Conservation of Resources in the Automobile Industry

1 Introduction

In April 2014, the Japanese government approved the new Strategic Energy Plan, which forms the basis for Japan's energy policies for the immediate future. The basic concepts behind this plan are ensuring stable energy supplies, environmental suitability, and the utilization of market principles in a long-term, comprehensive, and systematic set of policies. The plan places a powerful emphasis on a comprehensive strategic approach to energy, including the development and introduction of various types of energy sources, the technological development of fuel cells and other types of new energy sources, the utilization of nuclear power under the assumption that safety can be ensured, the establishment of energy infrastructure, and the revision of regulations. It also incorporates measures to ensure stable oil supplies, such as the adoption of a comprehensive raw materials strategy, including strengthening relations with oil producing nations, and building a robust business foundation for the oil industry.

Figure 1 shows the global energy consumption trends since 1990 and the outlook up to 2035. Although fossil fuels are likely to account for the lion's share of energy demand, the development, introduction, and use of renewables and other energy sources will be a key issue. It is hoped that energy demand will gradually switch to renewables in the future since these energy sources also have the effect of helping to reduce CO_2 emissions.

2 Energy for Transportation

2. 1. Current situation of energy resources

In 2012, oil consumption in the U.S. amounted to 18.56 million barrels per day (B/D). In China, this figure was 10.22 million B/D. These two countries accounted for 20.7% and 11.4% of the world's oil consumption, respectively. After the U.S. and China, Japan consumed 4.714 million B/D, India 3.652 million B/D, and Russia 3.174 million B/D. Oil consumption in Europe as a whole was relatively low. Germany was the largest single consumer of oil in Europe and the 10th highest consumer globally at 2.358 million B/D. Oil consumption in China is expanding remarkably in accordance with its recent economic growth, and now stands 2.2 times higher than Japan.

Figure 2 shows the market price trends (in yen/liter) for crude oil, diesel, and gasoline. The price of diesel and gasoline in this graph includes tax (32.1 yen/liter for diesel and 53.8 yen/liter for gasoline). After stabilizing in the wake of the Gulf War (1990 to 1991) to between 10 and 20 yen/liter by 2004, crude oil prices have been increasing since 2005. In July 2008, the sub-prime loan crisis pushed prices up to 88 yen/liter, four times the level in 2004. This was restricted to a two-fold increase in diesel and gasoline prices by the use of the fuel tax. However, this increasing trend may also be seen as an opportunity to commercialize alternative fuels. Crude oil prices did drop after reaching record highs in 2008, but have risen constantly since then. Prices are currently trending at around 70 yen/liter, partly due to the effect of the depreciation in the yen.

2. 2. Biomass

Biomass is the fourth most important energy source after oil, coal, and natural gas. The market for biomass fuel is gradually expanding and now accounts for roughly 3% of road transport fuel demand on a global basis. Biomass also has the potential to be used as jet fuel.

2. 2. 1. Bioethanol

According to statistics compiled by F.O. Licht, global ethanol production in 2013 increased by roughly 4% to a record high of 106.60 million kL. Of this, approximately 83% was used for fuel. Figure 3 shows the annual production trends in each country. Of the two main producing countries (accounting for 75% of total global production), the proportion of ethanol production in Brazil increased by approximately 18% compared to 2012 as the price of sugar produced alongside sugar cane fell.

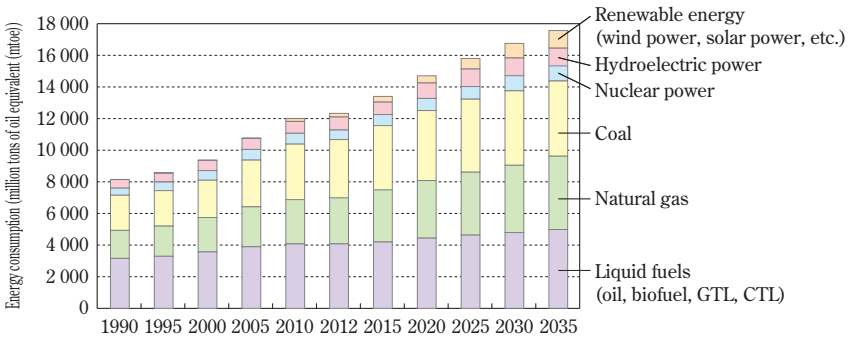


Fig. 1 Global energy consumption trends and future outlook.

