
THE ENVIRONMENT AND THE AUTOMOBILE INDUSTRY

1 Introduction

Sales of vehicles in Japan in 2021 were approximately 4.45 million, an even greater decrease than in the previous year, which itself had exhibited a large drop. Until now, the number one factor that determined the number of vehicles sold had been demand. However, the 2021 drop in sales can be described as different from past decreases in sales volume, since the closure of plants due to measures to prevent the spread of COVID-19 and the slowdown of semiconductor and other supply lines had a major impact. In that context, sales of next-generation vehicles, notably EVs and FCVs, reached about 21,000 units and 2,500 units, respectively. Although only a small proportion of total sales, those figures nevertheless represent an increase of 1.5 times compared to 2020 for both types of vehicles. This article addresses environmental performance topics such as the extent to which environmental standards have been achieved, overall trends throughout the year for carbon neutrality, and some new models released in 2021.

2 Overview of Atmospheric Environment

Environmental standards for both nitrogen dioxide (NO₂) and suspended particulate matter (SPM) were established for the first time in fiscal 2019 at all monitoring stations, including roadside air pollution monitoring stations. Focusing on air pollution conditions in 2020, the standard for NO₂ was achieved at all stations, while that for SPM was met at all roadside air pollution monitoring stations, but not at one of the 1,272 ambient air monitoring stations. Nevertheless, automobile emissions posing a threat to the achievement of environmental standards can now be said to be in the past.

The environmental standard achievement rate for PM_{2.5}, which has recently been attracting more attention than SPM, is also improving rapidly, and in 2020, it

was 98.3% at ambient air pollution monitoring stations and 98.3% at roadside air pollution monitoring stations (Fig. 1). Until 2014, the achievement rate was generally less than 50%, and the achievement rate at roadside air pollution monitoring stations tended to be lower than that of ambient air pollution monitoring stations, suggesting the impact of vehicle exhaust and other emissions (in addition to exhaust emissions, brake and tire dust has been recently been the object of discussion, particularly in Europe), a situation that has improved in the last several years.

Accordingly, the Subcommittee on Comprehensive Measures for Automobile Emissions under the Central Environment Council of the Ministry of the Environment has been discussing the idea of lifting the target areas designated in the automotive NO_x/PM law. There is no precedent for lifting emissions regulations and measures that have been continuously strengthened, how the process will be finalized remains to be seen. However, the environmental standards achievement rate shown earlier indicate that such a discussion is appropriate.

The standard achievement rate for photochemical oxidant (Ox) remains extremely low at 0.2% at ambient air pollution monitoring stations and 0% at roadside air pollution monitoring stations. The total number of photochemical oxidant warnings issued was 45 days, a decrease from 99 days from the previous year. Many photochemical oxidant warnings are issued in the metropolitan areas of Tokyo, Osaka, and Nagoya. Hydrocarbons (HCs) are listed as regulated emissions components from automobiles, not only because they are harmful but also because they contribute to the formation of photochemical oxidants. Figure 2 shows the change in atmospheric average concentrations of non-methane hydrocarbons (three-hour average values from 6:00 to 9:00 AM), which can be attributed to those regulations. Levels have recently fallen well below the atmospheric environment guideline of 0.20 to 0.31 ppmC or less. Not only do

