# Buses

## Overall Trends

### 1 Introduction: Social Trends Affecting Buses

Fortunately, few society-shaking natural disasters or major bus accidents occurred in 2013, but there were still a number of changes in social trends affecting buses. Although some of them bear little direct relation to vehicles or attendant technologies, this article introduces various events necessary to understanding market circumstances for the bus industry.

**1.1. Changes in the inter-city transport system: birth of the new expressway route transit buses**

Due to the convenience of Internet reservations and affordable prices, the demand for travel agency-planned bus tours where a charter bus is used to travel from one major city to another, or to theme parks, grew since the year 2000, and is estimated to have reached 6 million passengers a year by 2010. As user needs did not vary from those of established expressway route transit buses (bus businesses operating under the Road Transportation Act), problems with the "one country, two systems" parallel existence of inter-city tour buses and route transit buses were pointed out. In addition, since inter-city tour buses only operate between cities during periods of high demand, established expressway route transit operators have continued to decry the practice as cream skimming, a problem that had already been pointed out when the rules were relaxed. On top of that, with issues such as sloppy management and vague assignment of responsibility lurking behind the occasional major accident, the existence of bus operators with poor awareness of safety-related costs was brought into the limelight. Given this situation, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) started up a committee to examine the future of the bus industry in December 2010. After committee deliberations concluded, the inter-city tour buses, which had been operating under the Travel Agency Act, became new expressway route transit buses based on the bus licenses regulated by the Road Transportation Act, unifying the two systems as of August 1, 2013 (buses departing on July 31 for overnight buses). This also put a stop to inter-city tour buses letting passengers on and off along the roads near the main stations in major cities as they became route transit buses boarded at bus terminals (Fig. 1).

Inter-city tour bus operators have been hurrying to adapt to the change in systems, and now that they are competing in the same ring as established route transit bus operators, substantial upgrades are expected in vehicle features designed to offer services that prioritize customers. The bus industry is one of the few markets where demand is growing and stable expansion is anticipated. However, bus transportation is also a means of public transport that is extremely dependent on the drivers. In addition to the obvious need for a health and fatigue management framework, extensive vehicle technologies that eliminate as much human error as possible

Fig. 1 Former inter-city tour buses have become expressway route transit buses that clearly indicate their destination.

remain ongoing issues.

In long distance overnight buses, seats and equipment conducive to sleeping soundly have become sales points. However, considering that, unlike passengers on a plane before takeoff, expressway bus passengers do not receive instructions on emergency procedures in the event of an accident, there are calls in the industry to establish measures such as providing training for emergencies, grasping the time necessary for evacuation, or installing equipment to facilitate emergency escape. Automatic extinguishers in the engine compartment are also conducive to helping passengers sleep peacefully. While some operators have already installed them in all their vehicles, they remain a small minority. It is hoped that other operators will follow suit.

**1. 2. On the road to the Tokyo Olympic Games**

Tokyo was selected to host the 2020 Summer Olympic Games at the September 2013 IOC Session. These Games will take place 56 years after the 18th Tokyo Olympics held in 1964. With many facilities located in the area around Tokyo Bay, expectations regarding the use of buses as a means of transportation are high. Such expectations are only natural since buses are cheaper to introduce than trains and can also respond to demand more flexibly. Moreover, six years from now, it is likely that significant advances will have been made in vehicle and driving-related technologies. Although in the limited context of transportation during the event, it would be best to position buses as one option among the transport modes intended to meet the anticipated demand, it is hoped that the hosting of the Games will be seen as an opportunity to fundamentally overhaul the public transportation system, and will generate ideas encompassing the reduction of future social costs and the preservation of the environment, as was the case at the time of the previous Games with the introduction of the Tokaido Shinkansen and the expressways.

**1. 3. Increases in fuel consumption and awareness of environmental protection**

Although the Abe government's economic revitalization measures to escape from deflation are being implemented, the price of oil, which has historically remained relatively stable, rose drastically in 2010 and remains high. While there are differences between regions, the price of the diesel purchased by bus operators (lorry unit price) increased by 9 to 11 percent between January and December 2013.

Bus operators have recently been promoting driving methods that improve fuel efficiency and while they are starting to bear fruit, it is believed their effectiveness will soon reach its limit. And even as definite progress is also being made in making vehicles more fuel efficient, rising fuel prices and a growing awareness of environmental protection are further increasing interest in reducing fuel consumption among bus operators.

