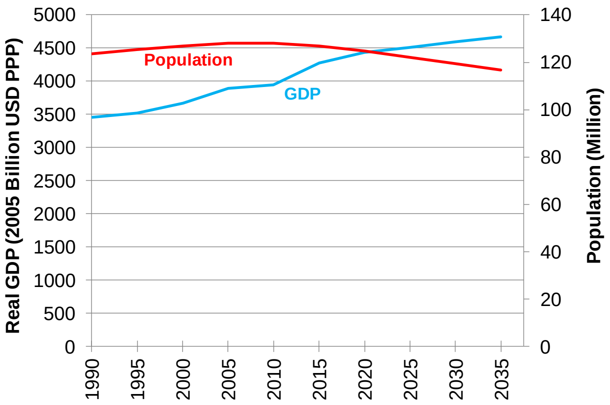
JAPAN

- *Japan's final energy consumption is expected to decrease at 0.6% per year over the outlook period as a result of Japan's slow GDP growth and declining final energy intensity.*
- *The future of nuclear power remains the largest uncertainty in Japan's energy outlook, as Japan has not yet reached a consensus on the role of nuclear power after the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011. This Outlook assumes no new nuclear units are built, and that existing nuclear units will continue to operate, but will be phased out at the end of their 40-year life. The Japanese Government is considering three options for how much nuclear energy will contribute to the power generation mix in 2030, namely 0%, 15% or 20–25%, and has called for public comments on these options.*
- *Japan's CO_2 emissions are expected to decrease at 0.5% per year toward 2035, because of the decrease in final energy consumption and decline of final energy intensity.*

ECONOMY

Japan is located in East Asia and is made up of several thousand islands, the largest of which are Honshu, Hokkaido, Kyushu and Shikoku. It has a land area of about 377 800 square kilometres, most of it mountainous and thickly forested. In 2010 the population was 128.1 million people and the population density was 339.1 people per square kilometre.

Figure JPN1: GDP and Population



Sources: Global Insight (2012) and APERC Analysis (2012)

Japan's population is expected to decrease to 117 million by 2035 (the annual average growth rate is decreasing at 0.4% for the period). In 2010 about 40% of the total population was concentrated in Tokyo Metropolitan Area and Kansai (Osaka, Kobe and Kyoto) Areas. The urbanization rate was 77.3% in 1990 and reached 90.5% in 2010. The urbanization rate is expected to reach 96.3% in 2025 (UN, 2012).

Japan's GDP per capita increased at an annual rate of 0.5% from USD 27 999 (2005 USD PPP) in 1990 to USD 30 807 in 2010. It is expected to increase at an annual rate of 1.1% from USD 30 807 in 2010 to above USD 40 000 in 2035. This low rate of annual growth of GDP can largely be explained by three factors:

- aging population combined with the diminishing number of children (decrease in domestic consumption)
- mature social infrastructure (decrease in domestic investment)
- relocation of production sites overseas by Japanese companies (decrease in export and increase in import).

Japan has diverse regional climates. On the Pacific Coast, summers are often rainy, while winters are generally dry; temperature averages are higher in the southern regions and lower in the north. On the coast of the Japan Sea, there is a lot of heavy snow in winter. In the Okinawa islands, off the coast of Kyushu, the climate is subtropical or tropical, with high temperatures throughout the year. In general, Japan faces heavy demands for electricity in summer (for cooling) and in winter (for heating).

In Japan, the major industries are iron and steel, chemical and petroleum, machinery, and non-metallic minerals. The share of final energy consumption by these four industries is about 65% of the total industry demand in 2009 (IEA, 2011). The iron and steel industry consume mainly coal and electricity, whereas the chemical and petroleum industry consume mainly oil products and electricity. These four major industries are expected to continue to play important roles into the future.

Road transport accounted for 66% of Japan's passenger-kilometres in 2012 (IEEJ, 2012, pp. 130–131). Japan has an extensive network of about 1.3 million kilometres of roads, including about 9000 kilometres of national expressway. Japanese roads are generally paved and well maintained (MLIT, 2012b).

Railways account for an unusually large share of passenger-kilometres at 29% (IEEJ, 2012, pp. 130–131). Japan is well known for its network of 'bullet trains' (*Shinkansen*) that provide high-speed service between major cities. All major Japanese cities have local railway and/or subway systems. Air transport accounts for most of the remaining non-road, non-rail domestic passenger-kilometres.

In freight transportation, road transport accounts for 64% of the tonne-kilometres. Water-based transport, mostly coastal shipping, accounts for another 32%. Japan has 23 'Specially Designated Ports', 105 'Major Ports', and many more small and medium-sized ones (MLIT, 2012a). In contrast to the large role of rail in passenger transport, freight transport by rail accounts for only about 4% of the freight tonne-kilometres (IEEJ, 2012, pp. 130–131).

