BUSES

Overall Trends

1 The Internationalizing Japanese Bus Market

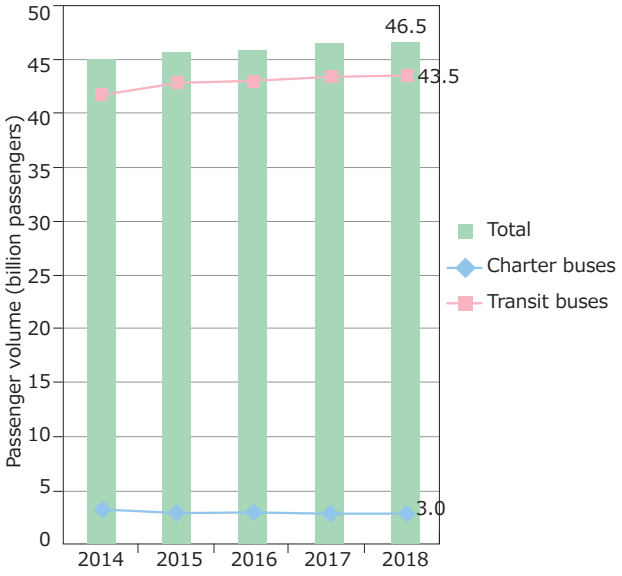
The Tokyo Motor Show, the largest automotive industry event in Japan, was held in October 2019. Exhibits of passenger vehicles from outside Japan decreased significantly, and the venue was split between two locations due to preparations for the 2020 Tokyo Olympic and Paralympic Games. Nevertheless, the various events planned by the organizers bore fruit and the number of visitors reached 1.3 million people, exceeding the one million mark for the first time in 12 years. However, the venue had few commercial vehicle exhibits, with only three commercially available Japanese-made buses featured, the lowest number in recent motor shows. After the Tokyo Motor Show ended, the subsequent Bus Tech in Shutoken, a buses only event, was held on November 18. It attracted 32 exhibitors and featured 17 bus exhibits, meeting the expectations of people involved in the Japanese bus industry (Fig. 1). In contrast to Tokyo Motor Show visitors who are primarily attracted to Japanese-made passenger vehicles, a dedicated event focusing on the purpose of the attendees is expected to have a high level of appeal for exhibitors as well. At the same time, the contents of the exhibits unmistakably reflected the past and current interests of the bus industry.

The choice of this event for the first unveiling of a Chinese heavy-duty electric bus and Spanish double-decker open-top bus in Japan, and the exhibiting of the fully low-floor buses introduced by the Bureau of Transportation of the Tokyo Metropolitan Government in 2018 highlighted the internationalization of buses operating in Japan. The structure of the Japanese bus market, which was dominated by Japanese-made buses for many years, has begun to change.

The first signs of a disturbance in the oligopoly of domestic vehicles in the Japanese market came with the sale of the Korean Hyundai-made Universe heavy-duty sightseeing bus in 2006. Sales subsequently rose steadily, and there are now 800 buses in operation. The electric bus unveiled at the events is Chinese, the double-decker bus is Spanish, and the fully low-floor buses of the Tokyo Bureau of Transportation consist of an Australian body on Swedish chassis. Participating manufacturers represented a greater number of nationalities. Moreover, the engine installed in the Spanish double-decker bus is German, and that same engine is also installed in all Japanese-made route buses.

Even for buses whose owners and operating area is limited to Japan, internationalization is making inroads in the bus industry similar to those observed in automotive engineering. For buses, which must contend a small market share among vehicles as well as the low-volume production of many diverse models as a given, importing vehicles from abroad as a complement for models unavailable in Japanese vehicles is a rational approach. Under market conditions that decrease the selection of Japanese-made buses, it is natural to import electric or double-decker buses that cannot be purchased in Japan as completed vehicles. At the same time, compliance with the safety regulations in the Japanese Road Transport Vehicle Act and the building of a servicing network present obstacles for imported buses seeking to expand their market share.