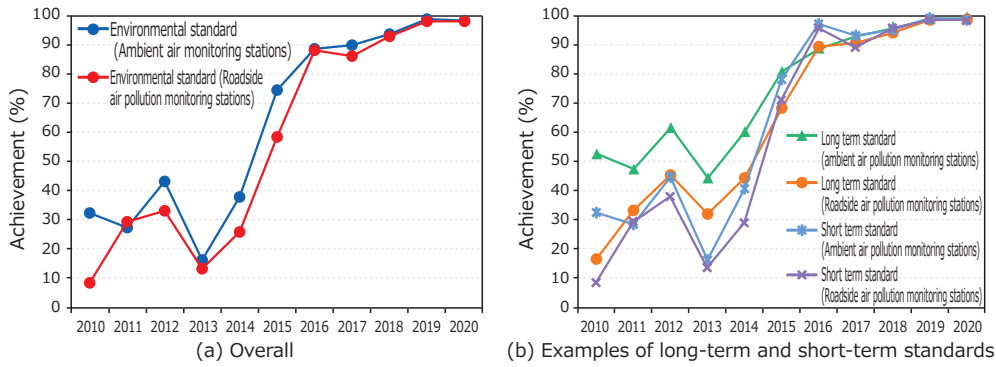


Fig. 1 Shift in PM 2.5 Environmental Standard Achievement

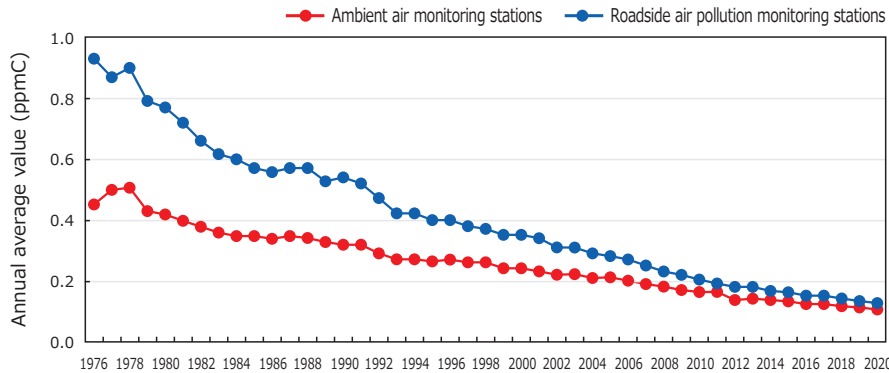


Fig. 2 Annual Average Value Trends in 3-Hour Averages of Non-methane Hydrocarbons from 6:00 to 9:00 a.m.

they continue to drop, but they also exhibit a small difference between roadside air pollution monitoring stations and ambient air monitoring stations. Despite the low rate of environmental standard achievement for photochemical oxidants, it seems fair to say that what can be done at the automobile level is being done.

In contrast, the transportation sector emitted 185 million tons (after the distribution of electricity and heat) of CO₂, which makes up the majority proportion of greenhouse gases, in fiscal 2020. This represents a decrease of 10.2% from fiscal 2019 (Fig. 3). That is a remarkably high level of decrease given the reduction rate of about 9.2% between 2013 and 2019. Breaking down the figures shows a decrease in the volume of passenger transportation emissions, which suggests that the drop in the amount of travel made by people due to measures to

prevent the spread of COVID-19 had a major impact. Consequently, the remarkable decrease in 2020 is projected to be temporary, and it is possible that the process of resuming normal social activity will result in a temporary increase, making it necessary to keep a close eye on the situation.

3 Major Environmental Events in 2021

Efforts to achieve carbon neutrality continue to be pursued despite the impact of COVID-19.

In May, Toyota Motor Corporation entered a 24-hour race in the Super Taikyu Series using a vehicle with a hydrogen engine (internal combustion engine) vehicle (Fig. 4). This approach of seeking to achieve carbon neutrality using an internal combustion engine drew considerable attention in a world where equating carbon neu-

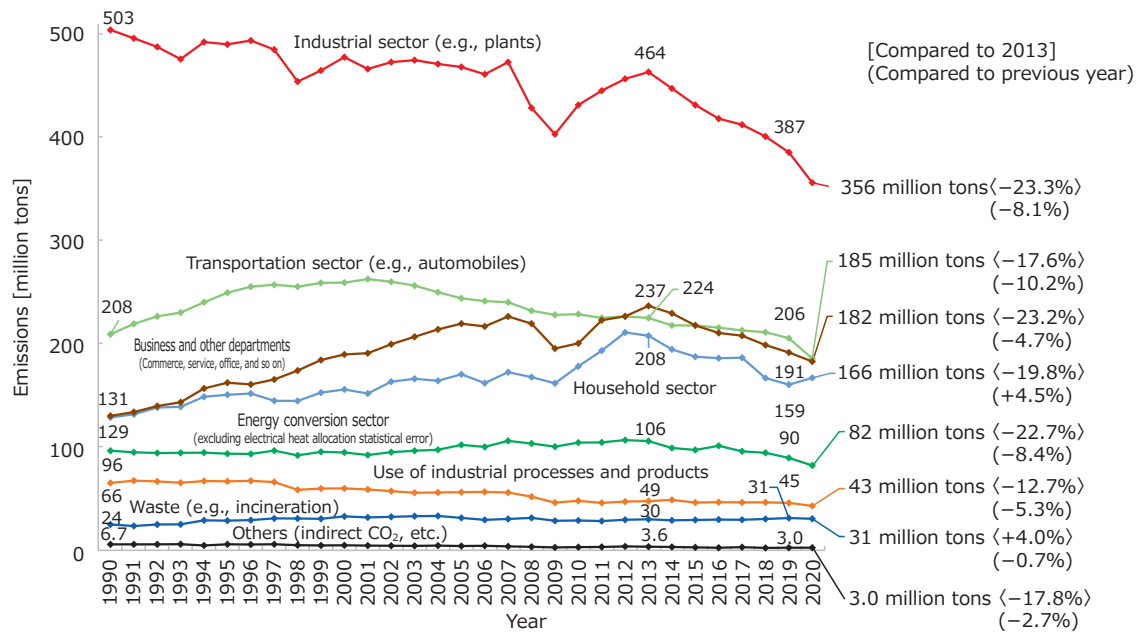


Fig. 3 CO₂ Emissions Trends by Sector (after Electricity and Heat Allocation)



Fig. 4 Toyota Corolla That Participated in an Endurance Race Equipped with a Hydrogen Engine

trality with EVs is becoming the norm. According to Toyota, the decision to participate was intended to make the race a starting point for development based on the hypothesis that doing would be an effective means of improving operability, safety and other technologies in a short period of time. In fact, power and fuel refilling performance was greatly improved in the November race in the same series.

