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; most of its land area is mountainous and thickly forested. Until 2009, it was the world's second-largest economy after the United States. In 2010, however, China surpassed Japan as the world's second-largest economy. Japan's real gross domestic product (GDP) in 2015 was about US$5,986 billion (constant 2010 prices) (World Bank, 2017), and the population is currently about 127 million.

1.1. Energy Situation

Japan possesses limited indigenous energy resources and imports almost all its crude oil, coal, and natural gas requirements to sustain economic activity. In 2015, Japan's primary energy supply was 429.8 million tons of oil equivalent (Mtoe). By energy type, oil represented the largest share at 43.0%, coal was second at 27.3%, followed by natural gas at 23.3%. Nuclear energy accounted for 0.6%. Others, such as hydro, geothermal, wind, and solar, represented the remainder of 5.8%. In 2015, net imports of energy accounted for about 99% of net primary energy supply. With limited indigenous energy sources, Japan imported almost 100% of oil and coal, and 98% 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. Natural gas is mainly used for electricity generation, followed by reticulated city gas and industrial fuels. In 2015, primary natural gas consumption was 100 Mtoe.

Japan's final energy consumption experienced a slight growth of 0.1% per year from 287.0 Mtoe in 1990 to 291.4 Mtoe in 2015. The residential/commercial ('others') sector had the highest growth rate during this period at 1.1% per year, followed by the transport sector with 0.2%. Consumption in the industry sector decreased at a rate of 1.1% per year on average over the period 1990–2015. Oil was the most-consumed product, having a share of 59.5% in 1990; it decreased to 52.3% in 2015. Electricity was the second most-consumed product.

Japan's primary energy supply decreased at the rate of 0.1% per year from 438.6 Mtoe in 1990 to 429.8 Mtoe in 2015. Amongst 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 3.3% and 1.7%, respectively, while nuclear energy declined at 11.5% in 1990–2015 due to the Great East Japan earthquake. Oil consumption declined by 1.2% per year over the same period.

In Japan, 292 gigawatts (GW) of power generation capacity was installed and generated about 1,035 terawatt-hours (TWh) of electricity in 2015. The generation by energy type is broken down as thermal (coal, natural gas, and oil) at 82.6%; nuclear, 0.9%; hydro, 8.2%; and geothermal, solar, and wind taking up the remaining 8.0%.

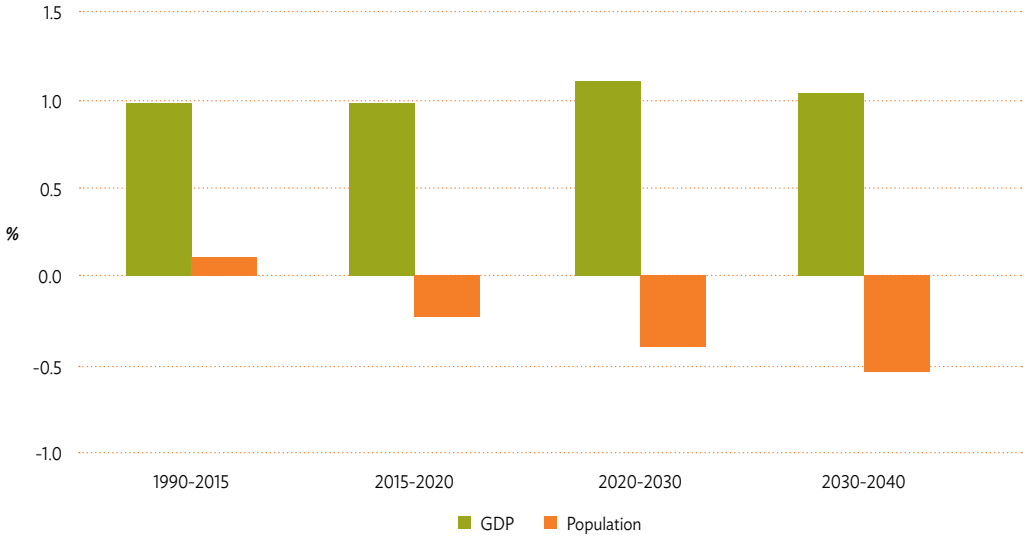
2. Modelling Assumptions

In this outlook, Japan's real GDP is assumed to grow at an average annual rate of 1% from 2015 to 2040. With the maturing of Japanese society and economy, the industry structure will become increasingly oriented towards the service industry.

