ZeEUS eBus Report

ZeEUS is an impressive project with over 40 consortium participants and a budget in excess of 22 million euros of which the European Commission co-finances 13.5 million. Put simply, ZeEUS is the most important European project focusing on electric buses.

In the light of the Paris Agreement reached at the COP 21 to limit global warming to 2 degrees Celsius, the transport sector has an important contribution to make to the achievement of the climate goals. Our common efforts to reduce greenhouse gas emissions are becoming even more of a priority as they are already. Transport contributes to about a quarter of total GHG emissions in the European Union. That is why the Energy Union strategy, adopted last year by the European Commission as one of the political priorities of President Juncker, includes as an objective the decarbonisation of transport.

Low-carbon mobility in cities requires us to embrace a range of strategies based on a mix of policy, technology and behavioural changes: the well-known avoid/shift/improve concept. In this holistic scenario, public transport plays a major role being one of the obvious solutions contributing to the fight against global warming, congestion and pollution. In this context and at the 2014 UN Climate Summit, UITP members pledged to double the global public transport market share by the year 2025 and scale up efforts on public transport, optimising infrastructure, vehicles and fuel efficiency, including the deployment of electric bus systems around the world.

With around 450 billion bus journeys per year worldwide, buses are a significant part of any public transport system and are the only public transport mode in many cities.

Worldwide Market Trends

The worldwide electric bus fleet is estimated to have reached approximately 173,000 in 2015. china is leading this global mass deployment, with more than 170,000 buses (98.3% of the global total) operating in Beijing, Changsha, Dalian, Hangzhou, Hebei, Nanjing, Shanghai, Shaoguan, Shenzhen, Tianjin, Xi'an and other cities.8 These developments are strongly endorsed by Chinese government policy, which includes an official programme for 'new energy buses', aiming to produce 1.67 million EVs (including E-buses), and to create 1.2 million jobs annually for the period 2010-2020.9

As an example, Shenzhen City currently has 4,887 purely electric buses in operation. By the end of 2017, all of the city's buses will be fully electrified, in accordance with municipal government requirements, reaching a total of 16,493 E-buses.

While the European market is one of the leading regions for electric bus research and development (R&D) – including vehicle technology – the Asia-pacific region is home to some of the biggest producers of both buses and batteries. In fact, the region contributes over two-thirds of the global output of buses and coaches for domestic markets, and leads the global electric bus market with substantial government initiatives in countries including China, Japan and, to a lesser extent, India. The dominance of the Asia-Pacific market is driven primarily by the increasing output of Chinese original equipment manufacturers (OEMs). With the introduction of technologically advanced 5th-generation electric buses in the regional market, and an increased emphasis on innovation and OEM investments in R&D, the government is planning to continue supporting the electric bus market over the next five years.

Government initiatives are playing a pivotal role in facilitating the growth of the electric bus market. In China, for example, the Ministry of Transport (MOT) provides subsidies and tax benefits to manufacturers of low-emission buses, including subsidies of $81,600 per bus for the purchase of electric buses in 2016. China has been one of the few developing economies worldwide to take initiatives to curb vehicular pollution with the introduction of electric buses. However, the infrastructure for charging electric buses is currently weak in many countries, restricting the growth of the electric bus market.

The demand for wirelessly-charged buses should also help to drive the demand for high-performance batteries. Alongside China, South Korea has also launched a wirelessly charged electric bus called 'on-line electric vehicle' to test induction charging for buses. The Korea Advanced Institute of Science and Technology has developed this technology back in 2014 and the bus is in operation in Se-jong City since June 2015. The market has also seen increased investments from the Chinese government to develop plug-in hybrid electric bus infrastructure, the latter will require a certain degree of expertise and capital to develop. Therefore government contributions are crucial to augment the market.

Trials of E-buses are planned to start in late 2016 in Singapore, where a close examination of the available technologies to be implemented locally will help shape strategy towards the introduction of clean buses.

Trolleybuses with an autonomous off-wire stand-alone course, equipped with batteries – also known as dualmode trolleybuses – have been tested on the streets of more than 40 cities in Russia, Belarus, Moldova, Kyrgyzstan and Serbia. A dual-mode trolleybus is able to run up to 15km without its connecting poles and was operationally tested, for example, in Saint Petersburg in 2014. New trolleybuses with extended autonomous run are expected to appear on routes to the residential areas of Saint Petersburg in 2017, while E-bus tests in the city's specific climate conditions are planned to continue. In Belarus, the Minsktrans public transport operator has also confirmed an order for charging stations and E-buses, in accordance with their 2017 plan.

