CONSERVATION OF RESOURCES IN THE AUTOMOBILE INDUSTRY

1 Introduction

The Energy White Paper 2016[1] indicates the direction of the energy policies of the Japanese government. Chapter 1 of this white paper describes the progress being made in the reconstruction of Fukushima. Chapter 2 covers the new direction of Japanese energy policy (revision of the JOGMEC Act, enforcement of the revised FIT Act, and thorough pursuit of electric power system reforms, etc.), while Chapter 3 describes energy system reforms in Japan and abroad, as well as trends in the energy industry. In addition, factors such as the shale gas boom and the Paris Agreement at COP21 are having an extremely large impact on the international energy situation. This article summarizes Japanese and international energy trends based on these developments.

2 Energy Trends in Japan[1]

Breaking down energy consumption trends in Japan by sector shows that consumption from 1973 to 2015 grew by 0.8 times in the industrial sector, 2.4 times in the business sector, 1.9 times in the household sector, and 1.7 times in the transportation sector. The Japanese GDP has continued to increase, but energy consumption has started to decline after peaking in 2004, reflecting the progress of overall efforts to save energy (Fig. 1).

The supply of crude oil as a primary energy source in Japan has decreased due to the promotion of alternative energy policies and energy conservation policies triggered by past oil shocks. It increased temporarily in the latter half of the 1980s, but since the mid-1990s, it has been on a downward trend due to advances in the use of alternative energy sources for petroleum.

In 2015 Japan imported a total of 195 million kL of crude oil. The sources of those imports and the percentage of the total that they account for are as follows: Saudi Arabia (33.8%), United Arab Emirates (25.3%), Qatar (8.4%), Russia (8.1%), Kuwait (7.8%), Iran (5.0%), Indonesia (2.2%), Iraq (1.6%), Mexico (1.5%), Colombia (0.8%), Kazakhstan (0.8%), Vietnam (0.7%), Ecuador (0.7%), and Malaysia (0.6%).

Fig. 2 shows the targets and current status for CO_2 reduction in the transportation sector in Japan[2]. The target in the Paris Agreement at COP21 is to reduce the amount of CO_2 emissions by 163 Mt (26.9%) by 2030 in comparison to 2013 levels. In 2015 emissions had been reduced by about 5%, which is decent progress, but it will become more difficult with each passing year so even further energy conservation measures should be promoted. In addition, this value temporarily exceeded the 2010 target value established in the Kyoto Protocol, but the transportation sector is now clearing this target easily.

3 International Energy Trends[1]

The final global energy consumption reached the equivalent of more than 9 billion tons of oil in 2014, an increase of approximately 2.2 times over the 43 years from 1971 to 2014. When this consumption is broken down by sector, both industrial and consumer use have increased by approximately 2 times, while use in the transportation sector has increased by approximately 2.7 times. The percentage of energy demand accounted for by the transportation sector out of the final energy consumption increased by about 5 points from 22.7% in 1971 to 27.9% in 2014.

4 Bioethanol

According to statistics compiled by F.O. Licht GmbH[3], global ethanol production decreased by approximately 1% in 2016 to about 116.19 million kL, the first such decrease since 2012. Approximately 83% of this total was used for fuel, which is about the same amount as in 2015. Figure 3 shows the annual production trends for bioethanol in each country. The two main bioethanol producing countries are the U.S. and Brazil (accounting for about 75% of total global production). The amount of bioethanol