Population growth, on the other hand, will decline by about 0.4% per year from 2015 to 2040 due to the decreasing birth rate. Japan's population is projected to decrease from 127 million in 2013 to 114 million in 2040. Figure 8.1 shows the assumptions of 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 as the population shrinks.

Figure 8.1: Annual Growth Rate of GDP and Population



GDP = gross domestic product.

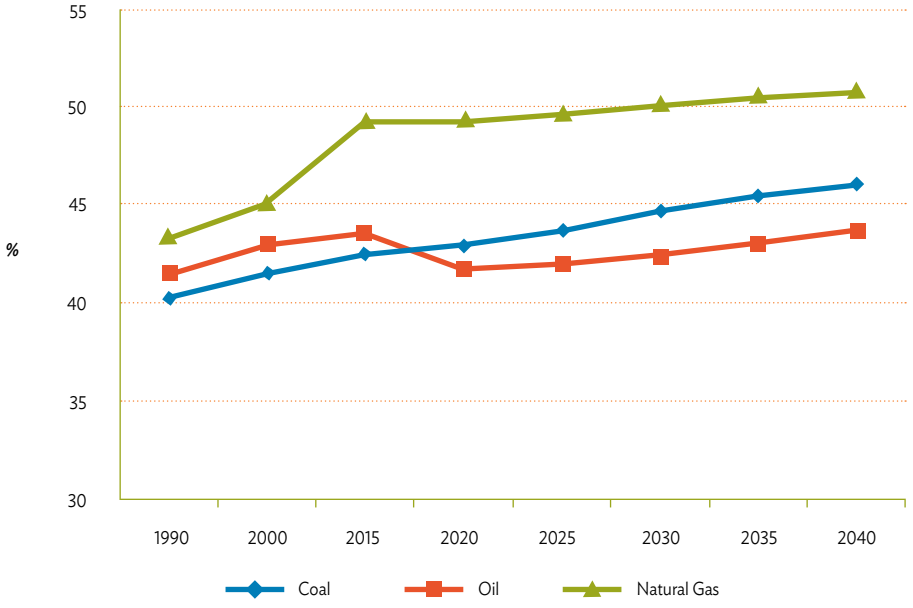
Source: Author's assumption.

The New Strategic Energy Plan was approved by the Cabinet in April 2014. Based on this plan, the Ministry of Economy, Trade and Industry (METI) approved the Long-term Energy Supply and Demand Outlook in July 2015. According to the Outlook, the share of nuclear power will be reduced from about 30% before the Great East Japan Earthquake to about 20%–22% in 2030. The share of renewable energy will be about 22% to 24% in 2030, which was 11% before the earthquake. Also, the share of baseload power (hydropower, coal-fired thermal power, nuclear power, etc.) will be approximately 56%.

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/commercial sector, the 'Top Runner Programme'[1] 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 from improvements in vehicle fuel efficiency, including increases in the stock of hybrid vehicles and structural changes in vehicles. Figure 8.2 shows the assumed thermal efficiencies of thermal power plants in the Business-As-Usual (BAU) scenario.

[1] This is Japan's energy efficiency programme that aims to improve the energy efficiency of household and office appliances as well as vehicles. It sets the end-use energy performance of the best technology available in the market as the standard for each product category.

Figure 8.2: Thermal Efficiency, BAU



BAU= Business-As-Usual.

Source: Author's calculation.

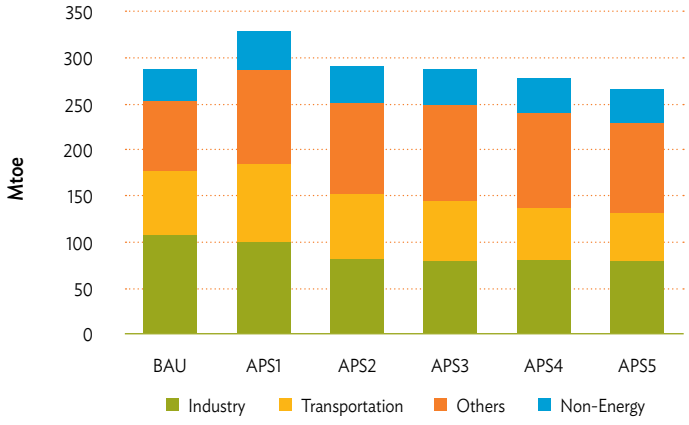
3. Simulation Results

3.1. Business-As-Usual Scenario

3.1.1. Final Energy Consumption

With the projected relatively low economic growth and declining population, Japan's final energy demand from 2015 to 2040 is projected to decline at an average rate of 0.4% per year in the BAU scenario. This is also driven by improved energy efficiency in the transport sector. The final energy consumption of the transport sector is projected to decrease at an annual average rate of 1.3% from 2015 to 2040. This is mainly due to improvements in the fuel economy of conventional internal combustion engine vehicles, and the penetration of hybrid vehicles. Figure 8.3 shows the projected final energy consumption by sector from 1990 to 2040 under the BAU scenario.

