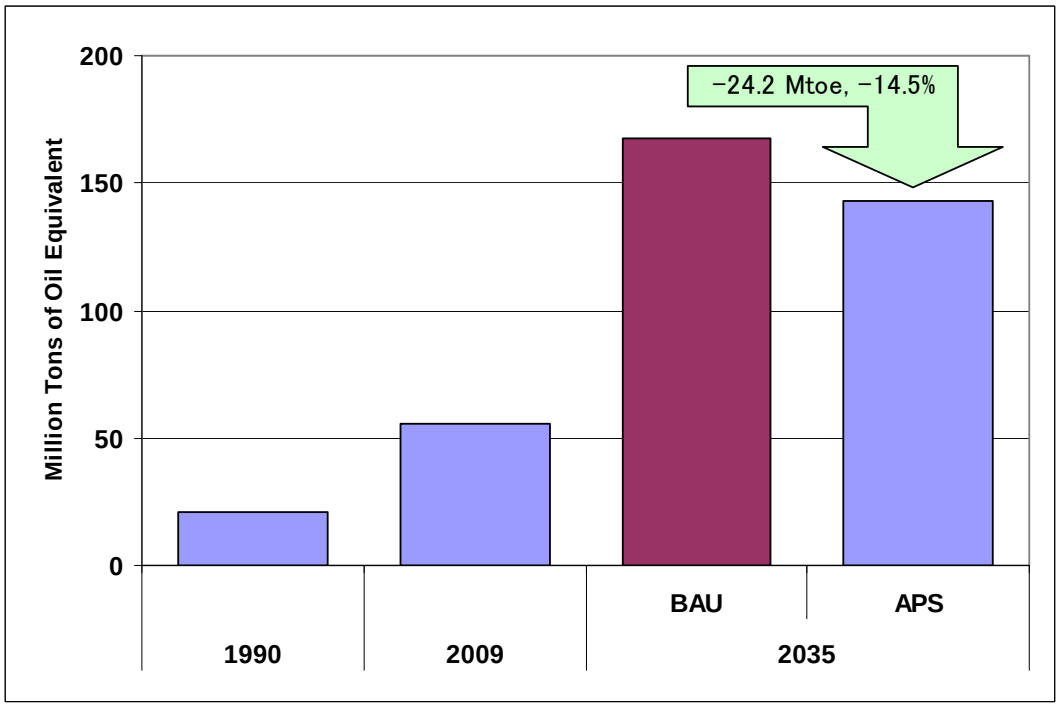
In the APS, primary energy consumption is projected to increase at a slower rate than in the BAU scenario at 3.7 percent per year from 55.4 Mtoe in 2009 to 143.2 Mtoe in 2035. Hydro will be growing the fastest at 5.1 percent per year followed by oil at 3.6 percent between 2009 and 2035. The implementation of FiT in power generation has a big impact to the primary energy consumption in 2035 as more renewable energy is expected to commission. However, natural gas and coal will have slower growth rates of 3.4 percent and 2.0 percent, respectively (Figure 11-2). 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 dependency on fossil fuels become less. Nuclear power as

one of the future energy option is also projected to increase in the future primary energy demand mix as zero carbon emission of energy supply.

### 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 24.2 Mtoe in 2035 (Figure ).

**Figure 11-3. Total Primary Energy Consumption, BAU and APS**




The major saving that can be achieved from that total is from switching coal to renewable energy and nuclear power. While for the final energy demand, the saving of 9.4 Mtoe can be achieved in 2035 based on APS assumption compared to BAU. The above savings in energy at 2035 consist of savings of 6.5 Mtoe in the industrial sector and 2.9 Mtoe in the commercial sector.

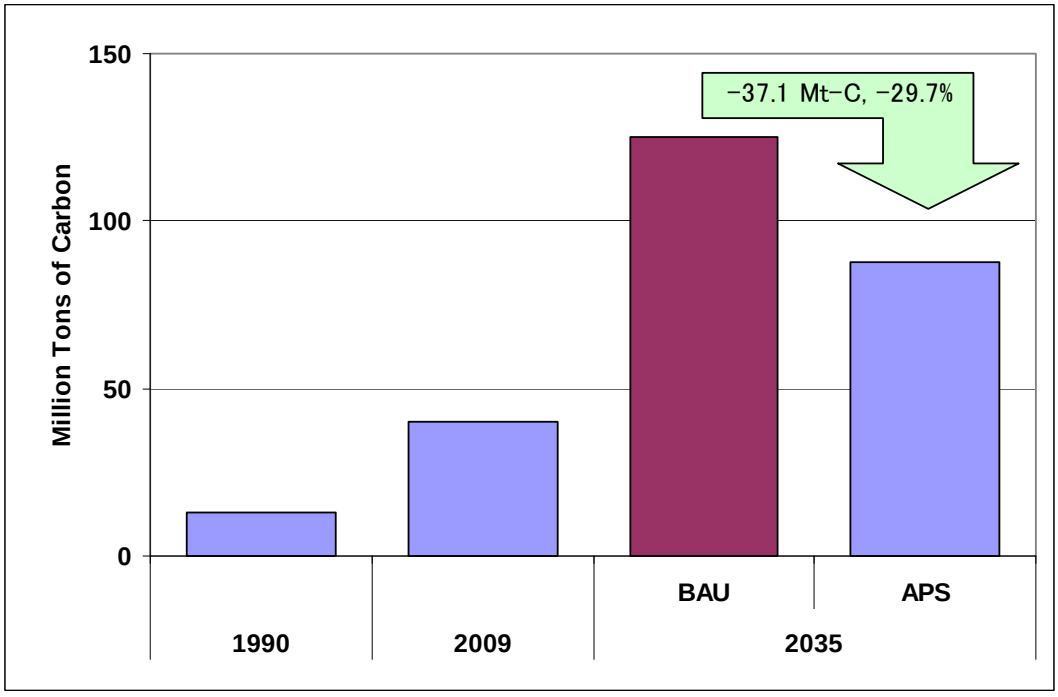
### 3.4. $CO_2$ Emissions from Energy Consumption

In the BAU, total carbon dioxide ($C0_2$) emissions from energy consumption are projected to increase by 4.5 percent per year from 2009 level until 2035. In 2009, the C02 level was at 40.0 million tons of carbon (Mt-C) and expected to increase to 125.0 Mt-C in 2035 under the BAU scenario.

In the APS, the annual increase in $C0_2$ emissions from 2009 to 2035 will be lower than in the BAU scenario at 3.1 percent per year, which is fairly consistent with the growth in primary energy consumption. The reduction in $C0_2$ emissions in the APS of 37.1 Mt-C or 29.7 percent relative to the BAU scenario is also due to a significant decrease in coal consumption for power generation in the APS, relative to the BAU scenario, as coal consumption is being replaced by natural gas and other clean energy sources such as nuclear and renewable energy. Furthermore, the lower energy usage in industrial and fuel switching in transport sector have also contributed to the reduction.

This indicates that Malaysia's energy saving effort and renewable energy action plan would be effective in reducing $C0_2$ emissions.

**Figure 11-4: $CO_2$ Emissions from Energy Combustion, BAU and APS**



## 4. Conclusions

Based on the GDP assumption until 2035 with selective possible scenarios that could be implemented to potentially save energy, Malaysia's primary energy intensity in the BAU scenario will be lower by 1.2 percent per year until 2035 from 2009 level. In APS scenario, primary energy intensity is expected to drop at 0.6 percent per year from 2009 until 2035. The reduction of primary energy intensity was due to efforts of energy saving measures undertaken by Malaysia in promoting energy efficiency and renewable energy. This was also contributed by programmes and activity under the Economic Transformation Programme (ETP) to increase diversification of the energy industry, step up exploration for new oil and gas resources, enhance production from known reserves, and encourage the use of alternative energy sources such as solar, hydro-electric and even nuclear.

Moving forward, to ensure the sustainable energy supply, in the next three years, over 50 exploration wells are expected to be drilled offshore Malaysia. Furthermore, the commissioning of regasification gas terminal in Peninsular Malaysia by 3Q 2012 should liberalised the natural gas market in Malaysia. Promotion of awareness in efficiency of energy utilisation will be increased in 2012 onwards. In the meantime the efficient management of energy programmes (Energy Performance Contracting) in 120 top energy-using government buildings will be further explored for implementation in all government buildings and private properties. In 2012 the target is to encourage individuals and households to install solar cells in their properties through the FiT campaign. This will incentivise local solar cell manufacturers to further expand growth in the local solar market. Other sources of renewable energy such as biomass, biogas and small hydroelectricity will be continuously promoted. A projected increase in demand for electricity, coupled with the Prime Minister's conditional commitment to reduce Malaysia's carbon intensity by up to 40 percent in 2020 as compared to 2005 levels has forced the government to reconsider the electricity generation mix in Malaysia. Under the nuclear energy for power generation initiative, the Malaysia Nuclear Power Corporation (MNPC) has been formed to lead the planning based on the current development timeline of 11 to 12 years, from pre-project to commissioning.

MNPC has since started its feasibility study and is expected to submit a detailed report to the Government in early 2013.

# Chapter 12

# Myanmar Country Report

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# CHAPTER 12

# Myanmar Country Report

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## 1. Background

Myanmar has a total land area of 676,600 square kilometres. It stretches for 936 kilometres from East to West and 2051 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 1.1 percent per year between 1990 and 2009 to about 50 million in 2009. Myanmar's gross domestic product (GDP) was US$ 19.3 billion (constant 2000) in 2009 and its GDP per capita grew from US$ 0.1 thousand in 1990 to US$ 0.4 thousand in 2009. 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 6.1 million tons of oil equivalent (Mtoe) in 2009. By fuel, gas represented the largest share at 52.1 percent; oil was second at 36.2 percent, followed by hydro with 7.4 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 2009. In 2009, thermal (coal, natural gas and oil) and hydro accounted for 28.5percent and 71.5 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 equipment and labelling of energy saving

appliances such as air-conditioner, motor & pump, electric appliances, etc.

- Encourage the private sector to implement the EE&C programs 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 consider EE&C in both demand and supply sides of electricity.
- There should be proper policy measures and action plans to achieve energy savings targets.

### 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 12-1. Energy Efficiency Initiatives**

| SECTORS | EEC INITATIVES |
|---|---|
| Industrial | - Promote introduction of equipment and facilities with high energy conservation capacity.<br>- Develop energy statistics<br>- Develop goals for voluntary action plans<br>- Develop R & D and AEMAS Program |
| Transportation | - Raise the fuel efficiency in terms of passenger-km, and km/liter, and<br>- Fuel substitution with biofuels |
| Electricity | - Develop technology transfer and renewable energy knowledge in rural area<br>- Assist sustainable renewable energy application in electricity generation |
| Household | - Labeling systems for buildings and appliances<br>- Develop demand side management programs<br>- 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 8.5 percent from 2009 to 2030. Growth was projected to be stronger from 2009 to 2020 at 8.7 percent per year and will taper off at 8.3 percent per year between 2020 and 2035. Population is assumed to increase by about 1.8 percent per year from 2009 to 2035.

## 2.2. 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 exploiting the abundant hydropower resources. Generation from natural gas power plants is expected to slightly increase over the period 2009-2035 in both the BAU and APS scenario. Output from hydro power plants is projected to increase significantly as the country plans to export electricity after 2020.

## 2.3. Energy Saving Goals and Action Plans

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

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 already in place although the amount of biofuel used in the country is still small for the time being.

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

- In the industrial sector, improve energy efficiency by 10 percent against BAU and reduce energy related greenhouse gases by 2020.
- In the transport sector, have biofuel (E85, biodiesel) substitution of at least 8 percent by 2020.
- Increase the total installed power capacity of renewable energy to 15-20 percent (around 18%) by 2020.
- Improve energy efficiency in the commercial/residential sector by 5-8 percent (around 7%) by 2020.

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

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

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

- In industry, gradual replacement of low efficiency equipment with higher efficiency alternatives will be encouraged.
- In the transportation sector, the state will encourage fuel switching in the transport sector to bio-fuels and natural gas as alternative fuels. The state also aims to achieve energy saving through exploiting more efficient transportation

networks including road, waterways, rail, air and seaway and develop high-capacity transportation with greater volume capacity for freight and passenger. Improvement in fuel efficiency in the transport sector is also considered.

- In the residential and commercial sectors, the following are the measures that will be implemented:
  - Encourage the use of alternative energy and improvement in energy efficiency in existing buildings in the public and private sectors.
  - Promote the use of higher energy efficient appliances and energy saving equipment in the residential and commercial sectors.
  - Launch the use of bio-diesel (B 100) in rural communities.
- In the electricity sector, the following measures that will be implemented are:
  - Develop and expand the energy mix and supply sources through utilization of the full energy potential of the country including frontier exploration and development and intensive research on oil, natural gas, coal, hydropower, geothermal, energy efficiency & conservation and new & renewable sources of energy.
  - Replace transformers and install the capacitor banks in main sub-stations. Optimize the voltage, conductor size and loading of transformers.

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Total final energy demand in Myanmar increased by about 7.6 percent per year from 1.0 Mtoe in 1990 to almost 4.0 Mtoe in 2009. The 'others' sector, which comprises the commercial, residential and agricultural sectors, was the fastest growing sector with an average annual growth of 16.8 percent between 1990 and 2009. Average annual growth in the industry and transport sector was 6.6 percent and 4.3 percent, respectively over the same period. The non-energy sector also grew by 4.3 percent per year over the same period. By fuel type, oil was the most consumed product in 1990

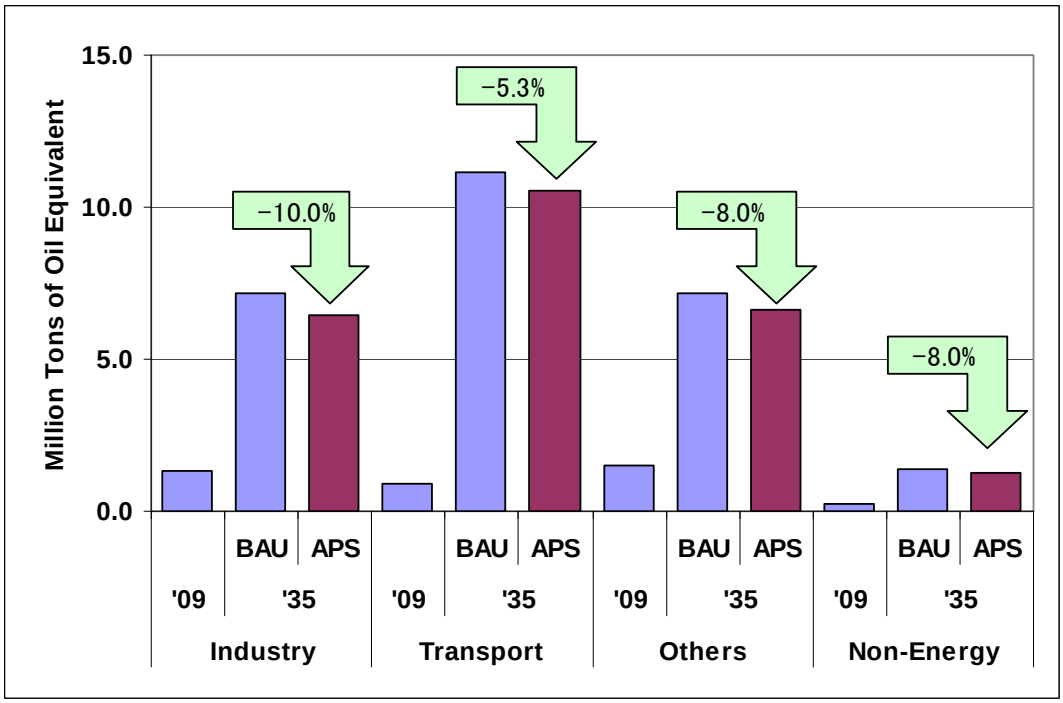
having a share of 57 percent in the total final energy demand of the country. Its share decreased to 28.8 percent in 2009 due to the rapid increase of natural gas consumption from 0.2 Mtoe in 1990 to 2.0 Mtoe in 2009.

***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 7.6 percent from 2009 to 2035 in the BAU scenario. Final energy demand is projected to grow the fastest to 2035 in the transportation sector with annual average growth of 10 percent. In the industry and others sectors, consumption is projected to grow at an annual average rate of 6.7 percent and 6.2 percent, respectively.

Natural gas is projected to increase over the period 2009-2035 but the growth rate is almost half of what it was over the 1990-2009 period. Consequently, the share of natural gas will decline from almost 50 percent in 2009 to 38.6 percent in 2035. In contrast, oil will become the dominant fuel with share increasing to almost 46 percent in 2035 from around 29 percent in 2009. Coal is projected to have an average annual growth rate of 6.4 percent in the period 2009-2035 driven by the projected growth in industrial GDP. The share of coal, however, will decrease from 3.6 percent in 2009 to 2.6 percent in 2035. Electricity demand will grow slower than oil and coal at an average annual growth rate of 5.8 percent per year over the period 2009-2035. Consequently, its share will decrease from 10.1 percent in 2009 to 6.5 percent in 2035.

