THE ENVIRONMENT AND THE AUTOMOBILE INDUSTRY

1 Introduction

In fiscal year 2013, vehicle sales in Japan increased to 5.69 million due to the depreciation of the yen orchestrated by the so-called Abenomics policies promoted by the second administration of Prime Minister Abe from December 2012, as well as last-minute demand created ahead of a hike in consumption tax. However, in 2014, the impact of this tax increase caused vehicle sales to fall by 6.9% to 5.3 million, the first year-on-year decline in sales in four years [(1)]. In contrast, the popularity of mini-vehicles continued to increase. Sales of mini-vehicles reached 2.17 million in 2014, exceeding 40% of total vehicle sales in Japan for the first time.

A large proportion of the Japanese vehicle market consists of fuel-efficient, low-emission vehicles such as hybrids and clean diesels. As a result, the CO_2 emissions of the transportation sector are declining every year. However, despite this trend, road vehicles account for virtually all CO_2 emissions in the transportation sector and continued efforts will be required to establish laws and develop technologies to further reduce fuel consumption and emissions.

Active measures are being carried out to restrict CO_2 and other harmful pollutants generated by the automotive industry. These measures are making a major contribution to reducing the emissions of Japanese industry as a whole. However, considering the operational status of Japan's nuclear power stations, it will be necessary to implement further energy saving measures in the future and facilitate the introduction of renewable energy sources.

2 Environmental Trends

2. 1. Japan

2. 1. 1. Reduction of greenhouse gas (GHG) emissions

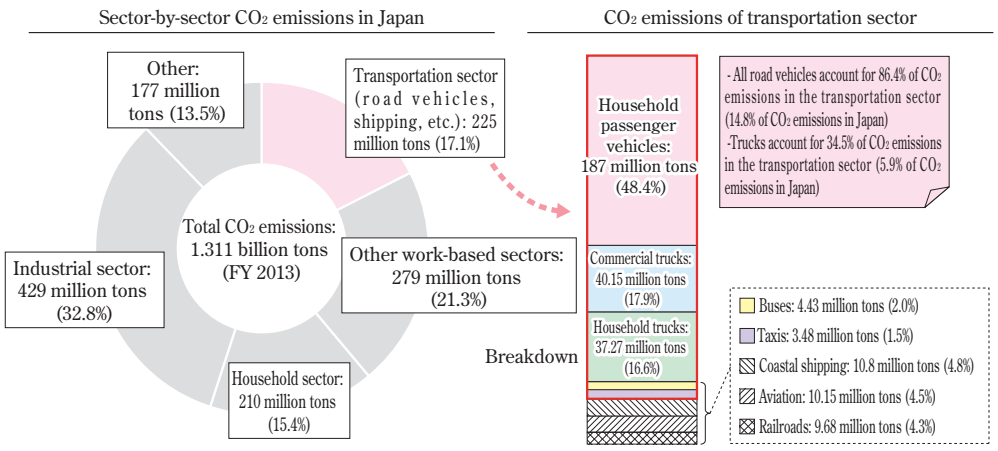
At the 19th United Nations Climate Change Conference (COP 19) held in Warsaw, Poland in November 2013, Japan reported that it had achieved an 8.2% reduction in GHG emissions, meeting the 6% target under the first commitment period of the Kyoto Protocol. Japan also announced a reduction target of 3.8% compared to the 2005 figure by the year 2020 [(2)]. Then, in April 2014 the Strategic Energy Plan compiled by the Japanese government was approved by the Cabinet. This plan was created to indicate the new direction of Japan's energy policies and to respond to major changes in the domestic and international environment surrounding energy, especially the Great East Japan Earthquake and the Fukushima Daiichi nuclear power plant accident.

The specific policies affecting the automotive industry include a target that next-generation vehicles should account for 70% of new vehicle sales by 2030 (up from 50%). The policies also include a comprehensive approach to traffic flow measures, such as the development of a central highway network that includes urban belt highways that will contribute to less energy use and the promotion of intelligent transport systems (ITS). Furthermore, the policies proposed the establishment of around 100 hydrogen refueling stations in 2015 to promote the popularization of fuel cell vehicles [(3)].