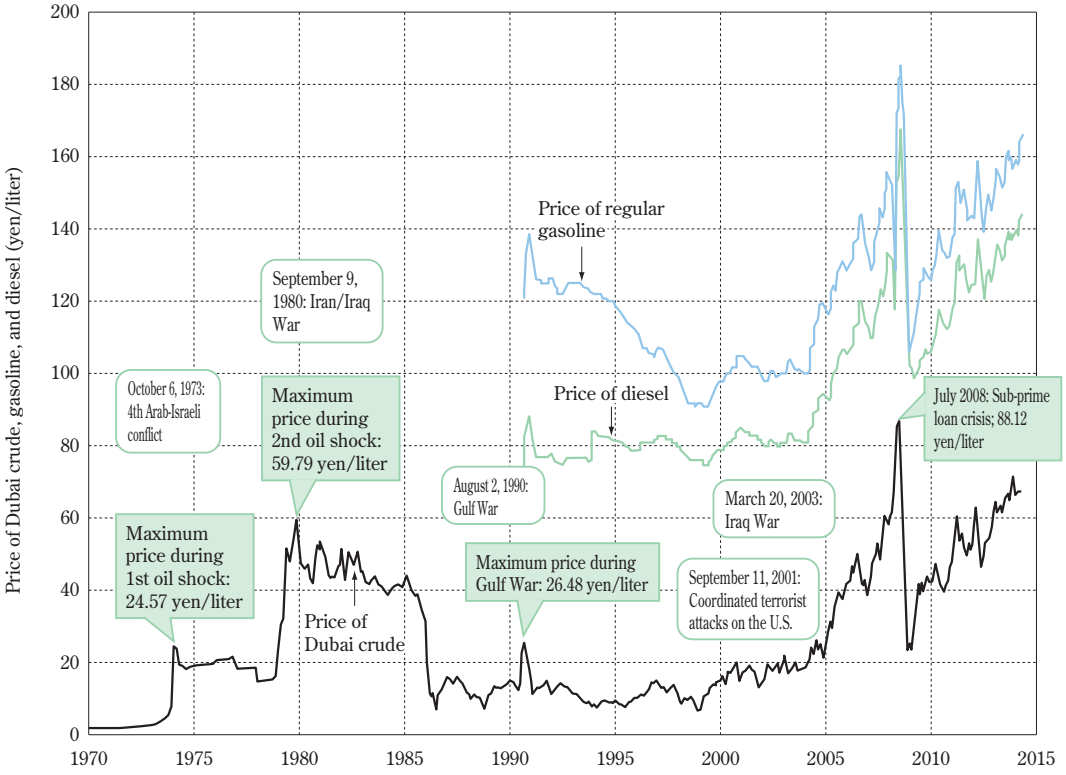
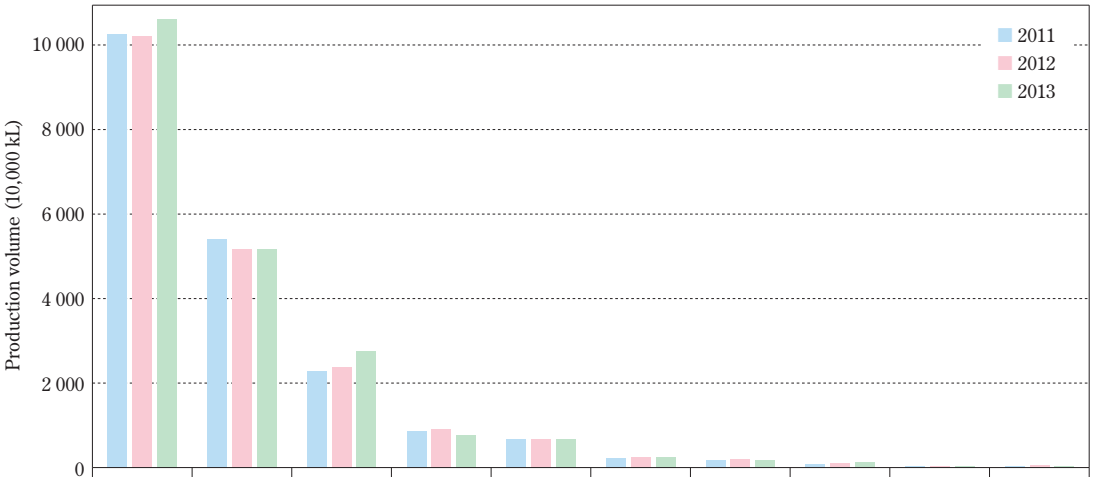


Fig. 2 Crude oil, gasoline, and diesel price trends.

