THE ENVIRONMENT AND THE AUTOMOBILE INDUSTRY

1 Introduction

In 2020, under the double blow of measures to prevent the spread of COVID-19 and problems with the supply of semiconductors, sales of new vehicles decreased by about 10% from the previous year to 4.6 million vehicles. In contrast, given that the time span of environmental issues as well as vehicle development and design exceeds the duration of the one-time spread of a contagious disease (two to three years, including variants based on the experience of the Spanish flu around 1920), there are no signs of a marked impact on the development of environmental technologies or regulatory trends. This article addresses environmental performance topics such as the extent to which environmental standards have been achieved, overall trends throughout the year for emissions regulations and fuel economy standards (CO_2), and some new models released in 2020.

2 Overview and Regulatory Trends

Focusing on air pollution conditions in 2019, both nitrogen dioxide (NO2) and suspended particulate matter (SPM) met the environmental standards for all ambient air monitoring stations and roadside air pollution monitoring stations. In the previous year, the NO2 achievement rate had been 100% for ambient air monitoring stations, and 99.7% for roadside air pollution monitoring stations, while the corresponding rate for SPM for such stations had been 99.% and 100%, respectively. The 2019 values represented the first time the NO2 achievement rate for roadside air pollution monitoring stations reached 100%. In terms of average concentration, both NO2 and SPM continue to decrease, and while the goal for the reduction stage for the NOx and PM at the center of automobile emissions measures until now was achieved, the stage of transitioning to maintenance is about to begin.

The achievement rate for particulate matter (PM 2.5) was 98.7% for ambient air monitoring stations and 98.3% for roadside air pollution monitoring stations represents an improvement over the corresponding 93.5% and 93.1% values of 2018. Looking at environmental standard achievement rate trends by region, stations that have not achieved the rates are concentrated in the Chugoku and Shikoku regions facing the Seto Inland see and the Kyushu regions facing the Ariake Sea. This suggests that fixed generation sources, ships, and sources originating from other countries have a stronger effect on air pollution than automobile emissions. The standard achievement rate remains extremely low for photochemical oxidant (Ox), at 0.2% for ambient air monitoring stations and 0% for roadside air pollution monitoring stations (0.1% and 0%, respectively, in 2018). The number of days photochemical oxidant warnings were issued and the number of people filing damage claims increased from the past year (Fig. 1). Notably, the number of people filing claims jumped suddenly from 13 in the previous year to 337. However, given that the damage originated from areas in the west in conjunction with the movement of a high-pressure front from May 22 to 27, 2019, as well as the fact that the majority of damage claims were recorded in Shimane, which has a low volume of road traffic, it is estimated that the impact of automobiles is negligible.

One major development with respect to emissions regulations in 2020 was the addition of particle number (PN) regulations in the Future Policy for Vehicle Emission Reduction (14th Report) released by the Ministry of the Environment in August of that year. The regulations apply to diesel vehicles and direct injection gasoline vehicles, and cover both light- and medium duty vehicles such as passenger cars, and heavy-duty vehicles such as buses. They are expected to come into effect by the end of 2024 for gasoline vehicles and of 2023 for diesel vehicles. Regulations on PN have already been introduced in Europe, and the regulatory values in the report essentially follow