An increase in fossil fuel consumption due to the greater role of conventional fuel-fired power stations caused Japan's total CO_2 emissions in 2013 to increase by 1.2% from 2012 to 1.311 billion tons. The CO_2 emissions of the transportation sector in 2013 sector fell by 0.7% to 225 million tons, or 17.1% of the country's total CO_2 emissions. Road vehicles accounted for 86.4% of these emissions, with household passenger vehicles accounting for 48.4% and trucks accounting for 34.5% (Fig. 1).

2. 1. 2. Japan's preferential tax scheme for environmentally friendly vehicles

In 2009, Japan enacted a preferential tax scheme (affecting the motor vehicle weight tax and vehicle acquisition tax) to encourage the popularization and adoption of environmentally friendly vehicles. In 2012, the fuel effi-



*Emissions caused by power generation by power companies and heat generation by heat service utilities are included in the sector responsible for the final demand in accordance with the volume of emissions.
*Created by the Environmental Policy Division of the Ministry of Land Infrastructure and Transport (MLIT)) based on the National Greenhouse Gas Inventory Report of Japan published by the Greenhouse Gas Inventory Office of Japan.

Fig. 1 Breakdown of transportation sector CO_2 emissions [4]

ciency standards of the applicable vehicles were adjusted into a new preferential tax scheme to emphasize a lower tax burden on vehicles with particularly high environmental performance.

The special provisions for environmental measures in the vehicle tax system that started in 2001 reduced the size of the taxation in accordance with the vehicle's emissions and fuel economy. These provisions were combined with higher taxation on vehicles for a set number of years after new vehicle registration. These measures are being continued.

2.1.3. Incentive system to purchase environmentally friendly vehicles

In May 2013, subsidies for promoting the adoption of clean energy vehicles were established to support the introduction of electric vehicles, plug-in hybrid vehicles, and clean diesels. In FY 2014 the deadline for applying for these subsidies was March 6, 2015. Applications reopened on March 9, 2015 and will be accepted until October 7, 2015 [5].

2.2. Outside Japan

2.2.1. Reduction of GHG emissions in the transportation sector

In April 2014, the third working group report (mitigation of climate change) of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) was published [6]. In 2010, passenger transportation and freight transportation accounted for approximately 27% of the final energy consumption within the transportation sector and was responsible for 6.7 billion tons of direct CO_2 emissions. In addition, the worldwide CO_2 emissions from passenger transportation and freight transportation are increasing. Consequently, it was reported that baseline emissions are predicted to approximately double by the year 2050 if additional mitigation measures are not implemented. As a part of these mitigation measures, vehicle energy efficiency and vehicle performance are predicted to improve by 30% to 50% compared to 2010 levels by 2030 (Fig. 2). In conjunction with other efforts, such as urban redevelopment, these predicted improvements indicate that it should be possible to reduce the final energy consumption of 2050 by approximately 40% in comparison to the baselines.

2.2.2. Trends in environmental regulations related to vehicles [8]

The U.S. government issued an advance notice of the new Tier 3 emissions standards in March 2013. California also introduced separate zero-emission vehicle (ZEV) standards mandating the sale or lease of electric or fuel cell vehicles. In 2010, the National Highway Traffic Safety Administration (NHTSA) and Environmental Protection Agency (EPA) formulated Corporate Average Fuel Efficiency (CAFE) and GHG emissions standards covering passenger and light commercial vehicles between 2017 and 2025. The final regulations were issued in August 2012. In addition, final fuel economy and GHG emissions standards covering heavy duty vehicles were also issued in August 2011.

Europe plans to adopt the Euro 6 regulations for emissions covering passenger vehicles and light commercial vehicles starting in 2014. An amendment to Euro 6 in June 2012 studied introducing a more stringent standard