Almost 99% of the passenger and freight vehicles used in Japan in 2009 were domestically produced. On the other hand, about 55% of the motorcycles in use in 2009 were domestically produced (MLIT, 2010 and MOF, 2010).

ENERGY RESOURCES AND INFRASTRUCTURE

Japan has very limited fossil fuel energy resources. Japan produces coal, crude oil and natural gas on a very small scale compared to its demand. Import dependency in 2009 for coal was 99%, crude oil almost 100%, and natural gas 96% (APEC, 2009).

Japan has no pipeline or electrical connections to other economies. All natural gas is imported in the form of LNG. Japan had 27 LNG receiving terminals as of 2009, with a total storage capacity of 15.09 million kilolitres. This is equivalent to about 9% of the total annual LNG import volumes. Japan will have seven more LNG receiving terminals by 2015 (JIE, 2011).

Japan has confirmed resources of methane hydrates equivalent to 1.1 trillion cubic metres of methane gas (about 1000 Mtoe) in the eastern Nankai Trough area. However, further research will be required before this resource can be developed. Japan started the Methane Hydrate Development Program in 2001 in order to utilize resources in the coastal waters of Japan. The program consists of three phases and will be completed in 2018 (METI, 2001).

Japan generated 1041.0 TWh of electricity in 2009. The sources of electricity generation are: coal 279.5 TWh (26.8%), oil 91.6 TWh (8.8%), gas 284.9 TWh (27.4%), hydro 75.2 TWh (7.2%), new renewable energy 30.0 TWh (2.9%), and nuclear 279.8 TWh (26.9%). Japan had 54 commercial nuclear units with about 49 GW of capacity prior to the Fukushima Nuclear Accident in March 2011 (IEEJ, 2012, p. 208). However, as discussed in the next section, all but two of these units were shut down at the time this Outlook was compiled.

Japan has already developed almost all of the sites suitable for large-scale hydro power plants. Therefore, hydro development must concentrate on sites suitable for small and medium-scale plants.

Japan has significant potential sources of renewable energy. These are as follows (NPU, 2011):

1. *Solar photovoltaic*
   - Residence: 91 GW
   - Non-residence:
     - Public buildings, other commercial and industry: 44 GW
     - Little-used and unused land (e.g. waste disposal sites, transport right-of-ways): 18 GW–39 GW
     - Fields and rice paddies that have been abandoned and are no longer cultivated: 3 GW–104 GW
2. *Wind*
   - Onshore: 290 GW
   - Offshore: 1500 GW
3. *Small and medium-sized hydro*: 20 GW
4. *Geothermal*
   - Hot water resources: 4.3 GW
   - Hot springs: 0.72 GW
5. *Biomass*: 0.73 GW.

There are constraints that may hinder the development of some of these resources. Most geothermal energy resources are in national parks where strict environmental rules and regulations may prevent or severely limit development. Biomass energy development must take into account competition for land with food supply, as well as potential environmental impacts.

ENERGY POLICIES

In 2007, the Japanese Government announced 'Cool Earth 50', a cooperative initiative with major greenhouse gas emitters to reduce worldwide emissions by 50% from current levels by 2050 (METI, 2008a). At the United Nations Summit on Climate Change in September 2009, the Japanese Prime Minister pledged that Japan would cut its greenhouse gas emissions by 25% from 1990 levels by 2020, provided that a fair and effective international framework, in which all major economies participate, had been established.

The Strategic Energy Plan, which was last revised in 2010, aims to fundamentally change the energy supply and demand system. It set these ambitious targets for 2030 (METI, 2010):

1. Doubling the energy self-sufficiency rate (18% in 2010) and the ratio for the self-developed fossil fuel supply (resources developed abroad by Japanese petroleum and gas companies, which were 26% in 2010), thereby raising Japan's 'energy independence ratio' to about 70% (38% in 2010).
2. Raising the ratio of zero-emission power sources (mainly nuclear) to about 70% (34% in 2010).
3. Halving CO_2 emissions from the residential sector.
4. Maintaining and enhancing energy efficiency in the industrial sector at the highest level in the world.
5. Maintaining or obtaining leading shares in global markets for energy-related products and systems.

However, after experiencing the Great East Japan Earthquake and Fukushima Nuclear Accident in March 2011, the Japanese Government decided to review the Strategic Energy Plan. This review process is underway at the time of writing, with the key issue being the share of nuclear power in the power supply mix, as discussed below.

Japan has a Law on the Rational Use of Energy (an energy conservation law). This law requires business organizations (such as manufacturers and service companies) with energy use equivalent to 1500 kilolitres or more per year of crude oil, to report annually on the amounts of energy they consume and to prepare and submit medium-term (3–5 years) plans for the rational use of energy, and to assign responsible people to energy management. The target for reducing energy consumption intensity is 1% or more per year on average over the medium term (APERC, 2011). Japan has no fossil fuel subsidies that would encourage wasteful consumption.