Fig. 1 Fifth Bus Tech in Shutoken that Highlighted the Internationalization of Buses in the Japanese Market



Ministry of Land, Infrastructure Transport and Tourism: designated statistics on transportation and other documentation

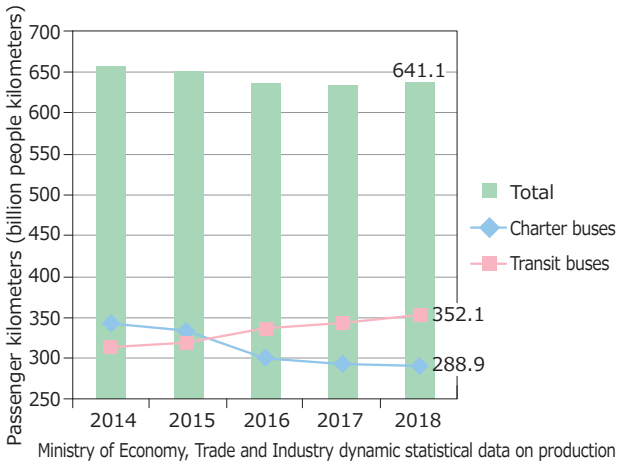
Fig. 2 Bus Transportation (Number of Passengers)

2 The Japanese Bus Industry in Statistics

2. 1. Passenger numbers

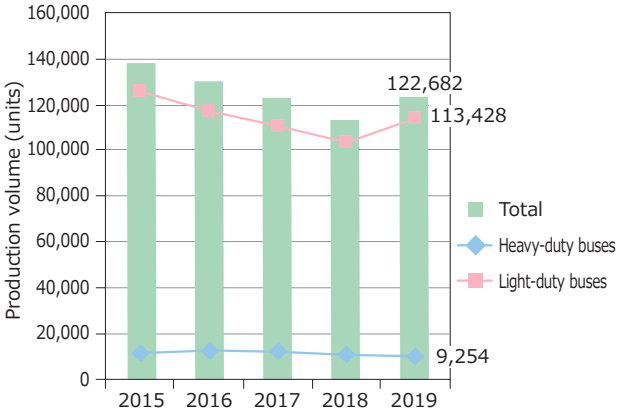
This article primarily relies on statistical data from 2018. The number of bus passengers was 4.572 billion, consisting of 4.3772 billion passengers riding transit buses and 298 million riding charter buses. This represents a slight increase compared to the 4.639 billion passengers in 2017 (Fig. 2). This increase also carries over to the individual categories. The heavy rains in Western Japan and the flooding of Kansai Airport by Typhoon No. 21 are symbolic of the natural disasters that marked the year 2018. Measures such as stopping transportation services ahead of time when a disaster is predicted have become the norm. At the same time, the small number of large-scale natural disasters in metropolitan areas, and particularly the Tokyo metropolitan area, where demand has been been steady, combined with the mobilization of a large number of buses to substitute for railway transportation in the wake of the heavy rains in Western Japan, are thought to have provided a cushion against a drop in demand.

The number of visitors to Japan has been growing steadily, first reaching 10 million in 2013 and 20 million in 2016. In 2018, that number rose to 31.19 million visitors (a 9% increase over the previous year) to pass the 30 million mark for the first time. However, the recent rise in the number of repeat visitors is said to lead to a greater



Ministry of Economy, Trade and Industry dynamic statistical data on production

Fig. 3 Bus Transportation (Passenger Kilometers)



*Quoted from Ministry of Economy, Trade and Industry dynamic statistical data since 2016.
Japan Automobile Manufacturers Association: monthly report on motor vehicle statistics

Fig. 4 Bus Production Volume

increase in the number of individual travelers over groups. These travelers are more likely to be contributing to higher demand for transit buses in sightseeing cities than to have an impact on the number of charter bus passengers. Although the revision of the system for charter bus fares and pricing enacted on April 1, 2014, has enabled charter bus operators to secure a standard fare, it has also generally increased the burden on customers and weakened demand for charter buses.

Figure 3 shows the total passenger kilometers representing the actual distance traveled by individual passengers. Dividing those figures by the number of passengers given above results in 8.1 km for transit buses, and 96.3 km for charter buses. This is a slight increase for the former, and a slight decrease for the latter. While unprofitable transit bus routes are being shortened or eliminated, it seems likely that these numbers reflect the inclusion of inter-city travel in the figures for transit buses, as