**Figure 12-1: Final Energy Consumption by Sector, BAU and APS**




***Alternative Policy Scenario (APS)***

In the APS, the growth in final energy demand is projected to grow at a lower average annual rate of 7.3 percent as compared to the 7.6 percent annual growth in the BAU. The reason for the slower growth rate is the result of technological improvement in manufacturing processes and the reduction of final energy demand of electricity and oil in the other sectors. Figure 12-1 shows the sectoral final energy demand in Myanmar in the BAU and APS.

### 3.2 Primary Energy Demand

Primary energy Consumption in Myanmar grew at an average annual rate of 6.9 percent from 1.7 Mtoe in 1990 to 6.1 Mtoe in 2009. Among the major energy sources, the fastest growing were hydro and natural gas with average annual growth rates of 8.1 percent and 7.8 percent, respectively. Coal consumption grew at an average annual rate of 0.4 percent over the same period. Oil consumption increased at the rate of 6.2 percent per year on the average over the same period.

Oil and gas dominate the primary energy consumption mix in 2009 with respective shares of 36.2 percent and 52.1 percent, respectively.

***Business-as-Usual (BAU) Scenario***

In the BAU scenario, Myanmar's primary energy consumption is projected to increase at an annual average rate of 6.2 percent per year to 28.9 Mtoe in 2035. Hydro is expected to grow at an annual average rate of 12.8 percent followed by coal at 9.9 percent over the period 2009-2035. This rapid increase of hydro is in line with the Government's plan on expanding hydroelectricity for export purposes.

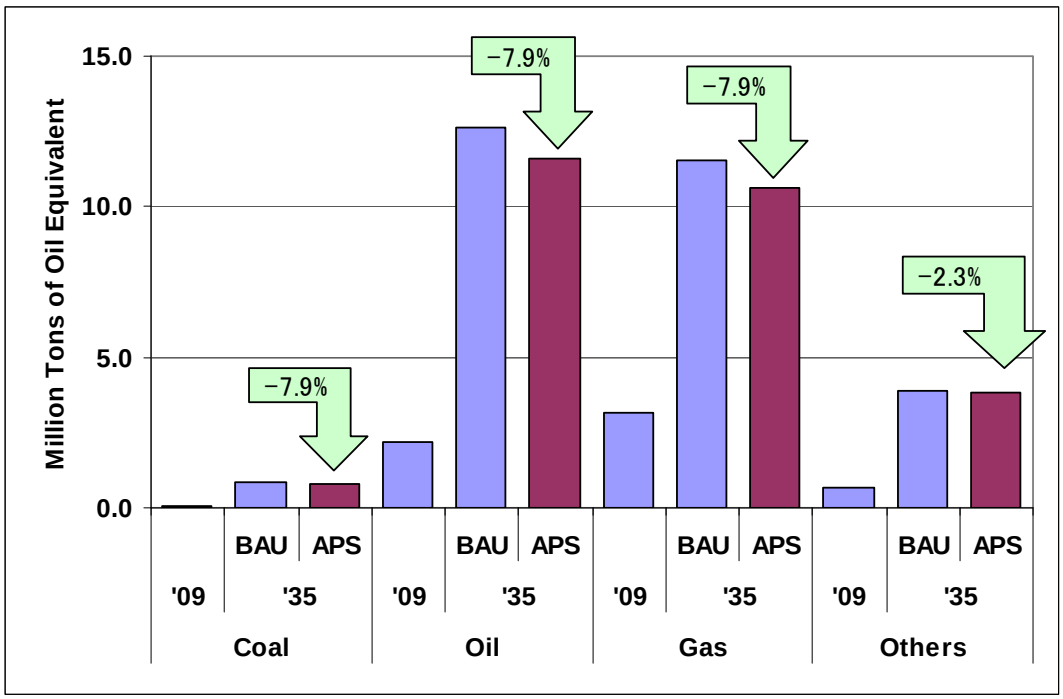
The share of hydro in the total primary energy mix of Myanmar will increase to 35.9 percent in 2035. However, since hydro will mainly be for electricity export, domestically, oil and gas will continue to dominate the primary energy mix through 2035. The shares of oil will increase further to 43.7 percent while the shares of gas will decline to 39.9 percent by 2035. Coal, on the other hand, will have an increasing share from and 1.2 percent in 2009 to 3.0 percent in 2035.

***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 5.9 percent per year from 6.1 Mtoe in 2009 to 26.8 Mtoe in 2035. Hydro will be the fastest growing at 12.7 percent per year followed by coal at 9.6 percent per year between 2009 and 2035. Natural gas is expected to grow at a lower annual rate of 4.7 percent over the same period, lower than oil which is

expected to grow at 6.6 percent per year. Figure 12-2 shows the future primary energy consumption mix in both the BAU scenario and APS.

**Figure 12-2: Primary Energy Demand by Source, 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 constraints, coefficients, derived by time series regression, had been applied to allocate energy. These allocations are made in accordance with the priority of the State organizations and enterprises. For the private sector, allocations are made in accordance with the registered licensed capacity of the firm.

Future saving in energy could be due to saving in primary energy consumption in the residential, commercial, transportation and industrial sectors. In this regard, Myanmar has implemented a range of energy efficiency and conservation goals and

action plans which target on energy savings in all sectors of the economy and in cooperation with both the private and public sectors. There is an estimated saving of 2.1 Mtoe in 2035 in the APS, relative to the BAU scenario. This is equivalent to 7.1 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.

**Figure 12-3: Total Primary Energy Demand, BAU and APS**

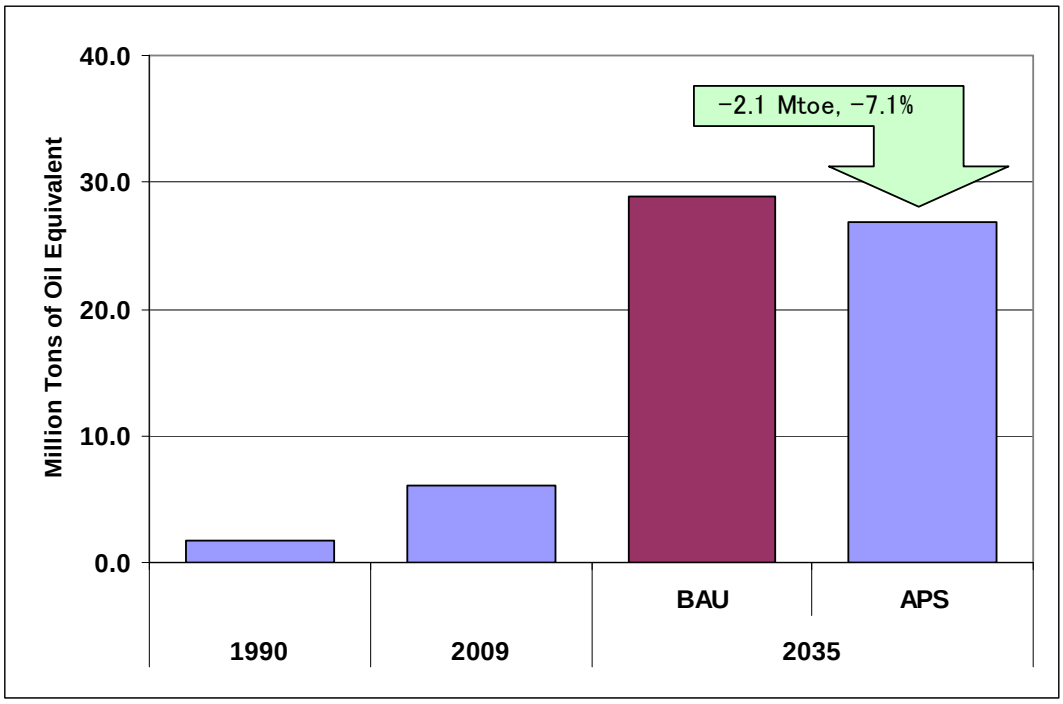
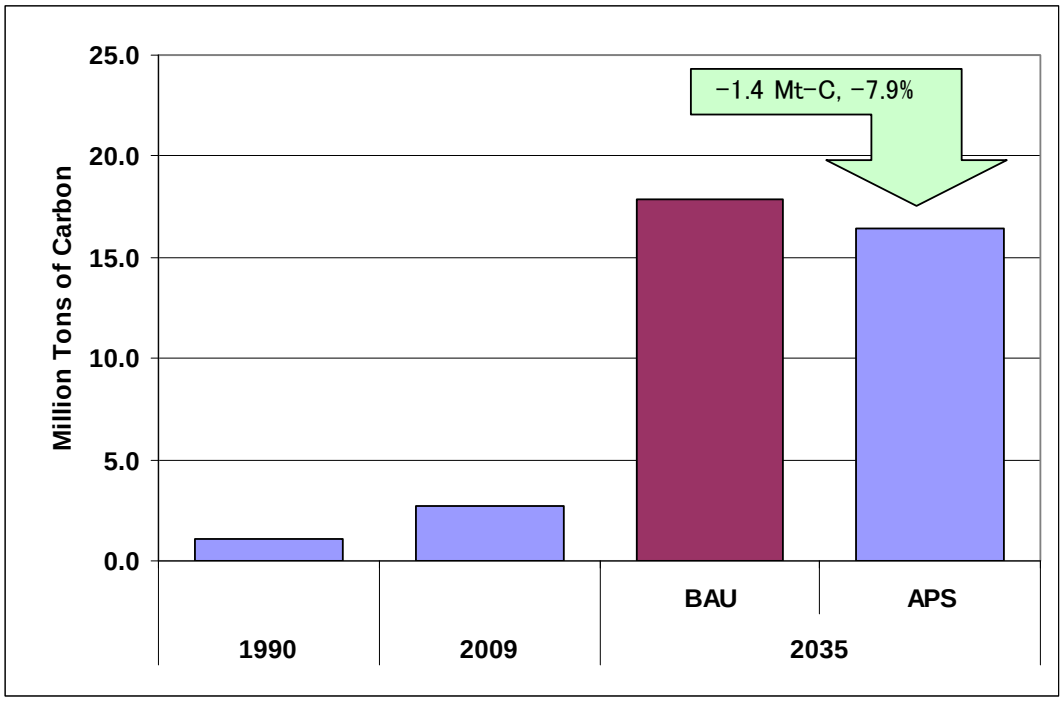


**Figure 12-4: $CO_2$ Emission from Energy Consumption, BAU and APS**




### 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. In 2035, in the APS, $CO_2$ emissions from energy consumption are projected to reach about 16.4 million tons of carbon (Mt-C) which is about 7.9 percent below the BAU level.

## 4. Implications and Policy Recommendations

Myanmar's primary energy intensity (TPES/GDP) has been declining since 1990. In 2009, the primary energy intensity was 316 toe/million 2000 USD, lower than what it was in 1990 which was 465 toe/million 2000 USD. It is projected that the intensity will continue to decrease at an average rate of 2.1 percent per year over the period 2009-2035.

Although energy intensity will decline, energy consumption is still increasing due to economic, population and vehicle population growth. Myanmar should increase adoption of energy efficient technologies to mitigate growth in energy consumption and

should also diversify energy availability. The energy saving will be targeted in the residential, commercial, transport and industry sectors.

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

- Better energy statistics would be needed for better analysis of energy saving potential in Myanmar
- Government needs more electricity supply to increase the electrification level– currently at 30 percent
- Myanmar needs a dedicated organization to implement energy efficiency policies and coordinate with other agencies and the private sector
- Hydropower would be the major source of electricity in the future in addition to the existing coal power plants and gas turbines; more infrastructure such as transmission lines would also be needed
- Myanmar needs international financial and technical assistance for energy efficiency and renewable energy
- Some industries are not efficient, these are being privatized aiming to operate these industries more efficiently after being retrofitted
- Need for public-private partnership for all energy projects including energy efficiency

# Chapter 13

# New Zealand Country Report

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June 2012

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# CHAPTER 13

# New Zealand Country Report

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## 1. Background

New Zealand is an island nation in the Pacific about 2000 km southeast of Australia. It consists of two main islands (the North Island and South Island), and a number of smaller, mostly uninhabited outer islands. The land area is approximately 269,000 square kilometres, making it smaller than Japan or Italy, but larger than the United Kingdom. Most of New Zealand is hilly or mountainous and has a mild temperate climate. The population is currently about 4.3 million. Although there is some light and heavy industry, foreign trade is heavily dependent on agriculture, tourism, forestry, and fishing. In 2009, New Zealand had a gross domestic product (GDP) of about US$62 billion, or about US$14,458 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 17.4 million tons of oil equivalent (Mtoe) in 2009. By fuel, oil represented the largest share at about 36 percent; gas was second at about 20 percent, followed by hydro, coal and geothermal,

each with around 8 percent. New Zealand obtains about 36 percent of its primary energy supply from renewable sources, including hydro, geothermal, woody biomass, and wind.

In 2005, electricity generation accounted for 58 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 53 percent of gas use, and industry sector for 21 percent while commercial and residential use accounted for most of the remainder. Reticulated natural gas is only available on the North Island. Transport accounted for an estimated 76 percent of New Zealand's oil consumption. In the transportation sector, New Zealand heavily depends on private road vehicles and air transport, with oil providing 99 percent of New Zealand's transport energy.

New Zealand had 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 2.3 percent between 2009 and 2035. Population will increase by 24.2 percent by 2035, relative to 2009 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. Coal use in electricity generation will move away, while natural gas use will increase at an average growth rate of 1.3 percent. Wind generation will continue to grow, but will still contribute only a small share on New Zealand's electricity by 2035.

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

production from new discoveries starting in 2012.

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

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

New Zealand's final energy consumption experienced a growth of 1.2 percent per year from 9.9 Mtoe in 1990 to 12.5 Mtoe in 2009. Oil was the most consumed energy source having a share of 40.6 percent in 1990 and increasing to 46.5 percent in 2009. Electricity was the second most consumed energy source.

### *Business as Usual Scenario*

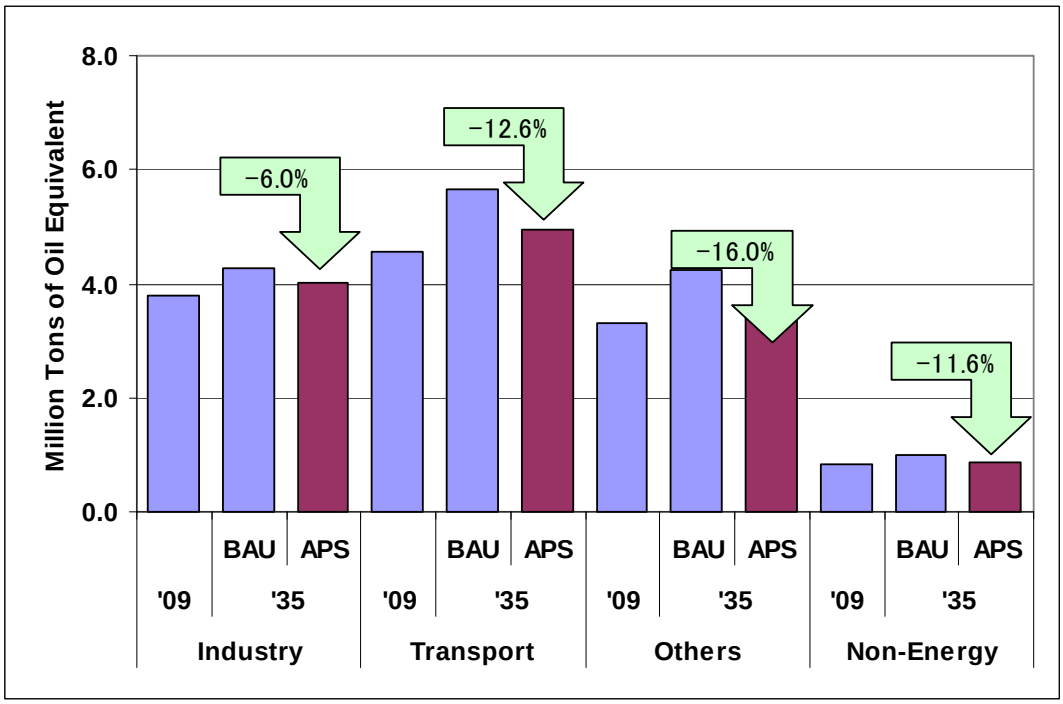
In the BAU scenario, final energy consumption from 2009 to 2035 is projected to grow at an average rate of 0.7 percent per year. The "Others" sector (primarily residential and commercial) will have the highest growth rate at 1.0 percent per year, and the transport sector will have the second highest growth rate at 0.8 percent per year. The industry sector consumption is projected to increase at a slow pace of 0.5 percent.

