BUSES

Overall Trends

1 Changing Mobility and Public Transportation

Automotive technology, which has a history of over one hundred years, is coming upon a period of major transformation. This is due to the revolutionary changes occurring not only on the material level of adapting to the transition from internal combustion engines to next-generation forms of energy, but also on the abstract level of usage patterns. With electrification and autonomous driving becoming reality, society is said to be transitioning from owning vehicles to sharing them, and furthermore, toward eliminating borders between means of transportation. This means that a transportation need comes first, with users choosing a mode of transport, such as bicycles, cars, or trains, that meets the need in question. For buses, which represent a resource that transports people, the trend itself is an extension of their history and could be perceived as a tailwind, but also suggest a potential blurring of the lines between buses and taxis, which are also a resource that transports people. The age of wanting to own a car is coming to an end, and in cities, the number of people who use car sharing is increasing. This is almost certainly due to the exorbitant parking fees and other maintenance costs associated with owning a car. The number of young people who choose not to obtain a driver's license is also growing. According to some data, the driver's license acquisition ratio by prefecture for young people aged 20 to 24 is below 20% across the board in the Tokyo metropolitan area and the Kinki area. One factor involved is the fact that the lack of a car does not present an impediment to getting around in the urban areas thanks to the extensive public transportation available. The bus industry is very interested in how these changing market conditions will affect buses.

The Mobility as a Service—MaaS—is a keyword drawing a lot of attention, but whether buses as a form of public transportation will be fully included in that concept will depend on the choices user make. The economic feasibility of public transportation is tied into demand, and the impact of ease of understanding and convenience on product appeal is just as important now as it was in the past. Even if AI can identify movement patterns and determine the balance of supply and demand, the range of options will vary depending on whether users have to bear the costs associated with freedom of mobility and time, or whether society will bear a portion of those costs. It will be necessary to keep an eye on the extent of actions taken to mitigate social costs in business models that maximizes efforts to satisfy separate demands for transportation. Since intelligently transporting people involves the intrinsic and universal goal of reducing social costs and mitigating environmental impact, public transportation has an important role to play.

1. 1. Drivers of Electric Bus Popularization

There is a large gap between Japan and other countries in terms of the interest shown in electric buses, which rely on next-generation energy. Although only a few electric buses started operations in Japan in 2018, in January 2019, the Chinese BYD production of electric buses exceeded a cumulative total of 50,000 vehicles. Approximately two years ago, 80,000 electric buses were in operation around the world. Half of them are Chinese made, with half of those made by BYD, whose K9 12 m urban bus appeared in 2010. This makes it clear that the pace of electric bus production has picked up. The serious problem of air pollution in China and government subsidies are some of the background factors behind electric buses having become a standard sight in China (Fig. 1). The 17,000 urban buses in the metropolis of Shenzhen in Southern China are, apparently, all electric buses. In Western European countries, along with Poland, 5% of registered urban buses (Class I, approximately 10,000 vehicles) are reported to be electric, a proportion predicted to grow to 20% in 2020. In the urban bus

Fig. 1 Bus Assembly Line in China Producing Electric Buses (Yangzhou Yaxing Motor Coach Head Office Plant)

market, electric buses have already entered the period of practical use.

In light of these circumstances, the Japanese Ministry of Land, Infrastructure Transport and Tourism (MLIT) announced guidelines for the introduction of electric buses in December 2018. Such guidelines had already been introduced in 2012 for local authorities and major bus operators to promote the introduction of electric buses, which contribute effectively to environmental conservation. Western nations were already well aware of their characteristics as motor vehicles and of the key points associated with the introduction of electric buses ten years ago. In Japan, the increased actual use of electric buses has led to using that term as an umbrella expression covering electric, plug-in hybrid, and hydrogen fuel cell buses, conflating the background behind their introduction, their price, and their various performance levels under that one term. Japan has a program to subsidize one-third to one-half of the vehicle cost, and that program has been used by 15 operators for 30 vehicles. One reason the number of vehicles remains low compared to other countries is the hefty price tag of electric buses, which make subsidies a prerequisite, but also runs into the issue that the amount available for subsidies is not unlimited. Another reason is that bus operators and the automotive industry in Japan have no complaints whatsoever about diesel buses, and in the past, there were no manufacturers of electric buses in the country.

Diesel buses have strongly established themselves as reliable in terms of performance, economic feasibility, experience with maintenance and management, and the refueling infrastructure. Simply put, it was difficult for Japanese bus operators to see the point of switching from convenient diesel buses to expensive electric buses with which they had no experience. This is because transit buses represent an industry with strict demands for both reliability and balancing costs. There is also a sentiment that the air in Japanese cities is cleaner than in large Western cities.

