BUSES

Overall Trends

1 Introduction

1. 1. The COVID-19 Blow to the Bus Industry

The COVID-19 disease first brought to the attention of Japan in January 2020 by infections on a cruise shipped spread simultaneously and indiscriminately throughout the world. Everyday life was turned upside down for people around the world in the blink of an eye, and there is still no end to the pandemic in sight. Even for an unknown disease, the speed at which it spread worldwide is testament to the progress of globalization, and the repercussions were not limited to the health system, but also extended to politics, the economy, and cultural exchanges. The Japanese automotive industry was obviously impacted as well. With the spread of COVID-19 primarily attributed to droplets, measures to restrict the movement of people were implemented, resulting in buses becoming the most strongly affected segment within that industry.

(1) Impact on International Travel

In previous years, Japan had been encouraging nationwide initiatives to attract tourists from other countries. As a result, the number of visitors to Japan kept growing steadily after exceeding 20 million in 2016, reaching 31.88 million in 2019. The tourists representing the majority of visitors to Japan had provided a major economic boon. However, that inbound flow stopped.

Over the four months from April to July 2020, the number of visitors to Japan, which had averaged 2.9 million per month in 2019, plunged to approximately 2,700 people. That was a decrease of 99.9% over the previous year. Although the number of business visitors recovered slightly from September, the total for 2020 was 4.116 million, an 87.1% decrease compared to the previous year. The worsening business conditions of airlines due to the drop in tourism drew headlines, but the charter buses serving as the means of transportation for group tours were also severely impacted.

The high expectations on increased tourism placed on the Tokyo Olympic and Paralympic Games scheduled for the summer of 2020 only served to throw off the estimates of the hotel industry which had invested in facilities, and of the sightseeing bus industry that transports the tourists. The cancellation of flights also force buses providing service to international airports to suspend operations. Plans to increase the number of charter buses for the Olympics were revised, and the nationwide charter bus orders that had been placed to transport spectators and athletes were postponed. The route buses that had been prepared for transportation between and around competition venues also never fully began operation.

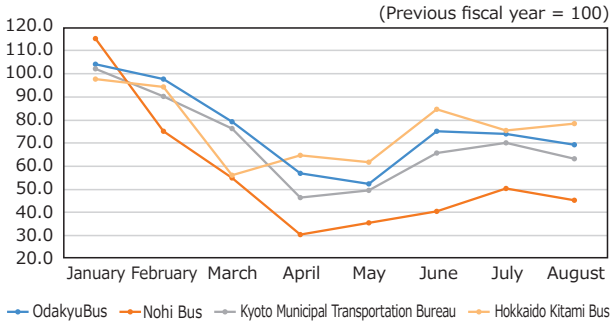
(2) Impact on Travel Demand in Japan

The drop in demand was identical for travel in Japan, and the state of emergency declaration in April 2020 requested that people refrain from non-urgent and non-essential outings. This led to the cancellation of bus tours, and forced inter-city expressway route buses, regular sightseeing buses, and routes depending largely on tourist demand to suspend operations. Buses catering to late night urban demand also stopped operating, and schools cancelled or postponed excursions and school trips.

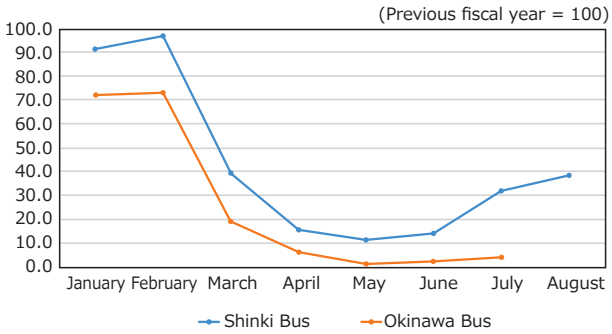
On top of that, social distancing was recommended to prevent the spread of the disease, and the introduction of telework and remote classes significantly reduce the demand for commuting to work or school. With many everyday routes operating the normal number of buses to avoid crowding, transit buses saw their core of stable fare revenue drop while fixed costs remained unchanged.