In July, the European Commission proposed banning the sale of vehicles with internal combustion engines, including hybrid vehicles, by 2035. In August, U.S. President Biden signed an executive order that set a goal of making 50% of passenger vehicles and light-duty trucks sold by 2030 zero-emission vehicles. Both topics were prominently raised by the Japanese media. Those actions added impetus to the trend of tying carbon neutrality to EVs. In Japan, Toyota and Honda also announced the

global expansion of their EV lineups at around the same time. However, zero-emission vehicles in the United States include plug-in hybrid vehicles (PHEVs), and although the overall direction is the same, the scenarios to follow it do not necessarily match.

From October 31st to November 13th, the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 26) was held in Glasgow, United Kingdom. Of particular note was the fact that more than 140 countries, regions, companies, and other parties signed the COP 26 declaration to accelerate the transition to zero-emission vehicles in the context of a Transportation Day side event. The declaration calls for all new vehicles on the market to be zero-emission in major markets by 2035 and worldwide by 2040, accelerating the movement to end the sale of internal combustion engine vehicles. However, it is difficult to predict the impact of the movement, as Japan, as well as the United States, China, Germany, France, and other automobile producing nations, have not signed the declaration.

One event with a significant impact on exhaust emissions was the tightening of export procedures for urea by China from November to December, which hindered the supply of the urea necessary to purify exhaust emissions from diesel vehicles, causing supply difficulties for some transportation companies. In response, the Ministry of Economy, Trade and Industry took measures such as

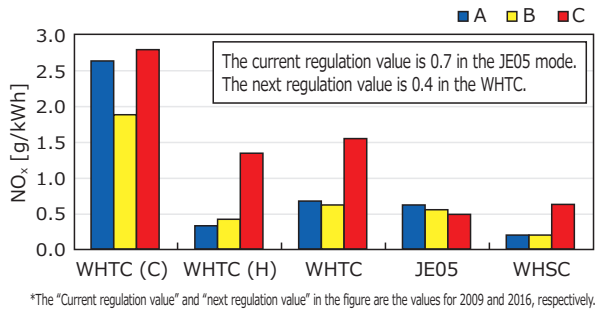


Fig. 5 Comparison of NOx Emissions in Various Test Cycles Performed on Automaker Engines

making an official request in December asking domestic urea water manufacturers to increase production. The impact in Japan was limited due to the existence of companies that manufacture everything from ammonia to urea (AdBlue), but it nevertheless demonstrate that urea, which is neither a cutting-edge technology or a strategic substance, can affect truck logistics, which form the lifeblood of the economy.

In March 2022, it was revealed that Hino Motors had cheated in emissions and fuel efficiency certification tests. The Ministry of Land, Infrastructure, Transport and Tourism took disciplinary actions, including revoking type approval for the several engine systems subjected to a fuel efficiency evaluation involving fraudulent fuel flow meter operation. Conducting surveys of emissions and fuel consumption tests sometimes gives the authors the opportunity to compare the performance of various manufacturers side by side. Figure 5 shows the NO_x emissions results from conducting different test cycles, including the WHTC, on heavy-duty diesel engines that comply with the post new long-term (2009) emission regulations from the viewpoint of conforming with the 2016 regulations. Items A to C are engines from different manufacturers, and while the corresponding manufacturer cannot be identified from the figure, the Hino engine exhibited excellent results (low emissions) in every test cycle. At that point, Hino was viewed as possessing top-level technical ability. However, media reports suggest that some of the fraudulent activities began around the same time. Outperforming rivals in the highly competitive field of environmental performance improvement technology cannot be easy, and more than that, it brought home just how difficult it is to sustain motivation, enthusiasm, and a philosophy of self-discipline under such conditions.



Fig. 6 Mercedes-Benz EQA



Fig. 7 Toyota Aqua



Fig. 8 Mitsubishi Outlander

4 Trends in Environmentally Friendly Technologies Seen in Models Released in 2021

This section presents the subset of models released in 2021 most likely to attract attention with respect to fuel efficiency and other areas of performance. The specifications for fuel economy values and the figures are based on manufacturer press releases, as well as catalog information, including information released on the Web. Unless otherwise indicated, fuel economy and cruising range on a single charge are those of the WLTC, and values with ranges depend on equipment and grade.