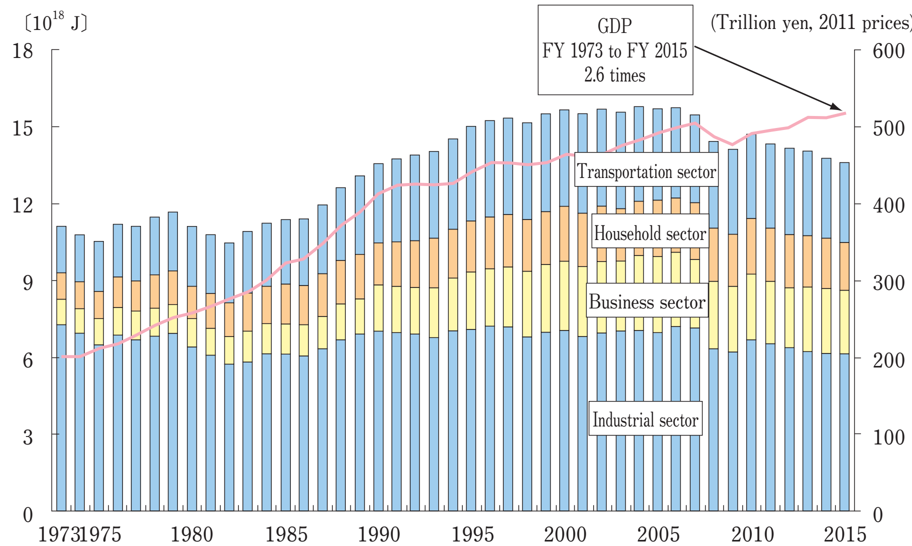


Fig. 1 Trends in Final Energy Consumption and Real GDP

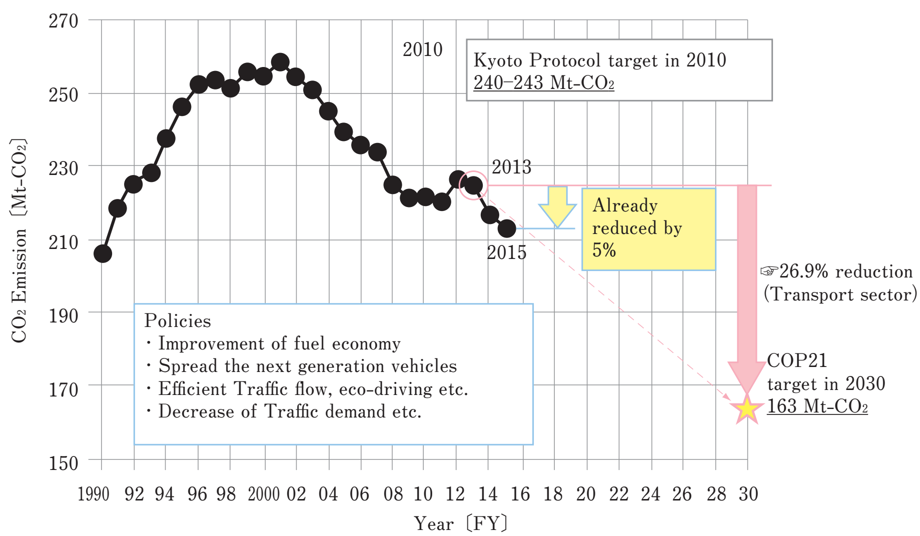


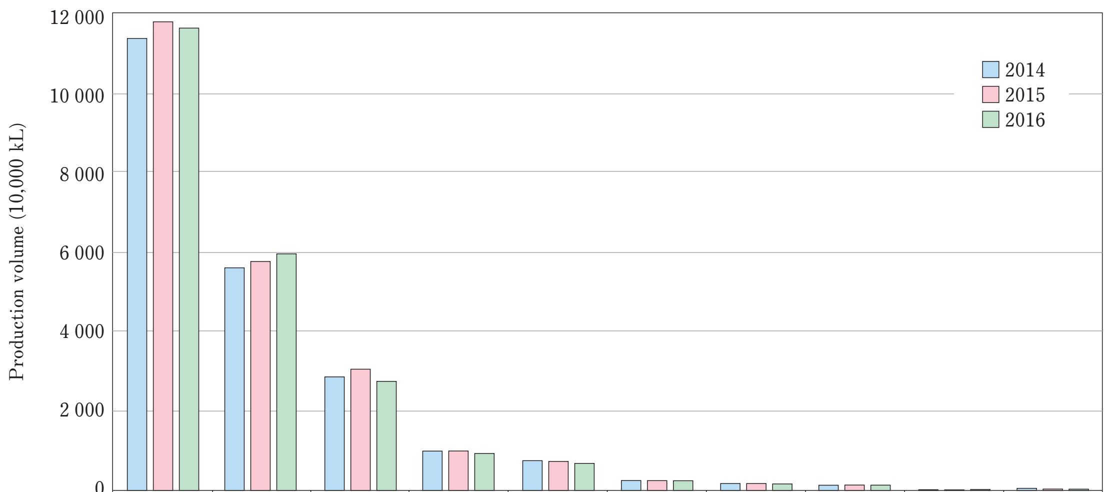
Fig. 2 Japanese Transportation Sector CO_2 Reduction Targets and Current Status

produced in the U.S. remained high thanks to high corn yields, and reached a record level. In Brazil, however, the amount of ethanol production decreased by approximately 10% compared to that in 2015 due to the rise in international sugar prices which significantly increased the proportion of corporate grown sugarcane that went toward sugar instead of bioethanol.