By fuel type, final consumption of electricity will increase at an average rate of 1.1 percent per year. Final consumption of oil and natural gas will increase by 0.6 percent and 0.4 percent, respectively. Meanwhile, final consumption of coal will decrease at an average rate of 1.8 percent per year.

***Alternative Policy Scenario***

In the APS, final energy consumption will increase at a rate of 0.3 percent per year from 12.5 Mtoe in 2009 to 13.4 Mtoe in 2035. Energy use in the transport sector will increase at an average of 0.3 percent per year, reflecting a shift to more energy efficient vehicles, particularly electric vehicles. Energy use in the 'Others' sector will increase by 0.3 percent per year, reflecting increased use of efficient appliances at the residential and commercial sectors. The sectoral final energy consumption in New Zealand in 2009 and 2035 in the BAU and APS is shown in Figure 13-1.

**Figure 13-1: Final Energy Consumption by Sector, BAU and APS**




## 3.2. Primary Energy Demand

Primary energy demand in New Zealand grew at a rate of 1.6 percent per year from 12.8 Mtoe in 1990 to 17.4 Mtoe in 2009. The fastest growing primary fuel in percentage terms was natural gas at 3.0 percent per year reflecting growing electricity demand. The fastest growing primary fuel in absolute terms was oil from 3.6 Mtoe in 1990 to 6.2 Mtoe in 2009. The increase in oil is due to the rapid growth in transport

energy demand. Natural gas declined at an average annual rate of 0.6 percent, reflecting the decrease in gas production from the Maui gas field. Geothermal consumption grew from 1.5 Mtoe in 1990 to 2.1 Mtoe in 2009 at an annual rate of 3.7 percent for electricity generation. Hydroelectricity production increased at a slower pace at 0.2 percent per year.

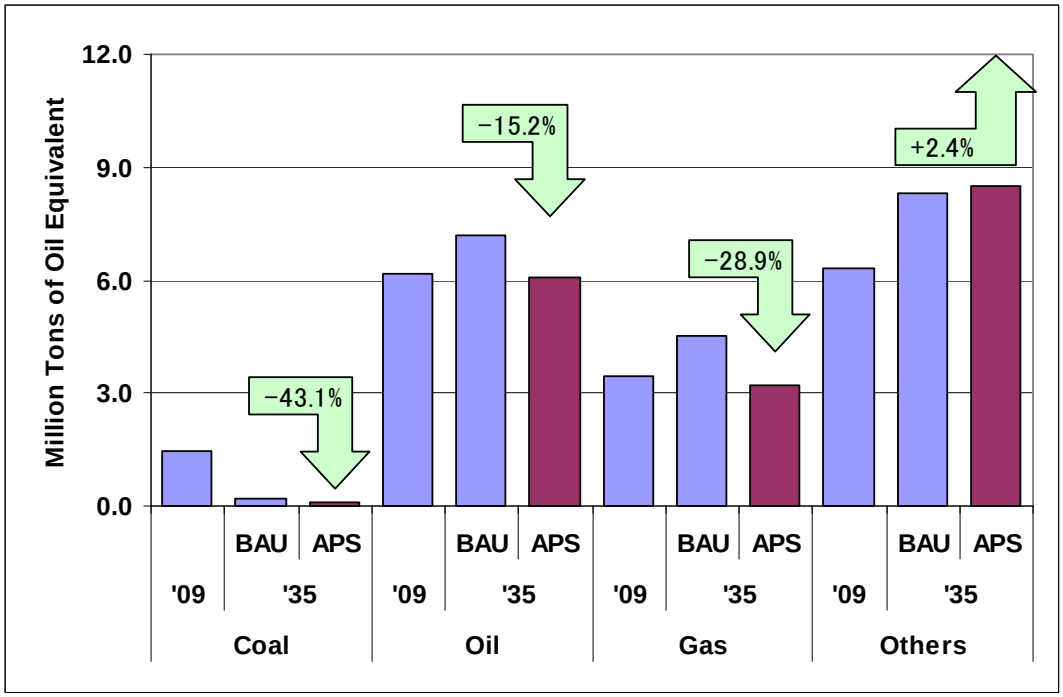
***Business as Usual Scenario***

In the BAU scenario, New Zealand's primary energy demand will grow at an annual rate of 0.6 percent per year to 120.2 Mtoe in 2035. To the incremental growth of primary energy demand between 2009 and 2035, oil contributes the most, accounting for an annual average share of 35.5 percent, followed by natural gas at 21.6 percent. This growth is mainly due to continued increases in oil and natural gas consumption at an annual rate of 0.6 percent and 1.0 percent, respectively. "Others" primary energy will grow by 2.9 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 0.1 percent per year to 17.9 Mtoe in 2035. Considering the 15% conversion efficiency of geothermal in electricity generation, primary energy demand will be almost the same in 2035 as it was in 2009. Geothermal primary energy is expected to grow by 0.6 percent per year, while 'others' primary energy, which includes wind and biomass, is expected to grow by 3.2 percent per year (note that the 'Others' shown in Figure 13-2 also includes hydro and geothermal). Oil and gas are expected to show modest declines of 0.1 percent and 0.3 percent per year, respectively. Coal will show a significant decline of 9.9 percent per year.

**Figure 13-2. Primary Energy Demand by Source, BAU and APS**

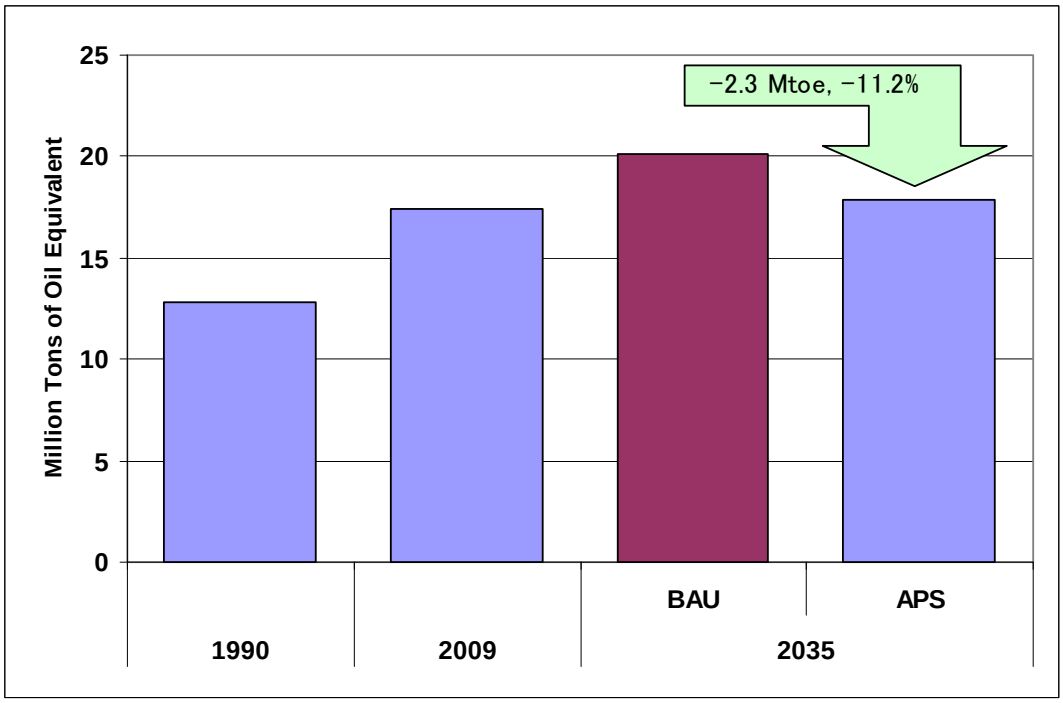



### 3.3. Projected Energy Savings

Under the APS, energy savings could amount to 2.3 Mtoe in 2035, the difference between the primary energy demands in the BAU scenario and the APS – 11.2 percent less than the BAU's in 2035 (Figure 13-3).

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

**Figure 13-3. Total Primary Energy Demand, BAU and APS**

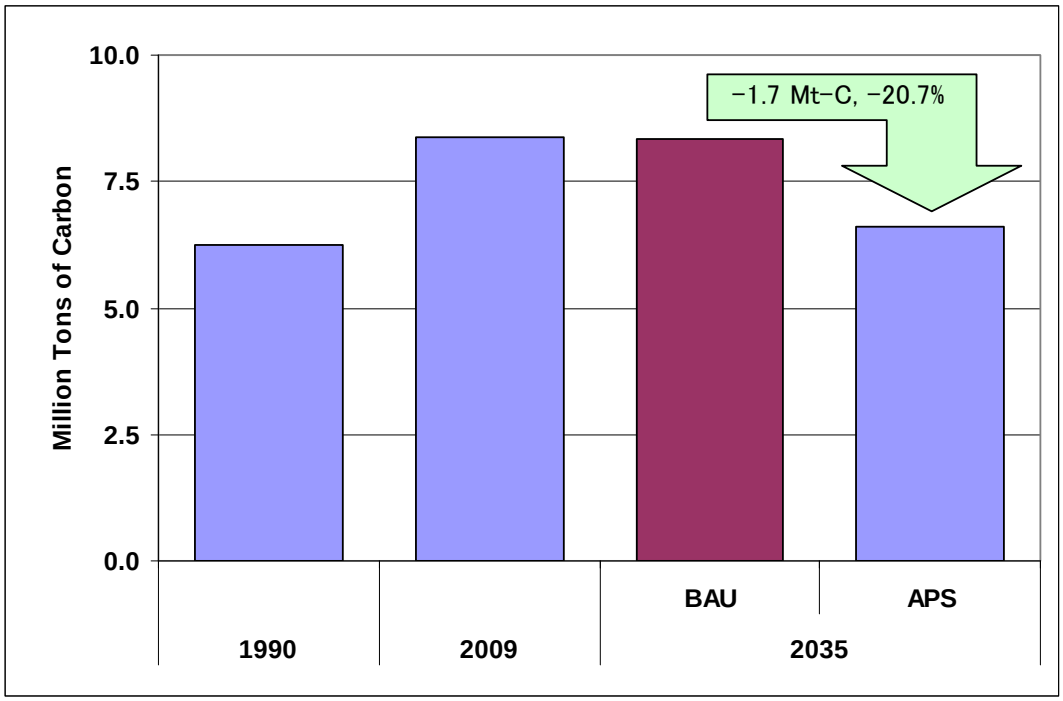



### 3.4. $CO_2$ Emissions

The carbon dioxide ($CO_2$) emissions in the BAU scenario will decrease by 0.01 percent per year from 9.0 million tons of carbon (Mt-C) in 2009 to 8.4 Mt-C in 2035. This decrease is roughly in line with decrease in coal primary energy demand.

In the APS, $CO_2$ emissions will decrease from 2009 to 2035 by 0.9 percent per year. Since primary energy demand, excluding geothermal is more or less stable over this period. The decrease reflects the switch to renewable energy in electricity generation, and the switch automobiles to electric vehicles in the transport sector. Figure 13-4 shows the $CO_2$ emissions from energy consumption in New Zealand from 2005 to 2035.

**Figure 13-4. $CO_2$ Emissions from Energy Combustion, BAU and APS**




## 4. Implications and Policy Recommendations

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

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

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

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

# Chapter 14

# Philippines Country Report

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June 2012

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# CHAPTER 14

# Philippines Country Report

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*Department of Energy (DOE), Philippines*

## 1. Background

### A. Socio-economic

The Philippines, officially known as The Republic of the Philippines, with Manila as its capital city is an archipelago comprising of 7107 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 meager increase of 3.7[1] percent in 2011 from 1.1 percent in 2009, despite the impact of international slowdown in Europe and United States and the typhoons towards the end of the year. The increase was driven by the catch up in government spending in the last quarter of 2011 and the increase in the services sector.

The 2010 population was estimated at 94.7[2] million from 92.2 million in 2009. The GDP per capita was about US$1,100[3] in the same year.

### B. 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

[1] National Accounts of the Philippines, National Statistics Coordination Board
[2] National Statistics Coordination Board.
[3] World Bank.

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 we do the least damage to the people and environment. Notwithstanding the fact that fossil fuels contribute significantly to the country's energy and electricity needs in view of its cost and reliability, the 60.0 percent energy self-sufficiency level target of the country 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.

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 the different economic sectors.

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

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

*Renewable Energy (RE)*

The passage of Republic Act No. 9513 or Renewable Energy Act of 2008 establishes policy and program framework to advance RE resources and technologies, and increase its utilisation. On June 14, 2011 the Government unveiled the National Renewable Energy Program (NREP) or the "Green Energy Roadmap" of the Philippines. The NREP is anchored on the DOE's Energy Reform Agenda, which aims to ensure greater energy supply security for the country. It establishes a policy and program framework for the promotion of renewable energy and a roadmap to guide efforts in realising the market penetration targets of each renewable energy resource in the country. The roadmap is targeting 15,304 MW installed RE capacity by 2030.

*Alternative Fuels for Transport*

Biofuels

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

The mandatory 1.0 percent biodiesel blend in all diesel fuel sold in the country in May 2007 was increased to 2.0 percent in February 2009 on a voluntary basis. On the other hand, the country now enjoys an accelerated use of E10 (10.0) bioethanol blend) as supplied by most of our gasoline retailers. For the year 2011 local production of biofuels reached 104 kTOE.

Compressed Natural Gas (CNG)

As of December 2011, there are 61 compressed natural gas (CNG) buses in the country of which 41 are commercially running. The CNG buses are plying the Manila-Batangas-Laguna routes. In addition there are 20 CNG buses that had completed technical evaluation and testing.

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 217 auto-LPG dispensing stations as of September 2011. To date, 31 auto-LPG conversion shops with Philippine National Standard (PNS) license are being monitored by the DOE to ensure safe operation and standards compliant conversion of gasoline fed motor vehicles to auto-LPG.

*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 2011, the country's total electrification level has reached 99.94 percent with 41,948 barangays already with access to electricity out of the 41,975 (formerly 41,980) barangays.

### C. Energy

The country's total primary energy supply in 2010 reached 40.7 million tons of oil equivalent (Mtoe). Oil accounted for 35.9 percent of the total energy supply followed by geothermal which comprised 21.0 percent. The country's total production reached 23.4 Mtoe making the country 57.5 percent self-sufficient.

Meanwhile, the country's total electricity generation in 2010 reached 67.7 terawatt-hours (TWh). Generation from coal-fired power plants dominated the power generation mix providing 34.4 percent or 23.3 TWh, while natural gas-fired power plants ranked second accounting for 28.80 percent or 19.5 TWh. Geothermal energy remained the 3rd largest provider of electricity with 14.7 percent share in the power generation mix of 2010.

## 2. Modelling Assumptions

This study used socio-economic indicators and energy policy assumptions that will affect the demand for energy in the future. It adopted most of the assumption used by the Philippines in updating the Philippine Energy Plan for 2011-2030.

The projections of growth rates of future GDP are based on the National Economic Development Authority (NEDA) target for 2012, GDP assumptions for 2013-2016 of DBCC, GDP projection for 2017-2020 of HSBC, and the GDP projections of "The World in 2050" company report projections released in January 2012 for 2021-2035.

Population growth is based on the adjusted 2000 Census-based medium population projections using the results of the 2007 census of population including the actual population level of 92.4 million for 2010 from the 2010 census of population.

The Philippine economy is projected to grow at a steady pace of 7.3 percent per year during the projection period 2009 to 2035. 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 1.5 percent from 2009 to 2035.

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. Further, the combined annual average share of renewable energy such as hydro, geothermal and other RE in the year 2009 constitute around more 36 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 renewable energy.

As part of the government’s initiatives to ensure security of energy supply and at the same time to conserve the environment and promote green technology, Republic Act No. 9513 or Renewable Energy Act of 2008 was passed into law in December 2008. Through the law, the National Renewable Energy Program was crafted. The NREP outlines the policy framework enshrined in Republic Act 9513. The NREP lays down the foundation for developing the country's renewable energy resources, stimulating investments in the RE sector, developing technologies, and providing the impetus for national and local renewable. The NREP sets out indicative interim targets for the delivery of renewable energy within the timeframe of 2011 to 2030.

Meanwhile, the intensified development and 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. A roadmap on electric vehicle is now being prepared by the Government to identify action plans and measures related to electric vehicles in the country.

Further, the energy saving goals of 10 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 also contributes to the energy saving goals. In the residential and commercial sectors, the utilisation of more efficient electrical appliance is projected to induce savings. Energy labelling and rating on major electrical appliance will help consumer to choose more efficient electrical products.