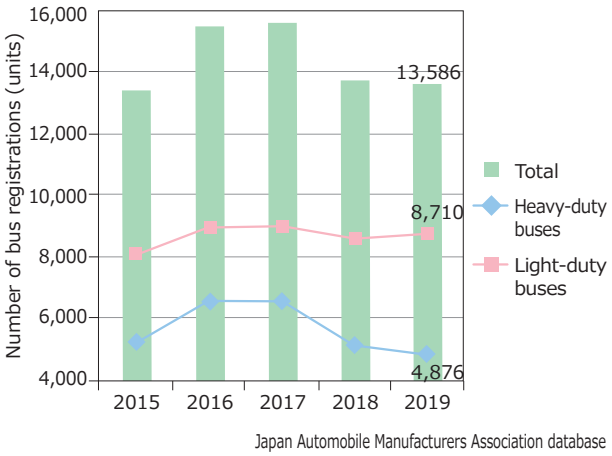


Fig. 5 Number of bus registrations in Japan

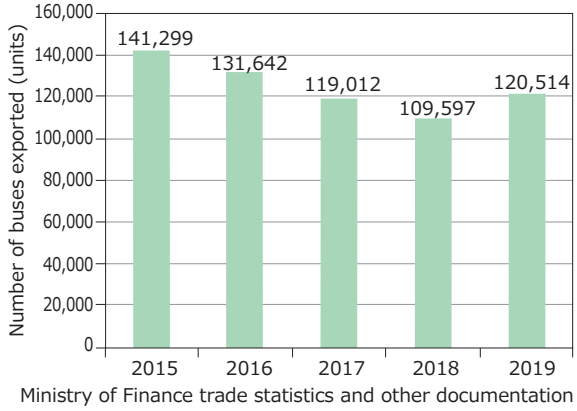


Fig. 6 Number of buses exported

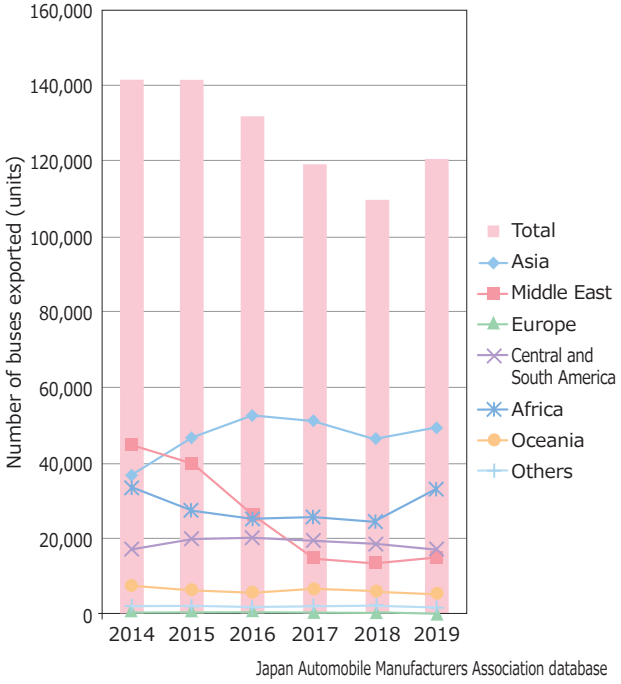


Fig. 7 Main export destinations

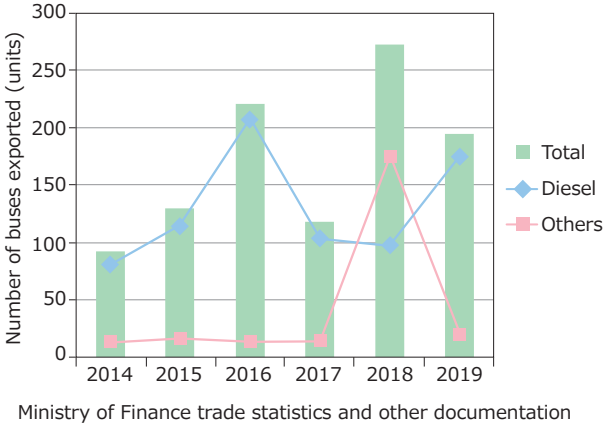


Fig. 8 Number of imported bus registrations

well as the reduced distance traveled by charter buses per day due to the requirement to reduce work hours.

2.2. Market Trends, Production and Registration

Figure 4 shows that total bus production was 122,682 thousand units, consisting of 9,254 units for heavy-duty buses and 113,428 units for light-duty buses. Although this is an increase of 8% over the previous year, heavy-duty bus production decreased by 3.3%. The number of bus registrations in Japan in 2019 presented in Figure 5 show a slight increase for light-duty buses at 13,586 vehicles, but the 5% decrease for heavy-duty buses brings the overall total down. Since there is little fluctuation in the size of the market for heavy-duty buses operating on urban routes, the decrease in the number of vehicles presumably reflects the demand for charter buses. The fallout from the rise in the demand for new buses prompted by the increase in visitors from 2016 to 2017 also certainly plays a role. Operators whose primary customer base consists of tourists visiting Japan own a relatively small number of vehicles, but the rise or fall of the number of visitors to Japan has an acute impact on the number of vehicles purchased.