**1. 4. Revision of the consumption tax**

Spurred by the rise of the consumption tax in April 2014, a trend towards the active upgrade of vehicles through the early replacement of high unit cost buses or the purchase of used vehicles was observed, although it was less pronounced than that for passenger vehicles. Specific figures will become available in 2014. For route transit bus operators, dealing with system changes accompanying fare revisions and other issues proved to be major undertakings heading into 2014.

**1. 5. Changes in the cast of operators**

In the labor intensive bus industry, the line between profit and loss is often determined by the extent of labor costs. Given this, instances where publicly-owned operators, who are estimated to bear comparatively higher costs, pulled out of the industry or expanded their outsourcing to private companies have stood out. At the end of March 2013, the Naruto City Transport Bureau discontinued its bus operations, which were taken over by the private Tokushima Bus Co., Ltd. There are also other publicly-owned operators who will be closing their doors throughout 2014. The shortage of bus drivers, a longstanding concern, now affects the entire nation. On the vehicle technology front, there are calls for even greater support for saving in labor and safe driving, as well as for improvements in driving comfort.

**1. 6. Retirement of imported light-duty buses**

The "red buses", foreign-made front wheel drive small non-step buses that had no domestic equivalent in 2000 when they began service in local routes within the wards of Osaka City, were fully phased out in March. The main reason for the phase-out was their lack of profitability, and the another factor was the end-of-life of the 85 Omni Nova models that constituted the bulk of the fleet. This vehicle, consisting of a Sweden-made plastic body over a Renault front-wheel drive commercial chassis (Fig. 2) was initially criticized for its weak HVAC and braking performance. With improvements to adapt it to its use environment, it was able to withstand severe use

Fig. 2 Osaka City "Red Bus" Omni Nova vehicle with improvements to adapt it to its use environment.

conditions involving driving distances 1.5 times longer than those of large buses and frequent starts and stops on narrow roads. Its average fuel consumption is reported as an excellent 5.3 km/L, as opposed to 3.6 km/L for its Japanese-made successor. Although imported buses in Japan are prone to problems due to differences in use environments, or in terms of parts supply and costs, this is one case worth remembering as an example where Japanese-made vehicles were outperformed through the use of proper maintenance technology.

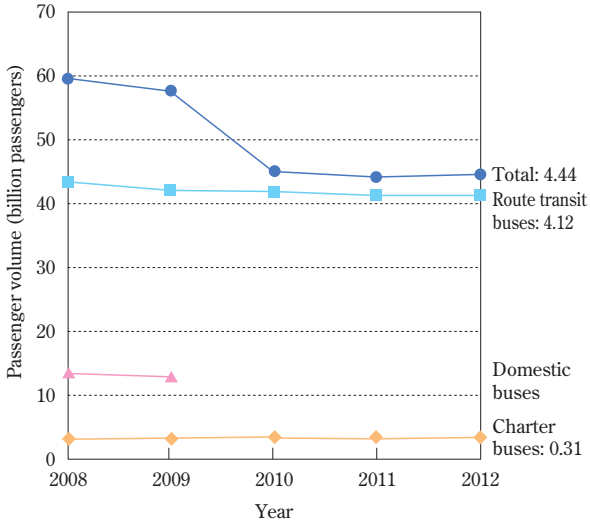
The Basic Act on Transport Policy was passed in November 2013. It sets clear basic principles for transport policy based on a long-term view and incorporates measures for global competitiveness and regional revitalization. The bus industry, where survival tends to depend on profitability, is hoping that its content will provide a positive social boost.

## 2 The Bus Industry in Statistics

### 2. 1. Passenger numbers

The number of route transit bus passengers in 2012 was 4.125 billion, an increase of approximately 7.3 million, or 100.2%, over the previous year. Is it premature to interpret this as a reversal of the long and continued decline in the number of route transit bus passengers in Japan? Keeping in mind that, despite the evident decrease in population and low birth rate, young people are tending to shy away from purchasing their own vehicles and that the expansion of public transport services is increasing awareness of environmental protection, and also considering the various initiatives of the bus industry, it would not be strange for route transit passenger numbers to finally start making a comeback.

Similarly, the number of charter bus passengers was




* Domestic buses were excluded from the survey in 2010.

Fig. 3 Passenger volume.