In April, Mercedes-Benz announced the EQA in Japan (Fig. 6). Until now, most of the EVs introduced in Japan by European manufacturers have been high-performance vehicles priced at more than 10 million yen. However, the EQA is in a lower price range, and has emerged as an SUV whose sales have been increasing lately. In terms of performance, a 66.5 kWh lithium-ion battery equipped with a water-cooled temperature control device



Fig. 9 Daihatsu Rocky



Fig. 11 Suzuki Alto



Fig. 10 Daihatsu Hijet



Fig. 12 Nissan Ariya

drives a 140 kW motor. Cruising performance has been upgraded frequently for different model year. It was initially announced as 422 km, revised to 410 km in October and then to 423 km in April 2022.

In July, Toyota completely redesigned the Aqua (Fig. 7). A compact car in priced to encourage adoption, the previous-generation Aqua featured the best fuel economy rating in Japan upon its release. It ranked first in the number of annual units sold in 2014 and 2015 and contributing greatly to the spread of fuel-efficient hybrid vehicles. This new model has the same engine and motor output as the Toyota Yaris Hybrid, but is equipped with a newly developed bipolar nickel-metal hydride battery. The new battery has approximately double the battery output of the previous model, making it possible to reduce its size and improve responsiveness to accelerator operation. It has a fuel economy of 33.6 to 35.8 km/L.

In October, the Mitsubishi Outlander (PHEV) underwent a complete redesign (Fig. 8). The powertrain configuration has not changed much from the previous generation, but the engine output, front and rear motor output, and battery capacity have all increased. The battery has a capacity of 20 kWh, and the EV cruising range is 83 to 87 km. In addition, the gasoline tank capacity was increased to 56 L, resulting in an external power supply capacity of about 12 days for a typical household. This is a difficult level for a normal battery EV, and constitutes an advantage of PHEVs since they also contain high energy density liquid fuel.

Hybrid models were added to the Daihatsu Rocky and Toyota Raize lines in November (Fig. 9). The Rocky uses a new series hybrid system unique to Daihatsu consisting of a 1.2-liter inline three-cylinder engine specially designed to generate electricity with drive provided only by the motor. The motor has a maximum output is 78 kW that outranks the engine maximum output of 60 kW, thereby achieving both fuel efficiency and power performance. Its fuel economy of 28.0 km/L is slightly lower than that of the Nissan Note—the nominal precursor of the series hybrid—but the performance of the system is essentially equivalent when factoring in the differences in frontal projection area (same overall width, but a slightly higher overall height for the Rocky).

The Daihatsu Hijet (truck/van) and Atrai were completely redesigned in December (Fig. 10). The biggest feature was the replacement of the conventional 4AT with newly developed front-engine, rear-wheel drive CVT, which is a first in this class. Although light commercial vehicles are often used in harsh conditions, the strong demand for low prices creates a tendency to adopt proven technology. Since they also use a front-engine, rear-wheel drive platform different from that passenger vehicles, they have not benefitted from as many improvements in fuel efficiency. The adoption of a CVT enables the vehicle to meet the 2022 fuel efficiency standards while taking advantage of a wider range of gear ratios. Standing start performance has been improved by lowering the starting gear ratio.

The Suzuki Alto underwent a complete redesign in December (Fig. 11). The Alto is one of the smaller and lighter mini-vehicles, and the previous model already had excellent fuel efficiency. Nevertheless, new model equipped with a mild hybrid mechanism that achieves a fuel efficiency of 27.7 km/L (2WD model) was launched.

In January 2022, sales of the already announced Nissan Ariya (B6 limited) started (Fig. 12). It features a front-wheel drive powered by a 160 kW motor, and a 66 kWh-capacity lithium-ion battery that achieves cruising range of 470 km on a single charge. The weight and battery capacity are similar to those of the aforementioned Mercedes-Benz EQA, but offers more efficient electricity consumption and an approximately 12% longer cruising range on a single charge. A lineup of vehicles featuring a battery with expanded capacity and 4WD vehicles has been announced.

5 Summary

Despite the consensus on the need to reduce green-

house gases to the greatest possible extent amid intensifying efforts toward carbon neutrality, the policies and other measures for doing so differ according to the particular circumstances of individual countries and regions. Put another way, approaches vary depending not only on industrial and social structures, but also on the frameworks for laws and regulations, as well as for infrastructure. The push for international cooperation and the particular circumstances of individual countries are intertwined, and overall progress can be expected despite differences in specific proposals. At the same time, as illustrated by the earlier examples of semiconductors and urea, problems in some regions or materials within the global network have a major impact on industry and society as a whole, and preparing for such risks is becoming necessary in all matters. Automakers are likely to continue to face difficult times.