There is currently no fully electric buses in commercial operation in India, although pilots took place in Bangalore (2014) and Delhi (2016) to demonstrate electric bus technology. Having

test-launched India's first electric bus in February 2014 with a vehicle imported from a company based in China, the Bangalore Metropolitan Transport Corporation's (BMTC's) board has given its in-principle clearance to invest in 150 electric buses. Bengaluru is likely to be the first city in the country to launch city bus transport operations using such a large fleet of electric buses. The Indian government has initiated the 'Faster Adoption and Manufacturing of Hybrid and Electric Vehicles' (FAME) scheme to promote adoption of electric buses. BMTC will approach the Department of Heavy Industry for subsidy under this funding scheme.

A joint venture between a Chinese and an Indian-based OEM has been set up to ensure a manufacturing base in India for the production of electric buses. However, the company has not yet encountered the expected levels of demand from the Indian market. One European OEM has also entered into a joint venture with an Indian-based company for the production of electric buses for the Indian market. They plan to invest $50m in establishing a manufacturing base. The first of these fully electric products will reach the market by March-April 2017.

in Australia, a free solar-electric bus service has been set up in Adelaide, where buses have 18 hours to charge and 6 hours of operation per day. Transport Canberra will also trial three E-buses across the ACTION bus network of school, suburban and rapid services. These vehicles are expected to be delivered in time for a trial that should start around January 2017 and last 12 months. The trial will quantify the economic, environmental and operational performance of electric buses in the network, compared to diesel buses.

Contrasting with the other continents, the electric bus sector is not highly developed in Africa, reflecting the current state of the public transport sector. However, some operational experiences are ongoing on the continent, including a French-based company that has used electric buses for student transport in Cameroon and Ivory Coast since 2014. There are three buses in use at the University of Yaoundé (Cameroon) and three in use at Felix Houphouet Boigny University of Abidjan (Ivory Coast). In Uganda, engineers have built a solar-powered electric bus, the 'Kayoola', a 35-seater that can run for up to 80km on two power banks. These power banks can also be recharged by solar panels installed on the roof of the bus. The City of Cape Town, meanwhile, has awarded the tender announced in February 2016 for the procurement of battery-powered electric buses and ancillary equipment for the MyCiTi service. With a service planned to start in June 2017, Cape Town will be the first municipality in South Africa to benefit from using electricity as an alternative fuel technology for its bus fleet.

In the north African region, the Morocco's Energy Investment Company (SIE) will launch production of its locally made electric buses in 2017, for local and international markets. Marrakech has also announced the deployment of 30 E-buses in 2016-2017, half of them to be fully operational at the occasion of the COP22 climate change conference in November 2016. These buses will be operating on the four Bus ŕ Haut Niveau de Service (BHNS)17 lines with dedicated lanes and high frequency.

In Latin America, development has also been quite modest. There are pilot projects ongoing in both Campinas (Brazil) and Montevideo (Uruguay). Itajaí Transportes Coletivos, a private bus operator in Campinas, has been testing a 70-passenger vehicle since November 2015. Following this, the plan is to introduce ten buses of this type. The local bus operator in Montevideo has been conducting a similar test since May 2016.

In parallel, a municipal law introduced in Sao Paulo in 2009 aims to fight air pollution and provides for the replacement of 100%

of fossil fuels vehicles with alternative fuels and less polluting vehicles by 2020. Among the available technologies, the electric drive is presented as one of the most advantageous solutions and Sao Paulo, which already has a large fleet of bus rapid transit (BRT) trolleybuses in operation, is currently considering investment in battery trolleybuses.

Approximately 200 full battery electric buses were delivered in the USA within 2016, with the largest number currently operated by Foothill Transit in the Los Angeles region (California). The North American market is also characterised by the presence of both an American and a Chinese OEMs. Last year, the US Department of Transportation announced $55m in competitive grants to deploy more zero-emission buses across the country. In California, the Fleet Rule for Transit Agencies requires reductions in both pollutant emissions and exposure to air contaminants from urban buses and transit fleet vehicles. The transit fleet rule also established a demonstration and purchase requirement for zero-emission technologies for large transit agencies. As operators gain experience with zero-emission bus technology, and as that technology evolves, purchase requirements are expected to increase, with the goal of transforming the state-wide transit bus fleet by 2040.21

In Canada, the Société de Transport de Laval (STL) purchased an electric bus in 2012 and tested it during 2013-14 before putting it into service in 2015. The main goal of this project was to test the bus in closed-circuit rather than real-life conditions, so that STL could make informed choices when the time comes to electrify its fleet. This project is part of a wider strategy to promote 'green' energy in the province of Quebec, which has abundant hydroelectricity. Similarly, and as part of the 'Cité Mobilité' project, the operator Société de transport de Montréal (STM) is purchasing three full electric buses and installing four rapid charging points in order to test the technology in a real-life operating context between 2016-2019.