Figure 8.3: Final Energy Consumption by Sector, BAU

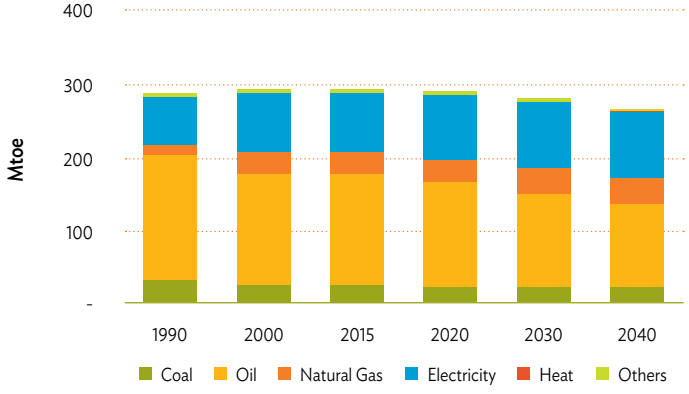


APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

By fuel type, the consumption of coal and oil is projected to decrease at an average annual rate of 0.4% and 1.1%, respectively, between 2015 and 2040. On the other hand, consumption of natural gas and electricity is projected to increase at 0.6% and 0.4% per year, respectively, over the period. Figure 8.4 shows the projected final energy consumption by source from 1990 to 2040 under the BAU scenario.

Figure 8.4: Final Energy Consumption by Source, BAU



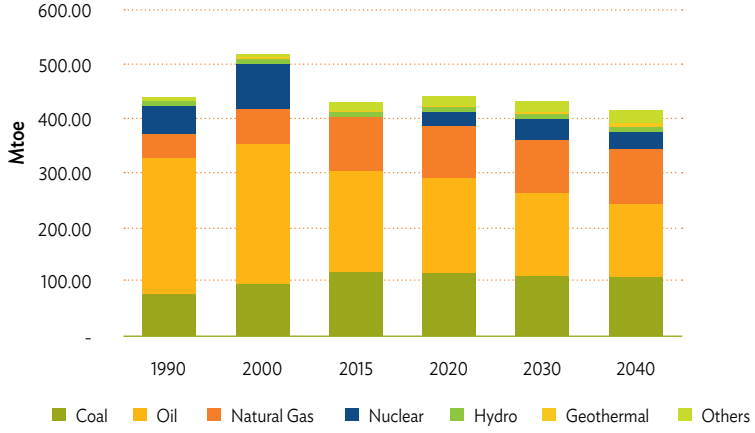
BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

3.1.2. Primary energy supply

Under the BAU scenario, Japan's net primary energy supply is projected to decrease at an average annual rate of 0.1% per year from 429.8 Mtoe in 2015 to 414.3 Mtoe in 2040 (Figure 8.5). This decrease is due mainly to the decreasing use of oil at an average annual growth rate (AAGR) of 1.5% between 2015 and 2040. On the other hand, nuclear and renewable energy including hydro will have increased AAGRs of 10.9% and 1.7%, respectively. The share of nuclear between 2015 and 2040 is projected to increase from 0.6% to 7.9%. The self-sufficiency rate of primary energy will reach 26.3% in 2040, from 7.0% in 2015, after the restart of nuclear power plants and penetration of renewable energy.