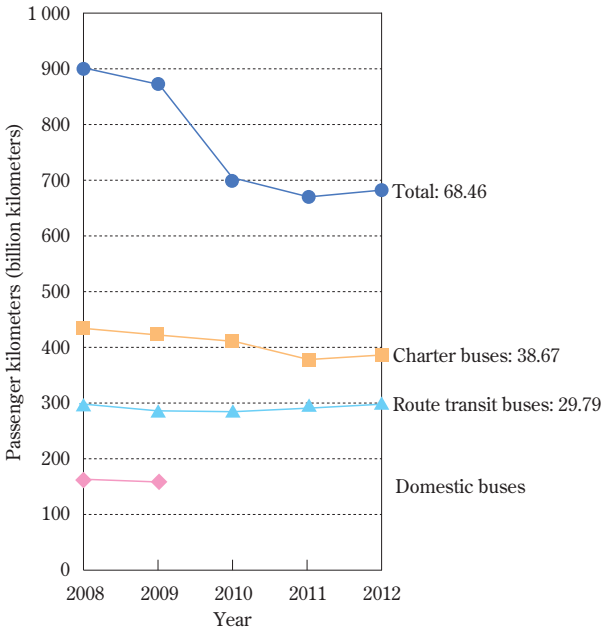
296.05 million, or 105.5% over the previous year. Demand for sightseeing buses, which had temporarily declined because of the Great East Japan Earthquake, is showing signs of recovery, spurred, in particular, by support among the middle-aged for bus tour packages providing convenient recreation. The fact that inter-city tour bus passengers are currently counted as charter bus passengers is also thought to have contributed to this increase (Fig. 3).

The number of kilometers actually travelled by bus users in 2012 was 68.458 billion passenger kilometers, a 2.6% increase over 2011. Despite this small increase in the number of passengers, which reflects the rise in charter bus passengers in particular, this figure represents only 76% of the 90.13 billion passenger kilometers recorded in 2008. The numbers also demonstrate the influence of additional choices in long distance travel provided by the appearance of low-cost carriers (Fig. 4).

### 2. 2. Market trends

The number of buses owned in Japan in 2012 was 226,000. An overview of the last ten years shows a continued decrease of approximately 1% per year. The number of buses owned peaked at 248,000 in 1997, but the figures themselves have shown no substantial change since the latter half of the 1970s.

Reflecting the market situation described above, bus production has also shown no substantial change (Fig. 5). While heavy-duty buses mainly target the Japanese market, the growth exhibited by light-duty buses, which are subject to international business sentiment and exchange




* Domestic buses were excluded from the survey in 2010.

Fig. 4 Passenger volume.

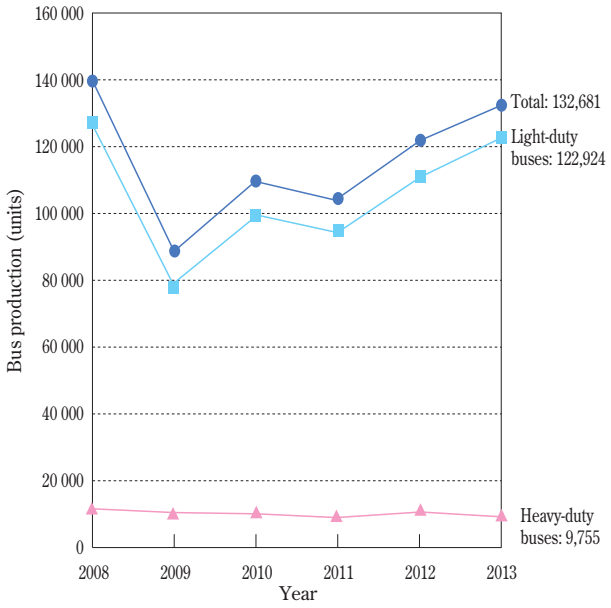
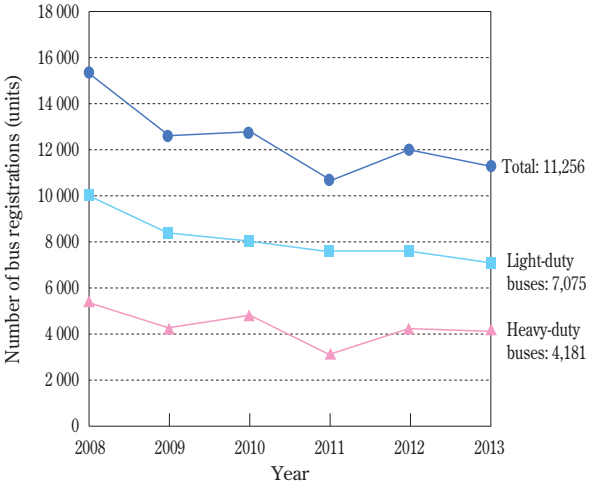



Fig. 5 Bus production in Japan.