In contrast, production in the U.S. hit the so-called blend wall. Due to safety concerns, the U.S. Environmental Protection Agency (EPA) decided to approve E10 blend fuel instead of E15, restricting the actual usage amount of ethanol and causing production to slow. In reaction to the market situation, the EPA proposed a renewable fuels standard (RFS) in November 2013 that included the first ever reduction in the amount of mandated biofuel (including ethanol). The proposed standard for 2014 was 15.21 billion gallons, 8% less than 2013.

As part of its Renewable and Alternative Energy Development Plan for 2012 to 2021, Thailand ended sales of regular gasoline on January 1, 2013. As a result, sales of E10 increased, reaching 9,180 kL per day in June 2013, 1.6 times the level in 2012. Ethanol production increased by 29% compared to 2012.

In Japan, the main activities promoting the use of biofuels are the three biofuel production site establishment projects between 2012 and 2016 managed by the Ministry of Agriculture, Forestry and Fisheries (MAFF), which are due to continue in the future. The project to popularize the use of biofuels in Okinawa supplied roughly 40,000 kL of E3 in 2013 and has established 58 E3 service stations as of April 2014. Sales of E10 started in August 2013 and 13 E10 service stations had been established as of July 1, 2014. In contrast, the number of service stations in Japan selling bio-gasoline blended with ethyl tert-butyl ether (ETBE) decreased by approxi-



	Total	U.S.	Brazil	China	EU	India	Canada	Thailand	Australia	Pakistan
2011	10 299	5 421	2 288	860	664	216	167	79	35	41
2012	10 255	5 180	2 354	895	660	231	187	97	34	53
2013	10 660	5 185	2 780	787	660	238	195	125	34	47

Fig. 3 Ethanol production of main global producers.

mately 2% from April 2013 to 3,360 (as of June 10, 2014).

MAFF examined bioethanol production technology through the Project for Developing Soft Cellulosic Resources Utilization Technology that ended in 2012. Based on the results of this project, Taisei Corporation provisionally calculated that the overall cost of ethanol from raw material harvesting and transportation to ethanol production equaled 85.2 yen/liter, and Kawasaki Heavy Industries, Ltd. announced the establishment of a commercial-scale subcritical water-based technology capable of producing bioethanol at a cost of 40 yen/liter.

Test methods for ethanol fuels are currently being standardized by the International Organization for Standardization (ISO). The methods of determining the electrical conductivity and total acidity by potentiometric titration are currently under discussion, and have reached the Final Draft International Standard (FDIS) stage.

2. 2. 2. Biodiesel

In 2013, only a small number of research papers were presented at automotive conferences in Japan related to fatty acid methyl ester (FAME) and other biodiesels. The pace of research into these fuels in Japan has slowed considerably. In contrast, at the 2013 Powertrains, Fuels & Lubricants Meeting co-hosted by the Society of Automotive Engineers (SAE) and the Korean Society of Automotive Engineers (KSAE) at the COEX venue in Seoul between October 21 and 23, 21 of the 192 papers presented related to FAME as a first-generation biodiesel and there were growing numbers of reports from India and South-East Asia. Most of this research covers the engine performance and emissions characteristics of FAME in vehicles. Other reports described the results of investigations and analysis into FAME with various fuel-property derived cold flow properties, research related to the reduction in fuel lubricating ability due to oxidation degradation, as well as research describing high fuel dilution by oil in B7 blend diesel. These papers indicated that research and production technology for biodiesel obtained from transesterification reactions is in a fairly advanced stage in Japan, Europe, and the U.S.

Recent technological advances have taken place in the fields of algae-derived biodiesel production and biodiesel production using biomass-to-liquid (BTL) methods. Examples include plans by Solazyme Inc. to establish several algae-based production plans mainly in the U.S. and plans in Europe to set up a number of BTL production plants as B7 becomes more widespread.

In November, E4tech Ltd. in the UK published the results of research that predicted that biodiesel will become more popular in Europe in the future. According to the published roadmap, B7 will consist of 7% FAME by 2030, whereas the commercialization of Fischer-Tropsch (FT) diesel and hydrofined biodiesel will start to fall off by 2020. After that point, the report predicts that technological innovations will lead to the start of commercial fuel production of new algae-derived diesels.

