Introducing high capacity e-buses in cities: the ZeEUS and ELIPTIC projects

For *Eurotransport* the UITP's Umberto Guida (Director of Research and Innovation Department), Yannick Bousse and Pauline Bruge (EU Project Managers) present the ZeEUS and ELIPTIC projects with particular attention to the electric bus charging infrastructure standardisation work being carried out in ZeEUS and examples from ELIPTIC.

Public transport is one of the backbones of sustainable transport strategies in Europe. With 30 billion passengers in the EU each year (half of all public transport passengers), the quality and cohesion of the bus services are decisive. It cannot be denied that urban buses play a major role: they contribute to answering the economic, social and environmental challenges faced by our cities. Unfortunately, they are too often overlooked and seen as the 'unattractive shoebox with wheels' that citizens *have* to take rather than *choose* to take.

Public transport and urban buses are crucial for the image cities want to project: they are often the very first interaction a citizen has with the services a city has to offer. All the conditions necessary for a high performance bus system to be implemented must be taken into account to generate the citizens' awareness that the city they live in (or visit) is enjoyable and attractive.

E-buses (electric buses) represent a big shift in how people experience public transport. By contributing to a cleaner environment, minimising noise levels and providing a smoother ride, they offer a completely different feel to traditional vehicles and help reinforce the attractiveness of the bus. Today the e-buses that have already been introduced to some cities are mostly mini- and midi-buses with a limited

capacity and autonomy. This is a great first step to adapt the mobility offering for low density areas and to lower occupancy levels on a specific bus route at a specific time of the day.

The current challenge is to implement the electric technology on high capacity buses in European cities and optimise the use of existing electric public transport infrastructure. E-buses shall be able to carry a high number of passengers with greater energy autonomy by using the existing electric infrastructure, allowing the fulfilment of daily hours of operation.

Two European funded projects aim to reach this goal: the ZeEUS (Zero Emission Urban Bus System) project – coordinated by the UITP – and ELIPTIC (Electrification of Public Transport in Cities) with strong involvement from the UITP.

Credit: Amics del bus

Figure 1: An 18m SOLARIS electric bus

Establishing a common European standard

ZeEUS is one of the largest electro-mobility projects ever funded by the European Commission and gathers 40 partners representing the entire value chain of standard electric buses: cities, operators, industries, researchers and energy providers. In order to extend the fully electric solution to a wider part of European urban bus networks, ZeEUS tests innovative electric bus technologies with different charging infrastructure solutions in 10 demonstration sites across Europe: Barcelona (ES); Bonn (DE); Cagliari (IT); London (UK); Munster (DE); Paris (FR); Plzen (CZ); Randstad (NL); Stockholm (SE); and Warsaw (PL). With nine demonstrations launched, the project has entered the evaluation phase. Principally the project will assess the feasibility of introducing high capacity electric buses from different aspects: economic, operational, social and environmental. The running demonstrations have already allowed some promising data to be gathered, which will be published at a later stage of the project.

One key barrier for the deployment of electric buses is the standardisation of charging infrastructure. Charging facilities can usually be easily introduced to depots, but installing them at termini or at roadside locations has so far been fraught with difficulty. As well as providing the required power capacity to the site, there are usually countless approvals and clearances needed for the design and construction process.

Whilst the car industry has recognised the importance of working towards a standard (or even a single system) for charging infrastructure, this is still lacking within the electric bus industry. A common standard must be developed lest the mistakes of 19th century rail networks be repeated with their different rail gauges, or the mountains of now redundant smartphone chargers prior to recent standardisation. The potential benefits of this standardisation are manifold; primarily the economic benefits to operators thanks to the ability to charge buses from different manufacturers which boosts the resale value of vehicles. This will help to inspire confidence in the technology and encourage further market take-up.

Credit: Stadtwerke Bonn

Figure 2: The German city of Bonn is a partner in the ZeEUS project

Fortunately progress is already being made on this front; a joint effort of ZeEUS, VDV and UITP has already delivered material to CEN/CENELEC – the European body for standardisation – which will be the base for developing the new standard. However, as this is unlikely to be ready before 2019, a group of manufacturers and technology providers are working on developing an industrial standard that can be used in the interim. The industry wants to have something sooner because

Figure 3: An 18m articulated SILEO battery electric bus in Bremen

the market is growing now and users don't want to wait until 2019 to start deciding.

Recent research shows that the global market for electric and hybrid electric buses offers significant growth potential with a projected annual growth rate of 17% from 2016-2021. Meanwhile, ZeEUS's own analysis has revealed that uptake of electric buses, while it may be slow over the next four years, is set to take off post-2020.

According to the team's analysis of Europe's most forward-thinking countries' clean transport strategies, by 2020 7% of the bus fleets of 25 European cities (those that have a strategy up to 2020, including Paris, Bonn, Amsterdam and Oslo), will be electric, while just five years later electric buses are set to make up an impressive 40% of the fleets of the 18 European cities with strategies that reach 2025.

By 2020 there will only be low growth of electric buses because all the barriers will still be in place, such as funding and the knowledge gaps for aspects such as battery lifetimes and how to update depots for electric buses. However, by 2025 the assumption authorities have is that these barriers will largely have been solved.

