

## POSSIBILITIES OF ELECTRIC POWERED PUBLIC TRANSPORT IN TOURISM OF SZEGED

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**Abstract:** *Number of tourists is increasing year by year. Szeged has nice architecture, lot of cultural programs like exhibitions, expo, open air festival. Hotels are available in quantity and quality as well. Most of attractions are in downtown, but some of interesting places are in different parts of suburban. Streets are narrow and traffic jam is typical day by day. It has harmful impact by emission to the air quality and take the city centre uncomfortable for visitors and inhabitants. Public transport company use trolleybuses and trams in some lines; a new idea is how to extend network to be approached touristic attractions. ELIPTIC – electrification of public transport in cities (Grant Agreement number: 636012) in H2020 examine feasibilities of it in Szeged.*

**Key words:** *H2020, electric powered public transport, public transport, Szeged, tourism*

### 1. INTRODUCTION

The main idea of the project is extension of trolleybus and tram network. Some touristic attractions are far from city centre and can be reached just by car or buses. For environmental friendly transportation looks good idea to use electric powered public transportation as trams or trolleybuses. Problem is the network, which does not cross interesting places. Two additional possibilities can be interesting as battery powered trolleys where there are no network or city tourist trams.

Electric public transport can also be highly cost efficient for the operator, when a long-term perspective is taken. A number of new vehicle concepts has been introduced over the last years, innovative energy management and storage technologies are being tested and public transport energy networks are expected to make a major contribution to the smart grid of the future. Exciting tram-like bus systems, the renaissance of the trolleybus, as well as autonomous electric buses are examples of the innovation capacity of Europe's public transport sector. Among the ELIPTIC (Figure 1) partner cities, all modes of electric public transport are covered and these will be the basis for analysing the potentials for upgrading and/or regenerating electric public

transport systems while ensuring the safe integration of electric vehicles into infrastructure. This approach will overcome the main barriers for further integration of electric vehicles in cities with existing electric public transport infrastructure by cost-effective principles of double- or even multi-use of this existing infrastructure. In particular, the often lacking city-wide coverage of charging infrastructure (due to high investment cost) and the limited driving range of electric vehicles – the two biggest challenges for electro mobility – will be overcome by providing different options for opportunity charging along the existing infrastructure thus extending driving ranges and/or reducing the size of the required battery packs.



Figure 1. ELIPTIC and EU logo

<http://www.uitp.org/eliptic-electrification-public-transport-cities> 15.03.2016

## 2. LITERATURE REVIEW

This needs a holistic and system-level approach and ELIPTIC covers every aspect of the electric public transport chain including industry suppliers as technology providers and enablers (from drive chain and vehicles to electric component suppliers to holistic system providers), research institutions, cities and operators of every mode of electric public transport (i.e. trolleybus, tram, light rail and metro). ELIPTIC supports the ambitious goals of the EU to halve the use of conventionally-fuelled cars in cities by 2030 (and phase them out by 2050) as well as the emissions reduction target of 60% by 2050, as laid down in the Transport White Paper. ELIPTIC sees electric public transport in a forerunner position to reach these goals, as increasing the capacity of electric public transport brings not only a shift from individual car traffic, but can also have a large impact on fossil fuel consumption and air quality. Investment in the electrification of public transport has a high impact as urban buses are in operation about 16 hours/day, as compared to cars, which generally operate less than 1 hour per day in city centres or urban areas.

Europe's bus fleet, which transports 30 billion people per year in the EU, is still approx. 95% diesel-fuelled. Electro mobility is a trend, but a lack of expensive city-wide charging infrastructure and the limited driving range of

electric vehicles are barriers for deployment. But rather than building new and costly stand-alone charging infrastructure, ELIPTIC aims to further electrify road vehicles (in particular buses) using existing electric public transport infrastructure. To date, the only demonstration in Europe of electric bus operation using tram infrastructure is in Vienna. In order to exploit the full potential of existing electric public transport infrastructure as a basis for further safe integration of electric road vehicles, ELIPTIC will provide a range of options for opportunity charging along existing infrastructure (en route or at sub-stations) extending driving ranges and/or reducing the size of the required battery packs. The technical development in the field of electric storage (e.g. trolley-hybrid-buses equipped with battery and supercapacitors) and power management allow for new solutions for practical operation. (Nagy E. Szabo D. 1984; Vow S. 2016; [1] and [2] 15.03.2016)