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

The Philippines' final energy consumption grew from 11.1 Mtoe in 1990 to 21.6 Mtoe in 2009 at an average growth rate of 3.6 percent per year. Over the period 1990-2009 energy demand in the transport sector grew the fastest at 4.6 percent per year followed by the residential/commercial (other) sector with average growth of 4.3 percent per year. The industrial sector grew by 1.9 percent per year. Oil was the most consumed fuel with a share of 69.2 percent in 1990 which decreased to 62.5 percent in 2009.

### *Business as Usual (BAU) Scenario*

Final energy consumption is expected to grow at an annual average rate of 6.2 percent in the BAU scenario over the period 2009-2035. This is due to increased activities in all sectors with the residential/commercial (other) sector growing the fastest

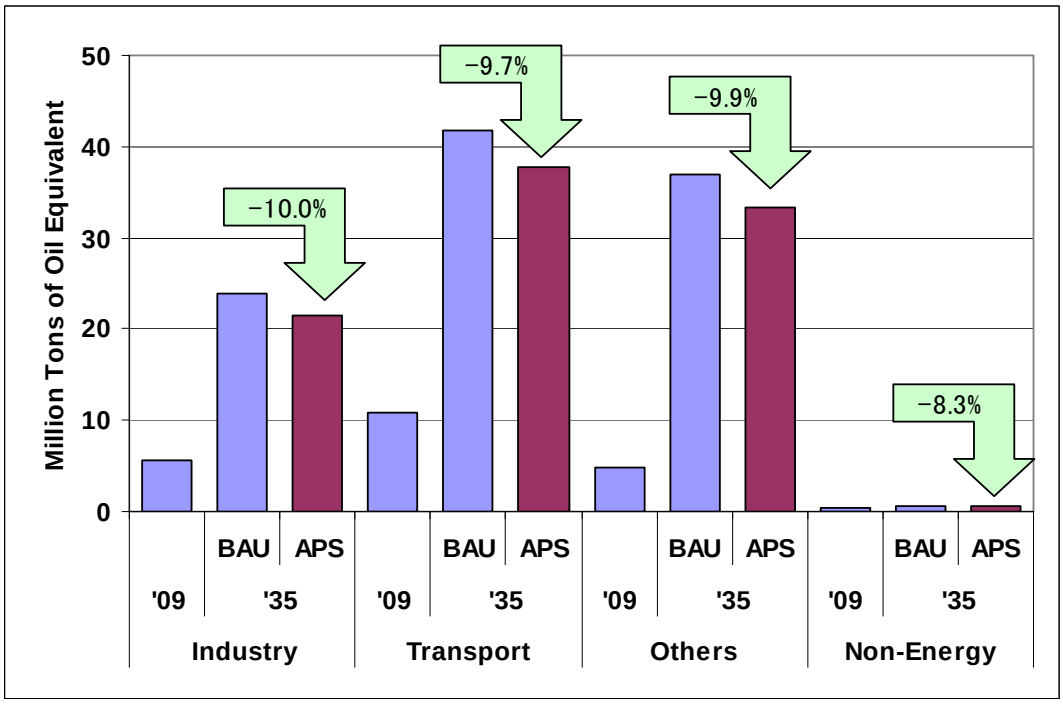
at 8.1 percent per year, followed by the industrial sector at an average rate of 5.7 percent per year.

In terms of fuel, electricity consumption is projected to grow the fastest at an average rate of 7.8 percent per year followed by others at an average rate of 6.6 percent and oil at an average rate of 5.8 percent per year from 2009 to 2035. Coal will grow at an average annual rate of 2.8 percent over the same period.

***Alternative Policy Scenario***

In the APS, final energy consumption is projected to increase at a slower average rate of 5.8 percent per year from 21.6 Mtoe in 2009 to 93.1 Mtoe in 2035. All sectors will increase with the residential/commercial (other) sector growing the fastest at an average annual growth at 7.7 percent between 2009 and 2035. The industrial sector is projected to follow with an annual growth of 5.3 percent over the same period. Meanwhile, the transport sector is expected to grow at an annual average rate of 4.9 percent. The projected final energy consumption in the BAU and APS are shown in Figure .

**Figure 14-1: Final Energy Consumption by Sector, BAU and APS**



### 3.1. Primary Energy Demand

Primary energy demand in the Philippines grew at an annual average rate of 4.2 percent, from 18.6 Mtoe in 1990 to 40.7 Mtoe in 2009. Among the major energy sources, consumption of coal grew the fastest at 9.4 percent per year followed by other (renewable energy) at 5.2 percent per year and geothermal at 4.9 percent per year. Oil grew only at an average annual rate of 1.7 percent and hydro at 2.5 percent between 1990 and 2009. For the period 1990 to 2009, oil accounts for the largest share on the total energy supply of the country but with decreasing share from 60.3 percent n 1990 to 38.0 percent in 2009, respectively.

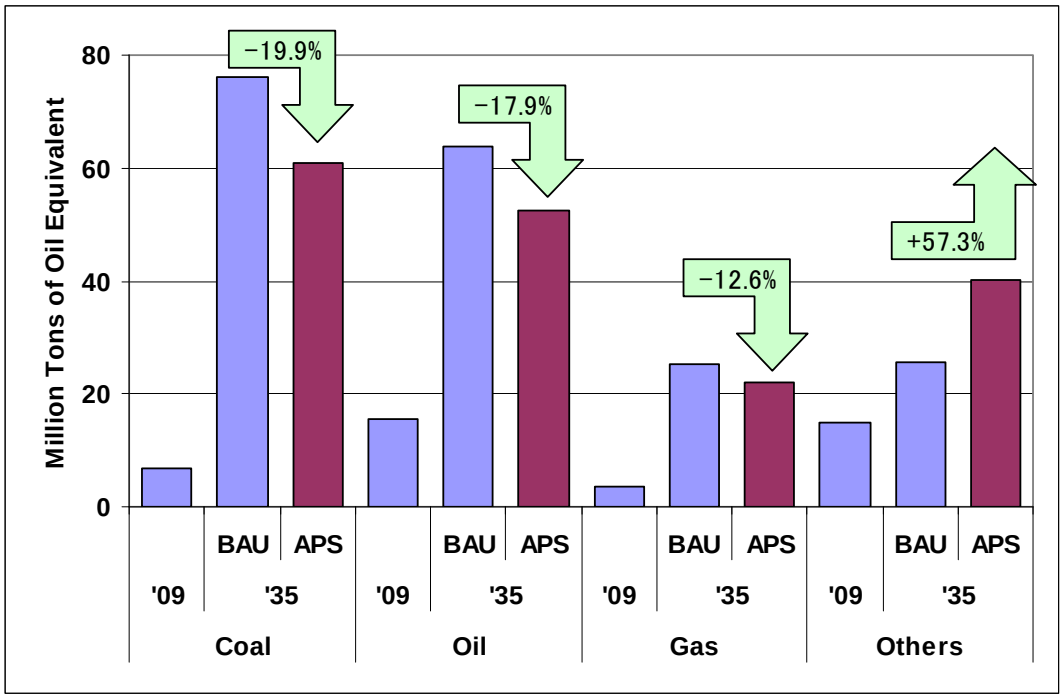
***Business as Usual (BAU) Scenario***

In the BAU scenario, the Philippines' primary energy demand is expected to increase by 6.1 percent per year from 40.7 Mtoe in 2009 to 190.8 Mtoe in 2035. Demand for all major energy sources is projected to increase with coal use growing the fastest at 9.7 percent per year from 2009 to 2035. Natural gas is also expected to expand with a growth rate of 8.0 percent per year during the same period. Coal will be the country's major energy source in 2035 comprising 39.9 percent of the TPES. Meanwhile, oil will be the second largest energy source in 2035 with a share of 33.5 percent.

***Alternative Policy Scenario***

In the APS, primary energy demand is projected to increase at an annual average rate of 5.8 percent increasing from 40.7 Mtoe in 2009 to 175.6 Mtoe in 2035. Although, coal accounts for the largest share in the total primary supply in 2035, its average annual growth rate would be lower at 8.8 percent as compared to the 9.7 percent in the BAU for the period 2005-2035. Natural gas consumption will grow at an annual average growth rate of 7.4 percent while oil will grow at an annual average growth rate of 4.8 percent for the same period.

**Figure 14-2: Primary Energy Demand by Source, BAU and APS**



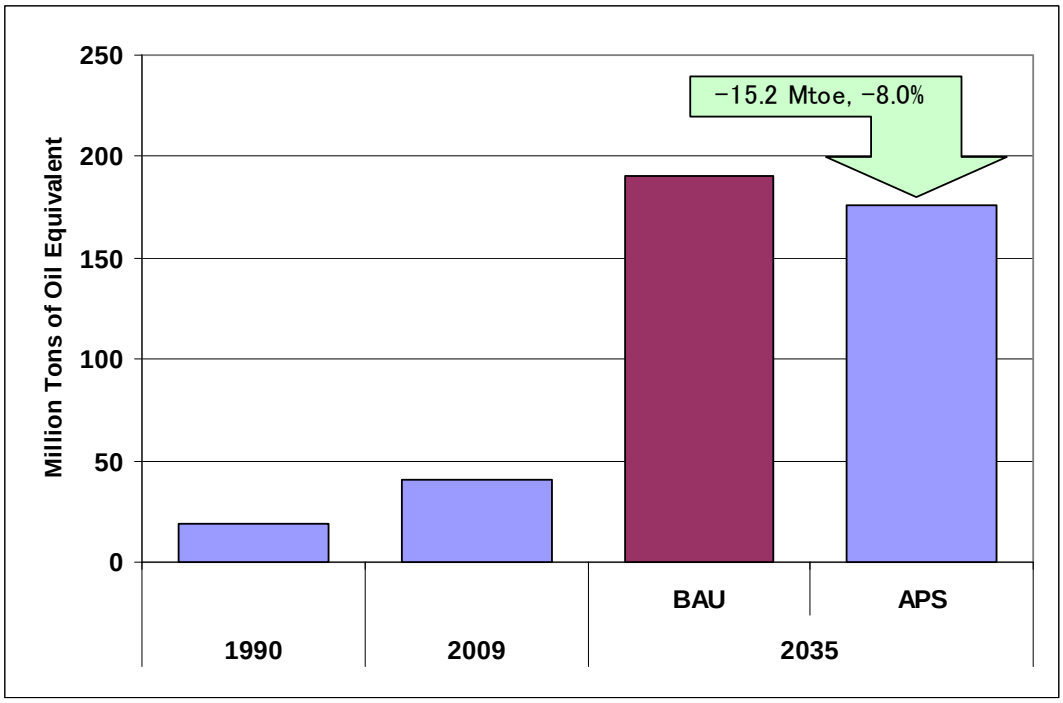

The share of renewable energy sources such as hydro, geothermal and "others" (including solar, wind, biomass and biofuels) will increase further in 2020-2035 with the full operation of the Renewable Energy Law. Compared to the BAU, the share of hydro in the year 2020 will increase by 96.8 percent from 0.5 percent in the BAU to 1.3 percent in the APS. The share of geothermal will also be higher at 12.2 percent compared to the BAU's 6.5 percent.

Figure shows the primary energy demand by source in the Philippines in 2009 and 2035 both in the BAU and APS.

### 3.2. Projected Energy Savings

In 2035, it is estimated that the EEC goals, action plans and policies of the Philippines could result in savings of 15.2 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure 14-3). This level is just a little lower than the Philippine's total energy consumption in 1990. At current oil prices (2011), this could lead to US$ 12.4 billion of oil import savings.

**Figure 14-3: Total Primary Energy Demand, BAU and APS**

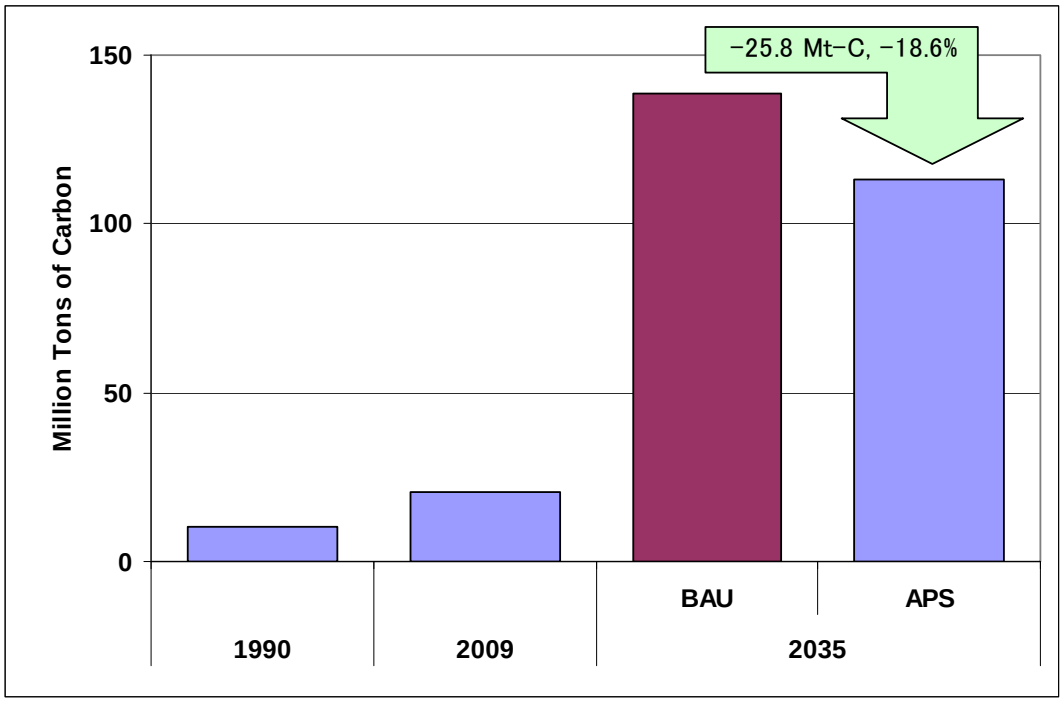



In terms of final energy consumption savings, the following savings were projected in the APS relative to the BAU scenario in the year 2035: residential/commercial (other) sector with 3.6 Mtoe, transport sector with 4.0 Mtoe and 2.4 Mtoe from the industry sector.

### 3.4. $CO_2$ Emissions from Energy Consumption

Carbon dioxide ($CO_2$) emissions from energy consumption are projected to increase by 7.6 percent annually from 20.8 million tonnes of carbon (Mt-C) in 2009 to 138.8 Mt-C in 2035 in the BAU scenario. However, in the APS, $CO_2$ emissions are projected to be reduced by almost 18.6 percent in 2035 relative to the BAU scenario (Figure 14-4). 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 14-4: $CO_2$ Emission from Energy Consumption, BAU and APS**




## 4. Implications and Policy Recommendations

In 2035 total final energy savings of 15.2 Mtoe could be achieved in the APS relative to the BAU. This is equivalent to a 9.8 percent reduction in total final energy consumption, an 8.0 percent reduction in the primary energy demand, 18.6% reduction in $CO_2$ emission and an equivalent savings of US$12.4 billion on oil importation.

Responses to surging oil prices and their inflationary effects on the prices of basic commodities will contribute to lower the energy to GDP intensity level. Improvement in the energy intensity of the Philippines to 2035 is expected to be driven in part by the country's changing economic structure to rely more on its service sector rather than on energy intensive industries.

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. With this, the Philippines should fast-track the approval of the Feed-in-Tariff (Fit) as well as facilitate the Renewable Portfolio Standard (RPS). The FiT and RPS are mechanisms that will boost the utilisation of RE.

Additionally the use of alternative fuels such as CNG, autogas (LPG for transportation), biofuels and electric vehicles for transport will reduce the effects of continuous increases in the prices of crude oil in the world market as well as reduce greenhouse gas emissions. Moreover, special attention must be directed to the transport sector since bulk of the energy requirement of the country comes from the transport sector. The DOE together with other government related to the transport sector should come up with additional policies that will lessen consumption in this sector.

Aside from the transport sector, the industrial sector is also one of the sectors that should be given focus since it is one of the most intensive energy consuming sectors of the country.

The country must set a quantitative sectoral energy savings target for easy evaluation and monitoring. To institutionalise energy efficiency and conservation, incentives towards greater participation is needed. Currently, the Philippines has a specific quantitative energy saving requirement as provided under Administrative Order (AO) No. 110, "Directing the Institutionalization of a Government Energy Management Program". The AO requires the reduction of at least ten percent (10%) in the cost of the consumption of fuel and electricity among others in the government. This can be duplicated or expanded to other sectors if there is an existing energy conservation law which will require strict regulation and implementation.

Finally, there is a need to pass the Energy Conservation Law to realise the targets set by the government. The Law will institutionalize energy conservation and enhance the efficient use of energy in the country, thereby making it a "People's Way of Life

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# Chapter 15

# Singapore Country Report

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# CHAPTER 15

# Singapore Country Report

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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 the policy objectives of economic competitiveness, energy security and environmental sustainability. [1] Singapore has a national target of improving energy intensity by 20 percent by 2020 and by 35 percent by 2030 compared with 2005.[2] It also has a voluntary target of reducing carbon dioxide ($CO_2$) emissions by 7-11 percent below business-as-usual levels in 2020.[3] This will be increased to 16 percent below business-as-usual levels if there is a global agreement on climate change.