Note 1: From 2003, statistics were collected based on the license plate number registration category rather than according to chassis (excluding mini-vehicles).

Fig. 6 Number of bus registrations in Japan.

rate fluctuations stands out. In Japan, reflecting the decline in the number of passengers, examples of regional bus operators making replacements by using both new and used vehicles side by side have become the norm. Furthermore, subsidies were granted to local route transit bus operators in 2011 and to charter bus operators in 2012 for the purchase of used vehicles, an example of a measure that has affected the new vehicle market. Since buses essentially represent a substitute demand market, the number of bus registrations (Fig. 6), like the number of owned buses, has shown no substantial change.

With the introduction of the law on barrier-free transportation (in 2000), non-step or one-step urban route transit buses became necessary, and this positively affected the number of new vehicles. However, some of the first (1997 onward) non-step buses have already been decommissioned, and are being converted to low-floor vehicles as their registration is transferred to regional bus operators. In contrast, measures were also taken to expand the use of such vehicles, as exemplified by the concentration of subsidies for Okinawan bus operators, who were lagging behind in adopting non-step buses. Such measures brought the adoption rate for non-step buses to 31% of all route transit buses by the end of March 2013. As of April 1, 2013, all buses on regular routes operated by the Tokyo Metropolitan Bureau of Transportation (TMBT) are non-step buses. Although other operators have achieved a 100% non-step bus adoption rate, the TMBT (which owns 1,452 buses) was the first operator with a fleet exceeding 1,000 buses to do so.

Figure 7 shows the number of vehicles exported, while Fig. 8 breaks those exports down by principal regions. Although exports to the oil-producing Middle-East regions are growing, there is little change in long-term export destinations for Japanese-made buses. In recent years, the underlying exchange rate has been favorable to Japanese-made vehicles, but as local bus needs become increasingly sophisticated, with strong demand for the

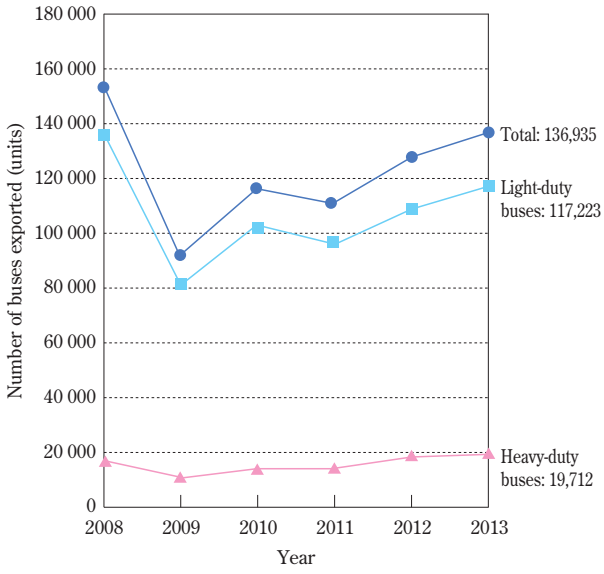



Fig. 7 Bus exports.

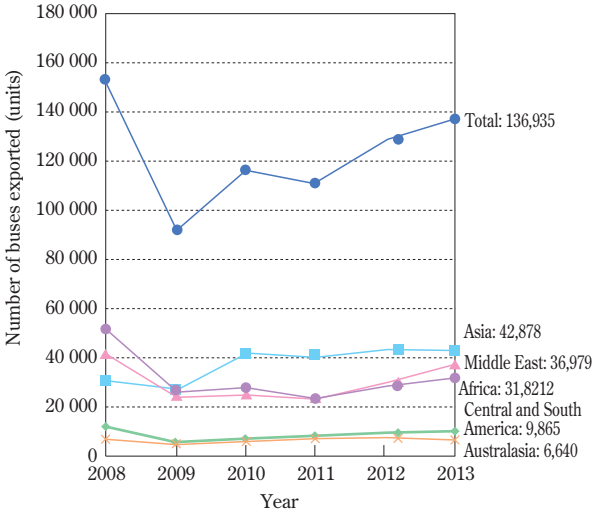



Fig. 8 Main export destinations.