Furthermore, zero-emission public transport systems, in particular electric (trolley)bus systems, are often neglected in national electro mobility investment and research programmes. And although significant research efforts are underway to develop and demonstrate innovative electric bus concepts across Europe in real life contexts, public transport operators and authorities too often launch stand-alone test projects to gain initial experience with electric buses. This trial and error approach can however be inefficient and the likelihood of costly mistakes being made by selecting sub-optimal electric buses and charging station solutions is high. ELIPTIC aims to avoid these pitfalls through a moderated software-based planning process based on validated ELIPTIC use cases and available information and data of demos from outside the project, e.g. through exchange with the ZeEUS Observatory. More and more, public transport operators are not just public transport providers but mobility providers. They facilitate seamless multimodal travel, often by partnering with providers of shared cars or bikes to create a full chain of mobility. ELIPTIC's objective of analysing the potential of multiple-use infrastructure to facilitate seamless multimodal door-to-door electric travel (e.g. linking e-bike charging to tram or bus infrastructure) will give an important new dimension to clean mobility options. This is also important as a shift from individual car traffic can make a large impact on fossil fuel consumption and air quality. By introducing more electric options, both mobility and access to urban areas will improve.

### **3. MATERIAL AND METHOD**

First introduced in the ELIPTIC partner city of Eberswalde, the development of trolley-hybrid-buses, equipped with a (lithium-ion) battery as an additional electric drive train option is a tangible innovation that will be carried forward in ELIPTIC. The partner cities of Gdynia and Szeged are also

introducing such trolley-hybrids (Figure 5) and ELIPTIC's trolleybus cities will analyse the potential of extending their trolleybus network by replacing diesel buses with these vehicles operating in battery mode and without additional costly infrastructure needed.

Installing supercapacitors or flywheels in public transport grid substations increases the energy efficiency of the entire system by better storing regenerative braking energy. The only experience with stationary or network-based energy storage systems to date, both for supercaps and for flywheels, has been in the area of trams; Gdynia and Salzburg would be the first to test them for trolleybuses (with supercaps and flywheel).

The project should lead to increased knowledge and awareness of cost-effective strategies, policies and approaches.

ELIPTIC is based on the cost-effective principle of optimising the use of existing infrastructure and rolling stock by developing and validating in practice a variety of innovative business cases, including:

- Existing electric charging infrastructure that traditionally serves only one public transport mode is reused to provide electric power for other modes (trolleys and hybrid buses charged by tram infrastructure, battery buses charged through trolleybus or tram network).
- Low-cost upgrading of trolleybus networks with battery buses or trolley hybrids will validate a strategy for replacing diesel buses. Automatic wiring/de-wiring technology will demonstrate catenary-free trolleybus operation for the first time on a wide scale.
- Operational efficiency of tram, light-rail and trolleybus systems will be increased through recuperated energy storage concepts (e.g. flywheel, supercapacitors, reversible sub-stations).
- Introduction of multipurpose use of electric public transport infrastructure (metro, tram, trolley) to safely charge non-public transport vehicles (electric cars/ taxis, vans, garbage collection trucks).

The public transport operators and local authorities in ELIPTIC will work closely with the research partners to optimise the cost benefit ratio of these new strategies. They are supported by major associations and leading industrial partners. Cooperation has been agreed upon with other leading Europe initiatives in electric public transport. ELIPTIC has a clear end-user orientation – including strong involvement of operators and authorities in the consortium, the forum approach and a set of deliverables focused on decision-makers.

The ELIPTIC demonstrators will be connected with major local investment programmes in order to validate the project research results on a large scale, including 100 electric buses in Warsaw and 160 hybrid buses in Brussels. Innovations such as automated wiring and the introduction of the first 18m low floor battery buses will be monitored and evaluated. Such an investment in "trolleybus network / trolleybuses" constitutes a serious

investment. It is important that consumers in fact, traveller's convenience to the realized investment (Zsótér, Schmidt, Trandafir 2014). This measure could be after implementation, as this method has already been applied Zsótér and Toth (Zsótér, Toth 2014).

ELIPTIC's involvement of stakeholders and its end-user orientation will multiply the impact of the showcases and greatly increase the credibility and relevance of the results. Based on research and demonstration experience (within and outside ELIPTIC), a moderated scenario-based planning process and an electric public transport option generator will be developed to enable public transport operators to identify the best strategy options for their transition to a fully clean fleet. On the basis of relevant and credible validation results, ELIPTIC rollout and take-up support activities will contribute significantly to reaching the European Transport White Paper goal of halving the use of conventionally fuelled vehicles by 2030.