Figure 4: Charging infrastructure at tram sub-station in Oberhausen

Saving costs and energy by optimising existing infrastructure and rolling stock

The European funded project ELIPTIC aims to develop new concepts and business cases in order to optimise existing electric public transport infrastructure and rolling stock, saving both money and energy. ELIPTIC focuses on the electrification of urban buses as well as the improvement of energy performance in light-rail and the multi-purpose use of infrastructure to support further electrification in transport. The overall concept and main assumption underpinning ELIPTIC is that further take-up of electric vehicles can be supported cost-efficiently by integrating existing electric public transport infrastructure for multi-purpose use.

ELIPTIC has 20 cases of technical applications, or feasibility studies, within 11 cities (Barcelona, Bremen, Brussels, Eberswalde,

Gdynia, Lanciano, Leipzig, London, Oberhausen, Szeged and Warsaw) addressing two major barriers to electrifying public transport:

1. Uncertainty about the most appropriate technological path
2. Lack of a business case.

Today, apart from trolley-buses, the lion's share of electric buses is midi (< 10.5m) to standard (12m) in size. Battery-electric buses of 18m or more are the exception – but such buses are in demand by operators. In larger European cities there is a growing share of articulated and bi-articulated (18m, 24m and double-decker) buses. For example, two-thirds of Bremen's bus fleet (population 550,000) consists of articulated buses. As public transport operators have to operate efficiently, the business case of electric buses needs to be clearly analysed. Beside the vehicle purchase cost and the fuel/energy consumption, availability and maintenance costs are also crucial considerations. In addition, infrastructure requirements (including garages) and training staff to work with high voltage need to be analysed. Taking these needs into account it's not realistic to expect short-term financial viability. However, aside from the pure financial aspects, there is measurable value in reducing local and global emissions and in reducing dependence on (imported) mineral oil.

The demonstrations include new battery buses of high passenger capacity (18m articulated) as they are increasingly in demand by public transport operators (see **Figure 3** on page 24).

Another concept is the combination of battery and trolley-bus concepts, allowing for battery recharging during operation (when connected to the overhead wires) and giving trolley-bus cities an opportunity to extend the electric operation into areas without overhead wires. All-in -all the concepts of battery volume and recharging need to be adapted to operational conditions. Another idea is to install a system that can use excess energy from tram systems to power buses using a sub-station, or by directly connecting to existing overhead lines (see **Figure 4** on page 24).

There is a lot of interest from cities and public transport operators in such concepts and related business cases. It is an explicit objective of the project to develop business cases by showing how costs and energy can be saved by electrifying public transport and optimising the use of existing infrastructure and rolling stock.

ELIPTIC will further develop use-cases into development schemes and business cases based on an iterative, moderated software-based planning process as a decision-making support tool for local stakeholders (e.g. authorities and energy suppliers).

Conclusions

Electric bus technology and its charging infrastructure are still undeveloped compared to a century of diesel bus development. Market take-up will therefore depend on the speed and quality of the progress made in the electric bus building and battery technology sectors in the coming years, while also providing sufficient charging capacity.

Governments at all levels still need to demonstrate a commitment to electric bus technology and implement clear policies and guidelines to facilitate the provision of the required infrastructure. In the absence of such policies, electric bus take-up and the electrification of public transport will not occur or will remain very limited.

ZeEUS

Testing electrification solutions at the heart of the urban bus system network through live urban demonstrations and facilitating the market uptake of electric buses in Europe.

Website:	www.zeeus.eu
Duration:	November 2013-April 2017
Budget:	€22.5 million (€13.5 million EU-funded)
Coordinator:	UITP
Partners:	see website
Twitter:	@zeeusproject
LinkedIn:	www.linkedin.com/groups/8130500/profile
Facebook:	www.facebook.com/zeeusproject?ref=hl

ELIPTIC

Optimising existing electric infrastructure and rolling stock in order to reduce costs and energy consumption.

Website:	www.eliptic-project.eu
Duration:	June 2015-May 2018
Budget:	€5.98 million EU-funded
Coordinator:	City of Bremen
Partners:	see website
Twitter:	@elipticproject
LinkedIn:	www.linkedin.com/groups/8314559/profile

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Yannick Bousse works as an EU Projects Manager for the UITP. He joined the UITP in June 2015 being responsible for EU Horizon 2020 bus projects ELIPTIC and EBSF_2. Yannick holds a MsC in Urban Sustainability from the Geography Department at the University of Reading, UK. Yannick previously worked with the organisations Polis and EUROCITIES and has worked on EU sustainable urban mobility projects and policy dossiers including FP7 research and innovation projects TIDE; CIVITAS CAPITAL; CIVITAS VANGUARD; OPTICITIES; and policy dossiers such as the urban mobility package; the weights and dimensions directive; and TEN-T.

Pauline Bruge is a Projects Manager at the UITP. She graduated from the Institut d'Etudes Politiques of Lille and Kent University (UK) with a Bachelor of Politics and International Relations and a Master of International Law and Political Science. She joined the UITP in 2011 where she worked on various projects related to urban bus (EBSF and 3iBS) and more cross-cutting issues for public transport (information technology systems for public transport; CIVITAS initiative; and international cooperation). She is now managing the ZeEUS project focusing on bus systems electrification and the ITxPT Association aiming to support IT standards' deployment.