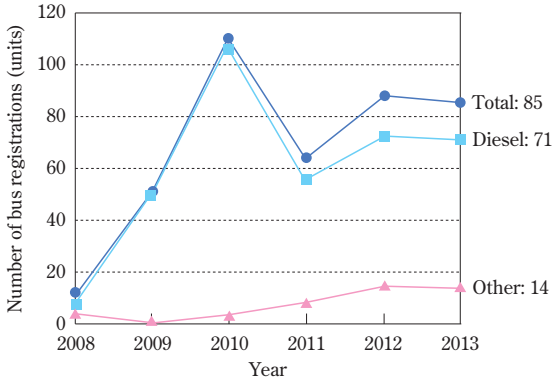



Fig. 9 Number of imported bus registrations.

introduction of bus rapid transit (BRT) systems and articulated non-step buses in regions with expanding urban areas, maintaining the competitiveness of Japanese-made buses is a major challenge. Even the Japanese light-duty buses, which exhibit a strong showing in global markets, are starting to face competition from foreign-made rivals.

Figure 9 shows the number of imported bus registrations. In addition to the steady increase in imports of the Korean-made Hyundai Universe, two Mercedes-Benz Citaro G articulated buses have been imported from Germany. They will be operated by Shinki Bus Co., Ltd. in the Newtown area of Mita, in Hyogo Prefecture. This brings the total number of articulated buses operating in Japan to 27.

## 3 Regulatory Trends

### 3.1. Japan's preferential tax scheme for environmentally friendly vehicles

The year 2012 saw the introduction of the 2015 heavy-duty vehicle fuel economy standards along with the preferential tax scheme for the purchase of vehicles with excellent environmental performance and fuel efficiency, new safety standards for seats, and new structural requirements for driver-only buses. In contrast no new regulations were adopted or implemented in 2013. Some vehicles have already been made compliant with regulations coming into effect starting in 2014 concerning collision damage mitigation braking, vehicle stability control, and lane departure warning systems.

## 4 New Buses

With the adaptation to environmental regulations and the driver-only standards unique to buses having been completed in the previous years, very few buses produced in Japan in 2013 received new product appeal enhancements. Counting models not presented in last year's issue of this journal, new models on the market are limited to only three new Japanese-made light duty buses and one Korean-made heavy-duty bus.

### 4.1. Light-duty buses

In December 2012, the full model change to Nissan's NV350 Caravan commercial vehicle series included a new Caravan Micro Bus model (Fig. 10), with a 14-passenger capacity. The OEM version of that model, the Isuzu Como Micro Bus, has received the same treatment.

In December 2013, Toyota redesigned the front to the Hiace. At the same time, it introduced a new model of

Fig. 10 Nissan Caravan Micro Bus.

Fig. 11 Toyota Hiace.


Fig. 12 Hyundai Universe.

the Hiace Commuter light-duty bus with a 14-passenger capacity (Fig. 11).

**4. 2. Heavy-duty buses**

Korean manufacturer Hyundai launched a 2013 model of their Universe equipped with a vehicle height adjustment system, distinct from kneeling, that raises vehicle height by 30 mm for additional road clearance (Fig. 12).

**4. 3. Buses presented at the Tokyo Motor Show**

A total of six buses were presented at the 43rd Tokyo Motor Show held in November 2013. Of those, four were commercial models incorporating new approaches in terms of interior and specifications. The other two were concept models.

The Hino Poncho Mini is a concept model that takes the small Hino Poncho, a popular choice in the small

Fig. 13 Hino Poncho Mini.


Fig. 14 Hino Melpha Plug-In Hybrid.

community bus niche, and turns it into an even smaller, 11-passenger capacity electric vehicle. It shares a platform with the small EV truck (equipped with a 350 V lithium-ion battery) that is already undergoing validity trials. Although this means it does not have a non-step structure, a ramp for wheelchair access is provided at the rear of the vehicle. It offers a bright and attractive cabin with large windows (Fig. 13).

Featuring an external power supply function, the Hino Melpha Plug-In Hybrid, which is based on the mid-sized Melpha, can provide electricity to evacuation facilities in the event of a natural disaster. The model exhibited at the Tokyo Motor Show was designed, inside and out, to look like a mobile medical clinic (Fig. 14).

The other vehicles on display were the commercial Erga Hybrid launched in 2012, the (aforementioned) 2013 Hyundai Universe model, the Mitsubishi Fuso Aero Queen luxury vehicle which, despite being a heavy-duty vehicle, limits itself to a 13-passenger capacity and offers individual electric seats worthy of airliner first-class seats, and the Hino S'elega featuring a driver monitor system that tracks the driver's gaze and emits a warning upon detecting drowsiness.