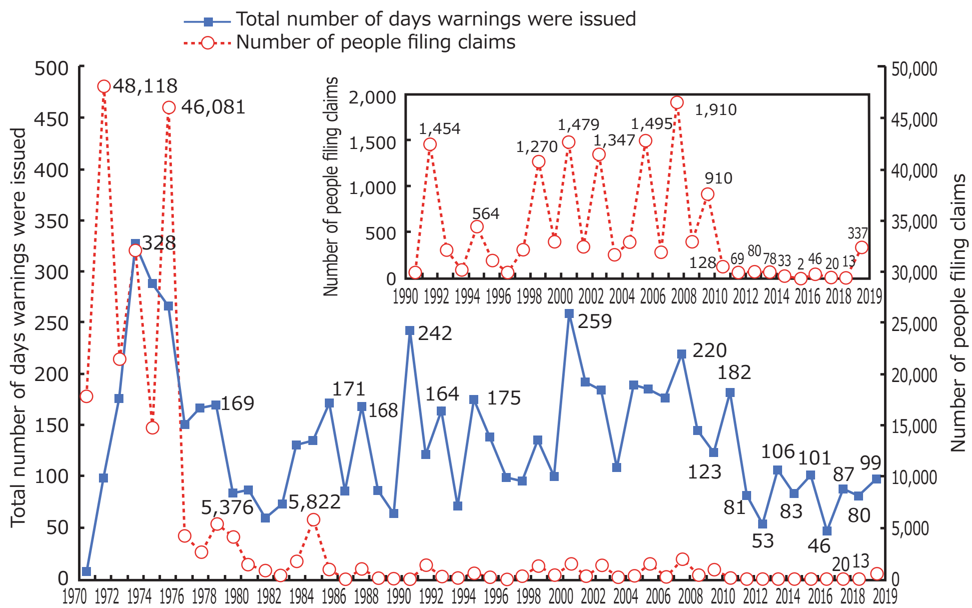

Fig. 1 Shift in the Total Number of Days Photochemical Oxidant Warnings Were Issued and the Number of People Filing Damage Claims

Table 1 Regulatory Values in Particle Number (PN) Regulations (Diesel Vehicles)

Vehicle type	Allowable limit target (average)
	PN
Diesel passenger vehicles (Note 1) Light-duty diesel vehicles (Note 2) Medium-duty diesel vehicles (Note 3)	6.0×10^{11} (particles/km)
Heavy-duty diesel vehicles (Note 4)	6.0×10^{11} (particles/km) (limited to the WHTC)
	8.0×10^{11} (particles/km) (limited to the WHSC)

Note 1 : Ordinary or light-duty vehicles using diesel fuel with a capacity of 10 occupants or less used exclusively to carry passengers (excluding motorcycles and vehicles with a gross vehicle weight over 3.5 tons even if their capacity limited to 10 occupants).
Note 2 : Ordinary or light-duty vehicles using diesel fuel (excluding motorcycles and vehicles with a capacity of 10 occupants or less used exclusively to carry passengers) with a gross vehicle weight of 1.7 tons or less.
Note 3 : Ordinary or light-duty vehicles using diesel fuel (excluding motorcycles and vehicles with a capacity of 10 occupants or less used exclusively to carry passengers) with a gross vehicle weight of over 1.7 tons and not exceeding 3.5 tons.
Note 4 : Ordinary or light-duty vehicles using diesel fuel (excluding motorcycles and vehicles with a capacity of 10 occupants or less used exclusively to carry passengers) with a gross vehicle weight of over 3.5 tons.

the European values. (Table 1 presents the regulatory values for diesel vehicles. The same values apply to light- and medium-duty gasoline vehicles.)

Regulations on PM also came into effect for direct injection gasoline vehicles in 2020, and some of the new models described later are equipped with a gasoline particulate filter (GPF).

In terms of global environmental issues, the transportation sector emitted 206 megatons (Mt) of CO_2 in 2019, a 2.5% decrease over the previous year. This represents a reduction of 1.83 million tons (8.2%) compared to 2013. Automobiles, which accounted for approximately 86%, are the main source of emissions. The decrease from the previous year is attributed to both reduced energy consumption per unit of transportation resulting from improved vehicle fuel efficiency in the passenger segment, and the drop in freight shipments.

In his policy speech on October 26, 2020, Prime Minister Suga declared that Japan would aim to cut greenhouse house gas emissions to net zero and thus essentially become a carbon-neutral society by 2050, prompting the formulation of a green growth strategy shifting course away from the current approach of relying fuel economy standards based on the Energy Conservation Law. It is clear that electrification holds the key to going carbon-free. However, when the power/fuel consumption conversion for electric vehicles (EVs) in the 2030 fuel economy standards is applied the high performance European EVs, many of them are in the 30 km/L range. While that is twice the value for equivalent gasoline vehicles, it offers almost no advantage over hybrid vehicles with excellent fuel efficiency, and the issue is not a simple matter of switching to EVs. Consequently, the green growth strategy touches upon the composition of power generation and carbon-free fuels in addition to enhancing the performance and reducing the cost of vehicle-mounted batteries. Discussions from a broad perspective will be required to achieve a viable carbon-free model.

