Chapter 8

Japan Country Report

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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 a land area of approximately 377,960 square kilometres and most of its land area is mountainous and thickly forested. Until 2009, it was the world's second largest economy after the United States. But in 2010 China surpassed Japan as the world's second-largest economy. Japan's real gross domestic product (GDP) in 2013 was about US$4,686 billion (constant 2005 prices), and the population is currently about 127 million.

1.1. Energy Situation

Japan possesses limited indigenous energy resources and imports almost all of its crude oil, coal, and natural gas requirements to sustain economic activity.

In 2013, Japan's net primary energy supply was 454.7 million tons of oil equivalent (Mtoe). By energy type, oil represented the largest share at 44.5 percent; coal was second at 26.7 percent; followed by natural gas (23.4 percent). Nuclear energy accounted for 0.5 percent. Others, such as hydro, geothermal, wind, and solar, made up the remaining 4.9 percent. In 2013, net imports of energy accounted for about 99 percent of the net primary energy supply. With limited indigenous energy sources, Japan imported almost 100 percent of oil, 100 percent of coal, and 98 percent of gas.

Japan is a large importer of coal: steam coal for power generation, pulp and paper, and cement production; and coking coal for steel production. Domestic demand for natural gas is met almost entirely by imports of liquefied natural gas (LNG). Electricity generation mostly uses natural gas, followed by reticulated city gas, and industrial fuels. In 2013, primary natural gas consumption was 106.3 Mtoe.

Japan's final energy consumption recorded low growth of 0.2 percent per year from 297.8 Mtoe in 1990 to 311.4 Mtoe in 2013. The residential/commercial (other) sector had the highest growth rate during this period, at 1.1 percent per year followed by the transport sector with 0.1 percent. Consumption in the industry sector decreased at a rate of 0.9 percent per year on average from 1990 to 2013. Oil was the most consumed product with a share of 61.2 percent in 1990, and it fell slightly, to 53.2 percent in 2013. Electricity was the second most consumed product.

Japan's primary energy supply grew at a rate of 0.1 percent per year from 439.3 Mtoe in 1990 to 454.6 Mtoe in 2013. Among the major energy sources, the fastest growing fuels were natural gas and coal. Natural gas and coal consumption grew at an average annual rate of 3.9 percent and 2.0 percent, respectively, whereas nuclear energy declined by 12.5 percent from 1990 to 2013 due to the Great East Japan Earthquake in March 2011. Oil consumption declined by 0.9 percent per year over the same period.

Japan had 289 GW of installed electricity generating capacity and generated about 1,038 TWh of electricity in 2013. The generation by energy type is broken down as follows: thermal (coal, natural gas, and oil) at 85.5 percent; nuclear (0.9 percent); hydro (7.5 percent); and geothermal, solar, and wind (6.0 percent).

2. Modelling Assumptions

In this outlook, Japan's real GDP is assumed to grow at an annual average rate of 1.5 percent from 2013 to 2040, projecting recovery from economic recession. In

2014, Abenomics[1] is estimated to have increased GDP strongly through the impact of economic reform to address Japan's two decades of stagnation. The approach has been known as the 'three arrows'. The first arrow would kick-start the economy out of its deflationary difficulties. Abe attempted to do this by increasing the money supply and making the country more competitive through encouraging private investment. The second arrow would address employment, and the third, which has been the most important and the most difficult arrow, announced in June 2014, composed of a number of new policies such as corporate tax rate cuts and liberalisation of the healthcare and agriculture sectors. Other measures that have been taken include changes to the investment strategy of the Government Pension Investment Fund and getting rid of a spousal tax exemption to encourage women to find work and improve their career opportunities.