Figure 8.5: Primary Energy Supply, BAU



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

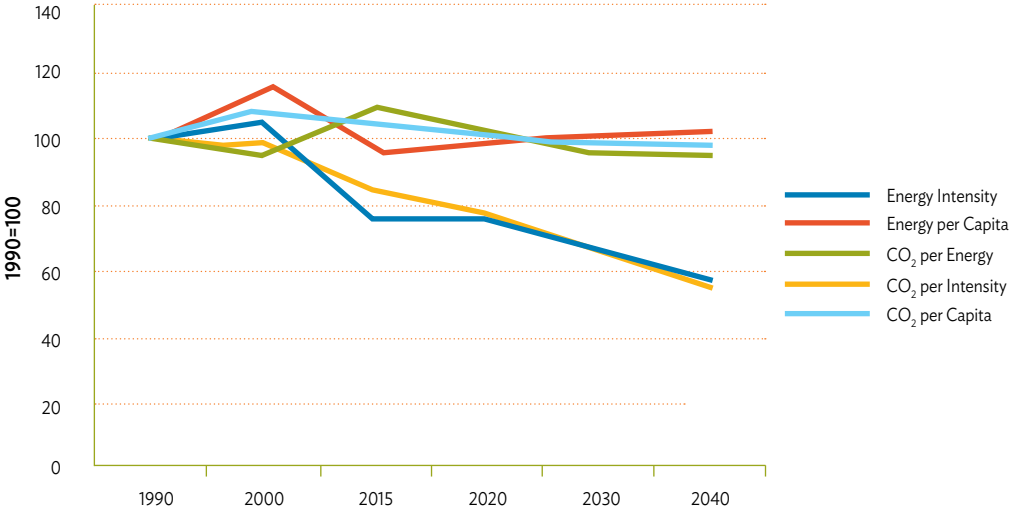
3.1.3. Energy indicators

The energy consumption per capita towards 2040 will increase during the projection period. Income elasticity[2] between 2015 and 2040 is expected to decline because the growth rate in energy consumption will be negative while the GDP growth rate is assumed to be positive.

Except for energy consumption per capita, all other energy indicators will exhibit decreases from the 2015 levels by 2040. CO_2 intensity carbonisation rate (CO_2 emissions per unit of energy consumption) will be about 46% lower than the 1990 levels and about 44% lower than the 2015 levels. Figure 8.6 shows the evolution of several kinds of indicators of energy consumption in Japan from 1990 to 2040 under the BAU scenario.

2 Growth rate of energy consumption divided by growth rate of GDP.

Figure 8.6: Indices of Energy and CO_2 Intensities, Energy per Capita, and Carbonisation Rate, BAU (1990–2040)



BAU = Business-As-Usual.

Source: Author's calculation.

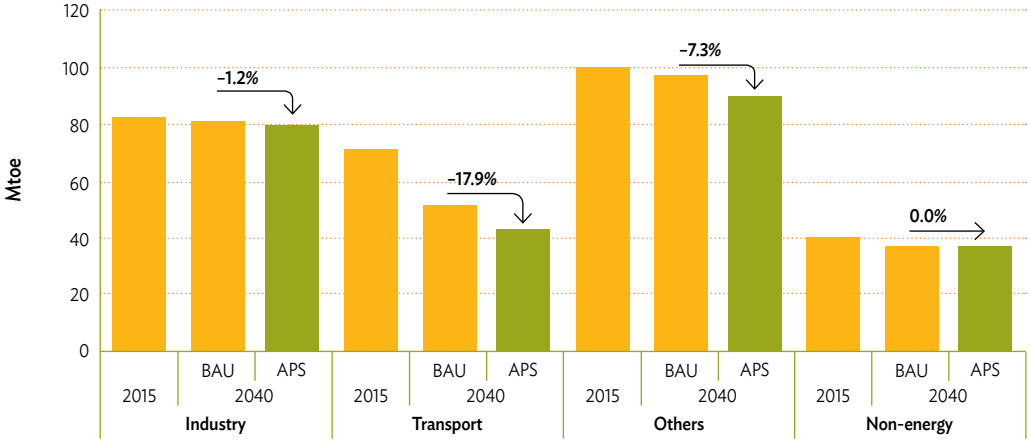
3.2. Energy Savings and CO_2 Reduction Potential

3.2.1. Final energy consumption

In the Alternative Policy Scenario (APS), final energy consumption is projected to decline at the faster rate of 0.6% per year, from 291.4 Mtoe in 2015 to 248.8 Mtoe in 2040. In all final sectors (industry, transport, 'others'), energy consumption will continue to decrease due to improved energy efficiency. The transport sector especially will achieve a remarkable savings of 1.3% per year due to the Top Runner Programme and more aggressive energy management systems. Japan will implement continuous efforts to improve energy efficiency, especially regarding the penetration of energy-efficient automobiles, such as hybrid vehicles, electric vehicles, and plug-in hybrid electric vehicles.

The industry and services sectors will also make efforts to improve their energy efficiency although it will be difficult for these sectors to do so drastically because energy efficiency and conservation actions in those sectors have already been done so far. Figure 8.7 shows the final energy consumption by sector in the BAU scenario and the APS.