## 1 Outline

Buses are essentially rectangular boxes, and the conflicting restrictions involved in trying to balance aerodynamic characteristics and cabin space leave designers little room to "try things out". There is also a strong tendency to prioritize the wishes of the customer purchasing the vehicle in terms of the production goods represented by the paint or body style, which makes it difficult for designers to express their own ideas. Nonetheless, since they are a part of everyday life, buses should also play a part as elements of the attractive urban landscape desired by society, be appealing to users, and fulfill expectations of their role as symbols setting the tone for the city's ambience.

In Japanese-made buses, the emergency exits and the sliding doors on urban buses can be described as distinctive exterior features. Since they were made mandatory after a trailer bus fire incident in 1950, emergency exits on Japanese-made buses have not been designed with rollovers on the side or roof in mind. Due, in part, to the raised floors in sightseeing buses, current emergency exits are currently evaluated according to their effectiveness in allowing escape from the vehicle in the event of an emergency. Setting the middle door on urban buses as an emergency exit was also considered when non-step buses were made standard, but firm support for the conventional recessed sliding door among bus operators stopped any new proposals from being put forth.

Recently, opportunities for users to see articulated buses or other imported buses are increasing and, as with emergency exits, the time has come to study both functionality and design from the point of view of expanding effective cabin space and streamlining body structure. As previously stated, there were effectively no styling changes in Japanese-made buses in 2013. However, the current styles have been the same for 7 to 9 years for heavy-duty sightseeing buses, and 14 to 30 years for urban buses. Relative to global trends, this represents an exceptionally long time, especially for urban buses, and users are subconsciously yearning for sleeker urban bus designs.

One 2013 Japanese-made bus that offered something new in terms of style is the Hino Poncho Mini exhibited at the Tokyo Motor Show. Its inclusion of the manufacturer mark as a design feature in the middle of the front of the vehicle is a rare approach in Japanese-made buses (see previous section).

Whether it reflects the paucity of styling changes or represents a facet of Showa reminiscence is unclear, but "revival painting" that evokes the styles of yesteryear is appearing all over Japan. Despite significant differences in body structural elements such as area of the windows and the height of the waist rail, it is drawing the attention of users and more bus operators are expected to adopt it (Fig. 1).

## 2 Designs in Buses Manufactured outside Japan

In other countries, there is a wide selection of buses, and design is a major aspect of product appeal. In May 2013, the International Association of Public Transport (UITP) held its World Congress in Geneva, Switzerland, and the Busworld exposition was held in Kortrijk, Belgium in October. These are two major showcases for the global bus industry, and buses exhibited at these events are introduced below.

### 2. 1. Bus or tram?

Hybrid and electric buses were the highlight of the UITP World Congress. Electric vehicles included not only battery-equipped pure electric buses, but also a larger number of so-called plug-in electric buses that use a lower capacity battery and assume frequent rapid charging at terminals or at start and end points. For all intents and purposes, the same can also be said, of wireless trolley buses and plug-in hybrids. The boundary be-

Fig. 1 Example of revival painting: Nara Kotsu.

Fig. 2 HESS Wireless Trolley Bus.


Fig. 3 Van Hool ExquiCity.

tween trams and buses is gradually fading. As the role of diesel engines changes, the inevitability of layouts that put the driver on one side of the bus and the engine on the other appears to be diminishing.

**2. 1. 1. HESS Wireless Trolley Bus (Switzerland)**

This bus was introduced as a means of access to the venue during the UITP congress. HESS is famous for its CO-BOLT system of bolted aluminum assembly, and also counts trolley and articulated buses among its specialties. This vehicle uses a pantagraph to collect electricity, but can also operate without overhead wiring. It adopts a bold streamlined body and wheel covers, and runs more silently than trams.

**2. 1. 2. Van Hool ExquiCity (Belgium)**

The front and rear of the body were given the same style, which can be applied equally well to articulated buses, trolley buses and trams. Although a tram-like narrowing of the front and rear that ensures mobility characterizes this bus, its face will be adapted to each city, in anticipation of customers looking for a proper bus feel (Fig. 3).

**2. 1. 3. Iveco Bus Ellisup (Italy/France)**

This is a plug-in EV concept model exhibited at Busworld. The small-diameter wheels that do not protrude


Fig. 4 Iveco Bus Ellisup.

Fig. 5 Iveco Bus Ellisup.

into the cabin and the small motor system driving each wheel were developed by well-known tire manufacturer Michelin. While the model presented at the show was a charming eight-wheel single vehicle, its fully symmetrical body is also adaptable to long articulated buses and trams, hinting at the great potential of this vehicle. It may only be a concept model, but it is clear that with such buses in operation, the atmosphere of the city would change. The use of graining on the seats may or may not represent confidence in ride comfort, but it certainly feels fresh (Figs. 4 and 5).