Viewed over the long term, bus exports are also declining (Fig. 6). Recent data no longer distinguishes between light- and heavy-duty vehicles, but light-duty completed vehicles have always represented the bulk of bus exports. Asia, Africa, the Middle East, and Central and South America account for 90% of export destinations (Fig. 7). The reputation of Japanese-made buses has been built on durability, reliability, and after-sales service. However, Chinese- and Korean-made light-duty buses produced using Japanese-made buses as a model are rap-

Fig. 9 Toyota Coaster superlong model

idly gaining prominence in those destinations. The ability to respond to new market needs is being put to the test.

A total of 194 buses were imported to Japan in 2018. Of those, 174 were diesel vehicles, and 20 used another source of power (Fig. 8). The non-diesel completed vehicles are assumed to be electric buses, which are expected to become more common as local authorities adopt the concepts of environmental preservation and zero emissions.

3 New Buses Announced by Japanese Manufacturers

The buses produced in Japan announced and sold in 2019 have been compliant with emissions regulations, equipped with advanced OBD, and given a broader range of safety systems. They also include an articulated bus, which had never been produced in Japan before.

The 2016 emissions regulations already applied to vehicles with a GVW of 7.5 t or more. Application to vehicles equipped with diesel engines with a GVW between 3.5 t and 7.5 t started on October 1, 2018 for new models and September1, 2019 for existing vehicles. Consequently, manufacturers partially redesigned their front engine light-duty buses between August and October 2019. As a result, all diesel buses produced in Japan with a GVW of 3.5 t or more are compliant with the 2016 emissions regulations.

3. 1. Light-Duty Buses (GVW between 3.5 t and 7.5 t)

(1) Toyota Coaster/Hino Liesse II In July 2019, the engine was refined and a urea SCR system was added to the exhaust aftertreatment device to make all variants compliant with the 2016 emissions regulations. This opportunity was also used to add a superlong variant with a total length of 7.725 meters to the existing short and long variants (Fig. 9). The superlong model has 13 seats and a floor surface length of 2.75 m at the rear of the cabin. A lift installed at the rear makes the vehicle suitable for transporting passengers who use a wheelchair. The gliding door has been combined with a system that detects obstructions, and the closing of the door has become softer. Both a 5-speed manual transmission and a 6-speed automatic transmission are available.

(2) Mitsubishi Fuso Rosa Following a facelift in 2018, the Rosa was made compliant the 2016 emissions regulations in October 2019 and, at the same time, partially redesigned from top to bottom and sold as a 2019 model. New equipment include disc brakes on all wheels, the Advanced Emergency Braking System (AEBS), Electronic Stability Program (ESP), Lane Departure Warning System (LDWS), and Hill Start Assist. The dashboard design was revamped, and the parking brake has been modified to use a lever. Three-point seat belts have been installed on all seats.

3. 2. Medium- and Heavy-Duty Buses (GVW of 7.5 t or higher)

As stated earlier, the 2016 emissions regulations already applied to Japanese-made buses in this class. However, in the interest of maintaining emissions performance, the installation of Advanced OBD, an on-board diagnostics device for the emissions reduction device superior to the previous on-board diagnostics device (J-OBD-I), has been made mandatory. Advanced OBD monitors the performance or failure of functions such as DPF, SCR, oxidation catalysts, EGR, NOx storage-reduction catalyst, and intake turbocharging. For existing vehicles, the installation and enactment of Advanced ODB to buses with a GVW of 7.5 t or higher began on September 1, 2019 and is introduced below along with other safety system and function redesigns applied to various models. Note that Advanced OBD compliance for diesel buses with a GVW between 3.5 t and 7.5 t is scheduled for September 1, 2021.

(1) Hino Poncho The Hino Poncho, the only light-duty non-step bus produced in Japan was made compliant with the 2016 emissions regulations in December 2017 and with Advanced OBD in June 2019.

(2) Hino Melpha/Isuzu Gala Mio The medium-duty Hino Melpha/Isuzu Gala Mio sightseeing bus was made compliant with the 2016 emissions regulations in July 2017 and with Advanced OBD in June 2019.