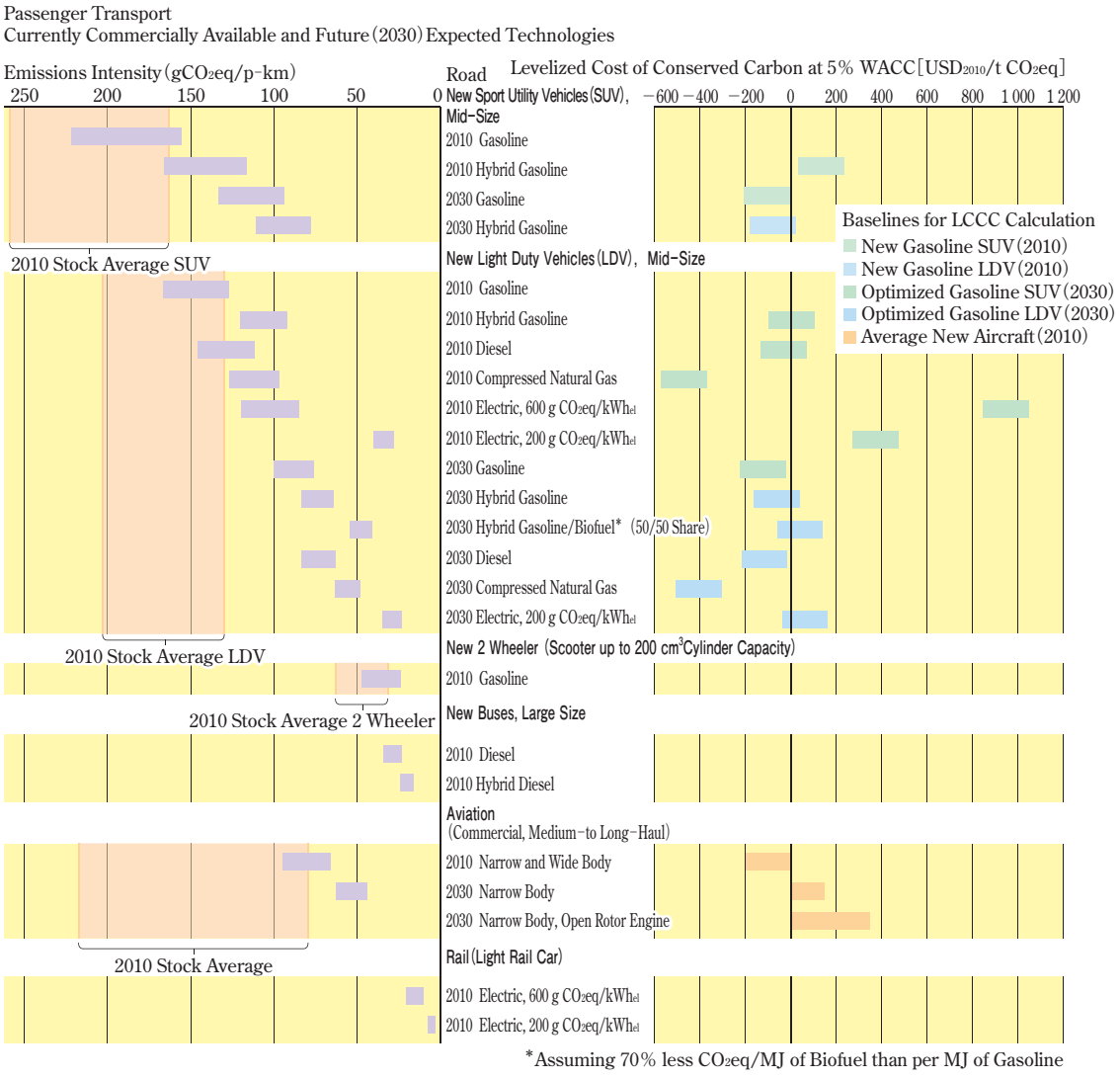


Fig. 2 Emissions intensity and abatement costs associated with expected technologies in the passenger transportation Sector in 2030 [7]

for particulate matter (PM) emitted from gasoline vehicles and simultaneously adopting a NO_2 standard, the Real Driving Emissions (RDE) standards, and the Worldwide Harmonized Light Vehicles Test Procedure (WLTP). For heavy-duty vehicles, Euro V was replaced by Euro VI at the end of 2012. Euro VI calls for NOx reductions of 80% and PM reductions of 50%. The details of onboard diagnostics (OBD) standards and requirements for NOx reduction systems were decided in June 2011. The EU is also studying long-term targets for CO_2 emissions standards for the year 2020 and beyond. Targets of 95 g/km for passenger vehicles and 147 g/km for light commercial vehicles have been decided upon. The specific details of these standards were proposed by the EU committee in July 2012.