**2. 1. 4. BYD electric bus (China)**

Operational test drives for this pure electric bus have been conducted all over the world since it first rolled off the line in 2010. Due to its lightweight aluminum body it can mount a battery with enough capacity for a 250 km range on a single charge. It provides both rapid and normal charging. While its design is not especially innovative, it does demonstrate the technical skill of specialized Chinese manufacturers. Service in the Netherlands began in April 2013, representing the first export to Europe (Fig. 6).

**2. 1. 5. Ebusco electric bus (the Netherlands/China)**

This vehicle debuted in 2012. Its components and body are made in China, and design coordination uses Dutch technology, giving it a styling finish that compares


Fig. 6 BYD ebus.


Fig. 7 Ebusco (Electric Bus).


Fig. 8 Viseon Bombardier Electric Bus.


Fig. 9 Iveco Bus Urbanway.

favorably with that of European urban buses (Fig. 7)

**2. 1. 6. Viseon electric bus (Italy/Germany)**

This is a 3-door urban bus equipped with non-contact charging technology by Bombardier, an Italian general machinery manufacturer. After it was announced, Viseon itself filed for insolvency and its future is uncertain, but the bold window graphics proclaiming its identity go well beyond what is seen as the norm for urban buses in Japan (Fig. 8).


Fig. 10 Iveco Bus Urbanway.

Fig. 11 Plastic seats proposed for urban buses.


Fig. 12 Karsan Jest.

**2. 1. 7. Iveco Urbanway (Italy/France)**

Irisbus, which has a large market share in Italy and France, changed its name to Iveco Bus. At the same time, it announced a new generation mass production urban bus. It is a full model change of the Citelis launched in 2005 after a minor model change. With an assembly that makes generous use of LED headlamps, it presents an elegant front among urban buses, and also features an interesting rear unlike that of any other bus (Figs. 9 and

10). It presents many highlights, including a chassis layout design with the standard Italian rear door in mind. The seats made partially transparent with the use of plastic provide an air of freshness, which is also starting to be seen in buses by other manufacturers (Fig. 11).

**2. 1. 8. Karsan Jest (Turkey)**

This is a light-duty bus with an overall length of 5.8 m announced by a manufacturer in Turkey, where bus production is rapidly increasing due to the establishment of production bases there by several Western European manufacturers. It is a non-step bus with a front engine targeting use in urban routes and care-oriented services. Its launch marks the birth of a strong rival in a market that is the exclusive province of Japanese-made light-duty buses. Japanese-made light-duty buses have been praised for their durability and reliability in any situation, but the steadily evolving local needs of export destinations are starting to exert new pressure.

# Bus Body Structures

## 1 Changes to Regulations

In 2012, there were changes affecting all production vehicles involving tightened seat safety rules and structural requirements for driver-only buses, but there were no notable changes in 2013. Driving-related safety equipment, typified by collision damage mitigation braking systems, are scheduled to become mandatory in 2014, but all affected Japanese-made vehicles have already been made compliant with those requirements. Manufacturers are now working on adapting to the pending international harmonization of safety standards concerning the body rigidity of light-duty buses.

## 2 New Buses

In principle, the development of the chassis and body is unified in recent Japanese-made buses, but this section moves away from generalities to present new buses whose entry in the market came about through the wishes of local operators.

**2. 1. Guided buses**

Twelve years after starting operations, Nagoya Guideway Bus has replaced its vehicles (Fig. 1). While its entirely elevated guided segment makes it a global rarity, there have been no attempts to expand the system to other cities since its launch. Since the new models require storage space for the guide wheels, they are two-step vehicles based on the Hino Motors Blue Ribbon City Hybrid Non-Step. Compliance with barrier-free transportation is assured by equipping the vehicles with a lift for passengers in wheelchairs. Although the original vehicles used a torque converter automatic transmission, the base model for the new ones uses a manual transmission, requiring the driver to perform gear shifting operations.


Fig. 1 The new generation Nagoya Guideway Bus.

**2. 2. Open-top buses**

Double-decker open-top buses where the roof of the upper deck has been removed to provide a broader view are used for sightseeing in cities all over the world. They received a favorable reception after being introduced in Japan with the remodeling of a vehicle owned by Tokyo-based Hinomaru Jidosha Kogyo in 2004. Initially, the remodeling of double-decker buses was contracted to a German company, BVG (a Berlin public transport operator running its own fleet of 1,300 buses), with expertise in open-top conversions. Japanese customizing and remodeling contractors subsequently acquired open-top conversion technical know-how. They have started doing remodeling, and the number of converted vehicles is rising (Fig. 2).