#### 4. ASSESSMENT OF THE RESEARCH RESULTS

ELIPTIC represents the full range of challenges and differences across European cities:

- Topography and climate: cold Central European winters to Mediterranean climate; hilly and flat cities; compact to sprawled urban forms; strongly mixed to purely mono-functional land use; premium value historic areas to modern, vibrant districts.
- Size and complexity: multi-million metropolitan city (London); major cities of 1-2 million (Warsaw, Barcelona, Brussels); medium to large cities (Bremen, Leipzig, Gdynia, Oberhausen); small to medium cities (Salzburg, Szeged, Eberswalde).
- Electric modes: light-rail, metro, tram, trolleybus, battery bus and hybrid bus (in various combinations and in diverse operational contexts)
- Approaches and contexts: The 11 ELIPTIC operators represent a wide range of business approaches, mobility cultures and urban policy contexts.
- Associations: association partners (e.g. UITP, POLIS) can complement this wide spectrum as needed.

ELIPTIC is driven by the interests of operators and related authorities, meaning practice-oriented approaches will fully represent the diversity of urban realities in Europe.

The Szeged use case will be modelling the case of replacing diesel bus lines with extension of the trolley bus network with trolley-hybrids without the need for additional infrastructure. In 2013 SZKT purchased battery equipped

trolleybuses that will be used in the demonstration. The charging will come from the existing catenary network and the battery trolley buses will run in accumulator mode in between the existing and extended network. At first SZKT will to conduct a feasibility study to explore possible/alternative route definitions, the effects of such a system on the traffic, external effects, the determination of external partners and the definition of important indicators. After the results of the feasibility study, the demonstration preparation would involve the following sub tasks:

- Selection of the test route from the alternatives
- Definition of the transport service based on the traffic and technical parameters
- Definition of the demanded vehicle fleet
- Definition of test period and time
- Authorization of the test. (Partner: Municipality, Authority)
- Temporary infrastructure installations (bus-stations, etc.)
- Measuring device/system preparations (vehicle and catenary system)

Once the demonstration is in the execution phase, the following sub tasks will be completed: equipment preparation (vehicle, data measurement/collection), staff training (drivers, technical assistance, traffic assistance) and the test run.

Bus, tram and trolleybus lines are rich in Szeged. (Figure 2) You can see lines are concentrated in city centre, but radial structure typical. There are some new lines connecting radials, but mainly for buses. In ELIPTIC project we examine how to develop network for touristic purposes as well. It is impossible just to use the existing overhead line network and build new sections are expensive and complicated. Solution can be using hybrid trolleybuses among existing lines. Between them powered by batteries. The question is how to move down and up pantographs. Trolleybuses can change to battery mode easy by driver pressing a button, but backwards takes longer time and special equipment or tools.

Hop on and hop off mode requires well defined stops close to interesting places. In Szeged there are many touristic attractions in the downtown and suburban as well. In the centre the top 10 are Mora Fervency Museum, Pick Museum, Black House, Kiss Gallery, The Votive Church of Szeged, Synagogue, Lower City Franciscan Church and Monastery, Dom Square in Szeged, Szechenyi Square in Szeged and Dugonics Square.

Visiting some unique places and buildings we need extended trolleybus network. One of the most interesting place is the Botanical Garden (Figure 3) of University of Szeged, which is few kilometres far from centre, 10-minute travel by public transport. It is located in new part of the town, where you can find Liget Park and water park at the riverside. On the opposite side of Szeged in Kiskundorozsma district can be seen a windmill (Figure 4) which is a

workable technological monument in a housing estate. It is difficult to find among buildings. New trolleybus hybrid line maybe can reach it too.



Figure 2. Public transport network of Szeged  
<http://szkt.hu/page.fcgi?menuparam21=54> 15.03.2016



Figure 3. Botanical Garden of University of Szeged  
<http://www.fuvesz kert.u-szeged.hu/hu/> 15.03.2016



Figure 4. Windmill in Kiskundorozsma district of Szeged  
<http://egykor.hu/kiskundorozsma/szelmalom/1849> 15.03.2016



Figure 5. Hybrid trolleybus in Szeged  
<http://szeged.hu/hirek/21218-mar-hat-uj-troli-megerkezett-szegedre.html>  
15.03.2016

## 5. SUMMARY

The results of our survey and answers of inhabitants living in Szeged wish and ready to accept electric powered public transport vehicles in city transport. Szeged has different trolleybus and tram lines for main streams of everyday passenger traffic. Tram lines do not form a coherent network of

tourism attractions, so infrastructure is not available to realize it. The trolleybus network provides flexible options for this purpose. The overhead line network reaching Szeged territory, but in itself is not capable of achieving the set tasks tourism. Solution in the wired and battery powered hybrid trolley buses, as they stand between the lines pass. The suburban locations can be achieved in battery mode, then return to the line. In this way, circular lines organized that meet the urban transport and tourist purposes alike. These tourist lines should be operated only in the tourist season, using the special fare. This approach is flexible and environment friendly at the same time.

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