In China, emissions standards are based on those determined by the Economic Commission for Europe (ECE) and EU directives. Although current Chinese standards are equivalent to Euro 4, other standards that are equivalent to Euro 5 have been introduced in Beijing ahead of the rest of the country. The targeted average fuel economy for passenger vehicles is 6.9 L/100 km by 2015 and 5.0 L/100 km by 2020. To achieve these targets, Stage 3 fuel economy standards were announced in December 2011 and Stage 4 standards are currently being studied. The Chinese Ministry of Industry and Information Technology also introduced fuel economy standards for heavy-duty commercial vehicles in 2012.

More stringent standards for emissions and fuel economy are being introduced in other countries around the world as well. In consideration of this trend, the United Nations (UN) is accelerating the harmonization of interna-

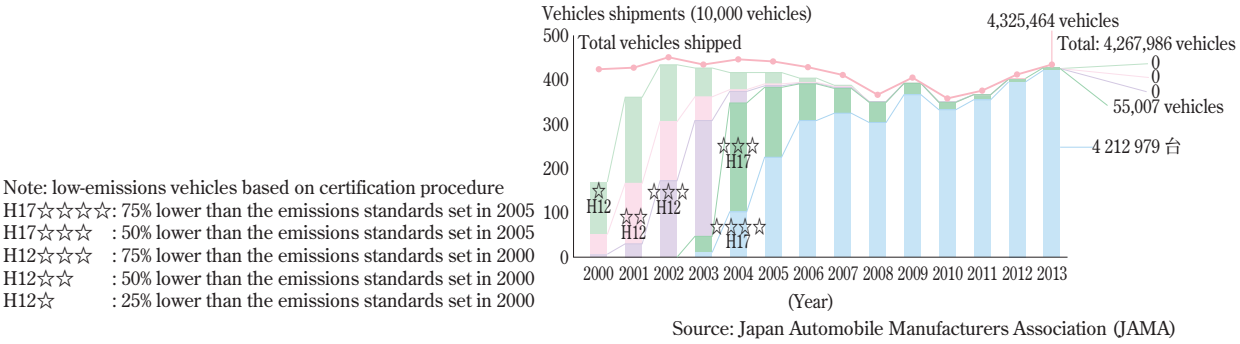


Fig. 3 Proportion of low-emissions vehicles in new vehicle sales [9]

tional standards, including the formulation of test methods for emissions and global technical regulations (GTR) for unified vehicle testing modes, based on a 1998 agreement. Formulation of the Worldwide Harmonized Motorcycle Emissions Certification (WMTC) procedure, Worldwide Harmonized Heavy-Duty Certification (WHDC) procedure, Off-Cycle Emissions (OCE) procedure, and Non-Road Mobile Machinery (NRMM) procedure have been completed. Efforts are also currently under way to draw up the Worldwide harmonized Light-duty driving Test Cycle (WLTC).

3 Automotive Environmentally Friendly Measures

3. 1. Urban environmental issues

3. 1. 1. Gasoline vehicles

Modern gasoline engine vehicles are able to achieve extremely high environmental performance by combining direct fuel injection and stoichiometric combustion (i.e., burning fuel at the theoretical air-fuel ratio) with a 3-way catalyst. Gasoline engines designed specifically for use in hybrid vehicles employ technologies such as cooled exhaust gas recirculation (EGR) and the Atkinson cycle to achieve both low emissions and low fuel consumption. The number of certified low-emission gasoline passenger vehicles exceeded 98% of new vehicle sales in 2013. Of these, approximately 97% achieved emissions that were 75% lower than the standards set in 2005 (i.e., vehicles awarded four stars (☆☆☆☆)) (Fig. 3). In contrast, direct injection gasoline engine vehicles emit at least 10 times more particulates (soot) as conventional port injection gasoline engine vehicles, and countermeasures are required to identify and help address the current situation as soon as possible [10]. Due to this situation, the mass production of gasoline particulate filters (GPF) to remove PM specifically for direct injection gasoline engine vehicles has begun, and there are also efforts underway to apply the PM regulations in Euro 6 described above to direct injection gasoline engine vehicles [11].