Data that makes the impact of COVID-19 on the bus industry crystal clear is available. Figure 1 shows the number of transit and charter bus users for various operators from January to August 2020 compared to the previous year. Despite minor differences in client base, the overall trends match.

As bus operators throughout keep losing fare revenue due to being in operation but not having customers, some have attempted to reduce fixed costs by removing



(a) Ordinary bus business (compared to 2019)



(b) Charter bus business (compared to 2019)

Fig. 1 Impact of COVID-19 on the Bus Business

some of their vehicles from service or reducing their fleet size. Some charter bus operators with visitors to Japan as their primary market have had to abandon the idea of remaining in business. The suspension of bus usage has led to revising plans to upgrade vehicles, and bus operators canceled purchase orders, decreasing the number of actually ordered units. Bus manufacturing lines were halted. This represented an emergency unlike anything faced by the bus industry before.

Refraining from non-essential, non-urgent outings led to the "stay-at-home demand" expression as some people did their shopping online and had food delivered from restaurants to their home. As a result, food delivery bicycles and scooters rode to and fro, and heavy-duty trucks filled with small packages formed queues on expressways late at night. The surge in logistics activities due to restrictions on the movement of people represents another effect of COVID-19, and despite being equivalent production goods, a stark contrast arose between trucks and buses. That market situation was also reflected in data such as the number of new vehicle registrations.

(3) Bus Industry-Wide Measures against COVID-19

The bus industry did not just stand passively doing nothing while COVID-19 struck it one blow after another.

Fig. 2 Demonstration of the Bus Providing Sufficient Ventilation

Starting in May, various measures against the COVID-19 pandemic were introduced. Although the nuance diverges from the core theme of this article, the measures were given a section as they represent technology adapted to changes in the environment and constitute a matter of vital importance for the bus industry. Bus manufacturers and operators both took action concurrently with an underlying tone of not letting consumers turn their backs on buses. Put another way, the focus was on convincing consumers that buses could be safely used even during the pandemic. The main recommendations to avoid the risk of infection are securing ventilation and social distancing, as well as the disinfection and sterilization of vehicles and passengers.

The latest sightseeing bus ventilation systems can replace the air in the bus within five minutes if used in conjunction with introducing outside air, and recirculation becomes more efficient if some windows are opened. The bus industry rushed to advertise its sufficient ventilation (Fig. 2). Route buses also offer sufficient ventilation by opening and closing the doors at stops and opening some windows. Visors for side windows to prevent rain from blowing in when windows are open to ventilate the bus have been developed and introduced by vehicle body remodeling contractors and bus operators, and are sold as an accessory.

For inter-city expressway buses and bus tours, selling seats while leaving the adjacent seat unoccupied became a popular measure. Keeping the same unit price for passenger cuts half of the business operator profits. Consequently, installing partitions to the front and back of the passenger seat, and between adjacent seats, became more common. For partitions on the front and back, a clear material that does not obstruct the view from the top of the seat back is used. Operators also applied ideas such as using a semi-transparent material for the partition between adjacent seats to provide privacy (Fig. 3).

In route buses where collecting fares creates frequent

Fig. 3 Social Distancing Ideas

Fig. 4 Example of Applying Photocatalytic Coating to the Inside Wall

opportunities for contact with passengers the approach of setting a transparent curtain around the fare collection box took off in a short time. Despite the sense of hasty preparation on-site, vehicle body remodeling contractors developed a product shaped to ensure visibility at the left rear of the driver. In sightseeing buses, a clear partition that does not obstruct the passenger's view was set behind the driver's seat, and prohibiting the use of the first row of seats is common in both transit and sightseeing buses.