(3) Isuzu Erga Mio/Hino Rainbow The medium-duty Isuzu Erga Mio/Hino Rainbow route bus was made

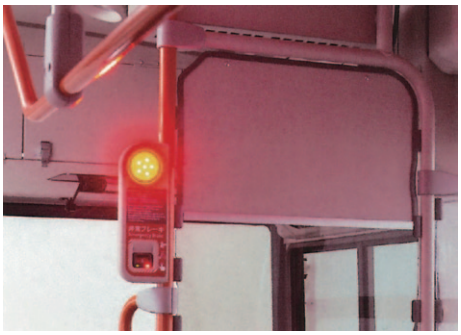


Fig. 10 EDSS in the Isuzu Erga/Hino Blue Ribbon

Fig. 11 Automatic Detection EDSS in the Hino S'elega

compliant with the 2016 emissions regulations in August 2017 and with advanced OBD in June 2019, at which time an Emergency Driving Stop System (EDSS) that responds to a driver emergency was made standard equipment. This EDSS is the same as the system made standard in heavy-duty sightseeing and other buses (including both sightseeing and highway routes) in August 2018 and is described in more detail in the later section on heavy-duty buses.

(4) Isuzu Erga/Hino Blue Ribbon This heavy-duty bus was made compliant with the 2016 emissions regulations in August 2017. It was released again after the EDSS was made standard equipment and Advanced OBD compliance was completed in June 2019. The EDSS deployed to route buses is essentially identical to the one adopted in heavy-duty sightseeing buses. If driving becomes difficult due to an unusual condition such as the driver feeling unwell, the driver or a passenger who notices the problem can activate the system to automatically stop the vehicle. Activating the switch simultaneously turns on warning lamp and an emergency announcement inside the bus, and flashes the hazard while sounding the horn continuously to notify people outside the vehicle. On route buses, the system takes standing passengers into consideration and decelerates more slowly than on sightseeing buses.

Fig. 12 Mitsubishi Fuso Active Sideguard Assist

The front-door shuttle version based on both vehicles has also been made compliant with Advanced OBD and equipped with EDSS as standard. In contrast, the hybrid version based on both vehicles was made compliant with Advanced OBD in June 2019, but did not feature the EDSS as standard equipment at that time.

(5) Mitsubishi Fuso Aero Star The Mitsubishi Fuso heavy-duty Aero Star route bus was made compliant with the 2016 emissions regulations in October 2017. In September 2019, it was made compliant with Advanced OBD and equipped with the EDSS as standard. At the same time, the tail lamps, stop lamps and optional flashing stop lamps have all been switched to LEDs.

(6) Toyota Sora This mass-produced fuel cell bus developed by Toyota Motor Corporation mounts 600 liter high pressure hydrogen tanks on its roof and combines an FC stack with a maximum output of 228 kW with a 226 kW motor. The fuel cell system is the same as that of the existing model, and the August 2019 partial redesign made the EDSS standard equipment. A vehicle-to-infrastructure communication system (DSSS), vehicle convoy information service, radio-based PTPS, and automatic arrival control system, all applications of ITS Connect technology, are offered as options.

(7) Hino S' elega/Isuzu Gala These two buses were the first commercial vehicles to make the EDSS standard equipment. In July 2019, that EDSS was upgraded to provide automatic detection in addition to making the vehicle compliant with Advance OBD (Fig. 11). The automatic detection EDSS, complements the conventional system activation with a driver monitor set in the meter panel that keeps track of the driver's gaze and posture, identifies significant changes in posture such as drowsiness or falling on the steering wheel as a driver emergency condition, and automatically stops the vehicle. The collision mitigation braking system has been

Fig. 13 External Appearance and Interior of the 18-Meter Articulated Bus

Fig. 14 New Shape of the Hyundai Universe Side Windows

updated with a pedestrian detection function that uses the camera concurrently. The inclusion of automatic following distance control, vehicle stability control, vehicle swerving warning, lane departure warning and other systems bring these vehicles one step closer to autonomous driving.

(8) Mitsubishi Fuso Aero Queen & Aero Ace In February 2019, the design of the area around the front lamps of the Mitsubishi Fuso Truck and Bus Corporation heavy-duty Aero series of sightseeing buses was revamped, and safety systems were enhanced by making the EDSS standard equipment and upgrading the collision mitigation braking system with a pedestrian detection function. The new Active Sideguard Assist safety system detects pedestrians, cyclists, and other objects on the left side to alert the driver when making a left turn or moving into the lane on the left (Fig. 12) is a first in this class. A 12 m variant with 13 rows of seats and 65-passenger capacity has been added to the lineup.

Fig. 15 BYD K7 Introduced to Answer Environmental Protection Expectations in Ose

Picture: Hiroshi Gibu

Fig. 16 BYD C9 Heavy-Duty Sightseeing Electric Bus Introduced in Okinawa

Weight was reduced by mounting a low displacement engine, and operators who want higher passenger capacities are taking a close look at this model.