3. 1. 2. Diesel vehicles

To comply with the post new long-term regulations, most heavy vehicles have adopted high-pressure multi-stage fuel injection, variable geometry turbochargers, and EGR to control combustion, in combination with aftertreatment systems such as diesel particulate filters (DPF) or selective catalyst reduction of NOx using urea as a reduction catalyst (urea SCR). In addition, the Central Environmental Council has published a report about future automotive emissions reductions measures (the 11th guidelines) in response to the urgent need to prohibit so-called defeat strategies, i.e., functions that disable emissions reduction devices outside of official test cycles. These guidelines address the prohibition of these functions, conditions that are not defined as defeat strategies, and the verification of whether these functions are present [12]. It has also been confirmed that vehicles that comply with the new post long-term regulations using an onboard urea SCR system often exceed the regulated value for NOx emissions due to poisoning of the system by unburned hydrocarbons (HCs). As a result, the relevant automakers voluntarily introduced a temperature-raising strategy into the system to eliminate HC poisoning starting in August 2013 [13].

3. 2. Global environmental issues

3. 2. 1. Improving fuel economy

One recent trend to improve the fuel economy of gasoline engine passenger vehicles is to combine smaller engine sizes with direct injection and turbochargers. The competition to achieve better fuel economy is particularly fierce for mini-vehicles, some of which have substantially improved fuel economy by introducing regenerative systems to recover energy on deceleration.

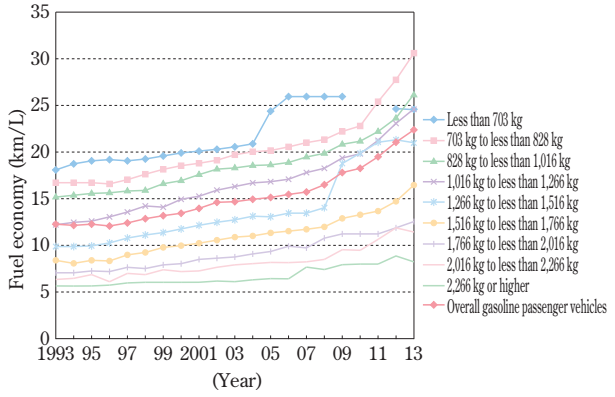


Fig. 4 Trends for average 10-15 test cycle fuel economy of gasoline engine passenger vehicles [14]

As a result, the average overall fuel economy for gasoline passenger vehicles reached 22.5 km/L in 2013, which is substantially higher than the corresponding standard for 2015 (18.6 km/L) (Fig. 4). In addition, the passenger vehicle fuel economy standards for 2020 were set in March 2013, targeting a 19.6% improvement compared to the 2015 standard. As a result, automakers will need to maintain a continued focus on fuel economy.

However, as fuel-efficient vehicles become more popular and widely used, the divergence between real-world and advertised fuel economy has become an issue, particularly because this divergence increases for vehicles with better environmental performance. Real-world fuel economy is affected by various factors, including the usage environment, driving style, and operational status of electrical equipment. Measures will be required in the future to help resolve this issue.

3. 2. 2. Popularization of next-generation vehicles

The strategy for promoting environmentally friendly vehicles drawn up by the Japanese Ministry of the Environment (MOE) [15] and the Next Generation Vehicle Strategy 2010 from the Ministry of Economy, Trade and Industry (METI) [16] call for the development and market introduction of next-generation vehicle technology (i.e., for hybrid, electric, clean diesel, fuel cell, and natural gas vehicles) to help counter global warming, as well as from the standpoint of strengthening the international competitiveness of the automotive industry. Since the full-scale introduction of the preferential tax scheme and incentives for environmentally friendly vehicles in 2009, sales of next-generation passenger vehicles have increased substantially, reaching roughly 4.13 million in 2013. Approximately 94.5% of these vehicles are hybrids. However, only about 5.4% of all vehicles on the roads