### *Singapore's Policy Initiatives*

In May 2007, the National Environment Agency (NEA) of Singapore set up the inter-agency Energy Efficiency Programme Office ($E^2PO$) to identify and implement measures to improve Singapore's energy efficiency in six priority areas, namely, power

[1] Ministry of Trade and Industry of Singapore (2007). National Energy Policy Report - Energy for Growth, from http://app.mti.gov.sg/data/pages/2546/doc/NEPR.pdf.
[2] Singapore Government (2009). The Sustainable Development Blueprint, from http://app.mewr.gov.sg/data/ImgCont/1292/sustainblebluepr int_forweb.pdf.
[3] National Climate Change Secretariat (2012). Speech on Climate Change by Mr Teo Chee Hean, Deputy Prime Minister, Coordinating Minister for National Security and Minister for Home Affairs, at the Committee of Supply Debate, from http://app.nccs.gov.sg/news_details.aspx?nid=642&pageid=97.

generation, industry, transport, buildings, the public sector and households.[4]

Since January 2008, the Mandatory Energy Labelling Scheme (MELS) has required that household appliances have energy labels.[5] Currently, all refrigerators, air-conditioners and clothes dryers sold in Singapore must have an energy label. NEA is reviewing the design of energy labels and is looking to incorporate the estimated energy cost of operating appliances to help consumers make more informed choices.[6] The mandatory energy labelling scheme will improve energy efficiency and mitigate growth of energy use in the residential, commercial and transport sectors. The NEA launched a "10% Energy Challenge" national campaign in 2008 to promote electricity saving in households.[7] It should be noted 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.

After introducing the MELS and the Fuel Economy Labelling Scheme (FELS), NEA subsequently implemented Minimum Energy Performance Standards (MEPS) for household air conditioners and refrigerators. MEPS eliminate energy inefficient appliances from the market by prohibiting the sale of appliances that fall short of a specified minimum efficiency level. It helps consumers avoid being locked into using inefficient appliances with high operating costs and encourages suppliers to bring more energy-efficient appliances to the market as technology improves.

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 undergoing major retrofitting works with a gross floor area above 2000 square

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[4] Energy Efficiency Programme Office of Singapore (2009). National Environment Agency's Labelling Schemes on Energy and Fuel Efficiency to Start In April 09, from http://www.e2singapore.gov.sg/news_310309.html.

[5] National Environment Agency. About Mandatory Energy Labelling, from http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=258.

[6] Ministry for the Environment and Water Resources (2012). Written Reply by Dr Vivian Balakrishnan, to Parliamentary Question on Water/Energy Efficiency & Fuel Economy Labelling, from http://app.mewr.gov.sg/web/contents/Contents.aspx?Yr=2012&ContId=1520.

[7] National Environment Agency (2008). NEA to households: cut your energy bills by 10%, from http://app2.nea.gov.sg/news_detail_2008.aspx?news_sid=20080715639643177734.

metres must meet Green Mark Certified standards. The BCA Green Mark Scheme promotes the adoption of green building technologies and reduces the use of electricity in the commercial sector via efficiency improvements and conservation.[8] The BCA is developing a web-based carbon emission calculator that takes into account a building's lifespan and major construction materials.[9] In the case of building standards, there are some uncertainties as to how effective these standards will be in the long run, even if relatively detailed calculations about expected energy savings from engineering measurements can be made.

Certificates of Entitlement (COEs) give Singaporeans the right to own a vehicle. COEs are integral to the Vehicle Quota System (VQS), a landmark scheme implemented to regulate the growth of the vehicle population in Singapore. Under the VQS, the vehicle population growth rate has been capped at 1.5 percent per year between 2009 and 2011,[10] down from the 3 percent cap in place three years ago given the constrained expansion of roads and highways in Singapore's urban environment. The actual compound annual growth rate of the vehicle population between 1990 and 2008 was 2.8 percent per year. The Land Transport Authority (LTA) has announced new vehicle growth rates for the next 3 quota years (2012-2014); the annual vehicle growth rate will be reduced to 1.0 percent in 2012 and 0.5 percent in 2013 and 2014.[11]

The Fuel Economy Labelling Scheme (FELS) mandated fuel economy labels to be affixed to vehicles at the point of sale. The FELS has been complemented by a Green Vehicle Rebate (GVR) Scheme which provides rebates of up to 40 percent of the vehicle's Open Market Value for green vehicles such as electric, petro-electric hybrid, Compressed Natural Gas (CNG) and Bi-fuel (CNG/Petrol) vehicles, narrowing their cost differentials. The GVR seeks to encourage the purchase of green vehicles, which

[8] Building and Construction Authority Singapore. 2nd Green Building Masterplan, from http://www.bca.gov.sg/GreenMark/others/gbmp2.pdf.

[9] National Climate Change Secretariat (2012). Responses to Feedback on Building Sector, from http://app.nccs.gov.sg/page.aspx?pageid=146&secid=128.

[10] Land Transport Authority (2010).Change to the Vehicle Quota System (VQS) Methodology and Certificate of Entitlement (COE), from http://app.lta.gov.sg/corp_press_content.asp?start=p66ynmbgdeyuq369f24rmd9t76bh1s172h0315j6ydswsl8gfe.

[11] Lower Vehicle Growth Rate for Next 3 Quota Years (2011). News Releases of Land Transport Authority Singapore, from http://app.lta.gov.sg/corp_press_content.asp?start=v2b51fpnwad6ob8wc32o08pc24dxdz8bmsj859wfc2u2otg153.

are more fuel efficient and emit less air pollutants than their internal combustion equivalents.

Just after the current Rebate Scheme based on engine type expires on 31 December 2012, buyers of cars with low carbon dioxide emissions (≤ 160 g carbon emissions per kilometre) will enjoy tax rebates (of up to SGD 20,000) to offset the Additional Registration Fee[12]. This is referred to as the Carbon Emission-based Vehicle Scheme (CEVS). To give consumers and the automobile industry more time to adjust, those who buy cars with high $CO_2$ emission (≥ 211 $gCO_2$/km) will face registration surcharges (of up to SGD 20,000) levied in cash six months later (July 2013). The majority of car buyers will not be affected either way by the new Scheme if they keep to their usual buying patterns. Around 60 percent of cars registered in 2011 fall into a neutral category (with 161-210 $gCO_2$/km carbon dioxide emission), implying neither rebates nor surcharges will be faced.[13] The new Scheme will be in place for two years and be reviewed at the end of 2014.

The Government launched the Energy Efficiency National Partnership (EENP) programme in 2010 to help companies put in place energy management systems and implement projects to improve energy efficiency. The Government introduced mandatory energy management requirements for large energy users who consume more than 15GWh in the industry sector. Large energy users will soon have to appoint an energy manager, monitor and report energy use and greenhouse gas emissions and submit energy efficiency improvement plans to the government.[14] The Energy Conservation Bill, which was passed in Parliament on 9 April 2012, consolidates laws on energy efficiency. The Energy Conservation Act will be jointly administered by the Ministry of Environment and Water Resources, which will oversee the measures in the industry and household sectors and the Transport Ministry, which will oversee the

[12] Additional Registration Fee is a tax imposed upon registration of a vehicle and calculated based on a percentage of the Open Market Value of the vehicle.
[13] Ministry of Transport (2012). Speech by Mr Lui Tuck Yew, Minister for Transport, for COS 2012 from http://www.straitstimes.com/mnt/html/parliament/mar7-luituckyew-pt2.pdf.
[14] Ministry of the Environment and Water Resources. Energy Conservation Act Factsheet, FROM http://app.mewr.gov.sg/data/ImgCont/1386/2.%20Factsheet_Energy%20Conservation%20Act%20%5Bweb%5D.pdf.

transport measures.[15]

## 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 the end of 2011, while the "Alternative Policy Scenario" (APS) projects energy use and $CO_2$ emissions in the 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 2009, the overall thermal efficiency of gas fired power plants was 42 percent. According to the International Energy Agency (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.[16] It is assumed that the efficiency of gas and thermal power plants will improve under both the BAU and APS scenarios. By 2035, it is assumed that gas-fired turbines will attain 54 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 2035.

Another assumption made is that gasoline consumption is linearly proportional to Singapore's car population. The LTA has capped the growth rate of vehicles at 1.5 percent between 2009 and 2011. The annual vehicle population growth rate will be reduced to 1.0 percent in 2012 and then to 0.5 percent thereafter.

A joint study conducted by the Building and Construction Authority (BCA) and the National University of Singapore (NUS) demonstrated that retrofitting to achieve the standard BCA Green Mark certification can result in a 17 percent reduction in energy

[15] Ministry of the Environment and Water Resources (2012). Second Reading Speech by Minister for the Environment and Water Resources, Dr Vivian Balakrishnan, on the Energy Conservation Bill in Parliament on 9 April 2012 from http://app.mewr.gov.sg/web/Contents/Contents.aspx?Yr=2012&ContId=1548.

[16] International Energy Agency (2010). Projected costs of generation electricity, page 102.

consumption.[17] If measured by the area of the buildings where owners are responsible for paying for the utilities, the average savings are even higher at nearly 30 percent. In 2005, the total number of buildings awarded the Green Mark Scheme was 17. As at February 2012, there were 1000 Green Mark building projects in Singapore.[18] At this rate, Singapore is on track to achieve its target of having 80 percent of its existing and future buildings Green- Mark-certified by 2030.[19] In the commercial sector, given our understanding of the vintage of the building stock in Singapore and building stock replacement rates, a 17 percent reduction in electricity use relative to the baseline case in the BAU scenario, and a 20 percent reduction in the APS has been assumed.

With reference to the IEA's Energy Technology Transitions for Industry 2009, the application of Best Available Technology (BAT) could reduce energy use in the industry sector by 13-29 percent.[20] Therefore, the energy saving potential in the industry sector is assumed to be 5 percent and 10 percent in 2030 in the BAU and APS scenarios respectively.

Singapore has a long-term aim of expanding ethylene production to a range of 6-8 million tonnes per year by 2020.[21] Singapore's petrochemical complex primarily uses LPG and naphtha to produce olefins, ethylene, and propylene. Most ethylene plants in Singapore are naphtha-based; therefore, capacity additions in the petrochemical sector will affect naphtha demand. In 2009, naphtha accounted for 99 percent of the petrochemical feedstock in Singapore and LPG 1 percent.[22] According to the IEA, 155 GJ of naphtha is required to produce one tonne of ethylene. If the share of naphtha in the production of ethylene increases to 100 percent by 2020 and the above conversion factor is used, the production of 6 million tonnes of ethylene implies the consumption of 22.2 Mtoe of naphtha in the non-energy sector.

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[17] Yu, S.M., Tu, Y., Luo, C.X. (2011). Green Retrofitting Costs and Benefits: A New Research Agenda, Institute of Real Estate Studies 2011-022, from http://www.ires.nus.edu.sg/workingpapers/IRES2011-022.pdf.

[18] Building and Construction Authority Singapore (2012). Singapore celebrates 1000th BCA Green Mark Building Project, from http://www.bca.gov.sg/Newsroom/pr26022012_GM.html.

[19] Building and Construction Authority Singapore. 2nd Green Building Masterplan, from http://www.bca.gov.sg/GreenMark/others/gbmp2.pdf.

[20] International Energy Agency (2009). Energy Technology Transitions for Industry, page 31.

[21] Economic Development Board (2007). ExxonMobil's second steam cracker brings chemical industry to the next lap, from http://www.edb.gov.sg/edb/sg/en_uk/index/news/articles/exxonmobil_s_second.html.

[22] International Energy Agency (2011). Energy Balances of Non-OECD Countries.

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Singapore's total final energy consumption grew at an annual rate of 5.6 percent from 5 Mtoe in 1990 to 14.1 Mtoe in 2009. Electricity generation grew by 5.3 percent per year from 15.7TWh to 41.8 TWh over the same period. The electricity generation mix 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 81 percent of Singapore's electricity by 2009. Currently, fuel oil use for thermal power generation is around 18.8 percent[23] and is seen as a reasonable "balancing" alternative to a total dependence on natural gas.

### *Business-as-Usual (BAU) Scenario*

Total final energy consumption is projected to grow by 3.3 percent a year between 2009 and 2035. The fastest growth is expected to occur in the non-energy sector, increasing by 4.3 percent a year. This is followed by the industry sector which is projected to grow by 2.9 percent a year (Figure 15-1). The transport sector is projected to grow by 0.7 percent a year while the other (residential and commercial) sector is projected to grow by 1.9 percent per year. Both in the BAU and APS the Energy Labelling Scheme, the EENP programme and BCA Green Mark Scheme retard the growth of energy use in the industry and other (which includes commercial and residential) sectors. Similarly, the VQS reduces energy use in the transport sector.

### *Alternative Policy Scenario (APS)*

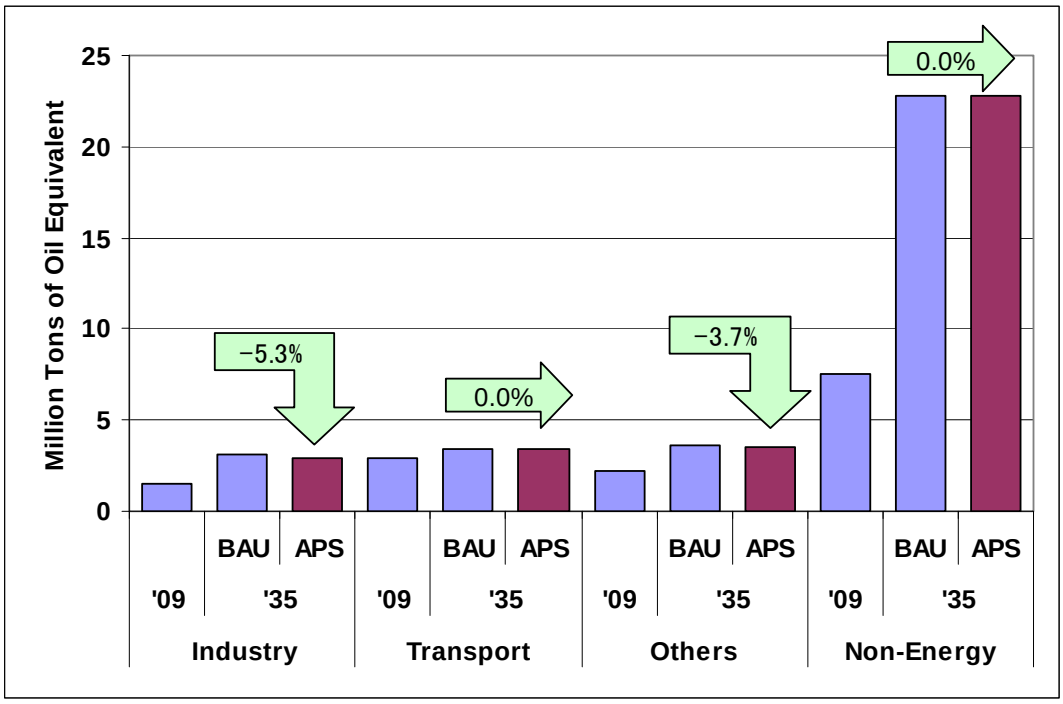
Final energy consumption under the APS is projected to grow by 3.3 percent per year between 2009 and 2035. Akin to the BAU, the non-energy sector is projected to exhibit the fastest growth under the APS at 4.3 percent, followed by the industry sector

[23] Energy Market Authority (2011). Energising Our Nation – Singapore Energy Statistics 2011, page 14, from http://www.ema.gov.sg/media/files/publications/SES2011.pdf.

at 2.7 percent and the other (residential and commercial) sector at 1.7 percent. The industry sector realizes the largest saving at around 6 percent.

Oil will still dominate the final energy mix with an 80.2 percent share. Electricity and natural gas are expected to contribute 17.3 and 2.5 percent of fuel consumption, respectively. A 5 percent improvement will be achieved on the use of electricity for the period 2009-2035.

**Figure 15-1: Final energy Consumption by Sector, BAU and APS**




## 3.2. Primary Energy Demand

Total primary energy demand grew by 3.2 percent per year, from 11.4 Mtoe in 1990 to 19.7 Mtoe in 2009. Singapore's sole energy source in 1990 was oil, whose consumption increased by 0.5 percent a year from 11.4 Mtoe in 1990 to 12.6 Mtoe in 2009. Following the construction of pipelines for gas-fired power plants, the first of which sourced gas from Malaysia in 1991, and two more recent pipelines from Indonesia, the share of natural gas has increased. Consumption of natural gas increased rapidly from 0.4 Mtoe in 1992 to 7.1 Mtoe in 2009 at a growth rate of 17.3 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 year by the end of 2013.[24]

***Business-as-Usual (BAU) Scenario***

Primary energy demand in the BAU is projected to grow by 3.2 percent a year between 2009 and 2035. Among the energy sources, oil is expected to grow the fastest at 3.7 percent a year followed by natural gas at 2.0 percent. Natural gas consumption is expected to grow in line with the expansion of gas-fired power plants.