At the same time, the bus manufacturers in Japan are subsidiaries of diesel engine manufacturers, and the manufacturing of buses without engines simply defied their imaginations. Consequently, planning the introduction of domestically-produced electric buses in Japan leaves remodeled completed vehicles with their engine and drivetrain removed as the only choice outside light-duty electric buses developed by engine manufacturers. The situation is far removed from the benefits of mass production. In the past, there were vehicle remodeling operators in Japan who would select an engine in accordance with customer desires and complete the bus, but such businesses no longer exist. Therefore, even if electric bus chassis are imported, it is difficult to have them remodeled in Japan. Importing completed vehicles from other countries has drawbacks in terms of costs as well as the time and effort required until they are registered.

The industry structure that treats the body and components separately for buses is the same in Western nations. Companies such as VDL, Solaris, or Irizar, which are actively releasing electric buses in Europe, are all manufacturers that complete bus vehicle bodies and are in a different position than manufacturers who produce diesel engines themselves. In addition, components that achieve electrification by replacing the existing diesel drivetrain have been developed, encouraging the spread of electric buses. The technologies have been developed with hydrogen fuel cell buses in mind. In other words, the possibility of switching from electric to fuel cell buses once the infrastructure is in place has been taken into account as a development policy.

Although an understanding that diesel buses are superior in terms of technology and convenience is shared by many engineers, this new trend in other countries is driven by governments. At the same time, the business opportunities for bus vehicle body manufacturers with no connection to diesel engines and for component suppliers, are another driver of electric bus popularization.

Governments differ significantly in the sense of crisis they feel toward the clearly growing issue of global warming. One view holds that the global warming mechanism itself is natural and transcends human activity. It is a belief that it represents a cyclical change in the long history of the Earth. Whether that is or is not the case, the rise in sea level is also affecting Japan. Some people also question how much the small market for bus electrification can contribute to reducing CO_2 and mitigating global warming. Be that as it may, since protecting the environment is a topic that must be addressed on a global scale, the spread of electric buses as a trend on global scale must at least be acknowledged. The Japanese government and bus industry will have to make choices for the future in the face of universal issues.

Fuel cell buses are described as the ultimate clean vehicle, and in Japan, the Toyota Sora, which followed a unique development path, has started route operations. Plans to operate approximately 100 fuel cell buses in Tokyo by the time of the 2020 Tokyo Olympic and Paralympic Games have been announced.

Fuel cell bus development is also actively pursued in countries around the world, and the European manufacturer Van Hool has sold 53 fuel cell buses since 2005. In 2018, it received orders for an additional 40 vehicles as well as, separately, orders for the world's first fuel cell articulated bus to start operation at the end of 2019. The start of operations of fuel cell bus manufacturing plant in the U.S. in 2020 has also been announced. In China as well, the promise of a zero emissions bus is giving impetus to development.

In contrast, a hydrogen infrastructure will clearly be needed for such buses to spread, and the cost of hydrogen cannot be overlooked. Targeting zero emissions leads to questions on how to generate electricity. While the hydrogen obtained from renewable energy is undeniably clean, the spread of these buses is not realistic unless infrastructure can be developed while taking operator profitability into account.

1. 2. Ongoing Attention Paid to Autonomous Driving

Autonomous driving using buses was again observed throughout Japan in 2018. Platoon driving for heavy-duty trucks, which involves using several models and reducing following distance, is also being studied. In the U.K., the development of technology based on platoon driving, in which the second and subsequent vehicles transport passengers without a driver, has begun, with the goal of starting business operations in 2020. Volvo is developing an autonomous heavy-duty bus.

In Japan, field tests of autonomous buses are being carried out on public roads. In the context of such autonomous driving technologies, Hino Motors held a public event to present its development efforts to the media in May, unveiling its bus stop precise arrival system. The system recognizes road markings using on-board cameras and automatically steers and decelerate. It was jointly developed with Isuzu Motors (Fig. 2). This system is useful for articulated buses, for which precise arrival is more difficult than in a straight-body bus, is the non-contact guided bus technology that has been in use in the BRT system in France for about ten years. Automatic deceleration for precise arrival, however, is a world first. The JTEKT test vehicle (Fig. 3), which is the subject of autonomous driving field testing within the budget of the Cabinet Office also features the precise arrival system and is being tested on public roads.

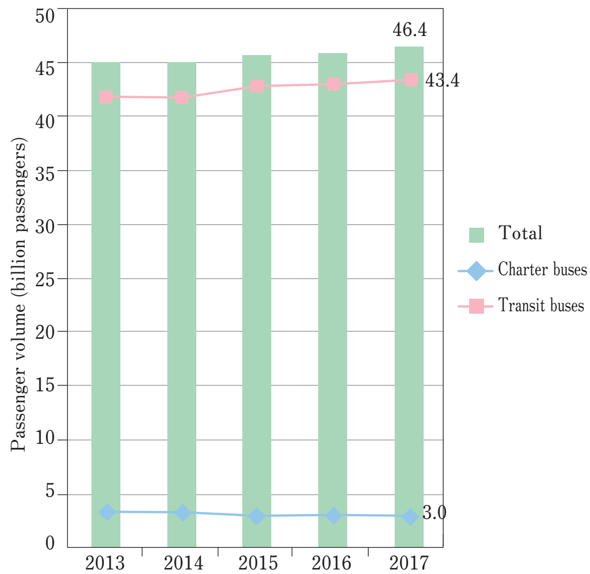
Fig. 2 Bus Stop Precise Arrival System under Development