Fig. 2 Mercedes-Benz GLB 200d

Fig. 3 Honda Honda-e

3 Trends in Environmentally Friendly Technologies Seen in Models Released in 2020

This section presents the subset of models released in 2020 most likely to attract attention with respect to technologies that improve fuel economy and reduce emissions. 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 are those of the WLTC, and values with ranges depend on equipment and grade.

In June, a new model of the Mercedes-Benz GLB was introduced in the Japanese market (Fig. 2). With respect to fuel economy, the 200d, which is equipped with a 2-liter diesel engine, is notable for achieving 17.5 km/L. There are no obvious equivalent directly competing Japanese vehicle models. However, taking the Serena e-Power (17.2 to 18.0 km/L) as an example baseline among 7-seater vehicles with a comparable gross vehicle weight and similar fuel economy, it is fair to say that the 200d offers a fuel economy performance that puts hybrid vehicles to shame.

The Honda-e, the first mass-produced EV from Honda, was announced in August (Fig. 3). As high-performance EVs by European and U.S. manufacturers are starting to enter the Japanese market, the Honda-e joins the fray, presenting a compact vehicle body with a total length of less than four meters, a motor output ranging from 100 to 113 kW, and a cruising range of 259 to 283 km on a single charge. Although billed as the “best choice for city driving”, its width puts it in the 3-series license plate category. However, the use of compact side mirrors and camera result in the total vehicle width including the mirrors being the same as the width of the vehicle body, a value well below that of ordinary 5-series license plate models. This represents a sophisticated embodiment of matching the concept to its use. In contrast, given a price unlikely to encourage widespread adoption, and annual target sales of 1,000 vehicles, it can hardly be described as a driving force in the shift to EVs.

Fig. 4 Subaru Levorg

Among other Japanese manufacturers, EV models of the Mazda MX-30 and the Lexus UX have been launched, but only have planned annual sales of 500 units for the former and 135 units for the latter (for 2020). These numbers are on par with those for special specification sports car and obviously target a limited group of users.

The Subaru Levorg was completely redesigned In November (Fig. 4). It has a fuel economy of 13.6 to 13.7 km/L. While those are not values to write home about, they do meet the 2020 fuel economy standard (JC08 test cycle). Few non-hybrid 4WD vehicles equipped with a turbocharged gasoline engine have met that standard. The fuel economy enhancing technologies enabling that achievement include a new 1.8-liter engine featuring lean burn and the first offset crankshaft in a horizontally-opposed engine. All manufacturers offered a broad line up of vehicles with lean burn gasoline engines around the year 2000. However, 3-way catalysts are ineffective in the lean state, and ensuring the durability of the NOx storage-reduction catalyst responsible for NOx conversion in that state was made difficult by subsequent strict durability requirements. Consequently, such engines became practically extinct. This models therefore represents a daring step. Whether the 2020 or other fuel economy standards are achieved is determined by the corporate

Fig. 5 Nissan Note e-Power (4WD)

Fig. 6 Jeep Renegade 4xe

Fig. 7 Toyota Mirai

Fig. 8 Isuzu Erga

average fuel economy. Consequently, the presence of EVs or hybrid vehicles performing well above those standards and providing a surplus makes it possible to achieve them even if there are vehicles with a fuel economy below the standards. However, the Subaru lineup does not have such vehicles, making it necessary for practically all of its vehicles to achieve the standards. The engine in this vehicle is therefore likely to play a key role in that respect. As if to confirm this, Subaru announced a Forester model equipped with this engine to replace the 2.5-liter gasoline engine model.

In November, Nissan completely redesigned the Note (Fig. 5). The only powertrain offered for this new model is the company's reputed series hybrid e-Power. The e-Power is in its second generation and offers slightly superior fuel economy compared to its predecessor in the JC08 test cycle. The standard S grade has a WLTC fuel economy of 28.4 km. The Note is more unique for its 4WD system than its powertrain. In the previous Note model and other light-duty hybrid vehicles built around a front-wheel drive base, the 4WD system normally focuses on using compact motors with an output of a few kilowatts on the rear wheels to assist the drive when starting off. In contrast, the new Note uses 50 kW motors on the rear wheels (85 kW motors on the front wheels), making it a true 4WD system. This raises regeneration efficiency, increasing not only power performance but also even improving fuel economy over the previous 4WD model under equivalent weight conditions, thereby achieving a balance between efficiency and driving performance.