There are also examples of installing a plasma ion generator aimed at sterilizing the air and removing odors in sightseeing buses that are ridden for a long time, and reports that COVID-19 becomes inactive in low-temperature ozone have led to the more widespread installation of ozone generators. In vehicles with ample seat dimensions, curtains with anti-bacterial & antiviral fiber were set between adjacent seats. Examples involving applying photocatalytic coating to curtains, seats and inside walls (Fig. 4) are also becoming more common. Each of those measures represents a painful investment when profitability has dropped, but some subsidies have been awarded as the importance of public transportation was

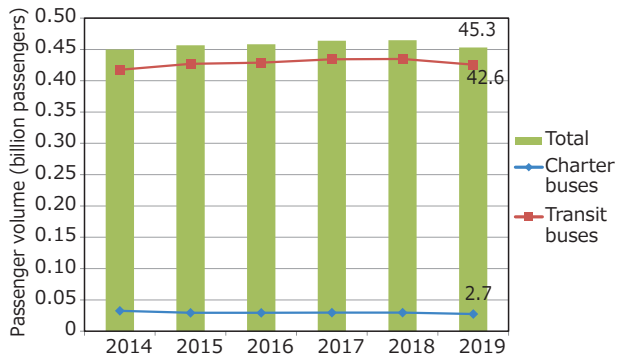


Fig. 5 Bus Transportation (Number of Passengers)

highlighted. The initiatives also have a high priority in promoting buses as clean and safe means of transportation. Another important measure rapidly becoming widespread, especially in buses ridden for a long time, is the provision of alcohol or other disinfectants for the hands.

Bus drivers are getting older throughout Japan, and there have been accidents due to health issues. Driver health management has therefore been a major area of focus for operators. The absence of clusters from bus operations despite the COVID-19 surge is a testament to the results achieved by day-to-day health management efforts. Passengers are also contributing their thorough individual efforts to limiting the spread of COVID-19, hopes are placed on moving toward a time when public transportation once again grows and contributes to reducing the burden on the environment and social costs.

1. 2. Automated Driving Endeavors

Despite the pandemic, automated driving field tests continued in 2020. Every month, except during the March to May and August periods overlapping with a state of emergency, several trials ranging from tests completed in one day to evaluations extending to one month or longer were conducted. Local bus operators were often involved with the universities or other research institutions, local governments, or corporations involved in communication acting as the main organizers. The buses used increased in size from light-duty to medium- and heavy-duty buses, and test locations also expanded from courses at large facilities to public roads. Many tests centered on Level 2 automated driving involving driver intervention when necessary, and driving was performed remotely.

In November, a light-duty bus began regular route operations covering a 5 km round trip on public roads in the town of Sakai, in Ibaraki. In large cities, suburban route service using automated heavy-duty buses is planned for

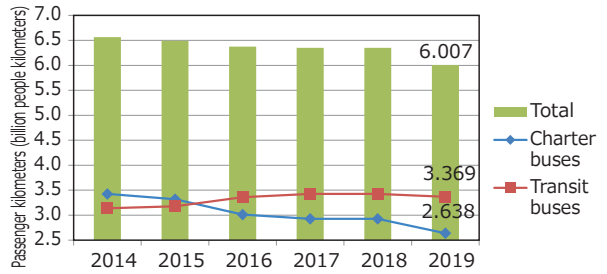
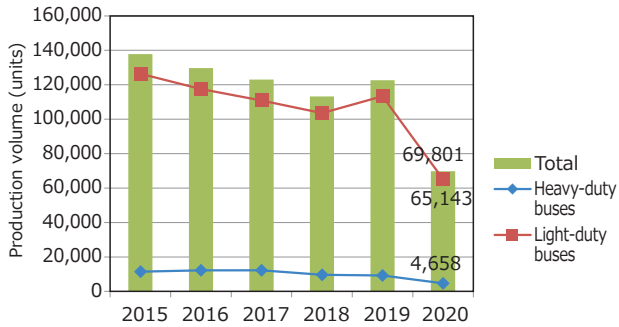


Fig. 6 Bus Transportation (Passenger Kilometers)



*2 Quoted from Ministry of Economy, Trade and Industry dynamic statistical data since 016.