Fig. 3 JTEKT Test Vehicle Used in Field Tests of Autonomous Driving and Bus Stop Precise Arrival

Interest in autonomous driving is rising in the bus industry, which faces a serious shortage of drivers. At the same time, there are expectations that automating the high-level techniques of experienced drivers would allow drivers with little experience to do the job, and making buses driverless will, crucially, require a consensus from users, and the bar for that is still high. Scenarios allowing autonomous driving to solve the issue of driver shortage are being called for.

2 The Japanese Bus Industry in Statistics

The succession of natural disasters that beset Japan



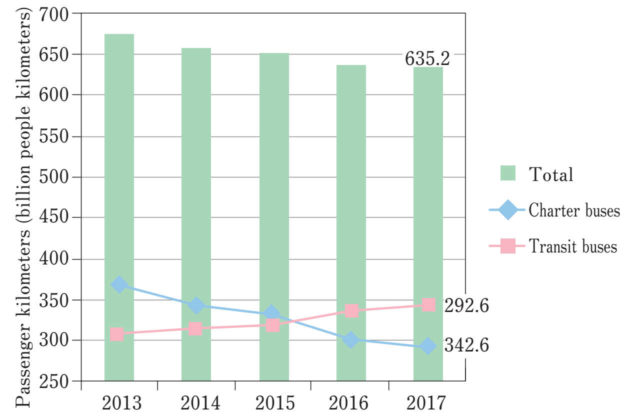
Ministry of Land, Infrastructure Transport and Tourism: designated statistics on transportation and other documentation

Fig. 4 Passenger Volume (Number of Passengers)

marked the year 2018. The heavy snows along the Sea of Japan from January to February, the concentrated heavy rains in Western Japan and the earthquake in northern Osaka between June and July, the nationwide extreme heat in the summer, the typhoon in September, the Hokkaido Eastern Iburi earthquake are the main examples of the natural disasters that struck the Japanese archipelago. The typhoon caused flooding at Kansai International Airport, severely disrupting the transportation of people and goods. In bus transport, the early stoppage of service based on past successfully avoided human losses, but the fallout, which included loss of revenue due to the stoppage and scrambling to compensate for disconnected railway routes, lasted several months. It will take another year for the data to reflect those effects, and the analysis below is based on the 2017 statistics.

2. 1. Passenger numbers

Figure 4 shows bus passenger numbers. The number of bus passengers in 2017 was 4.64 billion, consisting of 4.34 billion passengers riding transit buses and 300 million riding charter buses. This represents a 2% increase over the previous year, which breaks down to approximately 50 million passengers for transit buses and 10 million passengers for charter buses. The slight rise in the number of passengers riding transit buses in cities brings the overall figures up, but there have been no measures capable of stemming the drop in demand in regions where the population is declining. Passengers on



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

Fig. 5 Passenger Volume (Passenger Kilometers)

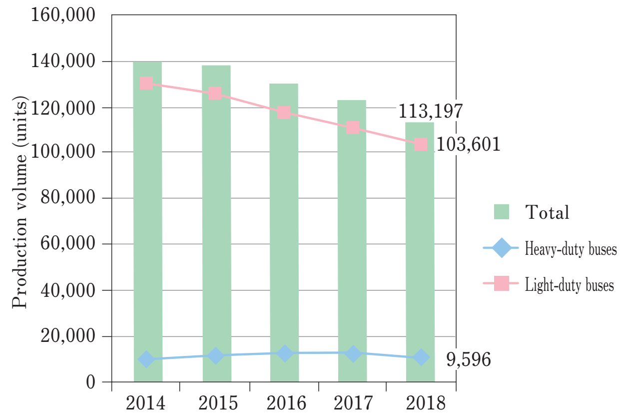
inter-city route buses, who are counted among transit bus passengers, represent a robust segment accounting for 110 million of the total for all passengers. Regional bus operators place high expectations in inter-city routes, which have high fares per passenger. However, due to the priority accorded to maintaining normal routes in light of the shortage of drivers, cases of inter-city routes being scaled down or eliminated stand out.

Charter buses appear to have returned to their 2015 results for the number of passengers, and inbound tourist demand is contributing to the increase. The government continues to work on attracting more tourists to Japan, creating strong expectations for charter buses. In the context of the labor shortage, the bus industry's ability to accommodate such tourists will be put to the test.

Figure 5 shows the actual distance traveled by buses transporting passengers, and transit buses continue to exhibit an increase over charter buses. Based on these figures, the distance traveled per passenger is a little less than 8 km for transit buses, and a little less than 100 km for charter buses. The tendency for the distance traveled by charter buses to decrease is attributed to stricter labor management policies for drivers becoming the norm.