Figure 8.7: Final Energy Consumption by Sectors, BAU and APS (2015 and 2040)



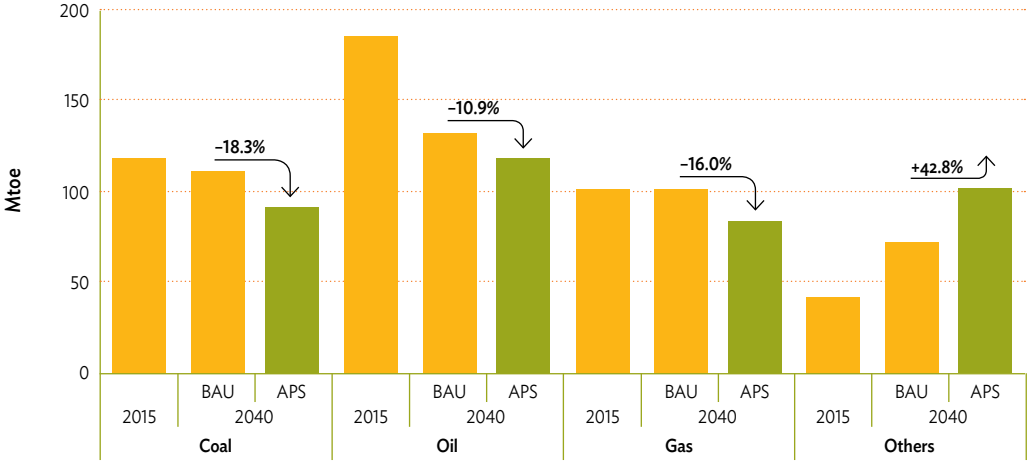
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

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 0.3% per year to 394.1 Mtoe in 2040, 35.7 Mtoe lower than that in 2015. Coal, oil, and natural gas will have decreasing AAGRs of 1.1%, 1.8%, and 0.7%, respectively. Nuclear and biomass will partially substitute fossil fuels. Figure 8.8 shows the primary energy supply by source under the BAU scenario and the APS.

Figure 8.8: Primary Energy Supply by Source, BAU and APS (2015 and 2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

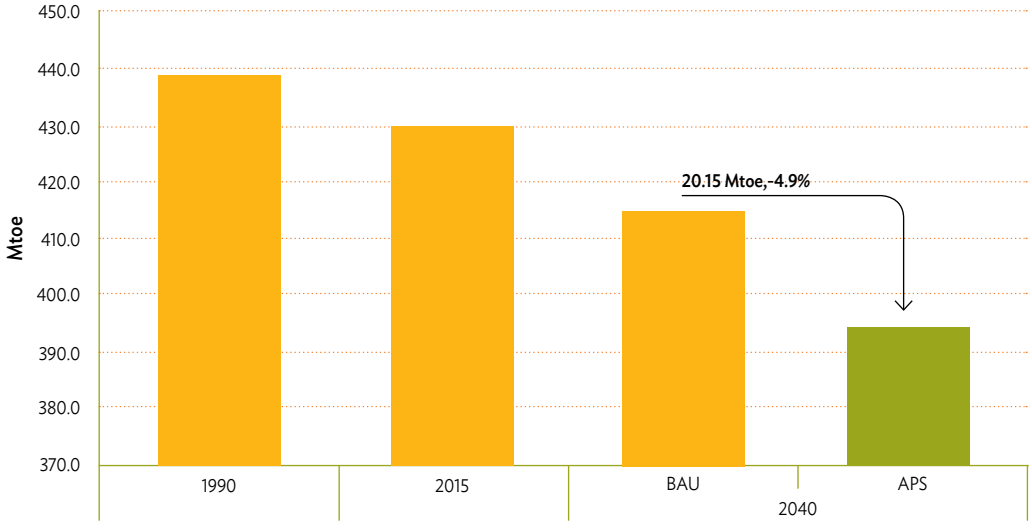
Source: Author's calculation.

3.2.3. Projected energy savings

Energy savings that could be derived from action plans of Japan amount to 20.15 Mtoe, the difference between the primary energy demand of the BAU scenario and the APS (Figure 8.9). This is equivalent to 4.9% reduction of Japan's consumption under the BAU scenario in 2040.

Estimated savings in final energy consumption in the residential/commercial sector will amount to 7.11 Mtoe and 9.25 Mtoe in the transport sector in 2040 in the APS. The projected decreases in the consumption of the transport sector in 2015–2040 are 25.3 Mtoe in the BAU scenario and 42.6 Mtoe in the APS. This is attributable to the increase of more efficient vehicles.