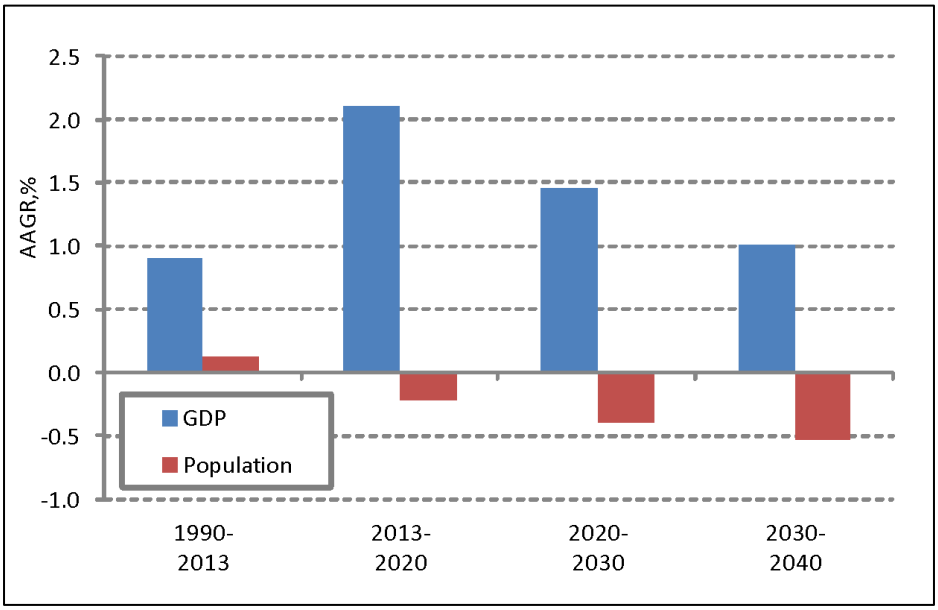
The industry structure, with the maturing of Japanese society and economy, will become increasingly oriented towards the services industry. Japan's population is projected to decline by about 0.4 percent per year from 2013 to 2040 due to the falling birth rate. This means Japan's population is expected to decrease from 127 million in 2013 to 114 million in 2040. Figure 8-1 shows the assumptions for GDP and population growth in this study.

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

The New Strategic Energy Plan was approved by the cabinet in April 2014, and based on this plan, the Long-term Energy Supply and Demand Outlook was approved by the Ministry of Economy, Trade and Industry in July 2015. It foresees that the share of nuclear power will fall sharply, from approximately 30 percent of total electricity generation before the Great East Japan Earthquake, to approximately 20 to 22 percent by 2030.

[1] An economic programme introduced by Prime Minister Shinzo Abe upon commencing his second term as Prime Minister of Japan from December 2012.

Figure 8-1. Growth Rate of GDP and Population



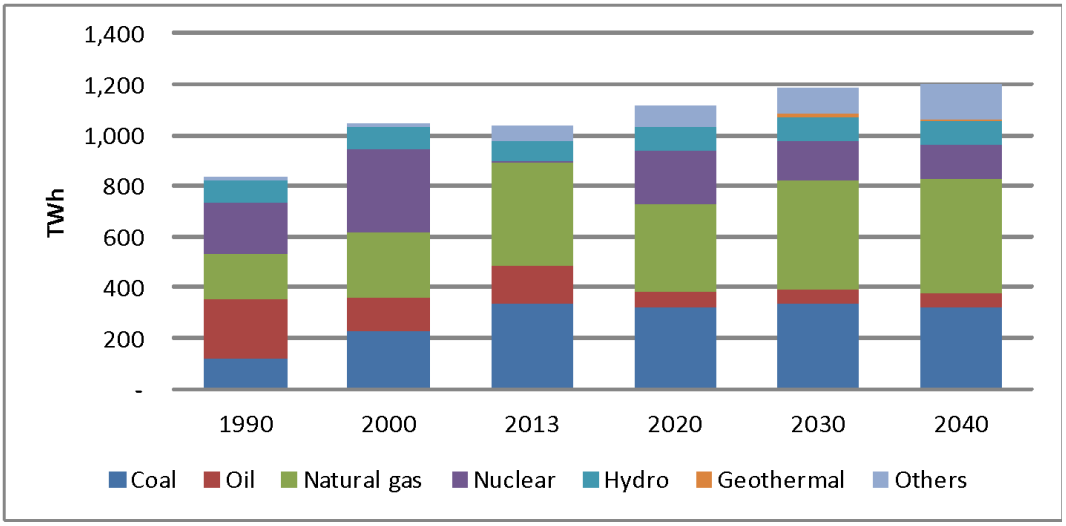
GDP = gross domestic product; AAGR = average annual growth rate.
Source: Author's calculation.