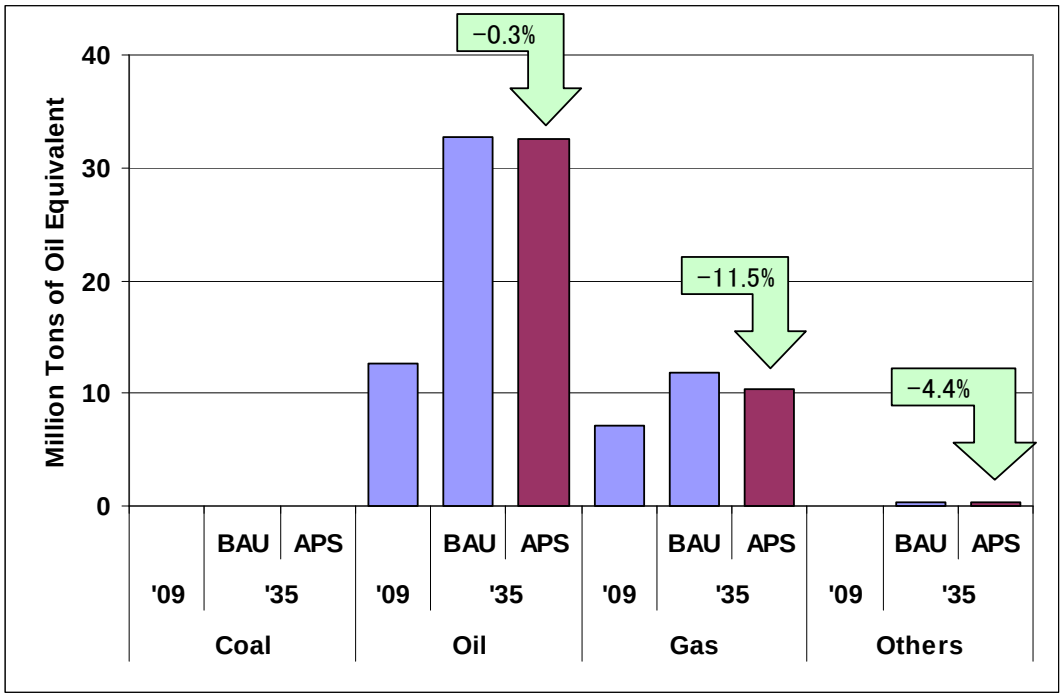
Over the next few years, Singapore's net generation capacity will increase by more than 2000MW or about 20 percent of current installed capacity and will be generated by more efficient CCGTs.[25] Nevertheless, oil is expected to remain the primary energy source accounting for 73 percent of primary energy consumption in 2035 followed by natural gas at 26 percent.

***Alternative Policy Scenario (APS)***

Results of the APS show that primary energy demand for the period 2009-2035 is expected to grow by 3.1 percent a year. In 2035, the difference between the growth rates of the BAU Scenario and the APS results in a 3.3 percent reduction in energy use. Natural gas will have a slower growth rate of around 1.5 percent a year. Oil will still be the country's primary energy source with a 75.1 percent share, followed by natural gas with a 24.1 percent share.

[24] Ministry of Trade and Industry (2012). LNG Terminal will Diversify Energy Sources and Enhance Singapore's Energy Security, from http://app.mti.gov.sg/data/article/27201/doc/Media%20Release%20on%20LNG%20visit.pdf.
[25] Ministry of Trade and Industry (2012). Speech by Mr Iswaran, Second Minister for Trade and Industry, during The Committee of Supply Debate, from http://app.mti.gov.sg/data/article/27422/doc/2M%27s%20COS%20Speech%20%282%20Mar%29.pdf.

**Figure 15-2: Total Primary Energy Demand, BAU and APS**

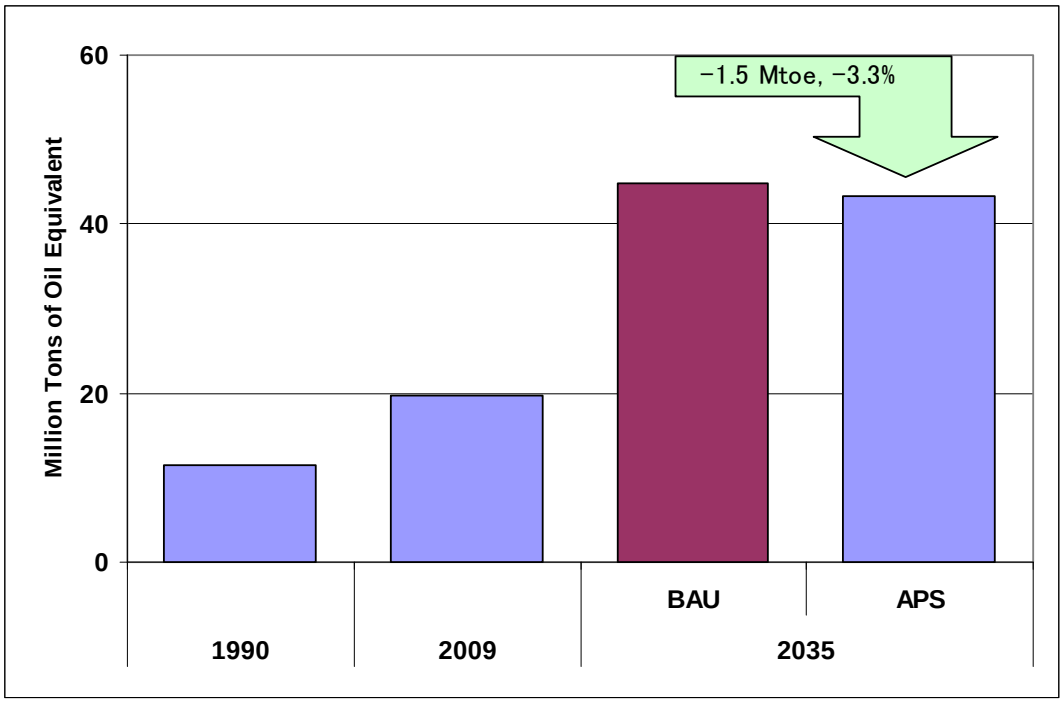



### 3.3. Projected Energy Savings

In 2035 it is estimated that Singapore's EEC goals, action plans and policies could result in savings of 1.5 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure 15-3). This is about 7.6 percent of Singapore's consumption in 2009.

In terms of final energy consumption savings, it is projected that the industrial sector and the other (residential and commercial) sectors will have savings of 163.0 ktoe and 135.0 ktoe, respectively.

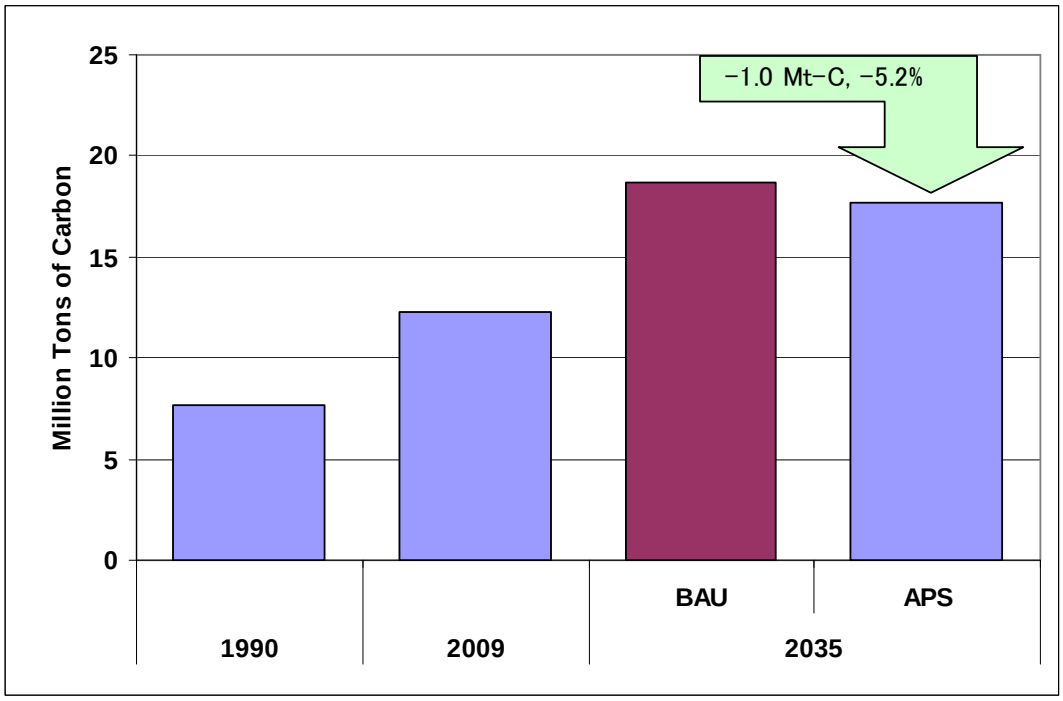
**Figure 15-3: Total Primary Energy Demand, BAU and APS**




### 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 1.6 percent, from 12.3 Mt-C in 2009 to around 18.7 Mt-C in 2035. In the APS, the annual average growth in $CO_2$ emissions from 2009 to 2035 is expected to be lower than in the BAU scenario at 1.4 percent.

**Figure 15-4: $CO_2$ Emissions from Energy Consumption, BAU and APS**




## 4. Implications and Policy Recommendations

The impetus for a reduction in energy use and emissions is provided by the myriad of programs instituted by the government that seek to incentivize the use of less carbon-intensive fuels and 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 the efforts of using energy efficiently and in an environmentally viable manner will continue to receive broad support.

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# Chapter 16

# Thailand Country Report

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# CHAPTER 16

# Thailand Country Report

**SUPIT PADPREM**

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## 1. Background

Thailand is in the middle of the South East Asian mainland, with the Pacific Ocean on the south-east coast and the Indian Ocean on the south-west coast. Its land area is approximately 513,115 square kilometres, with great plains in the centre, mountainous areas up north and highlands in the north-east. It has a small economy, with GDP in 2009 of around US$243.9 billion (in 2000 US$ terms). In 2009, the population was 67.8 million and income per capita was around US$ 3,600.

Thailand is an energy importer, especially crude oil, because of very limited domestic resources. Thailand's indigenous energy resources include natural gas, coal (only lignite) and biomass. In 2009, proven reserves were 0.4 billion barrels (62 million cubic metres) of oil, 11.0 trillion cubic feet (0.3 trillion cubic metres) of natural gas and 1,239 million tonnes of lignite.

Thailand's total primary energy supply (TPES) was 100.3 Mtoe in 2009. Oil accounted for the largest share at around 29 percent, followed by natural gas (27 percent), coal (15 percent). Others accounted for the remainder (29 percent). In 2009, net imports of energy accounted for 51 percent of TPES. Due to very limited indigenous oil resources, Thailand imported around 80 percent of its crude oil and most of its bituminous coal. Although Thailand produces large quantities of natural gas, about 21 percent of its use was imported from Myanmar.

In Thailand, natural gas is used as a major energy source for power generation. In

2009, primary natural gas supply was 21.8 Mtoe, around 68 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 29.2GW of installed electricity generation capacity and power generation was about 147.4TWh in 2009. The majority of Thailand's power is generation using thermal sources (coal, natural gas and oil), accounting for 91.2 percent of generation, followed by hydro (4.9 percent) and geothermal, solar, small hydro and biomass making up the remainder.

## 2. Modelling Assumptions

As a result of economic crises in 1997 and 2008, GDP growth during 1990 to 2009 was a moderate 4.2 percent per year. Thailand's GDP is assumed to grow at slightly stronger average rate of 4.4 percent per year between 2009 and 2035. Population growth is also projected to be reasonably slow at around 0.3 percent per year between 2009 and 2035, compared with average growth of about 1.1 percent per year between 1990 and 2009.

Coal and natural gas are projected to be the largest energy sources for power generation. Conversely, the shares of fuel-oil and diesel power plants are projected to decline. Nuclear power and renewable energy are projected to increase their shares in the power generation mix.

Thailand's energy saving goals are expected to be achieved through the implementation of energy efficiency programs in all sectors. In the industrial sector, improvements in technology development in manufacturing processes, 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 contribute to energy savings. Significant improvements in energy

efficiency in passenger vehicles are also expected to be achieved in line with new developments in car technologies and the introduction of the Eco car program.

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

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Between 1990 and 2009, Thailand's final energy consumption grew at a robust rate of 5.6 percent per year from 26.1 Mtoe in 1990 to 73.0 Mtoe in 2009. The transportation sector was the largest consumer of final energy in 1990, using 9.0 Mtoe. While consumption in the sector increased by 4 percent a year between 1990 and 2009, the share of transport declined from 35 percent in 1990 to 26 percent in 2009.

Strong growth in energy consumption in the industrial sector of about 5.5 percent per year between 1990 and 2009 increased final energy use in the sector from 8.7 Mtoe in 1990 to 24.3 Mtoe in 2009. By 2009, the industrial sector had overtaken transport as the largest consumer of final energy, accounting for around 33 percent of final energy consumption. Oil has been the dominant energy source in final energy consumption accounting for 32.6 Mtoe or a 45 percent share in 2009. Electricity was the second largest energy source, accounting for 11.6 Mtoe or a 16 percent share in 2009.

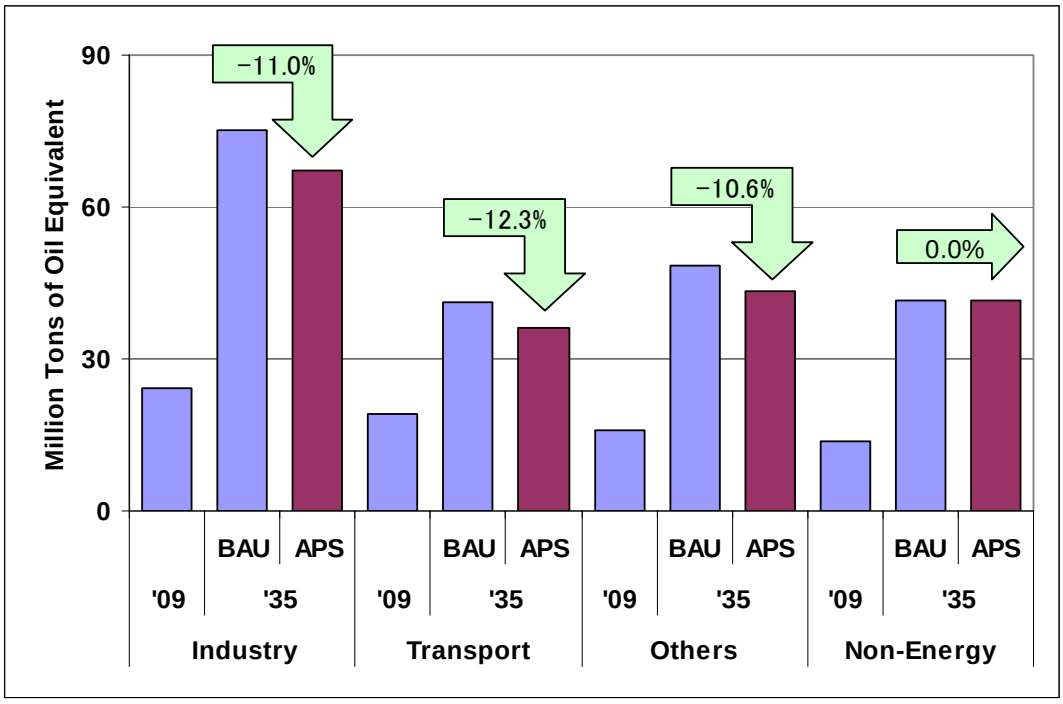
### *Business-as-Usual (BAU) Scenario*

Given moderate economic and population growth, final energy consumption is projected to grow at a moderate rate of around 4.1 percent per year between 2009 and

2035. The industry sector is projected to remain the largest consumer, accounting for 37 percent of final energy consumption in 2035. In contrast, the transportation sector will account for the smallest proportion of final energy consumption (20 percent) in 2035, continuing the declining share observed since 1990.

Oil is expected to remain the largest final energy source throughout the projection period. However, its share is projected to decline from 45 percent in 2009 to 37 percent in 2035. In 2035, the shares of electricity, natural gas and coal in final energy consumption are projected to increase to 22 percent, 16 percent and 12 percent, respectively.