Japan has a Top Runner Program to improve energy efficiency of machinery and equipment. This program sets standard target values for energy-using machinery and equipment, and calls for manufacturers and importers to, on average, meet this standard in their products. Currently, 23 categories of products are designated in the program (APERC, 2011).

Japan's Building Energy Codes define two categories of buildings for their targets: Type 1 House/Building (with floor area of 2000 square metres or more), and Type 2 House/Building (with floor area of 300–2000 square metres). Owners of these types of houses and buildings are required to report their energy conservation measures prior to construction, and afterwards to report the state of maintenance of the house or building to the relevant authority regularly (every three years). For the Type 1 House/Building, penalties may be levied if the building is not able to achieve satisfactory energy performance (APERC, 2011).

In the transport sector, large common carriers (rail, truck, bus, taxi, ship, and air) are required to annually prepare and submit energy conservation plans, as well as an annual report on their energy consumption. Similar rules apply to organizations that privately travel 30 million tonne-kilometres per year of their own freight (APERC, 2011).

Japan has a tax incentive scheme to promote the purchase of energy-efficient equipment. When small and medium-sized companies purchase specified energy-conserving equipment, they are given a tax credit. Companies of all sizes are given a special depreciation allowance on purchase of the specified equipment (APERC, 2011).

Japan has a vehicle-greening tax scheme and an eco-car tax reduction scheme; these provide tax incentives for owners of low-emission and/or high-fuel-efficiency vehicles. At the same time, heavy taxes are levied on older vehicles that are becoming harmful to the environment (APERC 2011).

Japan will grant direct subsidies for several types of efforts promoting energy efficiency:

- to support business operators who introduce 'highly significant' energy-saving facilities
- to introduce high-efficiency energy systems in homes/buildings or building energy management systems (BEMS)
- for research and demonstration projects to develop energy conservation technology (APERC, 2011).

Since Japan has very scarce domestic oil and gas reserves, the Japanese Government has given financial support for oil and gas exploration, development and production outside Japan through the Japan Oil, Gas and Metals National Corporation (JOGMEC). This has taken the form of investment and loan guarantees to project companies. In November 2011 there were 135 Japanese oil and gas companies engaging in exploration and development of crude oil and natural gas in 41 economies. The share of equity crude oil and natural gas to total imports is 23% in 2009 (JPDA, 2011).

Japan has 10 vertically integrated, mainly privately owned General Electricity Utilities, which have traditionally managed generation, transmission and distribution of electricity on a regulated monopoly basis. In addition, Wholesale Electricity Utilities operate large power plants and sell the output to a General Electric Utility. With the gradual liberalization of the Japanese power market since 1995, three new types of firms have entered the market: Wholesale Suppliers such as Independent Power Producers, which sell electricity to a General Electric Utility on a smaller scale than a Wholesale Electric Utility; Power Producers and Suppliers, who sell electricity directly to large customers using a transmission wheeling service provided by a General Electric Utility, and Specified Electricity Utilities which generate, transmit and distribute electricity directly to customers using their own network.

Customers with contract volumes of less than 50 kW are still categorized as 'regulated'. On the other hand, customers with contract volumes of 50 kW or more are categorized as 'de-regulated', and may purchase their electricity from either their General Electric Utility or a Power Producer and Supplier (TEPCO, 2012).

Japanese gas utilities also have historically operated as regulated monopolies. They are mainly privately owned, although some are municipally owned. As with electric utilities, the market has been partially liberalized since 1995 (METI, 2008b). De-regulated gas customers negotiate with gas companies on prices, while regulated customers pay regulated prices. Since 2007, customers with consumption volumes of more than 100 000 cubic metres per year were de-regulated (METI, 2008b).

Japan's Nuclear Energy Policy is currently under review after the Fukushima Nuclear Accident. Over the months after the accident, each of the nuclear units still in operation in Japan was shut down for scheduled inspection—this is required by law at least once every 13 months. After the inspection shutdowns, the companies did not restart operations for two reasons. First, the then Prime Minister Naoto Kan announced the government would carry out additional 'stress tests' for confirming the safety of nuclear power plants. Secondly, the power companies could not easily get agreements to restart from the local governments where the nuclear power plants were located. (Although agreement from the local government is not stipulated in Japanese regulations as a necessary condition for restart of a nuclear power unit, in practice the power companies cannot ignore the will of the local governments.)

By early May 2012, all 50 remaining nuclear power units (four units of the Fukushima Daiichi Nuclear Power Plant were decommissioned in April 2012) had ceased operation; that meant no electricity was being generated from nuclear power. Without nuclear power, there was concern that Japan would experience power shortages and blackouts during the summer of 2012 (from July to September). In July 2012, then Prime Minister Yoshihiko Noda announced the restart of two units of the Ohi Nuclear Power Plant. That decision, along with stringent electricity conservation efforts, allowed Japan to make it through the summer of 2012 without major disruptions to electricity service.