Fig. 7 Bus Production Volume

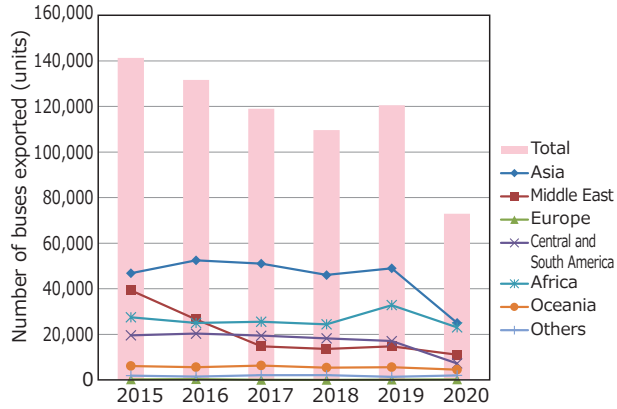


Fig. 8 Main Export Destinations

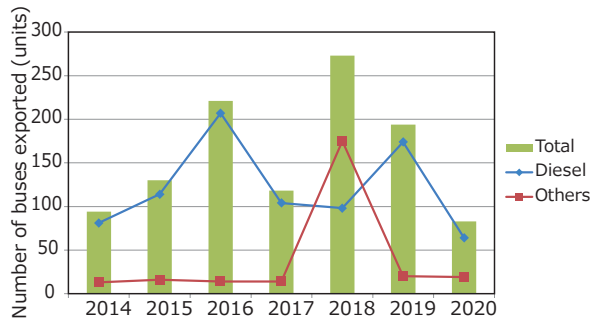


Fig. 9 Number of Imported Bus Registrations

the near future, and strides are being made in commercializing automated driving. In contrast, transport operators, whose primary mission is to transport passengers to their destinations safely, still harbor strong concerns about the burden of responsibility in an accident involving automated driving and ensuring the safety of passengers. User and public acceptance is a major prerequisite to realizing the expectations envisioned for automated driving by technology providers and the bus industry.

2 The Japanese Bus Industry in Statistics

2. 1. Passenger Numbers

Figure 5 shows the bus passenger volume (number of passengers). The statistics are from 2019 and do not reflect the impact of COVID-19. Transit bus use decreased by 2%, and charter bus use by approximately 10%, for a total decrease of 2.6%.

The bus passenger volume (number of passengers) data indicating the distance travelled by users in Fig. 6 also represents figures from 2019. The distance travelled by transit buses decreased by approximately 13%, but that value is not statistically significant.

2. 2. Market trends, Production and Registration

The bus production unit numbers in Fig. 7 are those for 2020, and clearly show the impact of COVID-19. The total number of units dropped by half from 122,682 in 2019 to 69,801. The decrease is primarily due to the cancellation or downward adjustment of orders in and after the summer, with a drop of 50% to 4,658 units for heavy-duty buses and of 43% to 65,143 units for light-duty buses. The large decrease in light-duty buses, which have a high ratio of private use, stands out. What the above figures do not show, however, is the severity of the drop in demand for sightseeing compared to urban route usage. With a decline in usage as the cause, the recovery of demand is likely to be measured in years, and the bus industry is hoping that events such as Expo 2025 in Osaka will boost demand.

Figure 8 shows the exports by main destinations, which remain the Asian nations, Africa, the Middle-East, and Central and South America. However, exports to Central and South America dropped by over 50%, and those to Asian nations also fell to nearly half. The prominence of inexpensive Chinese- and Korean-made light-duty buses may have played a larger role than COVID-19 in that decline.

Figure 9 shows the number of imported bus registra-

Fig. 10 Charter and Overnight Expressway Routes Added for Double-Decker Bus

Fig. 11 First Commercial Alfabus Electric Bus Coming into Operation

tions, which was 83 in 2020, just 43% of the 2019 figure. Those imports break down into 64 diesel vehicles and 19 other vehicles. The diesel vehicles consisted of double-decker, articulated, and sightseeing buses, while the others are assumed to be electric buses. Imports of electric bus completed vehicles are anticipated to continue, but not by a significant margin due to the current reliance on a fixed subsidy to make them more widespread in Japan.