The share of renewable energy will be about 22–24 percent of total electricity generation in 2030, compared with 11 percent before the Great East Japan Earthquake. And the base load rate consisting of hydropower, coal-fired thermal power, nuclear power, etc., will be approximately 56 percent.

Figure 8-2 shows the projected power generation mix in Japan to 2040 under the Business-as-Usual scenario (BAU), and Figure 8-3 shows the assumed thermal efficiencies of thermal power plants in the BAU.

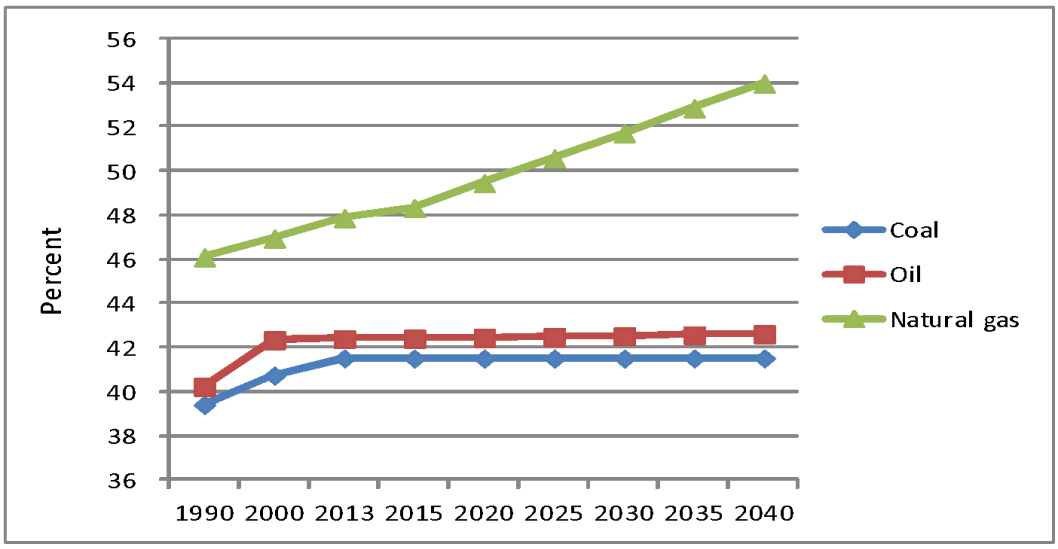
Japan's energy savings goal will be attained through the implementation of national energy efficiency programmes in all energy-consuming sectors. For the industry sector, energy savings are expected from improvements in manufacturing technologies. In the residential and commercial sectors, the 'Top Runner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

Figure 8-2. Power Generation, BAU



BAU = Business-as-Usual scenario; TWh = terawatt-hour.
Source: Author's calculation.

Figure 8-3. Thermal Efficiency, BAU



BAU = Business-as-Usual scenario.
Source: Author's calculation.

3. Outlook Results

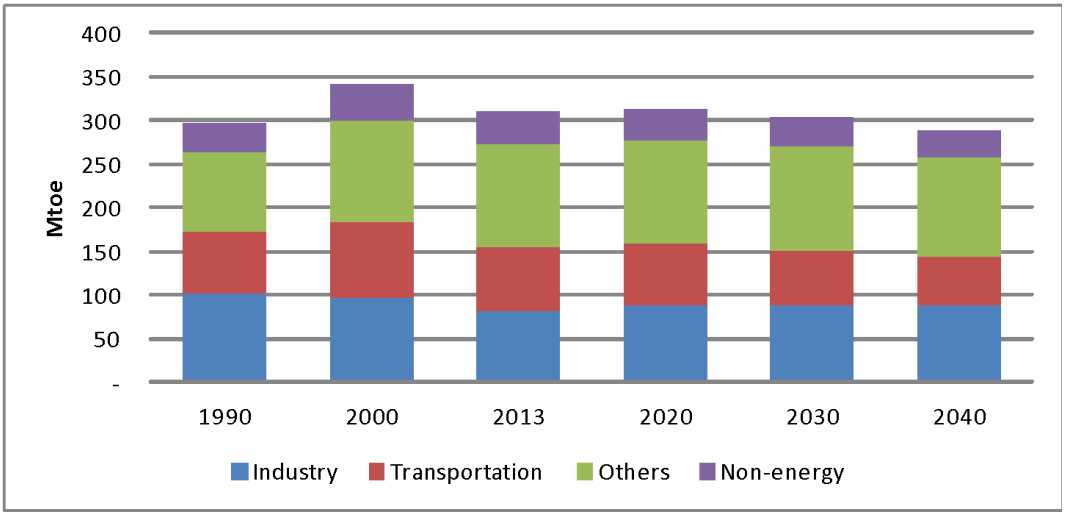
3.1. Business-as-Usual Scenario (BAU)