Over the longer term, Japan continues to face much controversy over the future of nuclear power. The Japanese Government is considering three options for how much nuclear energy will contribute to the power generation mix in 2030, namely 0%, 15% or 20–25%, and has called for public comments on these options (EEC, 2012).

In September 2012, a Nuclear Regulation Authority was established with the aim of integrating several nuclear safety authorities, while achieving separation of nuclear safety regulation and nuclear energy promotion. The government has emphasised that the rules regarding the 40-year limitation of the operation of nuclear power plants will be strictly applied (NPU, 2012). This means that unless there is new construction of nuclear power plant units, Japan will phase out all nuclear power by the end of 2049.

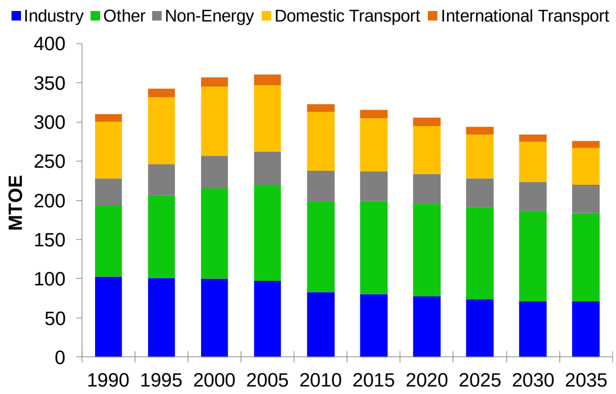
For the purposes of this Outlook, APERC assumed the existing nuclear units would resume operation once current safety reviews were completed, but each unit would be decommissioned at age 40 and there would be no newly built nuclear power units. The net effect of these assumptions is a gradual phase-out of nuclear power in Japan. APERC has also assumed that natural gas, coal and new renewable energy, such as wind, solar, biomass and other, would compensate for the decrease in electricity generation from nuclear energy. The current uncertainty regarding nuclear power is probably the largest uncertainty affecting Japan's business-as-usual energy outlook.

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

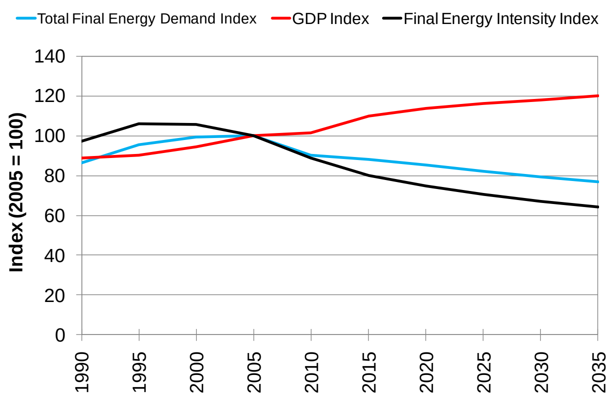
Japan's business-as-usual (BAU) final energy demand is expected to decrease at 0.6% per year over the outlook period (from 323.0 Mtoe in 2010 to 276 Mtoe in 2035). This decrease in final energy demand is caused by the slow growth of Japan's GDP and a decline in final energy intensity. The industry sector's share of the demand is expected to be about the same in 2010 and 2035, roughly 26%. However, the share taken up by the 'other' sector (which includes residential and commercial) is expected to increase from 36% in 2010 to 41% in 2035. The domestic transport share will decrease from 23% in 2010 to 17% in 2035. Final energy intensity is expected to decline by about 36% between 2005 and 2035.

Figure JPN2: BAU Final Energy Demand



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Figure JPN3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Final energy demand in the industrial sector is projected to decrease at 0.6% per year, from 83 Mtoe in 2010 to 71 Mtoe in 2035. Slow GDP growth, relocation of production overseas by Japanese companies and improvement of energy efficiency are the reasons for the decrease.

Transport

Final energy demand in the domestic transport sector is projected to decrease at 1.8% per year, from 75 Mtoe in 2010 to 47 Mtoe in 2035. Improvement in vehicle energy efficiency contributes significantly to the decrease in the final energy demand for transport.