**Figure 16-1: Final Energy Consumption by Sector, BAU and APS**




***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to grow at 3.7 percent per year, from 73.0 Mtoe in 2009 to 187.8 Mtoe in 2035, much slower than the BAU average annual growth rate of 4.1 percent. The majority of energy savings will be achieved through energy efficiency improvement programs implemented in the industry and transportation sectors. Improvements will also be achieved in other sectors as shown in Figure 16-1.

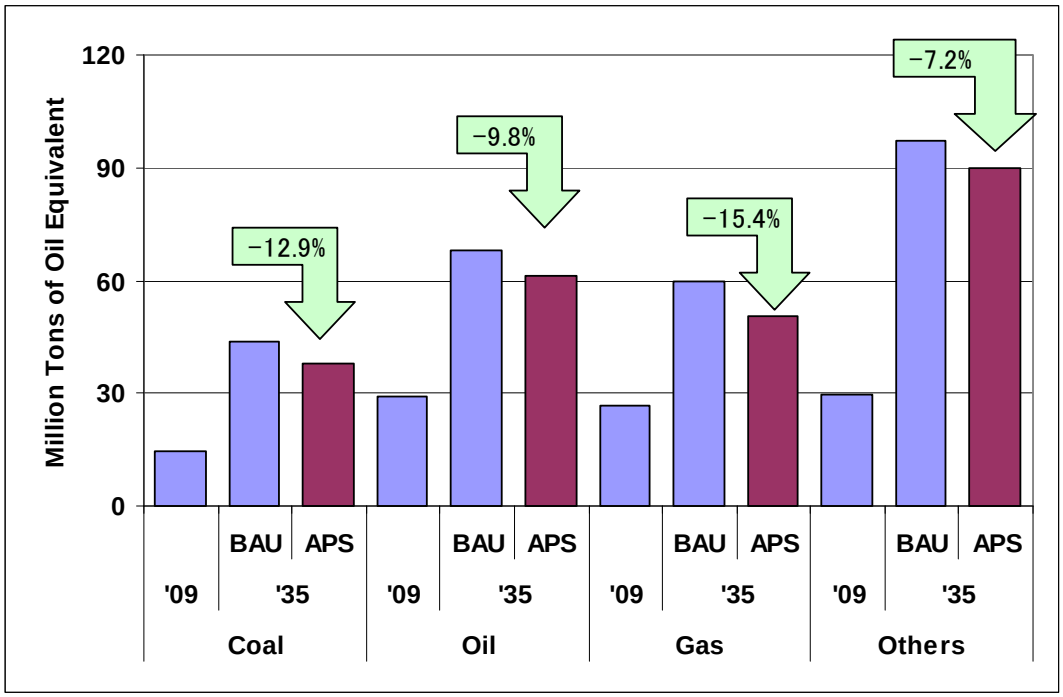
### 3.2. Primary Energy Demand

Primary energy demand grew at an average annual rate of 5.6 percent from 35.6 Mtoe in 1990 to 100.3 Mtoe in 2009, driven largely by fast economic development between 1990 and 1996. This growth in primary energy consumption was achieved despite the severe economic crisis in 1997-1998 and the world economic crisis in 2008. In 2009, the major sources of primary energy were oil, natural gas and coal with shares of 29 percent (29.2 Mtoe), 27 percent (26.6 Mtoe) and 15 percent (14.6 Mtoe), respectively. Although oil remained the largest source between 1990 and 2009, its share in primary energy demand shrank from 51 percent in 1990 to 29 percent in 2009. Natural gas, which is mainly consumed in the power generation sector, became an important source of energy with its share in primary energy demand increasing significantly from 14 percent in 1990 to 27 percent in 2009. The share of hydropower declined from 1.2 percent in 1990 to 0.6) percent in 2009.

***Business-as-Usual (BAU) Scenario***

In the BAU scenario, primary energy demand is projected to grow at about 3.9 percent per year from 2009 to 2035, reaching 268.3 Mtoe in 2035. The highest average annual growth rate is expected in coal (4.3 percent), with consumption expected to reach 43.6 Mtoe in 2035. Following the very strong average annual growth in natural gas of 9.2 percent between 1990 and 2009, growth is expected to slow to about 3.2 percent per year between 2009 and 2035. It is recognised that future growth in natural gas consumption in power generation may be limited, with the potential for nuclear and other alternative fuels to be used instead in line with government plans.

**Figure 16-2: Primary Energy Demand by Source, BAU and APS**




***Alternative Policy Scenario (APS)***

In the APS, growth in primary energy demand is projected to be slower than in the BAU scenario, increasing at 3.4 percent per year (compared with 3.9 percent in BAU) to reach 239.9 Mtoe in 2035. Primary energy demand is expected to be about 11 percent lower in the APS than in the BAU scenario in 2035 – an energy saving of about 28.4 Mtoe.

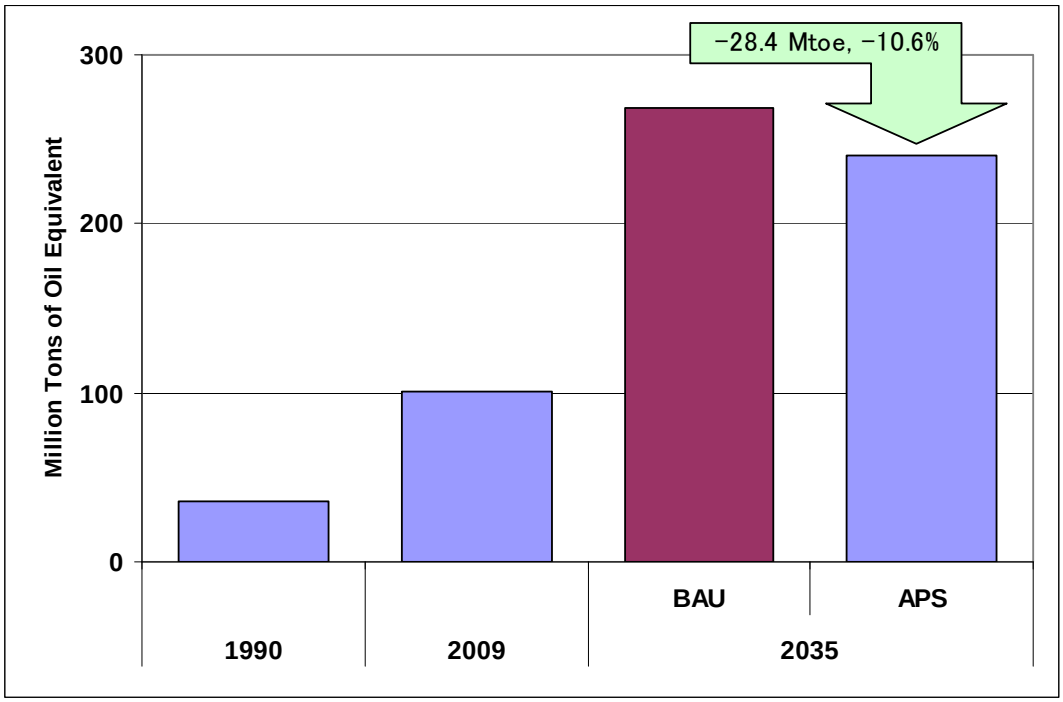
Oil is also projected to increase at an annual average rate of 2.9 percent from 29.2 Mtoe in 2009 to 61.4 Mtoe in 2035 and natural gas use is projected to increase at an annual average rate of 2.5 percent from 26.6 Mtoe in 2009 to 50.5 Mtoe in 2035. The lower growth rates, relative to the BAU scenario, are mainly achieved through energy efficiency and conservation measures on the demand side. The differences in the projections between the two scenarios are shown in Figure 16-2.

### 3.3. Projected Energy Savings

The difference between primary energy demand in the BAU scenario and the APS

in 2035 is 28.4 Mtoe (Figure ). 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 28 percent of Thailand's primary energy demand in 2009. Natural gas will contribute the largest energy savings (9.2 Mtoe) followed by oil (6.7 Mtoe).

**Figure 16-3: Total Primary Energy Demand, BAU and APS**



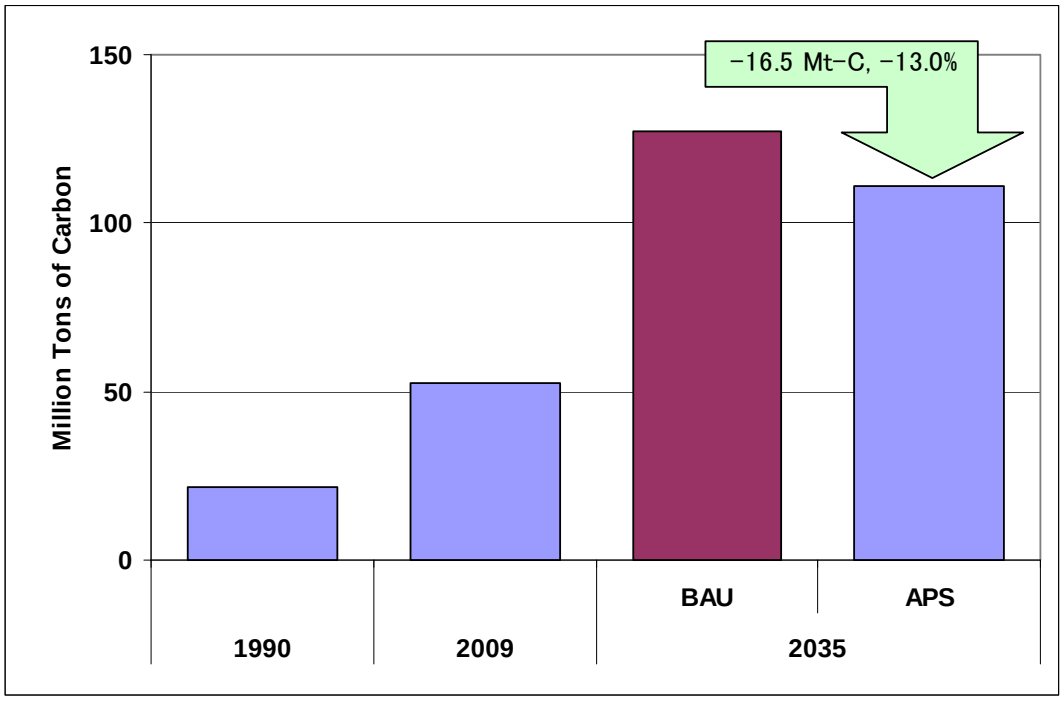

In final energy consumption, the savings in the APS, relative to the BAU scenario in 2035, could reach 18.5 Mtoe. The largest savings are expected to be achieved in the industry sector at 8.2 Mtoe. Both the transportation and other sectors are expected to achieve energy savings of 5.1 Mtoe.

### 3.4. $CO_2$ Emissions from Energy Consumption

$CO_2$ emissions from energy consumption are projected to increase by 3.5 percent per year on average from 52.3 Mt-C in 2009 to 127.5 Mt-C in 2035 under the BAU scenario. Thailand plans to promote the use of less carbon intensive energy sources such as nuclear and renewable fuels.

Under the APS, the average annual growth in $CO_2$ emissions from 2009 to 2035 is projected to be about 2.9 percent, with emissions of 111.0 Mt-C in 2035. The reduction in $CO_2$ emissions between the APS and BAU scenario highlights the range of benefits that can be achieved through energy efficiency improvements and savings via action plans (Figure 16-4).

**Figure 16-4: $CO_2$ Emissions from Energy Consumption, BAU and APS**




## 4. Implications and Policy Recommendations

Strong economic growth prior to the Asian Financial Crisis in 1997 contributed to relatively high energy intensity in Thailand between 1990 and 2009. However, the energy intensity of the economy has declined since it recovered from the 1997 crisis. Furthermore, Thailand's energy efficiency programs in a wide range of areas (including industry, transportation and residential sectors), and high world oil prices, are expected to contribute to a continued decline in the energy intensity of the Thai economy.

Improving energy efficiency will also help Thailand (which is an oil importer), to address the challenges posed by high world oil prices. Thailand is committed to

reducing the intensity of energy consumption, especially in oil, and is also looking for more sustainable energy sources and environmentally friendly fuels. It is recognised that the more Thailand saves energy, the less sensitive it will be to fluctuations in world energy prices and supply. It is wise and rational to try to be more self sufficient and more sustainable. Furthermore, Thailand realises that cooperation on energy savings is important and that all countries should participate.

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. In addition, policy evaluations should be undertaken to identify other potential areas for improvement. Improving energy projections and policy design and evaluation would be supported by the development of an energy end-use database. Greater coordination and cooperation among Thai government energy agencies will help to achieve long-term energy saving goals.

# Chapter 17

# Vietnam Country Report

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# CHAPTER 17

# Viet Nam Country Report

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## 1. Background

Viet Nam has a total land area of about 331,111 square kilometres and lies in the centre of South East Asia. In 2009, Viet Nam had a population of 86 million and GDP of US$58.8 billion in 2000 US$ terms. The industry sector contributes the most to Viet Nam's GDP (40.2 percent), followed by the commercial sector (38.9 percent) and agriculture (20.9 percent). GDP per capita was 684 US$ per person in 2009.

Viet Nam possesses considerable indigenous energy resources. It has 3,390 million tonnes of proven recoverable reserves of coal, 460 million cubic metres of crude oil reserves and 610 billion cubic metres of gas reserves.

Viet Nam's total primary energy supply (TPES) was 39.1 Mtoe in 2009. Oil represented the largest share of Viet Nam's TPES at 39.8 percent; coal was second at 29.2 percent, followed by natural gas (23.0 percent), hydro (6.1 percent) and others (1.9 percent). Viet Nam is a net exporter of crude oil and coal but is an importer of petroleum products because of capacity limitations at the Dung Quat oil refinery (6.5 million tonnes a year) that could meet around 30 percent of domestic demand.

Coal is mainly used in the industry sector with consumption of 7.3 Mtoe in 2009, while gas is largely used for electricity generation.

Viet Nam had 16.3GW of installed generating capacity and generated 79.6 TWh of electricity in 2009. Most of Viet Nam's electricity generation comes from thermal sources (coal, natural gas and oil), accounting for 65.2 percent of total generation, and hydro (34.8 percent).

## 2. Modelling Assumptions

In this outlook, Viet Nam's GDP is assumed to grow at an average annual rate of 7.8 percent between 2009 and 2035. Growth is projected to be slightly lower in the first half of the outlook period increasing at 7.7 percent per year between 2009 and 2020, before increasing to 7.8 percent per year between 2020 and 2035. Population growth is projected to increase at a much slower rate, increasing by 0.8 percent per year between 2009 and 2035.

The share of electricity generated at coal-fired power plants is projected to increase considerably, at the expense of other energy types (thermal and hydro). Viet Nam is expected to increase its imports of electricity, in particular from Lao PDR and China. The use of nuclear energy is assumed to start in 2020 in line with Viet Nam's nuclear power development plan. In the BAU scenario, nuclear power capacity is assumed to be 1000MW, 4000MW and 6000MW in 2020, 2025 and 2030, respectively.

Viet Nam's energy saving goals are assumed to be between 3-5 percent of total energy consumption, equivalent to 5 Mtoe, between 2006 and 2010, and 5-8 percent of total energy consumption, equivalent to 13.1 Mtoe between 2010 and 2015, in line with the national target on energy efficiency and conservation (EEC). Beyond 2015, Viet Nam's energy saving goals are assumed to follow the trend of earlier periods.

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

To complement the demand side energy efficiency measures, on the supply side, renewable energy technologies, particularly small hydro, wind and biomass are expected to come online intensively from 2010 in line with the master plan on renewable energy development. Installed electricity generating capacity from

renewable energy is assumed to reach 4900MW in 2035 with small hydro contributing 2400MW, wind 2100MW and biomass 400MW. The installed capacity of nuclear power plants is expected to reach 12,000MW under the APS scenario by 2030 compared with 6000 MW in the BAU Scenario.

Viet Nam has considered the use of biofuels to reduce dependency on oil and curb $CO_2$ emissions. According to the Prime Minister's decision 177/2007/QD-TTg approving the master plan on biofuel development. Viet Nam is assumed to produce 250,000 tonnes and 1.8 million tonnes of biofuels (both ethanol and biodiesel) in 2015 and in 2025, respectively.

# 3. Outlook Results

## 3.1. Total Final Energy Consumption

Viet Nam's final energy consumption increased at 10.8 percent per year from 4.2 Mtoe in 1990 to 29.8 Mtoe in 2009. The fastest growth occurred in the industrial sector (11.4 percent per year) followed by the transport sector (10.6 per cent) and the residential/commercial (others) sector (10.1 percent per year). Oil is the most consumed product, accounting for 55.9 percent of total final energy consumption in 1990, declining to 46.2 percent in 2009. Coal is the second most consumed product.