The Jeep Renegade 4xe became available in Japan in November (Fig. 6). This is the first plug-in hybrid offered by Jeep. The hybrid system has a FWD base and is built around a 1.3-liter turbocharged gasoline engine, and is complemented with separate 94 kW drive motors installed on the rear wheels, enabling 4WD use even while driving in EV mode (Trailhawk grade). The EV operating range is 48 km, and fuel economy in hybrid mode ranges between 16.0 and 17.3 km/L. Compared to the 132 kW of the gasoline model, the 4xe offers a system output of 178 kW while achieving a 20 to 30% improvement in fuel economy.

In December, the Suzuki Solio was completely redesigned. The most noteworthy aspect of the redesign is the removal of the hybrid system paired to mechanical manual transmission (AGS) found in existing models from the lineup, leaving only a gasoline model and a variant with mild hybrid system that uses a compact 2.3 kW motor. That hybrid system was limited a mild motor output of 10 kW that does not offer a notable improvement in fuel economy over other mild hybrid models, and cost effectiveness considerations are thought to underlie the decision to eliminate it. Nevertheless, in this climate of overall fuel economy enhancement, eliminating the hybrid system offering the best fuel economy in the lineup without having successor technology in the wings is extremely rare.

Mitsubishi partially redesigned the Eclipse Cross in

December. The introduction of a new model equipped with the plug-in hybrid system that has proven successful in that company's Outlander is counterbalanced by the elimination of the previously available diesel model.

The Toyota Mirai was completely redesigned in December (Fig. 7). It is equipped with three 70 MPa tanks holding 141 liters of hydrogen that provide a cruising range of 750 to 850 km on a full tank. Featuring both higher motor output and a larger vehicle body than its predecessor, the new model qualifies as a luxury vehicle. From that standpoint, it is not especially expensive, and is priced at a level that can compete with hybrid and other vehicles in the same class. It will be essential to bring both the vehicles and the infrastructure within reach to popularize fuel cell vehicles, and this redesign should be recognized as an initiative targeting eventual popularization by enhancing the appeal of the vehicle side of the equation.

Among heavy-duty vehicles, Isuzu and Hino announced partially upgraded versions of the Erga and Blue Ribbon, respectively, in June (Fig. 8). In the 14 t and over gross vehicle weight class, they stand out as automatic vehicles that exceed the 2015 fuel economy standards by 10%. When those standards were formulated, the same calculation was used for the fuel economy of both MT and AT vehicles, and the value of the latter was multiplied by 0.9 to account for factors such as transmission efficiency. The evaluation method was subsequently amended to reflect technological advances and incorporate AT shifting logic and actually measured transmission efficiency. Vehicles in the same weight class equipped with an automated manual transmission exceed the same standard by 15%, suggesting that AT transmission efficiency has progressed well beyond "multiplying by 0.9". In route buses that start and stop frequently, the ease of shifting and small shock of an AT benefits both the driver and passengers. Models such as these, which offer excellent fuel economy with an AT, are therefore extremely relevant. Technological breakthroughs and an evaluation method that reflects them have produced a beneficial result.

In other news, various manufacturers have made partial upgrades to their light-duty trucks (load capacity of 2 to 3 t), making them compliant with J-OBD2 in the process. For heavy-duty vehicles, the 2016 emissions regulations were introduced according to gross vehicle weight class over a three-year span, with J-OBD2 following, respectively, two years later. The introduction of J-OBD2 in light-duty trucks means it now applies across the board.

4 Summary

Past measures to reduce greenhouse gases at the individual level assumed that improving fuel economy would reduce CO_2, and have already achieved considerable results. However, bringing carbon neutrality in the equation will significantly alter past ways of thinking. With development shifting its focus to EVs, low-fuel economy hybrid vehicles or diesel vehicles, as already noted, are being eliminated. Close attention to the progress of events will be necessary as short-term reductions in CO_2 become less prevalent.