3 New Buses

New buses introduced in 2020 were limited to additional variations. The reason is that many vehicles were already made compliant with the emissions regulations and advanced OBD (J-OBD II) technical requirements common to all vehicles in 2019. Advanced OBD is a failure diagnostics system for emissions reduction devices that monitors the performance or failure of functions such as DPF, SCR, oxidation catalysts, and EGR. It will be introduced in light-duty buses with a GVW over 3.5 t and less than 7.5 t in September2021. This article presents electric and other buses that began operation in 2020.

3. 1. Heavy-Duty Sightseeing Buses

All heavy-duty sightseeing buses had their safety systems expanded and completed minor styling changes in 2019, and models sold in 2020 were there same as those of the previous year. Notable safety systems include the installation (in Japanese-made buses) of collision mitigation braking systems with automatic detection and emergency driving stop systems (EDSS), as well as of the Active Safeguard Assist system that detects pedestrians and cyclists on the left side and emits an alert (Mitsubishi Fuso). The focus on the Paralympic Games also led to an increase in vehicles equipped with lifts or elevators for users in wheelchairs, and preparations to mobilize them during the Games were also underway throughout Japan.

In 2020, the Scania/Van Hool TDX24 Astromega double-decker bus first introduced in Japan in 2016 complemented its initial regular sightseeing and daytime expressway route variants with a chartered variant equipped with a toilet and a nighttime expressway route variant featuring independent second floor seating. The number of vehicles for all variants has been increased (Fig. 10).

3. 2. Heavy-Duty Route Buses

The EDSS used in heavy-duty sightseeing buses has also been deployed to urban route buses since 2019, and also introduced in Hino and Isuzu hybrid models in June 2020.

Preparations to increase the number of Toyota SORA buses, the only Japanese-made fuel cell bus, in time for the Tokyo Olympic and Paralympic Games had been announced, and the Bureau of Transportation of the Tokyo Metropolitan Government introduced the originally planned 70 vehicles, while some private sector operators in the Tokyo metropolitan area each introduced one or two vehicles.

Deliveries of the articulated bus announced in 2019 (the Hino Blue Ribbon hybrid articulated bus/Isuzu Erga Duo) to the Yokohama City Transportation Bureau, Mie Kotsu, the Tokyo BRT and other organizations started in July 2020. Various other regions will be introducing it to begin operation in 2021.

3. 3. Medium and 3.3. Light-Duty Buses

In June, the medium-duty Isuzu Erga Mio/Hino Rainbow route bus made a 6-speed torque converter AT option available in addition to the electronically-controlled mechanical 6-speed AMT. It also features a function that eliminates creep and ensures safety when the middle door is open.

A top grade model with double doors at the rear of the elongated vehicle and a restricted number of seats was added to the Toyota Coaster/Hino Liesse II lineup in June.

Fig. 12 Cab-Behind-Engine Electric Bus by Ono Engineering

Fig. 13 New J6 Electric Bus by BYD

Fig. 14 Retrofit Electric Bus Converted from a Diesel Bus Starting Operation at Nishi-Nippon Railroad

Fig. 15 Retrofit Electric Bus Converted from a Diesel Bus Starting Operation in Yokohama

4 Electric Buses

Even as announcements of new Japanese-made buses remain limited, other electric buses first unveiled in 2019 went into operation. All of them are Chinese-made completed vehicle imports, and many bus operators are showing strong interest in electric buses. This section presents the three buses that began operation in 2020, as well as the two retrofitted heavy-duty electric buses made in Japan.

4. 1. Alfabus 10.5 m Vehicle

Equipped with a CATL lithium-ion battery, this is an urban route bus adapted to Japanese driver-only bus structure requirements by the Chinese Jiangsu Changlong Keche first unveiled by Alfabus Japan in 2019. The battery has a capacity of 296 kWh, and the drive motor has an output of 210 kW. Cruising range on a single charge is 240 km, which fully covers the average travel distance of bus operators in Japan. In autumn 2020, the first commercial bus began operation as a shuttle bus for employees at the Shikoku Electric Power Company Sakaide Power Station (Fig. 11). It is used in conjunction with the existing diesel shuttle, and undergoing a technical evaluation. A second us is apparently already scheduled to be delivered in early 2021.