3. 3. Articulated Bus

Isuzu Motors Limited and Hino Motors Ltd. jointly developed an articulated bus and unveiled it in May 2019 (Fig. 13). Articulated buses shine in high-capacity transportation, and some are already in use for transportation on main routes in major cities. However, all of them are imported vehicles, and issues such as the need to relax safety regulations for some of them had been prompting calls to develop a Japanese bus capable of using the existing service network. Expectations for securing capacity around the venues of the Tokyo Olympic and Paralympic Games scheduled for July 2020 were another factor. While globalization can still be seen in the use of components such as the Hübner turntable and bellows, and the ZF accelerator, the engine and hybrid system were made by Hino, the 18-meter body was developed by Isuzu, and the vehicle was manufactured by J-Bus. At launch, passenger capacity was 120 people. This model incorporates advanced systems such as the EDSS, an arrival control system, and a system that maintains following distance. Although it requires less slightly less relax-

Fig. 17 Alfa Bus Launched in the Urban Bus Market

ation of Japanese safety regulations than imported articulated buses, the requirement to obtain authorization to drive from road administration organizations is the same.

4 Imported Buses That Began Operation in 2019

4. 1. Hyundai Universe

In 2017, the Korean Hyundai heavy-duty Universe sightseeing bus was made compliant with the 2016 emissions regulations. It enhanced its product appeal in 2018 with the addition of an AT model featuring a ZF torque converter. The torque produced by the 10-liter displacement engine surpasses that of Japanese models. In the 2019 model, the shape of the rearmost side windows was changed (Fig. 14). It is also the first bus sold in Japan to feature automatic extinguishers in the engine compartment. This is an accessory developed in response to the recent high combustion temperatures in diesel engines resulting from low displacement high turbocharging.

4. 2. Electric buses

(1) BYD K7 & C9 New models have come onto the scene for electric buses, which are slowly growing in number with the introduction of government subsidies. The Chinese BYD electric bus, which is already in operation in Kyoto, Okinawa, Morioka and elsewhere, has added a variation to its lineup. In January 2019, the 12 meter K9 was complemented with the launch of the K7, a variant shortened to 9 meters, and the C9 sightseeing model. The K7 will operate in Ozenuma, where the preservation of the natural environment is a priority (Fig. 15). The C9, a front-door high-decker with a total height of 3.52 meters has made its debut as a charter bus in Okinawa Main Island (Fig. 16). The drive motor output is significantly more powerful than in the K9 and boasts a maximum speed of 100 km/h. If features the same cruising

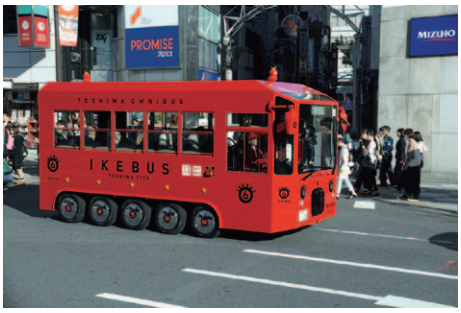


Fig. 18 Ikebus Light-Duty Electric Bus Turning Heads with Its 5-Axle Exterior

Fig. 19 UNVI Double-Decker Open-Top

range of 250 km on a single charge as the K9.

(2) Alfa Bus This Chinese heavy-duty route bus designed for city streets, made by Jiangsu Changlong Keche, has entered the Japanese market on the heels of BYD. The brand is named Alfa Bus. The Ecity L10 seeking to take hold in the Japanese market has a width of 2.5 meters, a rear wheel axle weight of less than 10 tons, and a 10.5-meter overall length that is standard for urban buses in Japan, with specifications that meet the driver-only bus structural requirements, tackles the Japanese urban bus market head on (Fig. 17). First unveiled at the November 2019 Bus Tech in Shutoken, it has attracted the attention of people involved in the Japanese bus industry. The body is made of aluminum, and the vehicle is equipped with a 296 kW lithium-ion battery that provides a cruising range of 240 km on a single charge. The vehicle offers a competitive price point among heavy-duty route buses in an effort to encourage adoption even without subsidies.