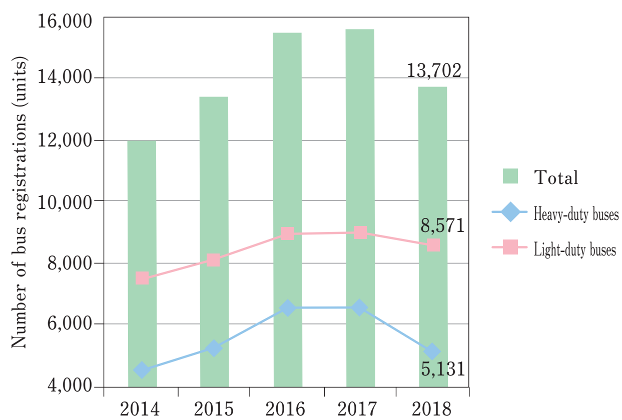
2. 2. Market trends, Production and Registration

Figure 6 shows bus production in Japan, and the total of a little over 113,000 is a decrease amounting to 92% of the total for the previous year, a decline that has continued since 2014. Light-duty buses, which accounted for the majority of production at 103,601 units, maintained a level of 93% compared to the previous year, but heavy-duty bus production, at only 9,596 units, fell below 10,000 and was limited to 79% of the previous year.



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

Fig. 6 Bus production in Japan

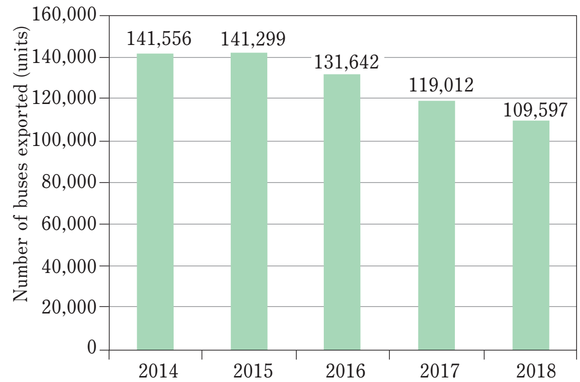


Source: Japan Automobile Manufacturers Association

Fig. 7 Number of bus registrations in Japan

Since there is little fluctuation in demand for urban buses, the main reason for the decrease in heavy-duty bus production is probably a drop in the demand for charter buses. For a time, new demand and orders for new buses rose as the number of tourists grew, providing brisk business for the bus industry, but the number of visitors from neighboring countries, which represent the majority of tourists visiting Japan, is strongly influenced by political factors, and a series of cancellations of new vehicle orders stand out among the conditions shaking up the foundations of that business. The result was a considerable decrease in production. Attracting tourists to Japan is a national policy, and the transport capacity of charter buses is an issue, but the shortage of drivers is also a concern in this area.

Figure 7 shows the number of registered buses in Japan. No significant increase or decrease was seen in the number of bus registrations in the replacement-centered



Ministry of Finance dynamic statistical data on trade

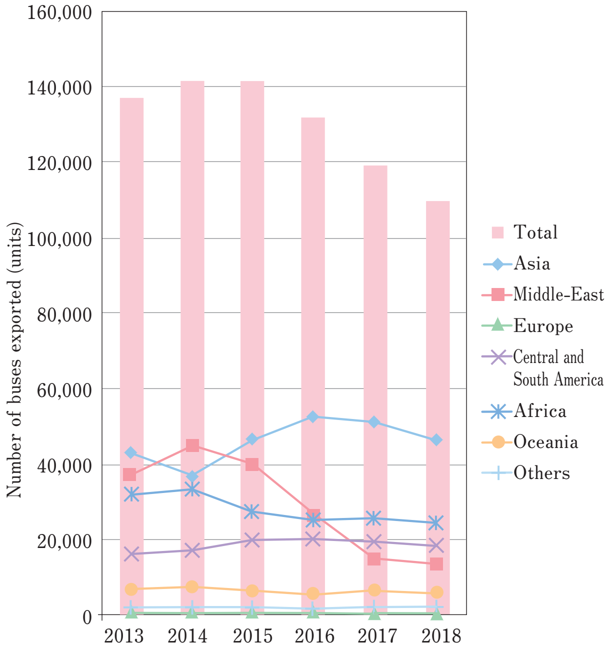
Fig. 8 Number of buses exported

market. Light-duty buses essentially remained at the same level, while the notable decrease observed for heavy-duty buses correlates strongly with their production figures.

Figure 8 shows the number of bus exports. The data has become difficult to interpret because the Japan Automobile Manufacturers Association (JAMA) no longer categorizes exports by heavy- and light-duty categories due to compliance-related reasons. In general, light-duty buses are exported as completed vehicles and heavy-duty buses as CKD vehicles, suggesting that light-duty buses represent the bulk of exported vehicles. For many years, Japanese-made front-engine cabover light-duty bus models served as a benchmark in the global light-duty bus market, but in individual markets, advances made by competitors from other countries stand out, and it has become necessary to adapt to a diversifying market. The majority of heavy-duty buses are destined for emerging countries, and competition is fierce in this arena as well. The direction of future trends hinges on strengthening product appeal.