3.1.1. Final energy demand

With the projected relatively low economic growth and the declining population, Japan's final energy consumption from 2013 to 2040 is projected to decline at an average rate of 0.3 percent per year in the BAU scenario. This is also driven by the

projected decline in the energy consumption of the transportation sector brought about by improving energy efficiency. The final energy consumption of the industrial sector is projected to increase at an annual average rate of 0.2 percent between 2013 and 2040. Figure 8-4 shows the projected final energy consumption by sector from 1990 to 2040 under BAU.

Figure 8-4. Final Energy Consumption by Sector, BAU



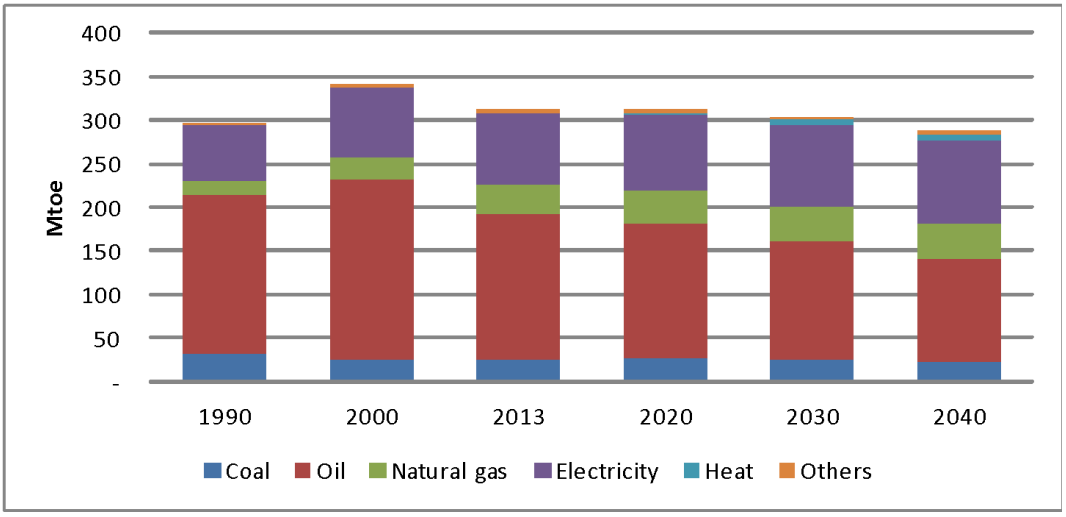
BAU = Business-as-Usual scenario; Mtoe = millions tons of oil equivalent.
Source: Author's calculation.

By fuel type, consumption of coal and oil are projected to decrease at an average annual rate of 0.5 and 1.2 percent, respectively, between 2013 and 2040. Consumption of natural gas and electricity are projected to increase, however, at a rate of 0.5 and 0.7 percent per year, respectively, over the period. Figure 8-5 shows the projected final energy consumption by source from 1990 to 2040 under the BAU.

3.1.2. Primary energy supply

Under BAU, Japan's total primary energy supply is projected to decrease at an average annual rate of 0.2 percent per year from 454.6 Mtoe in 2013 to 436.1 Mtoe in 2040 (Figure 8-6). This decrease is due mainly to the decreasing use of oil at an annual average growth rate of 1.5 percent over the period 2013–2040. On the other hand, nuclear and hydro will have increasing annual average growth rates of 10.3 percent and 0.7 percent, respectively.