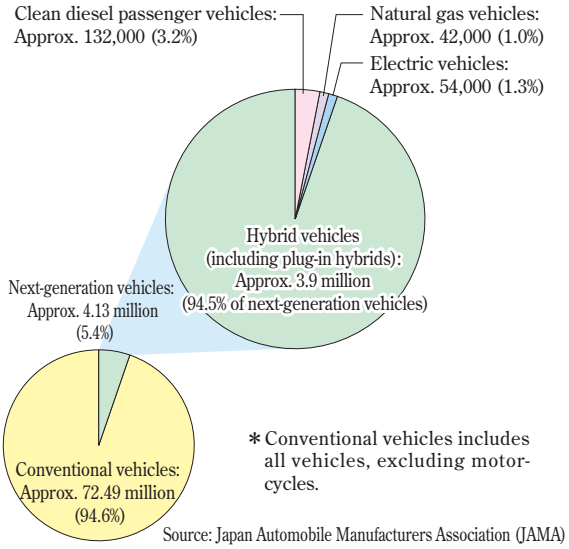


Fig. 5 Breakdown of vehicle ownership and next-generation vehicles (FY 2013) [9]

in Japan are classified as next-generation vehicles and further efforts to promote their popularization will be needed (Fig. 5).

3. 3. Traffic environment measures

3. 3. 1. Promotion of ITS

Currently, various ITS-based services have become widespread across Japan, including the non-stop Electronic Toll Collection (ETC) system and Vehicle Information and Communication System (VICS). In January 2015, the ETC usage rate reached 90.1% and the number of vehicles equipped with onboard VICS units reached a total of approximately 45.15 million units by December 2014. These systems help to improve fuel economy and reduce emissions by facilitating the flow of traffic (Fig. 6). In addition, ITS spot services began operating in roughly 1,600 locations around Japan in 2011 (Fig. 7). These use the same communication technology as ETC to provide various information-based services. One example of an ITS spot service is dynamic route guidance, which provides real-time road traffic information for urban expressways as well as highways and other feasible routes over a wide area that even crosses prefectural boundaries. The vehicle navigation system can then search and select the fastest route based on the latest regularly updated information, allowing for more efficient travel.

3. 3. 2. Popularization of environmentally friendly driving techniques

The Eco-Drive Promotion Liaison Committee, a joint organization of the National Police Agency (NPA), METI, MLIT, and MOE, designated November as the official

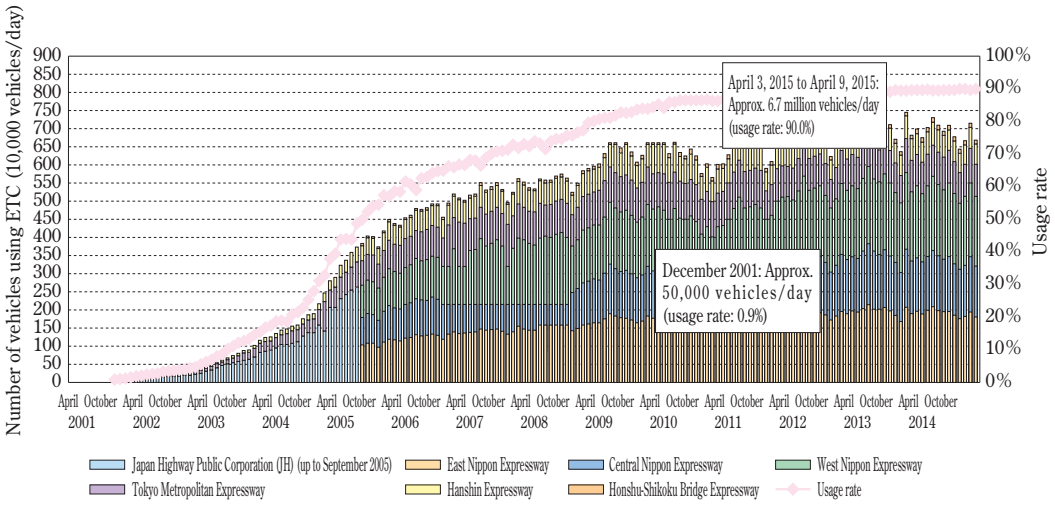


Fig. 6 ETC usage rate [17]