4. 2. Ono Engineering (Asiastar)

This completed electric bus by Yangzhou Yaxing Motor Coach is imported and sold by Asianstar Japan. It is available in lengths of 7, 9 and 10.5 meters, and the first commercial models were commissioned by Eagle Bus for a route operated in the city of Kawagoe. The school bus-like cab-behind-engine front which, following the pattern of the U.S. market, is also becoming more common in vehicles in China, has been remodeled into a classic style in Japan for the two special-order vehicles with a total length of 7.54 meters (Fig. 12). The mounted CATL lithium-ion battery has a capacity of 95.3 kWh, and the drive motor has an output of 90 kW. The manufacturer nominal cruising range on a single charge is 200 km. A 7-meter Ono Engineering original style vehicle is scheduled for delivery in the spring of 2021.

4. 3. BYD

The K9 12-meter made by BYD, which holds a large share of the global electric bus market, was first introduced in Japan in 2015. Its early arrival in Japan has given it a lead in sales, and the 7-meter J6 was announced in 2020 (Fig. 13). The mounted BYD in-house lithium iron phosphate battery has a capacity of 105.6 kWh, and the drive motor has an output of 100 kW. Cruising range on a single charge is 150 km. It aims to expand into the community bus and similar markets. In addition to the

already active K9, the C9 and J6 sightseeing buses have been followed by the announcement of a 10.5-meter model.

4. 4. Customized Electric Buses

A heavy-duty bus retrofitted by Nishi-Nippon Railroad to test the performance of electric buses began operation in February 2020 (Fig. 14). Despite its high price and low capacity relative to its weight, the Toshiba SCiB™ was chosen for the lithium-ion battery due to its stability, high power density and long life. The battery has a capacity of 105.6 kWh, the drive motor has an output 230 kW, and cruising range on a single charge is 90 km. Separate batteries are placed at the rear of the vehicle and on the front wheels, and seating capacity is almost the same as that of the base vehicle (a 2013 Isuzu LV).

The Yokohama City Transportation Bureau started operating a different retrofitted electric bus in October 2020. That bus is based on a Kumamoto University joint government-industry-academia project that has been working on retrofitting heavy-duty vehicles into electric buses. The bus uses the lithium-ion battery (capacity of 160 kWh) and drive motor (output of 190 KW) found in the mass-produced Nissan Leaf (Fig. 15). Another distinction is the preparation and release of a manual on constructing the vehicle body structure when retrofitting a diesel bus into an electric bus in an attempt to mitigate costs. Since the design is based on rapid charging at stations during breaks in the schedule, cruising range on a single charge is approximately 50 km. The Yokohama City Transportation Bureau plans to use the bus in various routes conditions, including up and downhills, and congestion, to evaluate its performance. A plan to import European electric buses in addition to Chinese one is also under preparation.

Design Trends

1 Japanese-Made Buses

1. 1. Mass-Produced Bus Designs Trends

Complete redesigns of currently active Japanese-made buses were carried out between 1996 and 2015, which means between 14 and 16 years ago, notably, for sightseeing models. Obviously, some components were revamped and facelifts were made in the interim, maintaining a product appeal in line with the times, but there is nothing of note to present in terms of design. Under these circumstances, the newly added articulated buses may be based on standalone vehicles, but the way the operators adopting them choose to highlight their total length exceeding that of a normal vehicle provides a glimpse of their sense of style. The first set of for models at the Yokohama City Transportation Bureau have a beautiful deep blue metallic tone that embodies their Bayside Blue nickname (Fig. 16). A tone with depth and a glossy feel is achieved by overlaying a metallic film over blue paint. The interior also offers a chic feel with a wood-like flooring and grey seat fabric. The uniform Japanese urban bus “blue seat covers and orange stanchion poles” interior is said to be intended for people with poor vision, but addressing the needs of such people requires