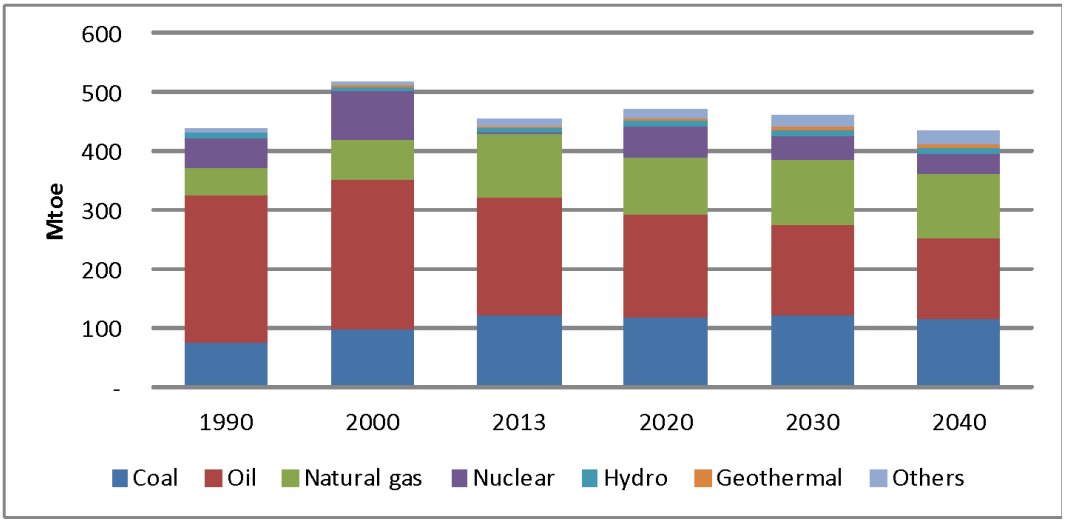
Figure 8-5. Final Energy Consumption by Source, BAU



BAU = Business-as-Usual scenario; Mtoe = millions tons of oil equivalent.
Source: Author's calculation.

Geothermal energy will grow at an average rate of 5.0 percent per year while other energies (such as biomass, solar, and wind) will increase at an annual rate of 2.0 percent in the same period. The share of nuclear in 2013 and 2040 is projected to increase from 0.5 percent to 7.9 percent. The Long-term Energy Supply and Demand Outlook by the Ministry of Economy, Trade and Industry highlights that the self-sufficiency rates of primary energy supply including renewable energy will increase to 24.3 percent in 2030.

Figure 8-6. Total Primary Energy Supply, BAU



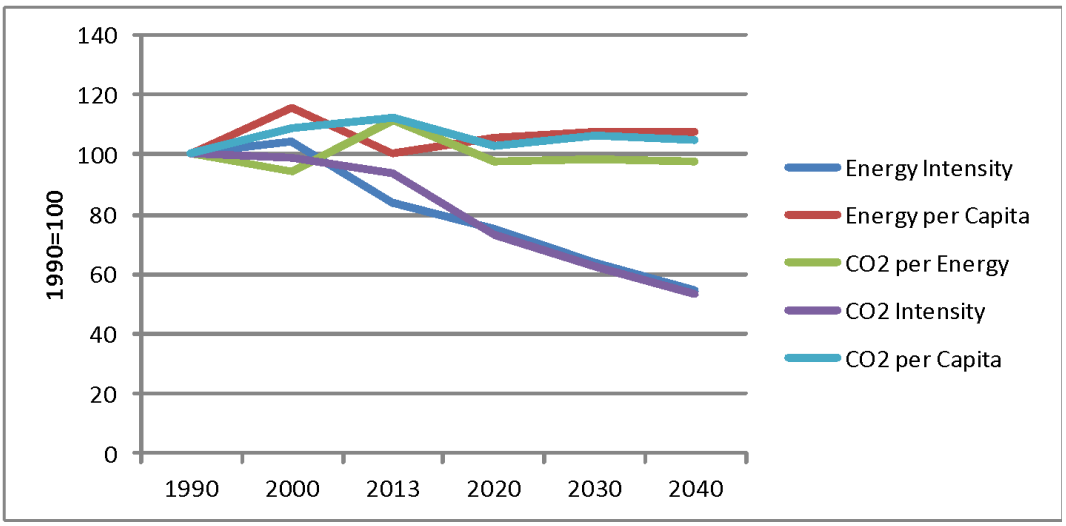
BAU = Business-as-Usual scenario; Mtoe = millions tons of oil equivalent.
Source: Author's calculation.