(3) Thinktogether This light-duty electric bus was developed by the Gunma Thinktogether venture which has been developing and manufacturing electric vehicles since 2007. Its lithium polymer battery is mounted in the underbody, and drive is provided by motors installed separately on each axle. An eight-wheel single-tire (10-passenger) eCOM-8 and a 10-wheel (16-passenger)

Source: ZMP

Fig. 20 Ankai Light-Duty EV Bus

Fig. 21 Toyota Concept Model (Tokyo Motor Show)

Fig. 22 Hino FlatFormer

Fig. 23 Heavy-Duty Sightseeing Bus Featuring an Interior with a Coffered Ceiling

eCOM-10 model are available, which have an operational speed of 20 km/h offering environmentally friendly low-speed mobility. It is based on a built-to-order premise and does not have a designated vehicle model. The vehicle features a plastic body that eschews the use of glass in an effort to reduce weight, and has been employed in limited driving areas to provide shuttle services. A circuit transit bus started operating in Ikebukuro, Tokyo in November 2019, instantly drawing attention in the metropolitan downtown area (Fig. 18)

That bus has an all steel body and glass windows.

4. 3. Double-Decker Open-Top Bus

The double-decker open-top bus, a genre are rising in popularity, especially in large cities and sightseeing areas, has seen the introduction of a new model. Originally introduced as sightseeing buses, most models consisted of remodeled older double-decker buses, but a new model designed expressly as a double-decker open-top bus has been imported (Fig. 19). Adopted by Hinomaru Limousine Group, which paved the way for operating this type of bus, the vehicle is made by the Spanish body manufacturer UNVI. Cities around the world have place orders for double-decker open-top bus with UNVI, which has been accumulating a wealth of know-how. The engine is made by Daimler, which gives operators adopting this vehicle the benefit of support from Mitsubishi Fuso. The first group of four vehicles has arrived, and two of those have closed front bodies allowing passengers to enjoy sightseeing even in extremely hot weather or when it rains. UNVI also has a track record of manufacturing electric double-decker open-top buses, and those may be adopted in the future.

Design Trends

1 Japanese-Made Buses

1. 1. Mass-Produced Bus Design Trends

(1) Articulated Buses The articulated bus is the only new Japanese-made bus launched in 2019. Minor arrangements to the base vehicle change the impression it gives. The main characteristic of articulated buses is their greater passenger capacity than single-body buses, making them functional candidates for routes or time slots involving many passengers, and are often employed in the BRT systems serving as the main transportation axis in European cities. This often leads to giving them

Fig. 24 Sample Bus Also Designed to Pass On Manufacturing Technology

Fig. 25 Scania NTX Concept Bus Exhibited at the 2019 UITP Summit

Fig. 26 Aptis Electric Bus Designed by a Manufacturer of Rail Products

an exclusive styling different from that of the mass-market model to emphasize their BRT role. In Western countries, some manufacturers refer to that difference from general models as BRT-style. In Japan as well, it would be nice to see more articulated bus deliveries and BRT systems lead to the pursuit of fresh styles.

1. 2. Electric Bus Design Trends

Bus design has evolved through the pursuit of functionality, leaving electric buses little room to apply designs that diverge significantly from those of diesel buses. However, value in terms of resources deserves a second look as shown, for example, by the use of the reduced protrusion of the engine compartment into the interior to increase seating.

Figure 20 shows the the Chinese light-duty Ankai bus used in an autonomous driving field test at Nagoya's

Fig. 27 Solaris Trollino 24 Bi-Articulated Trolleybus

Fig. 28 Scania New Generation Citywide Designed to be Lighter

Central International Airport. This 7-meter light-duty bus, which has no front door, and offers a wide floor surface by securing a long wheelbase, use the Hino Poncho as a benchmark. Within China, many designs copy the Hino Poncho. Making the Ankai an electric vehicle solves the drivetrain issue of the Hino Poncho to produce a longer non-step floor. On a different note, the multi-axle small diameter wheel layout of the Thinktogether eCOM-10 catches people by surprise. The highly practical decision not to use a low floor brushes bus design concepts aside.

Figure 21 shows the Toyota conceptual autonomous vehicle prototype exhibited at the 2019 autumn Tokyo Motor Show, which removes the driver's seat and demonstrates that there is still room for new vehicle styles. There are currently similar examples throughout the world, and light-duty vehicles are anticipated to lead the way in the field of autonomous and driverless mobility. The genre gives designers the freedom to pit their skills against one another, and the design of buses, which are part of the urban infrastructure, is expected to open new frontiers.

Figure 22 also shows a concept model exhibited at the 2019 Tokyo Motor Show. The Hino FlatFormer consists of a versatile chassis that integrates drive components and a drive battery. It can be used as either a bus or

Fig. 29 Ebusco 3.0 Featuring a Composite Body and Cruising Range of 500 km on One Charge

Fig. 30 New Idea in Window Graphics Volvo 9900

transport truck depending on the body configuration used. The space between the front wheels is wide enough for a wheelchair to pass between them. This is one possible answer to the role automakers will play in the society of the future.