**2. 3. Trends in electric buses**

With local governments setting up environmental protection policies leading the way, the adoption of electric buses is increasing. In 2013, Komatsu became the latest city to acquire the Hino Poncho EV launched the previous year, and a medium-duty plug-in electric bus began operations in the city of Miyako, Iwate Prefecture.

In Toyama Prefecture, one LPG-electric hybrid vehicle began operating in Takaoka. The LPG engine generates


Fig. 2 Double decker open-top bus remodeled in Japan.

electricity to power the motor. While rare in Japan, such buses are not uncommon in Europe. LPG is widely used in taxis and is free of infrastructure-related problems.

In 2013, the cities of Kitakyushu and Satsumagawa, the East Japan Railway Company, and Mie Kotsu Co., Ltd. announced their participation in the MLIT-sponsored project for green regional transportation through the use of electric vehicles.

Electric buses will begin operations throughout Japan by the end of the fiscal year (March 2014), and the inclusion of heavy-duty buses in some areas – a first – is notable.

## 3 Technological Trends outside Japan

As briefly touched upon in the previous part, hybrid, electric and fuel cell buses are in the spotlight at shows attended by people involved in the bus industry and public transport operators from all over the world. However, in terms of number of vehicles, buses with diesel engines obviously remain predominant. Europe has adopted the Euro VI norm as its latest emissions regulations, which presents a significant hurdle in terms of NOx emissions reduction compared to previous European regulations. In response, the deployment of devices and technologies such as high-pressure fuel injection, variable-geometry turbochargers, diesel particulate filters (DPF) and selective catalytic reduction (SCR) is nearly complete. As international emissions regulations converge, so do trends in approaches to comply with them.

In contrast, many choices are available for hybrid systems. In addition to various types of batteries, supercapacitors have also become available. Urban bus requirements vary depending on the use environment, particularly in terms of rapid charging during operation, non-contact or contact charging and, for the latter, trolley poles or pantagraphs, all of which directly affect infrastructure. Amidst such concerns, the EU bus industry is poised to follow up on its 2012 European Bus System of the Future (EBSF) initiative with the announcement, in January 2014, of the Zero Emission Urban Bus System (ZeEUS) project. Coordinated by the UITP, the project has a 13.5 million euro budget to conduct pilot trials involving 8 cities in 6 countries. The methods and results of this initiative which will take a systematic look at the possibilities as it strives to choose solutions optimally suited to cities deserve attention.

## 4 Conclusion

This final section sums up the technological differences in buses between Europe and America on the one hand, and Japan on the other, which have been discussed throughout this article.

From the standpoint of environmental protection, battery capacity and gross vehicle weight remain the keys to the practicality of electric buses, which are drawing increasing attention from society. Since this continues to advantage light-duty vehicles over heavy-duty ones, it is typical for the latter to be hybrid vehicles or use rapid charging to make the battery smaller. However, mounting batteries with a full operational capacity is still an appealing approach since it avoids the need for the infrastructure required by rapid charging. Unlike the vehicles made by China's BYD or Korea's Fiber, which have lightweight bodies specifically designed for use as electric buses, current Japanese models cannot be adapted to this approach. However, since the benefits provided by weight reduction also apply to diesel vehicles, reviewing the body structure represents a concrete challenge for the future. Also, as the BYD example illustrates, batteries, which present fewer difficulties in terms of safety, can be seen as a viable choice even if they fall slightly short in terms of performance.

A look at the world reveals many instances where advanced technology has already been commercialized, with a fair number of cities having applied them to enhance the convenience of their urban bus services. In the past, Japanese urban buses were equipped with a variety of devices as more and more buses became driver-only buses. In a way similar to the way those devices were consolidated into speech synthesis broadcast systems, it is conceivable that today's increasingly prevalent drive recorder data and communications technology

could also allow operation centers to view the number of passengers, the state of the cabin, or the driver's condition in real time. In the truck industry, dynamic management, such as managing the inside temperature of refrigerator trucks or providing advice on fuel efficiency while driving has been applied for many years. However, its inapplicability to different models also presents difficulties. Among major public bus operators, tenders are the norm so systems that differ between models are simply not accepted. The European and American approach which obtains time and cost savings by sharing existing systems is also worthy of attention. The undertaking of projects such as ZeEUS in Europe underscores the need for coordination – the consolidation of technologies in a manner appropriate to buses – in Japan as well.