3.1.3. Energy indicators

Energy consumption per capita towards 2040 will increase at a faster rate than in the last decades. Income elasticity between 2013 and 2040 is expected to be negative, because the growth rate of energy consumption is expected to be negative and the GDP growth rate is forecast to be positive.

Except for energy consumption per capita, all other energy indicators will see decreases from 2013 levels by 2040. The carbon dioxide (CO_2) intensity carbonisation rate – CO_2 emission per unit of energy consumption – will be about 45 percent lower than 1990 levels and about 40 percent lower than in 2013. Figure 8-7 shows the evolution of various indicators of energy consumption in Japan from 1990 to 2040 under BAU.

Figure 8-7. Indices of Energy and CO_2 Intensities, Energy per Capita and Carbonisation Rate, BAU (1990 level = 100)



CO_2 = carbon dioxide; BAU = Business-as-Usual scenario.
Source: Author's calculation.

3.2. Energy Saving and CO_2 Reduction Potential

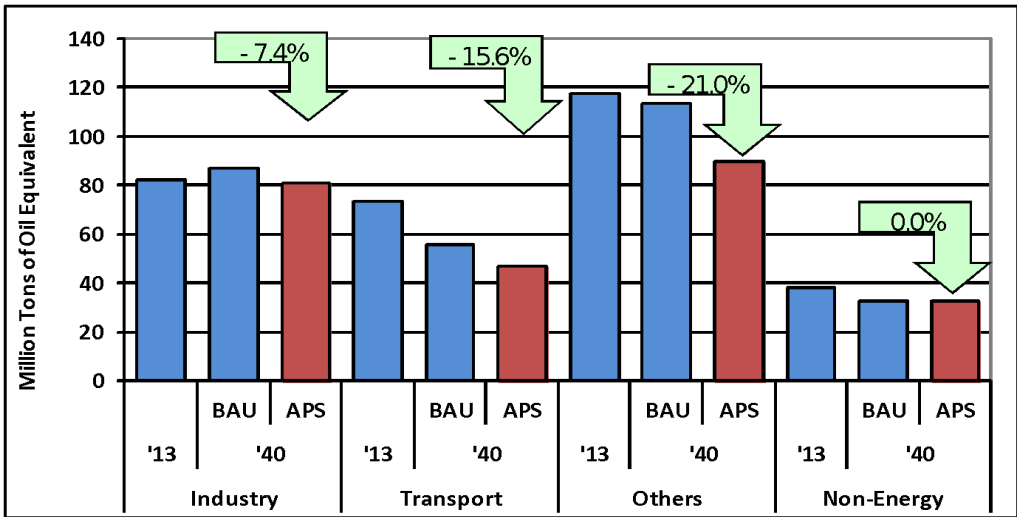
3.2.1. Final energy demand

In the Alternative Policy Scenario (APS), final energy consumption is projected to decline at a faster rate of 0.8 percent per year from 311.4 Mtoe in 2013 to 250.4 Mtoe in 2040. A rapid decline of 1.7 percent per year will be experienced in the

transport sector due to the Top Runner Program and more aggressive energy management systems. Japan will make continuous efforts to improve energy efficiency, especially with regard to introducing energy efficient automobiles such as hybrid vehicles, electric vehicles, and plug-in hybrid electric vehicles.