The exports by destination breakdown in Fig. 9 indicates that within the overall decrease in exports, the decline is especially notable in the main destinations of Asia and the Middle-East. This could be interpreted as a reflection of economic trends in those destinations, but both of those regions have a vigorous light-duty bus market and rivals to Japanese-made vehicles have entered the market. In the Hong Kong minibus market, for example, where Japanese-made light-duty buses had been unchallenged, functional rivals are standing out and could push Japanese exports into adopting a defensive strategy

Figure 10 shows the number of imported bus registra-



Source: Japan Automobile Manufacturers Association

Fig. 9 Main export destinations

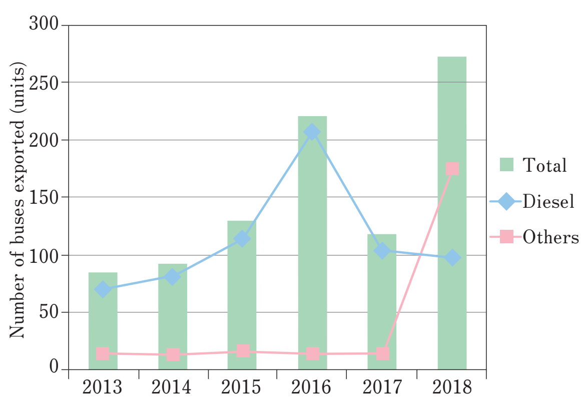


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Fig. 10 Number of imported bus registrations

tions. Sales of Korean-made heavy-duty sightseeing buses, which were predominant among diesel vehicles in the last few years, were low in 2018. However, there is no sense of incongruity in these figures as the 29 new fully low-floor buses used by the Bureau of Transportation of the Tokyo Metropolitan Government are accounted for, and double-decker and articulated buses are also counted. In contrast, 175 non-diesel vehicles are accounted for in the Other category, raising the overall total. These figures are unusual and what they actually represent is unclear.

Fig. 11 Toyota Sora Hydrogen Fuel Cell Bus

3 New Bus Models Announced by Automakers

This section presents a summary of buses introduced in 2018. Recent bus redesigns are often carried out when compliance with government environmental regulations becomes necessary, and vehicles with a gross vehicle weight (GVW) of 7.5 tons or more have already been made compliant with the 2016 emissions regulations. For vehicles with a GVW exceeding 3.5 tons and less than 7.5 tons, the regulations have been in effect since October 1, 2018 for new models and will apply in September 1, 2019 for existing vehicles. Similarly, the 2015 fuel efficiency standard applies to heavy-duty vehicles with a GVW exceeding 3.5 tons, but many heavy- and medium-duty buses already meeting that standard. Some redesigns of existing models have involved enhancing safety and providing a wider range of equipment and amenities.

3. 1. Heavy-Duty Buses

The Toyota Hydrogen Fuel Cell Bus went on sale in March, and is affectionately known as the Sora. It is the first such mass production model, and has acquired vehicle type certification. It essentially uses the same system as its TFCB predecessor, meaning it is equipped two fuel cell stacks with a maximum output of 114 kW and ten hydrogen tanks with a specification pressure of 70 MPa, and is driven by two motors with a maximum output of 113 kW. It features a large capacity external supply system that can provide electricity in an emergency. The Bureau of Transportation of the Tokyo Metropolitan Government has operated them since March 17.

In April, the Korean Hyundai Universe sightseeing bus was equipped with a 6-speed torque converter AT (ZF EcoLife). It offers both ease of driving and superior fuel economy. No changes were made to the exterior.

In April, the Isuzu Erga Hybrid was integrated as a

Fig. 12 Isuzu Erga Hybrid

Fig. 13 Hino S'elega Featuring Emergency Driving Stop System (EDSS) as Standard Equipment

variant of the Hino Blue Ribbon Hybrid, replacing the previous Eaton hybrid system to use both the Hino engine and hybrid system.

Hino added and the Emergency Driving Stop System (EDSS) that responds to driver medical emergencies to its S'elega heavy-duty sightseeing bus, introducing it to the market in July. The vehicle automatically stops if a driver feeling unwell, or a passenger noticing an unusual condition in the driver, presses an emergency button. The system also has a function allow the driver to cancel its activation if a passenger triggers it by mistake. Emergency lights blink inside the vehicle when the system activates, and the hazard lamps are activated and an alarm sounded to alert others nearby than an anomalous situation has occurred (Fig. 13). The EDSS is an integrated product that is also standard equipment on the Isuzu Gala. Based on the guidelines stipulated by MLIT, deceleration when the EDSS activates is set to 0.25 G. There are plans to bring the system to urban buses, which also have standing space. Brake control by the collision mitigation braking system is given priority is the risk of a collision occurs while the EDSS is active.