2. 3. Natural gas

In 2012, global confirmed accessible reserves of natural gas stood at 187.3 trillion m^3. These reserves are mostly located in Iran (33.6 trillion m^3 (17.9%)), Russia (32.9 trillion m^3 (17.6%)), Qatar (25.1 trillion m^3 (13.4%)), Turkmenistan (17.5 trillion m^3 (9.3%)), the U.S. (8.5 trillion m^3 (4.5%)), and Saudi Arabia (8.2 trillion m^3 (4.4%)). According to statistics published by the Japanese Ministry of Finance (MOF), Japan mainly imports natural gas from Qatar, Australia, Malaysia, and Russia. In 2013, the import price to Japan varied between 15 and 16 U.S. dollars/MMBtu. This was higher than the import price to the UK (10 U.S. dollars/MMBtu) and the U.S. (3 U.S. dollars/MMBtu). (MMBtu is an abbreviation for one million British thermal units and is roughly equivalent to 25 m^3 of natural gas.)

The U.S. is home to abundant reserves of shale gas. Production has increased rapidly due to the development of horizontal drilling and hydraulic fracturing techniques (the so-called shale gas revolution). In 2012, shale gas production in the U.S. rose by 23% to 9.7 trillion cubic feet (TCF). This accounted for 40% of all natural gas production in the U.S., a figure that is predicted to grow to 56% in 2040. The shale gas revolution has greatly decreased the dependence of the U.S. on imported oil and the country is likely to become an exporter in the future. However, possible risks related to shale gas and oil production include environmental concerns such as groundwater contamination, and there have been calls for greater regulation and the enforcement of stricter environmental standards.

2. 4. Natural energy and hydrogen

Natural energy sources such as wind, solar, and geothermal power have rapidly gained prominence in recent years. In Europe, roughly 70% of additional power generation in 2012 came from natural energy sources. Growth was particularly rapid in Germany with natural energy sources accounting for 22.9% of power consumption. The capacity of new wind power generators in 2013 was 33.5 GW, with China (16.1 GW) accounting for 45% of the global growth in wind power. This was followed by Germany (3.2 GW), the UK (1.8 GW), India (1.7 GW), Canada (1.6 GW), and the U.S. (1.1 GW). Total global wind power capacity has now reached 318.1 GW. The capacity of new solar power generators in 2013 was 38.4 GW. Growth was strongest in China (11.8 GW), followed by Europe (11 GW), Japan (6.9 GW), and the U.S. (4.8 GW). Asian countries have emerged as leaders in this field. In Japan, policies to use these renewables are restricted to the importation of liquid hydrogen and other energy sources by energy carriers.

The Strategic Energy Plan includes policies to utilize hydrogen as a secondary energy source with the aim of achieving a hydrogen-based society. On June 24, 2014, the Council for a Strategy for Hydrogen and Fuel Cells under the auspices of the Japanese Ministry of Economy, Trade and Industry (METI) released a Strategic Road Map for Hydrogen and Fuel Cells up to 2030.

In 2013, METI also started the development of technology for the storage and transportation of renewable energy sources. From 2014, these efforts were absorbed into the advanced research and development projects for the utilization of hydrogen being carried out by the New Energy and Industrial Technology Development Organization (NEDO). These projects are focusing on hydrogen production, the conversion, storage, and transportation of liquid hydrogen, and the potential of various types of energy carriers using cheap renewable energy sources such as wind power outside Japan, anticipating a dramatic increase in hydrogen use after 2030. Furthermore, the Cross-ministerial Strategic Innovation Promotion Program (SIP) includes an energy carrier program that started research and development of hydrogen gas turbines and other practical related technologies in 2014.

2. 5. Methanol and dimethyl ester (DME)

The use of methanol as a fuel is already well accepted since it can be produced easily from natural gas. The sharp rise in oil prices caused by the sub-prime loan crisis in July 2008 and the increase in methanol use for blending into gasoline in China increased global demand by 50% from 40 million tons in 2009 to 60 million tons in 2012. Statistics published by HIS forecast that methanol demand will reach 100 million tons in 2016.

DME is attracting attention as an alternative to diesel that can be produced easily from methanol. Mitsubishi Gas Chemical Company Inc. and Mitsubishi Corporation are reportedly working toward the production of DME in Trinidad and Tobago.

2. 6. Gas to liquid (GTL)

GTL methods convert natural gas to liquid fuels. Commercial-scale GTL projects are under way in Malaysia, Qatar, and South Africa. In addition, large-scale production projects have been started using cheap shale gas in both the U.S. and Canada.