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

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

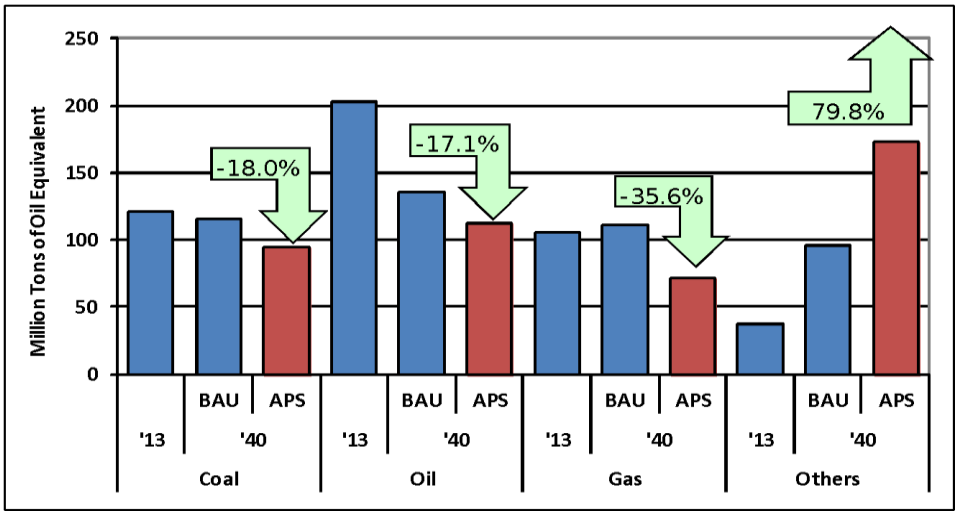


BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario.
Source: Author's calculation.

3.2.2. Primary energy supply

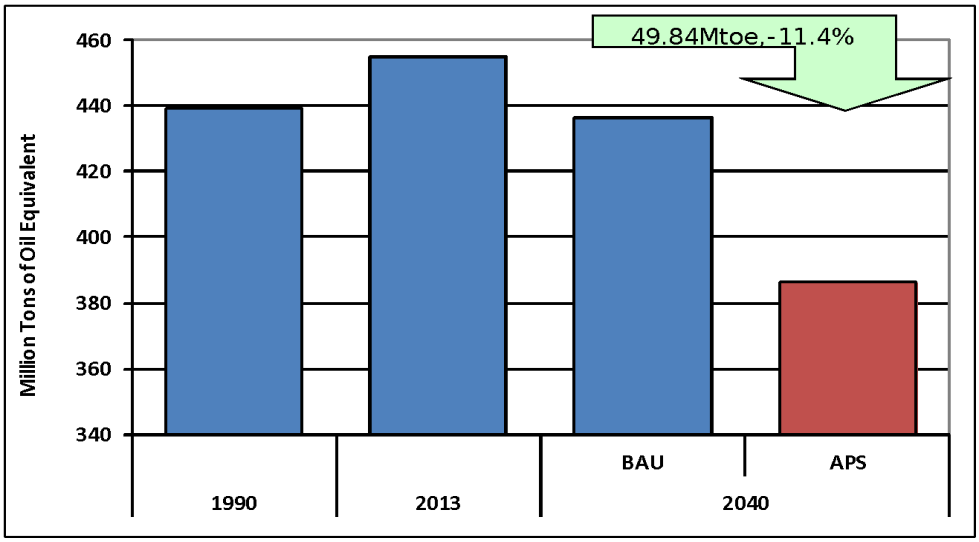
In the APS, the projected primary energy supply of Japan will decline at a rate of 0.6 percent per year to 386.3 Mtoe in 2040, 68.4 Mtoe lower than primary demand in 2013. Coal, oil, and natural gas will see decreasing annual average growth rates of 0.9 percent, 2.2 percent, and 1.4 percent, respectively. These decreases are due mainly to the increase of nuclear. Nuclear will have an increasing annual average growth rate of 12.4 percent. Figure 8-9 shows the primary energy supply by source under BAU and APS.

Figure 8-9. Primary Energy Supply by Source, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario.
Source: Author's calculation.

Figure 8-10. Total Primary Energy Supply, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mtoe = million tons of oil equivalent.
Source: Author's calculation.

3.2.3. Projected energy saving

The energy savings that could be derived from Japan's action plans amount to 49.8 Mtoe, the difference between the primary energy supply of the BAU and the APS (Figure 8-10). This is equivalent to an 11.4 percent reduction in Japan's BAU consumption in 2040.