The AMT already installed on the 9 m variant of the S'elega/Gala has also been added to the 12 m variant. The choice of MT or AMT is available for both the 9 L (7-speed model) and 13 L (6-speed model). Three-point seat belts are available as an option for all seats, and an alert is sounded when the seat belt is not worn.

In November, delivered the first commercial elevator-

Fig. 14 Mitsubishi Fuso Aero Ace with Elevator for Wheelchair Ingress/Egress

Fig. 15 The Daily NP Bus Iveco Plans to Sell on the Japanese Market

equipped Aero Ace to the Airport Transport Service. It provides a platform between the wheelbase that is raised and lowered via a screw bolt to enable wheelchair ingress and egress. Development was made public for the last few years, and user opinions were incorporated in this product designed as a barrier-free vehicle for the 2020 Paralympic Games (Fig. 14).

3. 2. Light-Duty Buses

At the Japan Truck Show in May, Iveco, a manufacturer with a proven track record in gas-based engines for long-distance transport heavy-duty trucks using CNG or LNG as fuel, made its entry in the Japanese market. Along with its tractor truck, it unveiled the Daily NP bus, which uses CNG as fuel (Fig. 15). Sales price and other details have not been disclosed.

In June, the Toyota Coaster received safety enhancements, becoming the first light-duty bus equipped with a collision mitigation braking system and a lane departure warning system. At the same time, an automatic lighting system was made standard equipment. The same improvements were brought to the Hino Liesse II OEM model.

In October, the Mitsubishi Fuso Rosa was given a facelift and sold as a 2018 model. The design of the headlamps was modified to incorporate LED lamps (Fig. 16).

Fig. 16 Mitsubishi Fuso Rosa Light-Duty Bus

Fig. 17 Electric Bus Used in Field Test in Kumamoto

Fig. 18 Electric Bus Introduced by Kansai Electric Power to Replace Trolley Buses

Fig. 19 Fully Low-Floor Scania/Volgren Bus Introduced by the Bureau of Transportation of the Tokyo Metropolitan Government

4 New Bus Models and Technologies Adopted by Bus Operators

4. 1. Electric Buses

A government-industry-academia has been developing an electric bus in Kumamoto, completing a test vehicle and carrying out route operations for one year starting in February (Fig. 17). The vehicle is based on a non-step bus in use, and efforts to reduce remodeling costs are being made by preparing a manual detailing the process of conversion to an electric bus. It is equipped with the drive motors (two 190 kW units) and batteries (three 30 kWh units) used on a commercial electric vehicle (the Nissan Leaf). Cruising range for one day is 117 km, and the bus is returns to the depot for recharging once in the morning and once in the afternoon.

In June, Kansai Electric Power unveiled an electric bus to replace the trolley bus it has been operating on the Tateyama Kurobe Alpine Route (Fig. 18). It is equipped with a Toshiba lithium-ion battery with a total capacity of 52.8 kWh and drive motors with an output of 230 kW. Cruising distance on a single charge is 30 km. It operates along a 6.1 km route between the start and end points, and rapid charging using a pantograph is applied for approximately ten minutes after each round trip. There are a total of 15 trolley buses, and replacing all of them to being full-fledged electric bus operation is scheduled for the spring of 2019.

4. 2. Fully Low-Floor Buses

In December, the Bureau of Transportation of the Tokyo Metropolitan Government introduced fully low-floor buses. In 2012, the Bureau of Transportation of the Tokyo Metropolitan Government made all of its buses non-step buses, but only the non-step floor at the front and middle doors provided low entry, and a low floor in the aisle between the rear wheels was highly desired. A fully low-floor design requires a dedicated rear axle, and imported vehicles were chosen as Japanese buses do not support that design. The buses have a Scania chassis and a body made by the Australian Volgren, and the rear axle is the ZF AV133 widely used in European non-step buses. Twenty-nine vehicles will start operations by the end of 2018 (Fig. 19).

4. 3. Imported Buses

Operators have been expanding their fleets of the double-decker buses (chassis: Scania, body: Volgren) first introduced in 2016, and the range of application of those buses is broadening. They are now used as airport shuttles and for inter-city routes in addition to their original role of regular sightseeing buses (Fig. 20).

The number of articulated buses is also increasing,

Fig. 20 Imported Double-Decker Bus with Expanding Applications

with operators (Nishi-Nippon Railroad, Shinki Bus, and Kanagawa Chuo Kotsu) expanding their fleet and purchases by a new operators (Nara Kotsu Bus Lines).

Mitsui & Co. has invested in Portuguese bus manufacturer CaetanoBus and established an assembly line for electric bus chassis. CaetanoBus originally specialized in remodeling vehicle bodies, and is anticipated to expand access to other vehicle body remodeling operators when its own electric bus chassis is completed. Mitsui & Co. is expecting to sell to vehicle body remodeling operators in Asia, and is also looking at deployment in the Japanese market.