In Japan, one of the main activities used to promote the use of biofuels was the project to popularize the use of biofuels in Okinawa Prefecture that was overseen by the Ministry of the Environment. However, the project will be shut down on the grounds that there are no prospects for successful commercialization[(4)]. In Miyakojima, the demonstration project for the high-efficiency production of bioethanol from molasses ended its sales of E3 biofuel in April 2016 because it could no longer procure the gasoline base material. However, in an effort to find new methods for utilizing bioethanol, there is a plan to continue other demonstration projects, such as using E100 fuel in the boilers of school cafeteria kitchens[(5)](6).

At the same time, sales of gasoline blended with ETBE are also being promoted to achieve the target (500,000 kL (crude oil equivalent) of bioethanol in 2017) stipulated in the Act on Sophisticated Methods of Energy Supply Structures[(7)].

Toray Industries, Inc. announced that it had succeeded in demonstrating a new bioethanol production technology involving the scaling up of a membrane-integrated



	Total	U.S.	Brazil	China	EU	India	Canada	Thailand	Australia	Pakistan
2014	11 367	5 576	2 855	980	723	215	187	141	27	49
2015	11 781	5 753	3 042	997	738	242	186	149	30	48
2016	11 619	5 953	2 739	960	696	243	181	155	35	45

Fig. 3 Changes in Annual Bioethanol Production Volume in Each Main Producing Country

continuous fermentation process to produce ethanol using recycling microorganisms from the sugar cane biomass (bagasse and molasses) generated at sugar factories[8]. Kyoto University announced that it had developed a strain of yeast with a gene mutation to induce better heat tolerance, and that this yeast produced more ethanol at high temperatures than wild yeast strains[9]. In addition, Nissan Motor Co., Ltd. announced a utilization technology in which a new fuel cell system called e-Bio Fuel-Cell that runs on electricity generated from bioethanol[10].

5 Biodiesel Fuel (BDF)

Biodiesel fuel is made from fatty acid methyl esters (FAME). In December 2009 the U.S. Department of Energy published the Biodiesel Handling and Use Guide (Fourth Edition), which was revised and updated in November 2016 with the publication of the Fifth Edition[11]. Some of the main added sections are listed below.

Biodiesel (B100):

(1) How is Biodiesel Different than Renewable Diesel?

Biodiesel Blends:

(2) Pump Labeling

(3) Refueling Infrastructure

(4) Purchasing Biodiesel

(5) Checklist for Installing B20 Dispensing Equipment or Converting Underground Storage Tanks

The section on Storage Tanks and Dispensing Equipment found under B100 in the fourth edition has been removed from the fifth edition. The Appendix entitled Renewable Identification Number was also removed, and is included in the content of section (1) listed above instead. Furthermore, the Appendix entitled Density and Viscosity as a Function of Temperature was also been removed and included in section (4) above instead. The purpose of this fifth edition of the guide remains unchanged from previous editions. It provides information on safety, proper handling, and use of B100 or B6 to B20 blended diesel fuels in diesel engines and boilers for those who use, manufacture or supply these fuels. However, since not all engine manufacturers allow the use of B6 to B20 biodiesel fuels, it is necessary verify and use the relevant OEM information[12].

The aviation industry is also undertaking efforts to reduce the amount of greenhouse gases it is producing. This industry continues to promote the distribution of bio-jet fuels, such as paraffinic kerosene. This biofuel uses the oils of microalgae and other plant sources as its raw material and is produced through hydrogen treating and FT synthesis. However, there are concerns that FAME will become mixed into these bio-jet fuels and conventional petroleum-based jet fuels during the distribution process, which would cause these jet fuels to have poorer low-temperature performance and also increase their kinematic viscosity. In other words, the current mechanism used to reduce the distribution cost, a multi-product pipeline (MPP), may be a problem. For example, soybean oil methyl ester (SME) is transported by tanker truck, and afterward jet fuel is transported in that same tank before it is used to fuel an aircraft. An organization called the Joint Inspection Group (JIG), which is composed of jet fuel manufacturers and users, has stated that the allowable limit of FAME mixture in jet fuel is 1 L of B5 for every 10 kL of jet fuel, representing 5 ppm (parts per million), which is equivalent to 5 mg/kg. However, it is difficult to maintain this limit in actual practice. Therefore, Airbus and other aviation companies have set the upper limit for FAME mixture in the jet fuel to 30 ppm, establishing the criteria for re-filling jet aircraft with jet fuel as long as the contamination concentration is between 5 to 30 ppm. Furthermore, the GC/MS analysis method (IP PM-DY/09 test and IP585 method) has also been developed to monitor the amount of FAME mixed into the jet fuel.