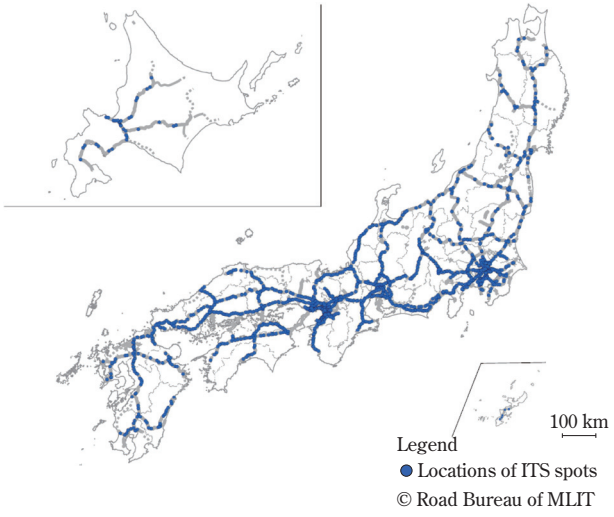


Fig. 7 Map of ITS spot locations in Japan (as of Jan. 1, 2015) [18]

national environmentally friendly driving month (official name: Eco-Drive Promotion Month) since this is a popular month for leisure trips and people have more opportunities to drive. The Committee also promotes coordination for holding of symposiums and events around the country to popularize and promote environmentally friendly driving. This Committee also created ten recommendations for environmentally friendly driving in 2003, which was then partially amended in 2006 and 2012 [19].

3. 3. 3. More efficient logistics and encouraging use of public transportation

In April 2012, after the approval of the Fourth Basic Environment Plan by the Cabinet, MLIT formulated its Environmental Action Plan for the seven year period from 2014 to 2020. One of the aims of this Action Plan is to counteract and alleviate global warming to help achieve a low carbon society. It includes measures to encourage the use of public transportation by increasing the user friendliness of railways and buses and by promoting mobility management, as well as measures to increase the efficiency of logistics by promoting a modal shift from transportation by truck to transportation by trains or ships, and by boosting the efficiency of international freight transportation [20].

3. 4. Measures for used vehicles

The End-of-Life Vehicle (ELV) Recycling Law introduced in January 2005 obligated each automaker to recycle and treat chlorofluorocarbons, airbags, and automotive shredder residue (ASR). In FY 2013, the weight of recovered airbags was 8,800 kg and the recycling rate was 93.9%. This was an increase of 0.4% over the 93.5% recycling rate achieved in FY 2012 and maintained a recycling rate that greatly exceeded the target of 85%. In the same year, 9,000 tons of ASR was recovered and a recycling rate of 97.1% was achieved. This was up 1.6% from the 95.5% achieved in 2012. The ASR recycling rate has exceeded the 2015 target of 70% since 2008 (Fig. 8).

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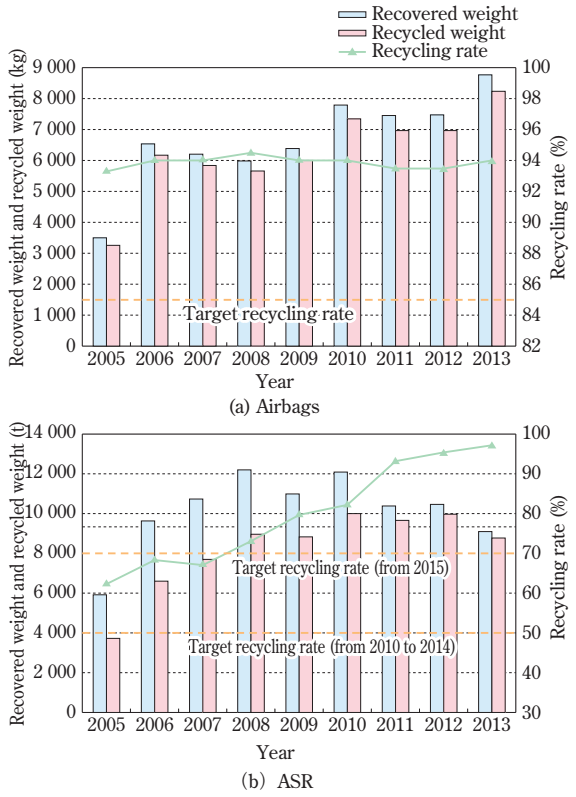

Fig. 8 Weights of recycled materials and recycling rates [21]

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