1. 3. Rethinking Interiors

The exterior appearance of Japanese-made buses has not seen any innovation for many years, but bus operators have been introducing buses with interiors built by hiring designers. Figure 23 shows a sightseeing bus featuring a classical coffered ceiling, and relies on a design focused on a high sense of quality as a selling point. In many cases, these vehicles are completed by a second-tier remodeling contractor after coming off the bus assembly line, some manufacturers are striving to build complete luxury specification vehicles completely in-house in order to maintain the technological capability of their production lines (Fig. 24).

2 Buses outside Japan

Keeping the considerable gap between mass-production and concept models in mind, this section introduces vehicles launched in 2019 that made heads turn.

The Scania NXT concept bus (Fig. 25) is an autonomous, self-driving concept vehicle with a 50-passenger capacity. It was exhibited at the 2019 UITP Global Public

Picture: Park Il Min

Fig. 31 Hyundai Universe New Model with a Length of 12.5 Meters

Transport Summit. Seats for passengers are also installed in the front and rear non-low-floor areas. The passenger area is further designed to be replaceable and turn the vehicle into a cargo truck. The transparent body that makes the frame visible follows the latest trend.

The Aptis (Fig. 26) is an electric bus developed by Alstrom, which has expertise in rail products. The prototype debuted in 2017, and the partially redesigned model in the picture has already started operations in European cities. The wheels are placed at the four corners of the 12-meter body, with mobility ensured by a four-wheel steering system. In terms of projected area, it does not differ from standard 12-meter vehicles. The end of the bus opposite the driver's seat features a passenger seat with a fresh view.

The Polish manufacturer Solaris built its first bi-articulated trolleybus, the Trollino 24 (Fig. 27). In addition to the mass-production design in the picture, a competitor-conscious BRT-style streamlined design is also available.

The new generation Scania Citywide (Fig. 28) is a complete redesign of the Citywide standard urban bus. Both diesel- and electric-powered variants will be available. The transparent side panel that brings in more natural light is a new idea, but the original purpose was to reduce weight. The lighter body improves fuel efficiency and allows a lower displacement engine or, for the electric variant, higher capacity batteries, making it beneficial for all buses.

The Ebusco 3.0 (Fig. 29) is a next-generation model announced by the Dutch up-and-coming manufacturer of electric buses. A light composite body was developed to increase mounted battery capacity without sacrificing passenger capacity, and a cruising range of 500 km on a single charge was achieved. The in-house batteries fit

completely in the fully low-floor, providing a low center of gravity and a passenger capacity of 98 people. The bus also features single-tire rear wheels and a camera mirror system.

As electrification leads to a focus on urban buses among new bus models in Europe, the Volvo 990 (Fig. 30) made its debut as a heavy-duty sightseeing bus. The mainstream 12-meter or longer EU sightseeing buses tend to have monotonous side window graphics, with no examples of ideas that add rhythmical highlights.

The new Hyundai Universe (Fig. 31) given a facelift for the 2019 Korean market features headlamps that give it a sharp impression. It is also notable for achieving a total length of 12.5 meters with the same allowable axle weight as in Japan. Its development was spurred by the acclaim lauded by operators on the Granbird, a 12.5-meter bus from the Kia division of Hyundai Motor Group launched in Korea in 2015. In Japan, buses longer than 12 meters are deemed unfeasible due to restrictions on length and allowable axle weight, and operator calls for a relaxation of the restrictions are becoming more insistent.

3 Summary

Although not discussed in the section on buses outside Japan, the U.S. is also making substantial advances in electric buses. These are not limited to urban buses, and manufactures continue to tackle the challenge of making long-distance electric buses.

Among heavy-duty buses, vehicles equipped with diesel engines, which have an established infrastructure and a rich body of usage experience, remain the mainstream. However, for urban buses, which have a limited area of operation, the shift toward electricity is an unmistakable trend, and hydrogen fuel cell buses represent the next step along that line. The powerful driver of that trend is the zero emissions policy pursued by governments, local authorities, and other administrations. Under these circumstances, the bus industry is pursuing electrification with an eye on autonomous driving and connectivity. The entry of a rail products manufacturer in the bus market is a new trend, and electrification-inspired innovations in vehicle design have been observed. Other industries bring their technology and turning the attention of their designers to the buses representing an integral part of urban functionality is a shit that must be followed closely. As everyday culture changes, efforts to make buses an attractive presence are pursued worldwide, and Japanese buses are also expected to respond to such needs in an insightful manner.