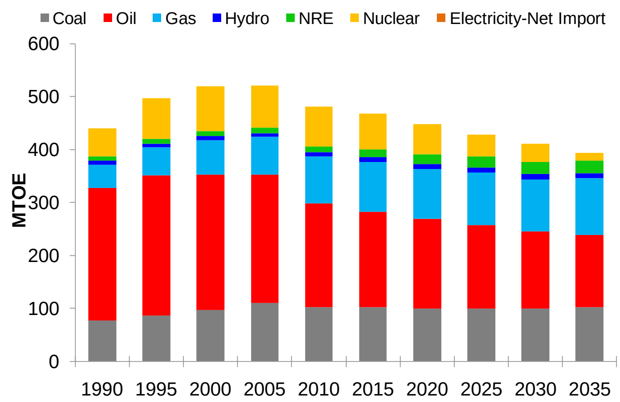
Other

Final energy demand in the 'other' sector is projected to decrease at 0.1% per year, from 115 Mtoe in 2010 to 113 Mtoe in 2035. Growing demand for various convenience appliances and equipment keeps energy demand from declining more quickly in this sector.

PRIMARY ENERGY SUPPLY

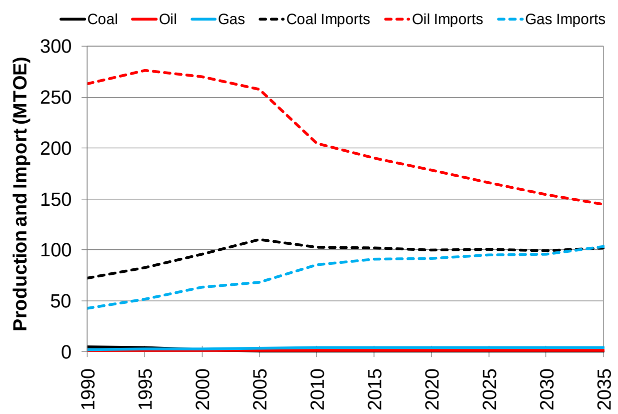
Japan's primary energy supply is projected to decrease at 0.7% per year, from 480 Mtoe in 2010 to 394 Mtoe in 2035. The new renewable share of the primary energy supply is projected to increase at 3.3% per year, while the nuclear share is projected to decrease at 6.2% per year. Fossil fuels (coal, oil and gas) are still expected to maintain a dominant role in the primary energy supply in 2035. Primary energy intensity is expected to decline by about 37% between 2005 and 2035.

Figure JPN4: BAU Primary Energy Supply



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Figure JPN5: BAU Energy Production and Net Imports



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

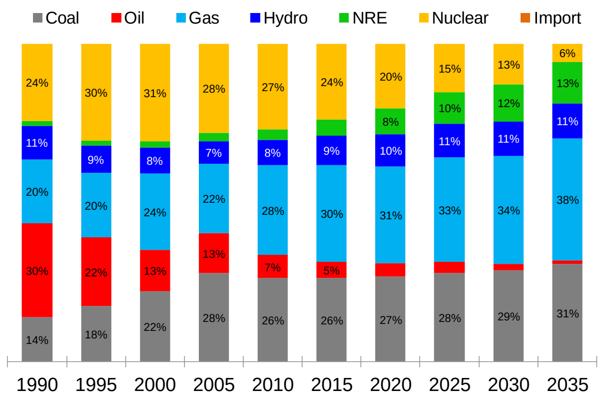
Both oil and gas production in Japan is expected to level off and then remain low throughout the period to 2035. While Japan has reasonable prospects of finding new oil and gas fields domestically, the economy faces depletion (decrease in production) of its existing oil and gas fields, and this would offset any increase in production from new fields.

Japan's net energy imports (coal, oil and gas combined) are projected to decrease at 0.4% per year over the outlook period, reflecting the decrease in the primary energy supply. Japan will continue to seek to import more equity oil and natural gas from overseas.

ELECTRICITY

Japan's BAU electricity generation is expected to decrease from 1071 TWh in 2010 to 1010 TWh in 2035; the average annual rate of this decrease is 0.2%. In 2010, coal, gas and nuclear are the main sources for electricity generation mix. Their share is 26%, 28% and 27% respectively. As discussed earlier, the share of nuclear is expected to decrease to 13% by 2035, while the share of coal and gas is expected to increase to 31% and 38%, respectively in 2035. The share of new renewable energy is expected to increase from 3% in 2010 to 13% in 2035.

Figure JPN6: BAU Electricity Generation Mix

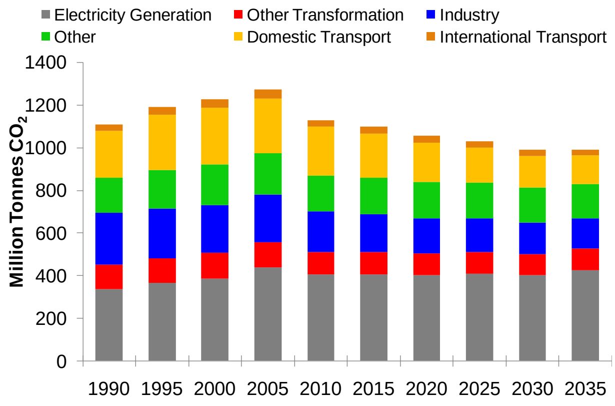


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

CO_2 EMISSIONS

Japan's BAU CO_2 emissions are projected to decrease at 0.5% per year, from about 1130 million tonnes of CO_2 in 2010 to 990 million tonnes of CO_2 in 2035. The decrease in the economy's final energy consumption and decline of final energy intensity are the main reasons for the decrease in CO_2 emissions.