4. 4. Other Technologies

As stated earlier, JTEKT, a manufacturer of steering and drive components, has a test vehicle based on a Hino heavy-duty route bus. The unique design using wrapping film is drawing attention, and, as the only heavy-duty bus with autonomous driving functionality, is currently undergoing field tests of the bus stop precise arrival system and autonomous driving on public roads in various regions.

One unexpected vehicle-related element is the growing availability of engine compartment fire extinguishers as an option. Nishitetsu Auto Body Tech of the Nishi-Nippon Railroad Group and Air Water Safety Service collaborated to install them on overnight expressway buses. As in the expressway and charter buses already equipped with extinguishers of companies in the JR Bus Group, this feature aims to increase customer trust.

Design Trends

1 Japanese-Made Buses

1. 1. Design of Mass Produced Buses

For Japanese-made buses, the disappearance of vehicle body remodeling operators, and the generalization of the integration of models or reliance on OEM supply between manufacturers has reduced the variety of bus types. Similarly, since the timing of redesigns is dependent on compliance with environmental regulations, design modifications are few and far between. The Mitsubishi Fuso Rosa is the only instance of a styling modification made in 2018. In conjunction with the adoption of LED headlamps to enhance functionality, the group identity was brought to all of the group's vehicles.

The design of the Toyota Sora is an extension of ongoing past fuel cell bus development, and although designers continue to propose unique innovations, the mass production model prioritizes the functionality requested by actual operations and make compromises on design. Nevertheless, this mass produced bus insistently maintain their unique window graphics, leaving little surface area for operators to apply their unique coatings. In addition, with non-step floors being limited to the space between the front and middle doors, low entry functionality is the same as that of diesel vehicles. It would be nice to see a package design that capitalizes on the characteristics of fuel cell buses.

1. 2. Options Chosen by Bus Operators

Amid a small number of base models choices, luxury vehicles with deliberately limited capacity stand out in the travel industry, with offers a broad variety of plans targeting the wealthy. Famous designers are hired in a supervisory role, and the inclusion of many special specifications in terms of manufacturing results in a high ratio of secondary remodeling, with some doubt remaining over whether product appeal is in line with the details of the trips. A remodeling example is shown in Fig. 21.

Fig. 21 Example of Luxury Sightseeing Bus that Limits Seating to 14 Passengers in a Heavy-Duty Bus Frame.

Fig. 22 Luxury Specifications in Increasingly High Demand in Light-Duty Buses

Fig. 23 Daimler eCitaro Electric Bus

These models have significant added value compared to the standard specifications, and not matter how much specifications have been unified, some might wonder if aspects such as the color of the ceiling should be a choice made by the customer. In luxury charter buses and expressway route buses, there is more and more demand for a larger restroom at the back of the bus, which is accompanied by requests for toilet seats with bidets that have warm water.

The luxury mentality involving reducing the number of seats to increase comfort is also prevalent in light-duty buses. At Bus Tech in Shutoken event, which gathers the latest buses and accessories in one place, oddly enough, many prototype and already delivered vehicles incorporating new ideas from vehicle remodeling operators excelling as the secondary remodeling of light-duty buses were exhibited.

2 Buses outside Japan

2. 1. Design of Electric Buses

The bus market outside Japan is large and includes many manufactures, leading to aggressive competition. Notable trends are presented below. Among new models, electric buses, fuel cell buses, and other next-generation vehicles now generally receive the most attention.

Electric bus variations include light-, medium-, and heavy-duty models, as well as articulated and double-decker models, and continue to expand. Some sightseeing buses, which have the prerequisites of long-distance and high-speed driving, a weak point of electric buses from the outset, are making the transition to electric buses. Even Daimler, which mass produces its own diesel engines, has announced the eCitaro electric bus (Fig. 23). Sharing the front color scheme design of the test Citaro used in public autonomous driving in the Netherlands in 2016, it distances its image from that of the diesel model.

Fig. 24 New MAN Urban Bus

Fig. 25 New BYD 12 m Electric Bus

MAN has also renewed its urban bus design (Fig. 24). The design now features an aggressive headlamp design that reflects the sightseeing-related identity of the manufacturer. In the rush to switch to hybrid or electric systems, or to engines that use natural gas, the models retain a shared design.

The world's leading manufacturer of electric buses, the Chinese BYD, has revamped is original boxy style and unveiled the Midibus, announcing a lineup including a 12 m vehicle and an 18 m articulated bus with the same mask.