6 Methanol and DME (Di-methyl Ether)

Methanol is mainly produced from natural gas and coal. In 2016 the worldwide demand for methanol was assumed to be 74 million tons, of which the demand in China alone was 42 million tons, exceeding half of the world's total. When this worldwide demand for methanol is broken down according to its uses, 21.7% of the methanol is used for energy (e.g., gasoline blends, DME, and biodiesel fuels)[13]. In China the local governments in major coal producing areas, such as Shanxi Province and Shaanxi Province, are planning to introduce policies to promote the use of methanol-blended gasoline[14], and construction of an MTG plant that synthesizes gasoline from methanol is underway[15].

DME is attracting attention as an alternative fuel to diesel that can be produced easily from methanol. In North America, Oberon Co., Ltd. and Mack Trucks, Inc. are carrying out demonstration operations using DME trucks with technology from the Volvo Truck Corporation. The Ford Motor Company in Germany and the Shanghai Jiao Tong University in China are both developing engines that run on DME, while in Japan the Isuzu Advanced Engineering Center, Ltd, is developing DME automobiles.

7 Natural Sources of Energy

7. 1. Wind-Based Electric Power Generation[16]

In 2016 the total capacity of newly built wind-based electric power generation around the world was 54.6 GW. The top 10 countries in the world for newly installed wind power were (1) China at 23.4 GW, (2) the U.S. at 8.2 GW, (3) Germany at 5.4 GW, (4) India at 3.6 GW, (5) Brazil at 2.0 GW, (6) France at 1.6 GW, (7) Turkey at 1.4 GW, (8) the Netherlands at 0.9 GW, (9) the UK at 0.7 GW, and (10) Canada at 0.7 GW. These 10 countries accounted for 88% of the newly installed wind power generated worldwide in 2016.

The total amount of installed wind power capacity around the world as of 2016 was 486.8 GW. The top 10 countries in the world for installed wind power as of 2016 were (1) China at 168.7 GW, (2) the U.S. at 82.2 GW, (3) Germany at 50.0 GW, (4) India at 28.7 GW, (5) Spain at 23.1 GW, (6) the UK at 14.5 GW, (7) France at 12.1 GW, (8) Canada at 11.9 GW, (9) Brazil at 10.7 GW, and (10) Italy at 9.3 GW. These 10 countries accounted for 84% of the total amount of installed wind power worldwide as of 2016.

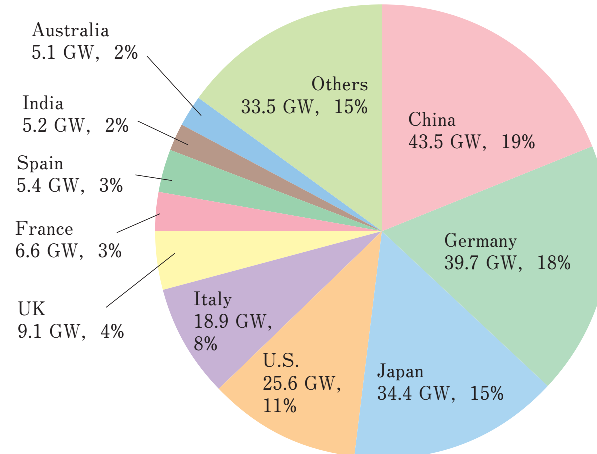


Fig. 4 Cumulative Installed Solar Power Capacity by Country at End of 2015

7. 2. Solar-Based Electric Power Generation[17]

In 2015 the total capacity of newly built solar-based electric power generation around the world was 50 GW. China led the way (15.2 GW) and was followed by Japan (11 GW). The total capacity from solar power around the world continues to increase and has now reached 227 GW. The annual increase in capacity from 2014 to 2015 was 30%. Figure 4 shows the cumulative installed solar power capacity in each country at the end of 2015. According to this data, China ranked number one for the first time, followed by Germany and Japan.

The cost of generating solar power and the purchasing price (FIT price) in Japan are extremely high, reaching about twice as much as in other countries. The high purchasing price in Japan means that it is easy for domestic and overseas company to earn a profit. Consequently, foreign energy companies, such as French oil giant Total S.A. and the largest state-owned energy company in Thailand, PTT Public Co., Ltd., have entered the Japanese market and are promoting the commercialization of mega-solar plants.