Fig. 16 Yokohama Articulated Bus with Beautiful Deep Blue Metallic Tone

Fig. 17 Articulated Bus in Use in the Tokyo BRT

Fig. 18 New Paint Design for Osaka Urban Buses

Fig. 19 Seibu Bus with Extensive Changes to Paint Design Used for 67 Years

Fig. 20 Luxury Sightseeing Bus Series by Nara Kotsu Bus Lines

Fig. 21 Yu-Yu Bus by Tokai Bus

Fig. 22 Takumi Bus Picking Up Tourists in Hida Takayama

Fig. 23 Melody Bus Operating in the City of Fukushima

Fig. 24 Remodeled Body Proposed by J-Bus

a difference in brightness and does not represent a condition that spoils color selections.

The Tokyo BRT, which aims to provide the main bus transportation around the Tokyo Olympic and Paralympic Games venues began preliminary operations in October. The nine vehicles include five SORA fuel cell buses and one articulated bus (made by Isuzu). The buses, including the fuel cell buses reputed not to allow unique operator paint designs, all feature the unified Tokyo BRT design. The pastel colored diagonal stripes crossing over a white background design is stereotypical, even outside Japan (Fig. 17).

Mie Kotsu, which began articulated bus operations in December 2020, maintains its identity by applying the same green as its ordinary buses over a white tone while achieving an overall design that drives on the route around the shrine with a sense of restraint.

The change to the Osaka urban bus stands out among paint designs for urban buses. With over 500 buses driving around Osaka, their paint design also represents the colors of the city. The cream color with a light green band used since 1979 was replaced by a light green, white and blue three-color scheme (Fig. 18). A film is used concurrently with paint for the cumbersome areas with gradation. Separating colors horizontally had been the norm in Japanese buses, but arranging colors vertically has become the new trend.

Seibu Bus, a major operator that owns over 800 buses, has similarly revamped the standard paint design it had traditionally used since 1953. The cool colored geometric patterns are described as expressing the function of the town and buses, and the black applied to the periphery of the bottom edge give the visual impression of a higher road clearance (Fig. 19).

Nara Kotsu Bus Lines introduced three high grade charter buses named Seiryu, Byakko and Genbu. With the Suzaku launched in 2019, they complete the four vehicle series (Fig. 20). The names are derived from the four gods who protect the four directions and are drawn on the wall of the Kitora Tomb in the village of Asuka. The exterior colors, paint design, and interior also differs between the four vehicles, but share a large washroom and a layout with a 32-passenger capacity aimed at a higher usage rate than the 10 to 20-passenger capacity highly luxurious buses seen in 2018 and 2019.

1. 2. Buses with Original Designs

Buses with original designs that catch the eye when they drive around appeared in various regions in 2020. Among medium-duty buses, the Yu-Yu Bus adopted by Tokai Bus (Fig. 21) exhibits elaborate detail. The half-deck front and higher level rear roof are distinctive. The base vehicle is a Hino Rainbow, and the remodeling was done by Iwado Industry. In Hida Takayama, a popular destination for visitors to Japan, Nohi Noriai Jidosha operates three Takumi Bus vehicles to provide transportation to attractions around the city. The three vehicles have different exterior appearances, with colorful looks that are worth seeing. The interior also incorporates de-

tails that highlight the craftsmanship of Hida. The base vehicle is a Hino Poncho, and production was performed by J-Bus.

The city of Fukushima drew inspiration from a television show featuring local composer Yuji Koseki to produce the Melody Bus operated by Fukushima Transportation. It is based on a "moving music hall" theme, and operates while playing melodies composed by Koseki inside and outside the bus (Fig. 23). The base vehicle is a Hino Poncho, and the remodeling was done by Vi-Crew.

After producing a luxury shuttle on a medium-duty sightseeing bus base in 2019, J-Bus produced a shuttle based on a heavy-duty bus in 2020. The rear of the Isuzu Erga roof was raised by 400 mm, and side skylights were installed (Fig. 24).