Netherlands manufacturer VDL, which boasts the largest sales of electric buses in Europe, uses the same lightweight body as the economic Citea standard urban bus for the electric bus variant, but has added a BRT-style model with a stretched streamlined shape to its standard

Fig. 26 VDL Articulated Electric Bus Operating in the Netherlands

Fig. 27 Irizar ie tram Articulated Electric Bus

Fig. 28 Light-Duty Electric Bus Developed by Yangzhou Yaxing Motor Coach

Fig. 29 Exclusive BRT Bus Operating in Shanghai

articulated bus model (Fig. 26). The operation of 44 vehicles in Eindhoven in 2017 and of 100 vehicles (including 51 BRT-style models) near the Amsterdam airport in 2018 were the initial contributors to the manufacturer's expanding sales of electric buses. Some of the articulated electric buses in these areas operate 24 hours a day, covering a distance of 300 km per day for those that travel the most. A simple calculation shows that data for 30,000 km of driving is accumulated in one day.

Solaris, which comes in second after VDL in the European electric bus market has applied the radial Urbino design originating with its diesel model to its electric bus, and offers an articulated bus variant.

The Spanish Irizar announced the sleek and stylish ie tram articulated electric bus, which started operating in San Sebastian, Spain, in 2018 (Fig. 27). The exterior featuring a jet black body with chrome plating lines appears to have come straight out of a designer's sketchbook. The side panels are made of a permeable material that lets light from inside the vehicle filter outside at night are another attractive feature. The variant subsequently delivered to Barcelona presents a different image as it is painted in the red and white colors of the local operator, but this accommodation of regional flavor takes nothing away from the beauty of the design. It also replaces the side mirrors with cameras.

An attractive design that makes pedestrians look twice as it passes by provides strong product appeal in urban buses, and that seems to be lacking in Japanese-made buses.

Yangzhou Yaxing Motor Coach, the bus manufacturer with the longest history in China, has developed a light-duty electric bus (Fig. 28). It has proportions very similar to those of the Hino Poncho, and can drive over 100 km on a single charge. The manufacturer owns a large, modern plant at which it is ambitiously working to develop leading edge technologies such as electric double-decker buses, and fuel cell buses with autonomous driving.

The Yutong ZK5180A bus exclusive to the Yan'an BRT (Shanghai Line 71) was built as the first BRT for Shanghai (Fig. 29). Respecting the theoretical definition of BRT as rapid, efficient transportation by bus, it features priority driving in a reserved lane and a style unlike that of existing buses, differing from typical urban buses in both its exterior painting and the door positions adapted to driving in the center of the road. This zero emissions bus is equipped with a trolley pole to receive electricity in sections with overhead cables, and runs on battery power in sections with no cables.

School bus manufacturer Thomas Built has introduced a model build in the conventional American style. Despite its classical body, it is actually an electric bus that

Fig. 30 Electric School Bus Manufactured by Thomas Built

Fig. 31 Optical Mirror System Replacing Side Mirrors

can drive 200 km on a single charge (Fig. 30).

Newcomers with diesel engines in the sightseeing family are described below. The Volvo 9700/9900 give a gentle impression, but have headlamps that make an impact. They are the same headlamps as on the heavy-duty trucks, and the shape of the LED daylight lamps makes them recognizable from a distance by oncoming vehicles.

Sightseeing vehicles in Europe range from over 12 m to 14 m, providing a range of overall lengths adapted to customer needs. The Japanese bus industry is also calling more strongly for vehicles longer than 12 m. The development of vehicles that use double shaft axles to cope with the weight of the rear wheel axle should impart vigor to the industry.

Efforts to replace side mirrors with cameras are also becoming more common (Fig. 31). They are promising from the standpoints of aerodynamic drag, vehicle maneuverability, and visibility at night are in poor weather, and expected to become standard, but there have also been reports that in practice, they remove a point of reference for the driver and have led to minor collisions. It seems necessary to carry out real world assessments before popularizing them.

3 Summary

The Japanese bus industry is placing high expectations on increased demand and greater vitality as the 2020 Tokyo Olympic and Paralympic Games approach. The event has also prompted the development of Japanese-made articulated buses, concentrated adoption of fuel cell buses, and production of barrier-free sightseeing buses, among other measures. The further need to safe and stable bus transport raised in the last few years is being addressed with the standardization of EDSS and stricter labor management frameworks. Cooperative drive recorder have become more common. The trend of operators reaching out to other countries to acquire double-decker, articulated, or other buses difficult to procure in Japan also stands out. Society has high expectations for the international trends of electrification, autonomous driving, and MaaS. In Japan, 2020 is symbolized by a major event, but for many manufacturers in Western countries, that year is seen as a technological turning point. The question of what constitutes effective technological support for the Japanese bus industry in the face of a driver shortage must be addressed.

The bus industry is not the only provider of services struggling with a labor shortage. In the Japan of today, the syndrome of wanting to be a customer has become prominent. The number of people wanting to receive services is rising, creating an imbalance relative to those providing those services. But didn't the hospitality culture Japan prides itself on flourish because customers understood how much effort the host had to make? There is hope for a Japan culture of hospitality that does not lose touch with its understanding of, and gratitude for, the efforts of the host to bring out technology what will resonate with people throughout the world.

References

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