Figure 8.9: Total Primary Energy Supply, BAU and APS (1990, 2015, and 2040)



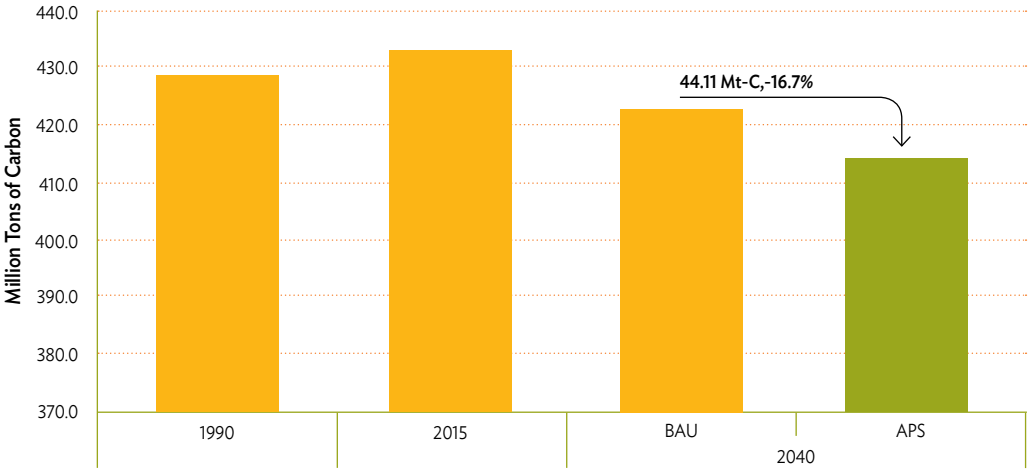
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

3.2.4. CO_2 emissions from energy consumption

Under the BAU scenario, CO_2 emissions from energy consumption are projected to decrease at an average annual rate of 0.7% from 312.9 million tons of carbon (Mt-C) in 2015 to 219.2 Mt-C in 2040 (Figure 8.10). Under the APS, CO_2 emissions are projected to decline at average annual rate of 1.4% between 2015 and 2040.

Figure 8.10: CO_2 Emissions from Fossil Fuel Combustion, BAU and APS



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mt-C = million tons of carbon.

Source: Author's calculation.

4. Japan's Intended Nationally Determined Contributions

Japan's Intended Nationally Determined Contributions towards reduced greenhouse gas emissions after 2020 is 26.6% by fiscal year (FY) 2030, compared to that of FY2013 (25.4% reduction compared to FY2005, approximately 1.042 billion tons of carbon dioxide equivalent (t-CO_2e). That target is consistent with METI's Long-term Energy Supply and Demand Outlook of Japan's quantitative policy target for energy mix in 2030. Japan is expected to achieve this target in the APS.

5. Implications and Policy Recommendations

Japan's primary energy intensity has been declining since 1980, and it is the lowest worldwide. This could be due to the enormous improvements in energy efficiencies in both supply- and demand-side technologies that have been developed and implemented in the country. The fact that Japan imports most of its energy requirements is another reason the country is very aggressive in improving energy efficiency.

The Cabinet approved the Strategic Energy Plan in April 2014 (Government of Japan, 2014). The plan was the basis for METI's approval in July 2015 of the Long-term Energy Supply and Demand Outlook (METI, 2015), which 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 objectives are safety, energy security, economic efficiency, and environment, which are the basic concepts of the policies.

CO_2 emissions in 2040 are projected to be much lower than those of the 1990 level in the APS, based on METI's Outlook, and even in the BAU scenario. However, to achieve the 26% reduction target for 2030, Japan should effectively implement its policies on low-carbon technology, including energy efficiency and zero emissions energy.

For energy efficiency, the APS requires a 1% improvement per year for companies that consume large amounts of energy, and a target of 50% share in sales for hybrid vehicles. Renewable and nuclear energy play a key role in decarbonising power generation. To achieve intensive renewable energy penetration, like in the APS, it is necessary to significantly reduce the capital cost, invest in grids to cope with fluctuations of power from photovoltaic and wind, and implement effective grid rules. As for nuclear energy, mature safety measures and sufficient communication with local communities for restart are required.

In addition, as the leader in energy efficiency, Japan's government and companies should share best practices of policies, services, and products with other countries. By doing this, Japan can contribute to reducing world energy consumption. This is beneficial to Japan as well since such activity helps with the global expansion of its market.

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