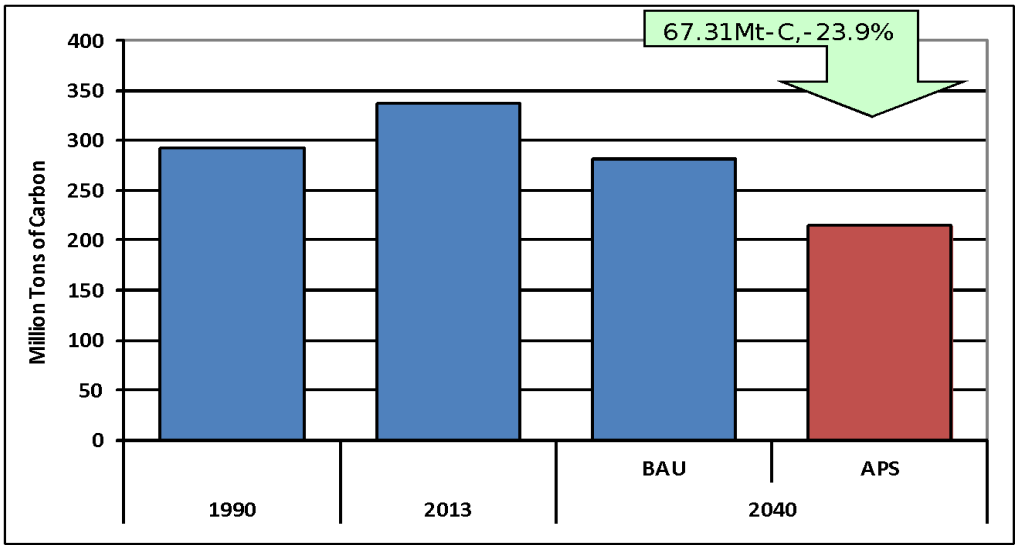
In terms of savings in final energy demand, there is an estimated saving of 23.9 Mtoe in the residential/commercial sector, and 8.7 Mtoe in the transportation sector in 2040 in the APS, relative to the BAU. The projected decreases in the consumption of the transportation sector from 2013 to 2040 are 17.8 Mtoe in the BAU and 26.7 Mtoe in the APS. This is attributable to the increase in more efficient vehicles.

3.2.4. CO_2 emissions from energy consumption

Under BAU, CO_2 emissions from energy consumption are projected to decrease at an average annual rate of 0.7 percent from 336.6 metric tons of carbon (Mt-C) in 2013 to 282.0 Mt-C in 2040 (Figure 8-11).

Under APS, the annual decrease in CO_2 emissions from 2013 to 2040 is projected to decline at an average annual rate of 1.7 percent. This rate of decrease is higher than that of primary energy supply of 0.6 percent. This indicates that the energy savings goals and action plans of Japan are very effective in reducing CO_2 emissions.

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



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mt-C = metric tons of carbon.
Source: Author's calculation.

4. Implications and Policy Recommendations

Japan's primary energy intensity has been declining since 1980 and it is the lowest in the world. This could be due to the enormous improvements in energy efficiencies in both supply side and demand side technologies that have been developed and implemented in Japan.

The fact that Japan imports most of its energy requirements is another reason why the country is very aggressive in improving energy efficiency.

The New Strategic Energy Plan was approved by the cabinet in April 2014. Based on the plan, the Long-term Energy Supply and Demand Outlook was approved by the Ministry of Economy, Trade and Industry in July 2015; it presents the ideal structure of energy supply and demand. This can be realised if appropriate measures are taken based on the fundamental direction of energy policies. Japan's envisioned policy objectives are safety, energy security, economic efficiency, and environment, which are the basic ideals of its energy policies.

In APS, which is estimated based on the Outlook, and even in BAU, CO_2 emissions in 2040 are projected to be much lower than the 1990 level. This indicates that Japan could achieve its target of reducing greenhouse gas (GhG) emissions by 26 percent in 2030 compared with the 2013 level. However, to achieve the target, Japan should effectively implement its policies on low-carbon technology, including both energy efficiency and zero emission energy. Regarding energy efficiency, the APS (higher aim of renewable share and energy saving technology) needs the promotional policies such as the required 1 percent improvement per year for large energy-consuming companies and the target of a 50 percent share in total sales of vehicles for hybrid vehicles. Regarding zero emission energy, renewable energy in Japan is concentrated in photovoltaics (PV). However, it needs to promote stable power sources such as geothermal and small hydro as well. To achieve the APS, it is necessary to restart nuclear plants under the improved nuclear safety system and based on intensive and effective communication with local residents.

In addition, as the world leader in energy efficiency, Japan should introduce such successful policies to other countries as early as possible. By doing so, Japan will be able to more effectively contribute to reducing world energy consumption, which would mean more available energy for the future years to come. This would benefit Japan economically as well. Therefore, Japan should look not only at its own market but also at the world market as a whole when developing policies regarding energy efficiency and low-carbon energy.