Figure JPN7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

As shown in Table JPN1, Japan's 2010–2035 change in CO_2 emissions will be driven by a 1.5% per year reduction in the energy intensity of GDP (improvements in energy efficiency and a shift toward less energy-intensive industry). This reduction will be offset by 0.7% per year growth in GDP and a 0.3% per year growth in the CO_2 intensity of energy (declining use of nuclear power). The net result will be a 0.5% per year decline in CO_2 emissions.

Table JPN1: Analysis of Reasons for Change in BAU CO_2 Emissions from Fuel Combustion

(Average Annual Percent Change)

	1990-2005	2005-2010	2005-2030	2005-2035	2010-2035
Change in CO_2 Intensity of Energy	-0.2%	-0.7%	0.0%	0.1%	0.3%
Change in Energy Intensity of GDP	0.4%	-2.0%	-1.6%	-1.5%	-1.5%
Change in GDP	0.8%	0.3%	0.7%	0.6%	0.7%
Total Change	0.9%	-2.4%	-1.0%	-0.8%	-0.5%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Japan has scarce domestic energy resources and is highly dependent on imported energy. Although the economy's primary energy supply is expected to decrease between 2010 and 2035, the share of its energy supply coming from fossil fuels (coal, oil and gas combined) is expected to increase throughout the outlook period (80% in 2010 and 88% in 2035). Ensuring access to secure energy resources (including equity crude oil and natural gas) remains one of the most important challenges for Japan in this period. This challenge is compounded by the forecast reduction under BAU in the contribution of nuclear energy to electricity generation—from 27% in 2010 to 6% in 2035. This decrease in nuclear use for electricity generation raises concerns for both Japan's economic development and its environmental sustainability (in terms of CO_2 emissions). To pursue the best mix of energy resources will be a key focus for Japan.

ALTERNATIVE SCENARIOS

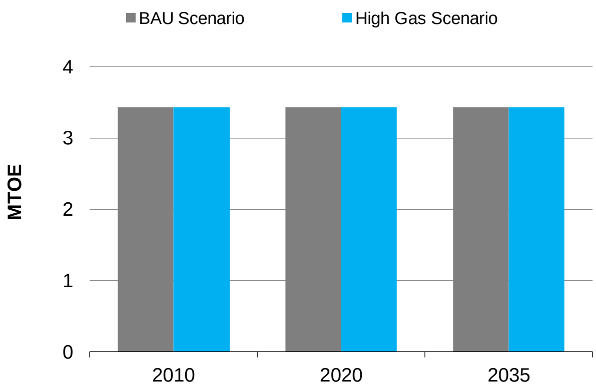
To address the energy security, economic development, and environmental sustainability challenges posed by the business-as-usual (BAU) outcomes, three sets of alternative scenarios were developed for most APEC economies.

HIGH GAS SCENARIO

To understand the impacts higher gas production might have on the energy sector, an alternative 'High Gas Scenario' was developed. The assumptions behind this scenario are discussed in more detail in Volume 1, Chapter 12. The scenario was built around estimates of gas production that might be available at BAU case prices or below, if constraints on gas production and trade could be reduced.

In the High Gas Scenario, no change was assumed in Japan's minimal domestic production, as shown in Figure JPN8.

Figure JPN8: High Gas Scenario – Gas Production

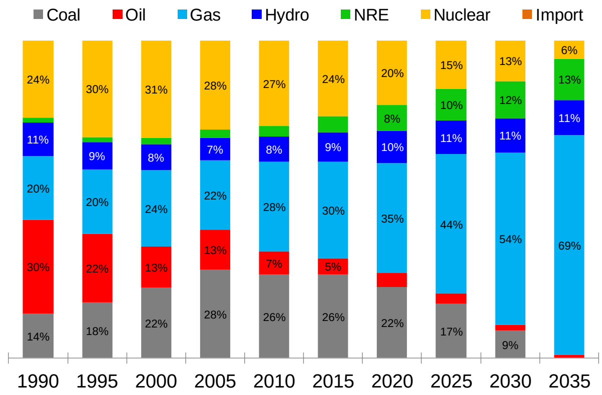


Source: APERC Analysis (2012)

However, under the High Gas Scenario, Japan would be able to import additional volumes of gas from other APEC economies at prices at or below BAU levels. Specifically, imports of gas would be up by 12% in 2020, by 25% in 2025, by 45% in 2030, and by 58% in 2035, compared to BAU. Japan would be importing an additional 49 Mtoe by 2035. It is assumed that Japan would use all of the additional gas imports for electricity generation, and that it would all be imported as LNG.