***Business-as-Usual (BAU) Scenario***

Driven by assumed strong economic growth and a rising population, final energy consumption is projected to increase at an average rate of 6.5 percent per year between 2009 and 2035. The strongest growth in consumption is projected to occur in the residential/commercial (others) sector, increasing by 7.3 percent per year. This is followed by the industry sector (6.4 percent per year) and the transportation sector (6 percent a year) (Figure 17-1).

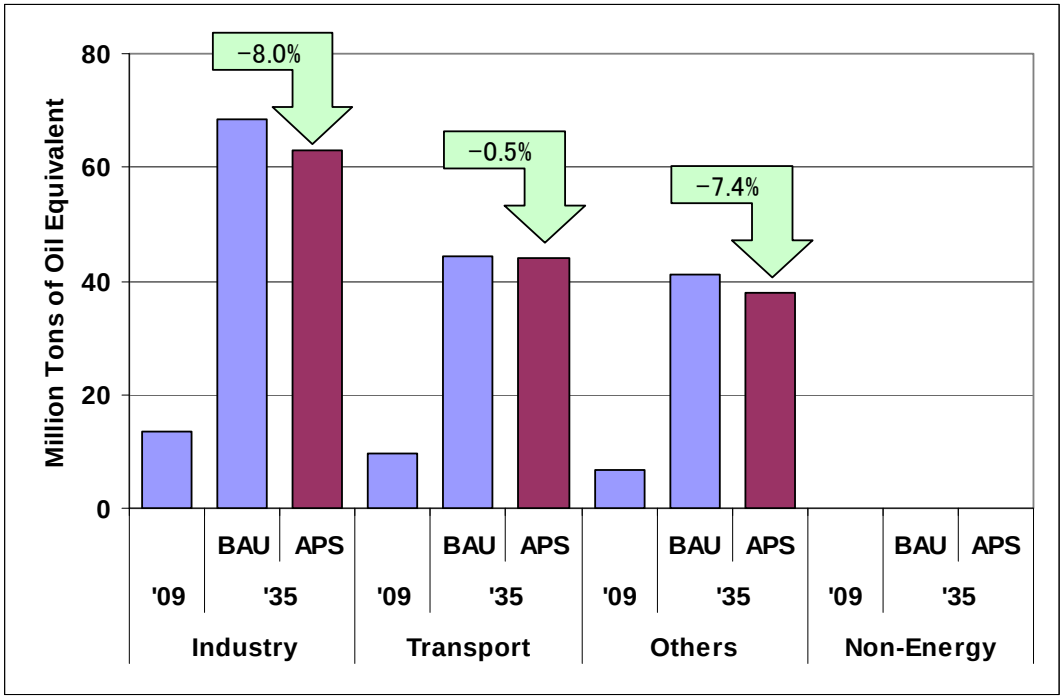
Electricity is projected to exhibit the fastest growth in final energy consumption, increasing at 7.3 percent per year between 2009 and 2035. Natural gas is projected to have the second highest growth rate of 6.5 percent per year, followed by oil (6.4

percent) and coal (5.9 percent).

***Alternative Policy Scenario (APS)***

In the APS, final energy consumption is projected to increase at a slower rate of 6.3 percent per year from 21.4 Mtoe in 2005 to 144.8 Mtoe in 2035 because of EEC programs. An improvement in end-use technologies and the introduction of energy management systems is expected to contribute to the slower rate of consumption growth, particularly in the industry, transport and residential/commercial (others) sectors.

**Figure 17-1: Final Energy Consumption, BAU vs. APS**




## 3.2. Primary Energy Demand

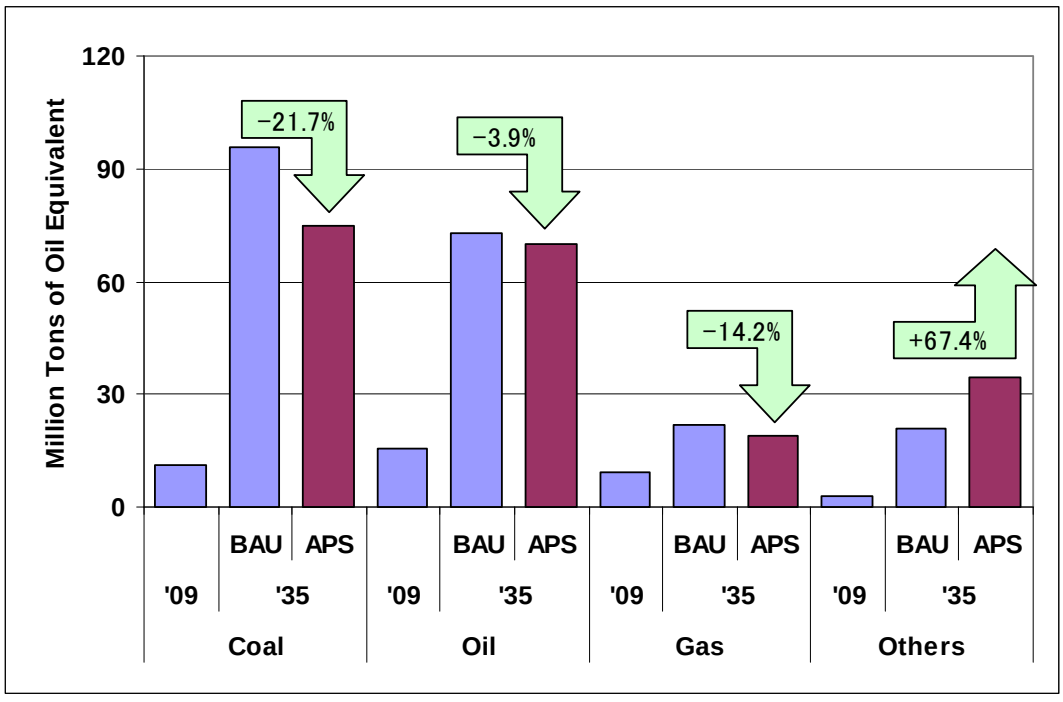
Primary energy demand in Viet Nam grew at a slower rate than final energy consumption, increasing at 10.9 percent per year from 5.4 Mtoe in 1990 to 39.1 Mtoe in 2009. Among the major energy sources, the fastest growing were natural gas, oil and coal. Natural gas consumption grew at an average annual rate of 52.4 percent between 1990 and 2009 while oil and coal grew at 9.6 percent and 9.0 percent per year, respectively. Hydro energy grew by 9.0 percent per year over the same period; however,

its only accounts for a small proportion of total primary energy demand (6.1 percent in 2009).

***Business-as-Usual (BAU) Scenario***

In the BAU scenario, Viet Nam's primary energy demand is projected to increase at an annual rate of 6.7 percent per year from 2009 to 211.2 Mtoe in 2035. The fastest growth is expected in coal, increasing at an annual average rate of 8.5 percent between 2009 and 2035, followed by oil and natural gas at 6.1 percent and 3.5 percent, respectively. The share of coal is projected to increase from 29.2 percent in 2009 to 45.3 percent in 2035. This growth is at the expense of oil and natural gas, whose shares are projected to decline from 39.8 percent to 34.4 percent and from 23.0 percent to 10.5 percent, respectively (Figure 17-2).

**Figure 17-2: Primary Energy Demand, BAU vs. APS**




***Alternative Policy Scenario (APS)***

In the APS, primary energy demand is projected to increase at a slower rate of 6.5 percent per year from 39.1 Mtoe in 2009 to 198.4 Mtoe in 2035. Coal, oil and natural

gas are projected to grow at an average annual rate of 7.5 percent, 6.0 percent and 2.9 percent, respectively over the over the same period. The slower growth in consumption, relative to the BAU scenario, stem from EEC measures on the demand side and the more aggressive uptake of renewable and nuclear energy on the supply side.

### 3.3. Projected Energy Saving

The savings that could be derived (the difference between primary energy demand under both scenarios) from the energy saving and conservation goals and action plans of Viet Nam amount to 12.8 Mtoe. This is equivalent to 6.1 percent of Viet Nam's consumption in 2035 under the BAU (Figure 17-3).

Savings in final energy consumption amount to 8.7 Mtoe. The bulk of the savings are expected to occur in the industry sector (5.5 Mtoe), followed by the residential/commercial (others) sector and 0.2 Mtoe in the transportation sector.

**Figure 17-3: Evolution of Primary Energy Demand, BAU and APS**

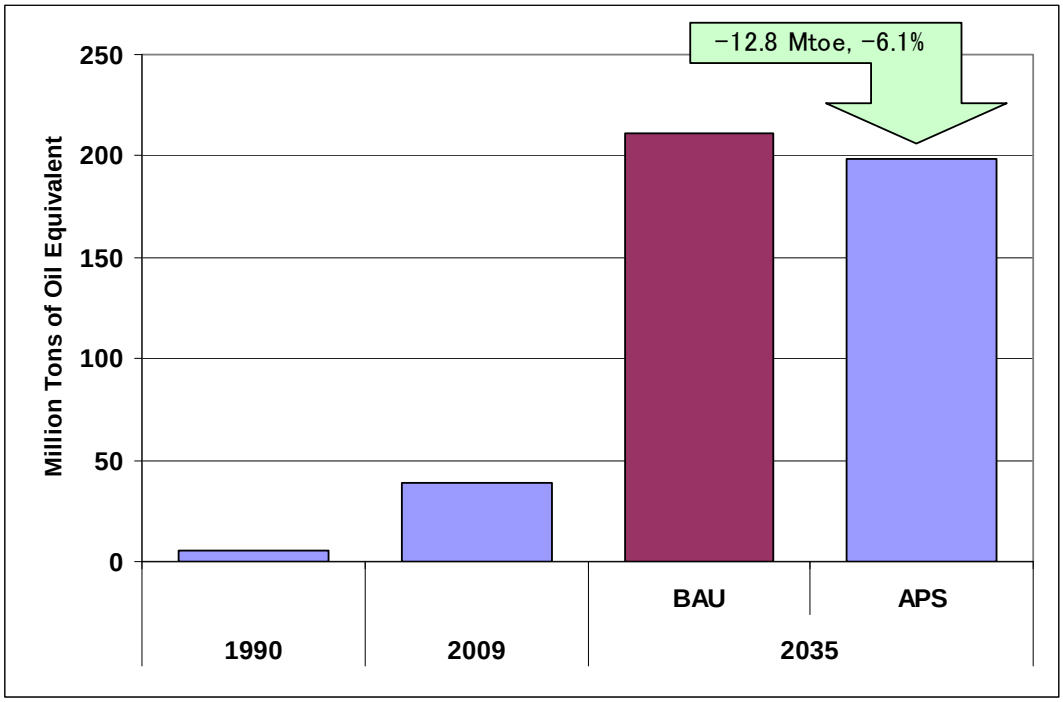
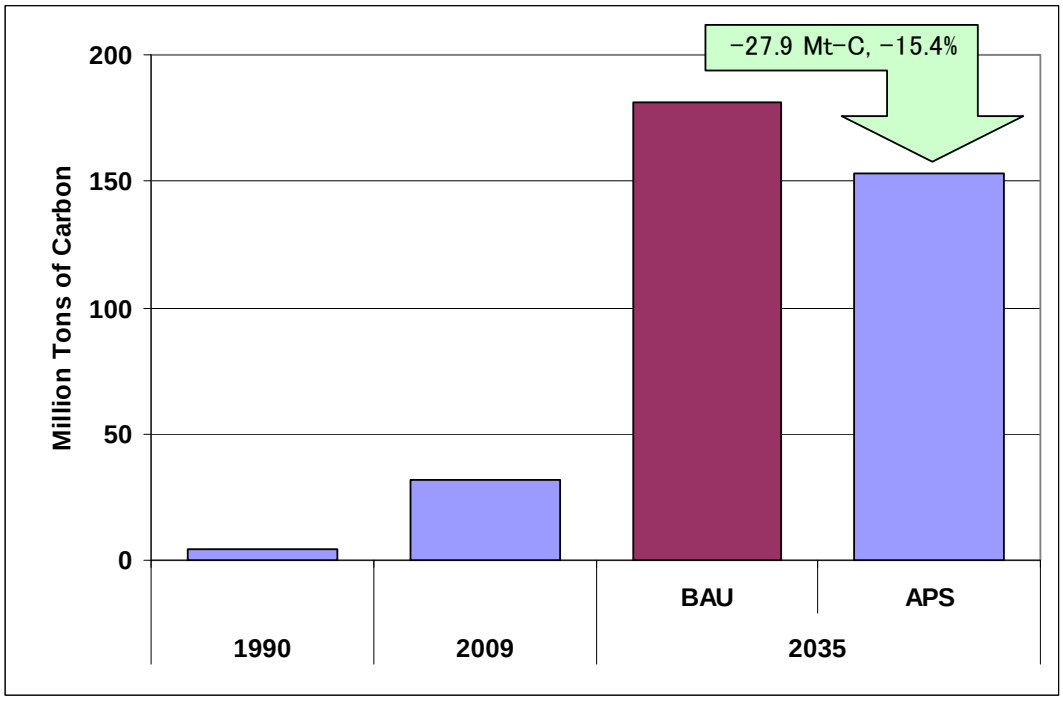


**Figure 17-4: Evolution of $CO_2$ Emissions, BAU and APS**




### 3.4. $CO_2$ Emissions from Energy Consumption

$CO_2$ emissions from energy consumption are projected to increase by 6.9 percent per year from 32.1 Mt-C in 2009 to 181.2 Mt-C in 2035 under the BAU scenario. Under the APS, the annual increase in $CO_2$ emissions between 2009 and 2035 is projected to be 6.2 percent. $CO_2$ emissions are 27.8 Mt-C lower (a 15.4 percent decline) under the APS compared with the BAU scenario in 2035, indicating that the energy saving goals and action plans of Viet Nam are very effective in reducing $CO_2$ emissions (Figure 17-4).

## 4. Implications and Policy Recommendations

The above analysis shows that energy demand in Viet Nam is expected to continue to grow at a significant rate, driven by robust economic growth, industrialization, urbanization and population growth. Energy conservation measures have the potential to contribute to meeting higher demand in a sustainable manner.

Viet Nam's energy intensity, which is amongst the highest in the world, indicates high saving potential. However, the energy saving potential derived from the EEC goals of Viet Nam (12.8 Mtoe) seem to be modest compared with its potential. This is largely because energy efficiency goals focus heavily on the industry sector and buildings.

To be able to implement EEC activities in Viet Nam effectively, the following actions are recommended:

- **Enhancement of data collection and management:** Databases containing information on the economic and energy system are critical for estimation of energy saving potential and policy analysis, development and implementation. In 2011, the Ministry of Industry and Trade established a General Directorate of Energy who is responsible for energy sector data collection, management and analysis to support decision making. This is an initial action for the enhancement of the energy sector database. Further work needs to be directed to data management, creation of data collection and distribution systems, training in data collection and management techniques, clarification of organizational and institutional arrangements for data management, especially the creation of long-term data management sustainability plan.
- **Establishment of new targets and a roadmap for EEC implementation**: The targets for EEC in Viet Nam have been set up for a short-term period (2006–2015) and focused on the industry sector and buildings. The new targets should be based on an assessment of energy saving potential for all energy sectors through a bottom-up method. To assist in this process, the collection of end-use energy consumption data should be organized. It is clear that the absence of detailed end-use energy consumption data can severely limit the estimation of energy saving potential. For example, the potential energy saving in the transport sector, one of the largest energy consumers, is not yet well evaluated in the present action plan, because of a lack of detailed consumption data. Therefore, it is proposed that a comprehensive end-use energy consumption data collection campaign be carried out.
- **Gradual removal of subsidized energy prices:** Low energy prices, especially for energy intensive industries (cement, fertilizer, pulp and paper**)** do not

encourage energy efficiency. As long as energy costs remain modest in the production cost, there is little incentive to save energy. A roadmap for energy price increases has been formulated but the actual increase so far has not kept pace with the increased required to encourage greater energy saving.

- **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 are more likely to implement simple no-cost and low cost measures.
- **Support for large consumers to implement EEC measures**: For large consumers, support for the implementation of EEC measures might be needed. These include training, financial assistance, etc. These consumers are requested to report energy consumption on an annual basis to the Office of Energy Efficiency and Conservation for control and for formulation of EEC programs.
- **Promotion of ESCO:** It is infeasible for energy consumers to carry out all EEC measures by themselves. There should be professional Energy Service Companies (ESCO) in place to provide these services. 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.
- **Energy indicators to monitor implementation of action plan**: It is important that energy saving goals 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 of some energy efficiency technologies and measures, Viet Nam should increase its

efforts to introduce improved technologies and efficient energy management models. In this regard, it is recommended that Viet Nam learn from the experiences of other countries such as Japan and Thailand. The cooperation could be in the formulation and implementation of a master plan on EEC or a concrete EEC project.

## References:

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