In terms of scale, Europe follows Asia with over 1,300 electric buses delivered or on order.22 This figure includes battery buses (overnight and opportunity charged), plug-in hybrid buses and trolleybuses with batteries for off-wire operation.

The greatest number of electric buses of the above types can be seen in the United kingdom, with over 18% of the total European fleet, followed by the Netherlands, Switzerland, Poland and Germany, with around 10% each.

In order to accelerate deployment, countries such as France23, germany24, italy25 and the Uk26 have set up, or are setting up, national legal frameworks to promote vehicles with reduced environmental impact and energy consumption. Local initiatives, including the establishment of low and ultra-low-emission zones, can also encourage the deployment of electric buses. Some funding and financing schemes have been identified as supporting this trend. In the UK, the Air Quality Grant scheme runs alongside the Green Bus Fund, Clean Bus Technology Fund, Low Emission Bus Scheme and Bus Service Operators Grant (BSOG)/Low Carbon Emission Bus (LCEB) incentives. In southern Europe, Spain has developed two similar schemes, the Integral Strategy for Electric Vehicle Support (MOVELE) and the Integral Strategy for Alternative Energies Vehicle Support (MOVEA).27

Further east, Istanbul's operator IETT has experience with hybrid BRT and has tested electric buses in the past. It is clear that deploying electric buses is part of their agenda. Izmir Metropolitan Municipality tendered and ordered 20 full battery electric buses. MOTAS, which operates in Malatya, introduced a new trolleybus system in 2014 and has bought ten 24-metre battery trolleybuses following a successful test of three fully electric trolleybuses. MOTAs's fleet will have 13 fully electric, high-capacity vehicles by the summer of 2017.

As part of the ZeEUS project, UITP has compiled the strategies of various European cities for the introduction of electric buses over the coming years. It reveals that 19 public transport operators and authorities, covering around 25 cities, have a published strategy up to 2020. By this cut-off date, there should be more than 2,500 electric buses operating in the relevant cities, representing 6% of their total fleet of 40,000.

Over 13 public transport operators and authorities in some 18 cities have a strategy up to 2025; by then, they are expected to have more than 6,100 electric buses in service, representing 43% of their total fleet of 14,000.

A more qualitative market analysis was conducted among bus manufacturers. This shows that a European series production of electric buses should reach full maturity by 2018-2020.

These latest developments bode well for the uptake of fully electric buses in the near future, since demand and supply are converging. In a context of transition however, the various transport providers are on a learning curve. The ZeEUS project partners have identified five challenges that must be tackled to ensure an increase in the use of electric buses in the years to come:

(1) The higher upfront cost of electric buses and their charging infrastructure compared to conventional vehicles
(2) The importance of identifying suitable technology solutions for specific local operational contexts
(3) The necessity to review current procurement and contractual frameworks
(4) The requisite to standardise charging interfaces to ensure the interoperability of E-buses, allowing multibrands fleets to recharge with multi-brands infrastructures
(5) The need to develop trust and cooperation with the electricity power generation and distribution sector, as well as grid owners and energy regulators.

Public transport stakeholders are confident that, by working hand-in-hand with everyone involved, most of these hurdles can be overcome by 2020.

Some electric bus rapid transit (BRT) systems have recently been developed in Malaysia (2014) and Kuala Lumpur (2015). Other cities such as Indianapolis, Lausanne, Lucerne, Nantes and Stavanger have launched similar projects, while Donostia/San Sebastian and Barcelona are considering adopting a full electric BRT system.

The future will see an expansion of electrified bus rapid transit, as well as the growing role of autonomous driving in speeding up the deployment of electric buses; fully automated vehicles and electrified BRT solutions are mutually reinforcing.

The full report can be accessed here:
http://zeeus.eu/uploads/publications/documents/zeeus-ebus-report-internet.pdf