Figure JPN9 shows the High Gas Scenario Electricity Generation Mix. This graph may be compared with the BAU scenario shown in Figure JPN6. It can be seen that the gas share in 2035 has increased from 38% to 69%, while the coal share has declined from 31% to nil. So, under this scenario, Japan would be able to eliminate all of its coal-fired generation by 2035.

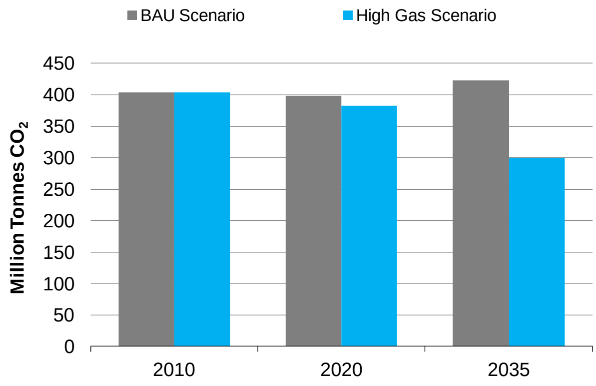
Figure JPN9: High Gas Scenario – Electricity Generation Mix



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Since gas has roughly half the CO_2 emissions per unit of electricity generated that coal has, this would have the impact of reducing CO_2 emissions from electricity generation by 30% by 2035. Figure JPN10 shows this CO_2 emissions reduction.

Figure JPN10: High Gas Scenario – CO_2 Emissions from Electricity Generation



Source: APERC Analysis (2012)

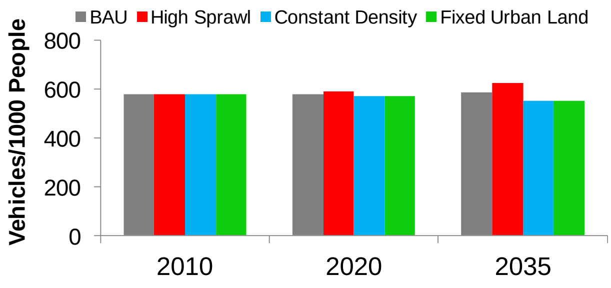
ALTERNATIVE URBAN DEVELOPMENT SCENARIOS

To understand the impacts of future urban development on the energy sector, three alternative urban development scenarios were developed: 'High Sprawl', 'Constant Density', and 'Fixed Urban Land'. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Since Japanese cities tend to be quite compact, and are unlikely to drop below the critical density at which transport energy demand starts to rise quickly under any scenario, the impact of better urban planning in Japan is fairly small.

Figure JPN11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. In the High Sprawl scenario, vehicle ownership is expected to be higher than in BAU by 7% in 2035. On the other hand, in both the Constant Density and Fixed Urban Land scenarios, vehicle ownership is expected to be smaller than in BAU by 6% in 2035.

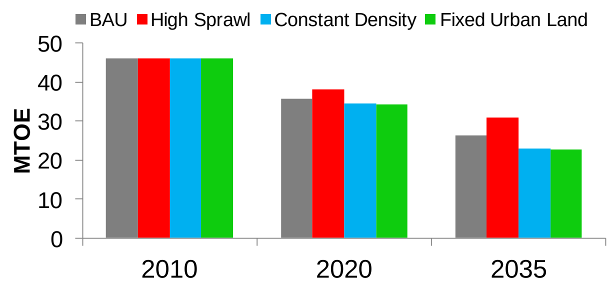
Figure JPN11: Urban Development Scenarios –Vehicle Ownership



Source: APERC Analysis (2012)

Figure JPN12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The impact of urban planning is moderate, but still significant. In the High Sprawl scenario, light vehicle oil consumption is expected to be 17% higher than BAU in 2035. On the other hand, in the Constant Density and Fixed Urban Land scenarios, light vehicle oil consumption is expected to be smaller than BAU, by 13% and 14% respectively.

Figure JPN12: Urban Development Scenarios – Light Vehicle Oil Consumption

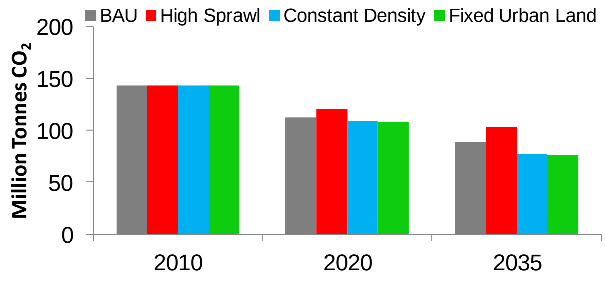


Source: APERC Analysis (2012)

Figure JPN13 shows the change in light vehicle CO_2 emissions under BAU and the three alternative urban development scenarios. The impact of urban planning on CO_2 emissions is similar to the impact of urban planning on energy use, since there is no significant change in the mix of fuels used under any of these scenarios.