2 Buses outside Japan

Bus manufacturers around the world target a global market, and therefore responded rapidly to COVID-19. The Brazilian Marcopolo, one of the largest bus manufacturers in the world released a video highlighting the high ventilation performance of its buses traveling long distances, as well as the provision of hand disinfectant kits at the boarding doors. The low level of risk presented by bus travel was promoted, and all manufacturers continued corporate activities such as making announcements to the press using remote communication. Nevertheless, the International Motor Show Germany, the world's largest commercial vehicle exhibition, the Union Internationale des Transports Publics (UITP) Expo and other events were canceled to avoid exposing visitors to crowds. The biggest bus show in the world, scheduled for October 2021, was also cancelled. Despite these circumstances, new sales results for electric and hydrogen (fuel cell) buses by European bus manufacturers is frequently reported.

According to a report by a German research institute, the eight years from 2009 to 2017 saw 123 electric buses start operation in Germany, but in the three years that followed, that number rose to 512 buses, 64 of which are fuel cell buses. At the same time, the number of electric buses owned is predicted to increase by 45% by 2025, and 65% of buses are forecast to be electric by 2030.

The spread of electric buses in Europe is promoted by local government bodies and bus operator who are not part of a diesel engine manufacturer group. Netherlands-based VDL, the Polish Solaris, and Belgian Van Hool all

Fig. 25 Ebusco 3.0 Electric Bus

Fig. 26 Van Hool CX45E Long-Distance Electric Bus with a Range of 500 km on a Single Charge

Fig. 27 Portuguese CaetanoBus H2.CityGold Equipped with the Toyota Fuel Cell System

compete for to deliver hybrid, trolley, and hydrogen-powered buses that combine for a total of around 1,000 units. The next level light- to medium-duty bus manufacturers, despite their short history, stand out due to their proactive up-and-coming business deployment typified by the Dutch Ebusco. This young company was launched in 2012, and has already delivered over 300 units in the Netherlands and Germany thanks to its proactive demonstrations and swift ongoing product refinements. In 2020, it developed an 18-meter articulated bus to complement its 12-meter bus. The 3.0 version announced in 2018 makes excellent use of composite materials, and the 12-meter bus boasts a light empty vehicle weight of 8,530 kg while drawing attention for its cruising range of 500

km on a single charge with a capacity of 95 passengers (Fig. 25).

Another bus that achieves a range of 500 km on a single charge with the on-board batteries is the American Proterra, and Van Hool has deployed that technology in long-distance sightseeing buses. The first ordered CX45E was completed in December 2020 and exported to the U.S. (Fig. 26).

CaetanoBus (Portugal), which established an electric bus chassis manufacturing line through capital from a Japanese trading company, has grown its business from vehicle body manufacturing to completed vehicle manufacturing. It has started selling completed vehicles using the Toyota SORA hydrogen fuel cell system in addition to electric buses that use Siemens technology. Orders have been confirmed not only for the right-hand drive U.K. market, but also for Germany (Fig. 27).

Companies in the Irizar Group, the Spanish supplier of electric buses, are operating Europe's largest clean power plant. The 66,000 solar panels that individually generate 355 W produce 40,000 megawatts of electricity per year, enough for 15,000 households, while reducing CO_2 emissions by 14,600 tons.

Buses from diesel engine manufacturers are also responding quickly to the movement to eliminate CO_2. The eCitaro offered by Mercedes-Benz combines a lithium-ion battery with a capacity of 292 kWh with two 125 kW drive motors and received the 2020 Bus of the Year award in the urban bus category.

Electric buses are now mainstream among Chinese urban buses, and also lead the way in the evolution of European and American urban buses, and hydrogen fuel has been solidifying its position as the next step in that evolution. The time needed to build a hydrogen infrastructure has already been the object of discussion, and technical discussions from various standpoints on means of obtaining clean, low cost electric power have become more vigorous. While available resources vary by region, the demand to decrease CO_2 is turning into a global tide. With respect motor vehicles, the expectation of meeting social needs placed on the bus industry means it is called upon to make sensible choices.