In the High Sprawl scenario, the figure for CO_2 emissions is 17% larger than BAU in 2035, whereas in the Constant Density and Fixed Urban Land scenarios, CO_2 emissions are smaller than BAU, by 13% and 14% respectively.

Figure JPN13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO_2 Emissions



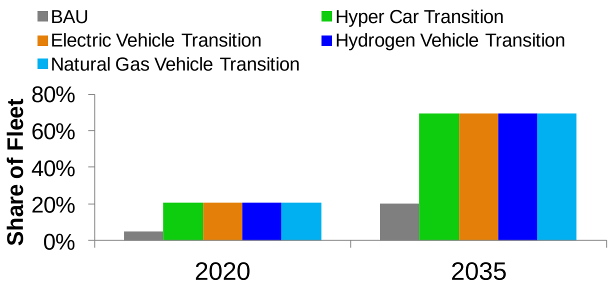
Source: APERC Analysis (2012)

VIRTUAL CLEAN CAR RACE

To understand the impacts of vehicle technology on the energy sector, four alternative vehicle scenarios were developed: 'Hyper Car Transition' (ultra-light conventionally powered vehicles), 'Electric Vehicle Transition', 'Hydrogen Vehicle Transition', and 'Natural Gas Vehicle Transition'. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Figure JPN14 shows the evolution of the light vehicle fleet under BAU and the four 'Virtual Clean Car Race' scenarios. By 2035, the share of alternative vehicles in the fleet is assumed to reach 69%, compared to about 20% under BAU. The share of conventional vehicles in the fleet is thus only about 31%, compared to about 80% in the BAU scenario.

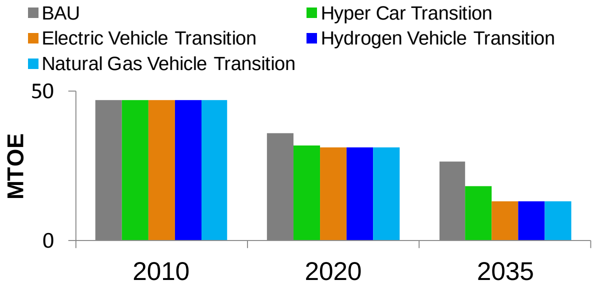
Figure JPN14: Virtual Clean Car Race – Shares of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure JPN15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 51% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to BAU by 2035. The drop is large as these alternative vehicles use no oil. Oil demand in the Hyper Car Transition scenario is also significantly reduced compared to BAU: down 31% by 2035, even though these highly efficient vehicles still use oil.

Figure JPN15: Virtual Clean Car Race – Light Vehicle Oil Consumption



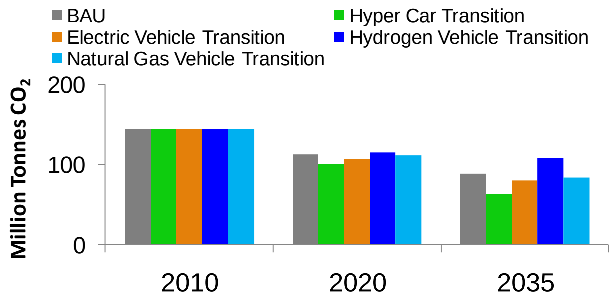
Source: APERC Analysis (2012)

Figure JPN16 shows the change in light vehicle CO_2 emissions under BAU and the four alternative vehicle scenarios. To allow for consistent comparisons, in the Electric Vehicle Transition and Hydrogen Vehicle Transition scenarios the change in CO_2 emissions is defined as the change in emissions from electricity and hydrogen generation. The emissions impact of each scenario may differ significantly from their oil consumption impact, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

In Japan, the Hyper Car Transition scenario is the clear winner in terms of CO_2 emissions reduction, with an emission reduction of 29% compared to BAU in 2035. The Electric Vehicle Transition scenario would also reduce emissions, but only by about 10% compared to BAU in 2035. The Electric Vehicle Transition scenario does not do as well as the Hyper Car Transition scenario in Japan because coal-fired generation is assumed to be the marginal source for much of the additional electricity required by the electric vehicles. The Natural Gas Vehicle Transition scenario would reduce emissions in 2035 by only 5%, reflecting the advances in conventional vehicle technology that are expected in Japan.

In contrast, the Hydrogen Vehicle Transition scenario would actually increase emissions by 21%, compared to BAU. This is mainly due to the way hydrogen is assumed to be produced—from steam methane reforming of gas, a process that involves significant CO_2 emissions.

Figure JPN16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

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