Use Cases

eLIPTIC
electrification of
public transport in cities

The overall aim of ELIPTIC was to develop new concepts and business cases to optimise existing electric infrastructure and rolling stock use, saving both money and energy. ELIPTIC advocates electrification of the public transport sector and helps to develop political support for the electrification of public transport across Europe.

With a strong focus on end users, ELIPTIC analysed 20 use cases within the four thematic clusters. The project supported the Europe-wide uptake and exploitation of results by developing strategies and guidelines, decision making support tools (e.g. option generator) and policy recommendations for implementation schemes for upgrading and/or regenerating electric public transport systems. Partners and other cities have benefited from ELIPTIC's stakeholder involvement and user forum approach. ELIPTIC addresses the challenge of “transforming the use of conventionally fuelled vehicles in urban areas” by focusing on increasing the capacity of electric public transport, reducing the need for individual travel in urban areas and by expanding electric intermodal options (e.g. linking e-cars charging to tram infrastructure) for long-distance commuters. The project strengthens the role of electric public transport, leading to both a significant reduction in fossil fuel consumption and to an improvement in air quality through reduced local emissions.

ELIPTIC looks at four thematic clusters:

INTEGRATION OF ELECTRIC BUSES USING EXISTING ELECTRIC PUBLIC TRANSPORT INFRASTRUCTURE

HYBRID TROLLEYBUS

ENERGY STORAGE SYSTEMS TO INCREASE OPERATIONAL EFFICIENCY

MULTI –PURPOSE USE OF ELECTRIC PUBLIC TRANSPORT INFRASTRUCTURE

Barcelona

OPPORTUNITY FAST (RE)CHARGING AND SLOW OVERNIGHT CHARGING OF ELECTRIC BUSES BASED ON METRO INFRASTRUCTURE

USE OF METRO/TRAM INFRASTRUCTURE FOR RECHARGING E-CARS (MUNICIPAL FLEET AND PRIVATE E-CARS)

USE CASE DESCRIPTION

One of the main challenges facing the Barcelona public transport operator, Transport Municipal de Barcelona, is to gain efficiency in exploiting e-bus systems within the city. To achieve this aim, the ELIPTIC project has been testing the operation of e-buses, comparing the fast on-street opportunity-charging technology with the slow overnight-charging system.

At the same time, one of the on-street chargers was connected to the metro grid of the city, seeking economies of scale. With the same goal of extracting possible synergies, the municipal entity Barcelona de Serveis Municipals has carried out a feasibility study, analysing the convenience of a widespread vehicle-charging network connected to the railway infrastructure.

RESULTS AND LESSONS LEARNT

Following analysis of both systems, the Barcelona bus operator found that the fast opportunity-charging system was best suited for their operational requirements. This was mainly due to the ability to operate the buses reliably for 16 hours per day, something that was not possible with the slow overnight-charging approach due to its lack of range. However, the City Council found some difficulties, since the authorities are reluctant to install these fast-charging systems at street level. For the electric vehicle chargers study, different connection modes were technically defined; from an operational standpoint, four potential scenarios were analysed to explain the alternative roles of the main actors of the system (public transport operators, parking operators, private electric vehicle fleets and private electric vehicle users). The major challenge in connecting the chargers to the metro grid were regulatory, which are highly restricted in the case of Spain.

FUTURE PLANS

The fast opportunity-charging point built thanks to the ELIPTIC project, which is connected to the metro grid, will continue to operate in the future. The Barcelona bus operator is currently implementing a plan to electrify four lines in the city and small buses devoted for short local services. At the same time, the feasibility study has defined five strategic lines that Barcelona Serveis Municipals should address to achieve the city's stated objectives.

> **"On-street charging points supplied by the metro power grid offer energy efficiency advantages compared to those supplied by the public distribution grid."**
>
> Josep Ariño, Infrastructures manager, Transports Municipals de Barcelona TMB

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Bremen

OPERATION-OPTIMIZED SYSTEM OF OPPORTUNITY CHARGING AT BUS DEPOTS

RECUPERATION OF BRAKING ENERGY FROM TRAMS

USE CASE DESCRIPTION

Public transport operator Bremer Straßenbahn AG (BSAG) tested two electric urban buses from the OEM, SILEO (12m and 18m low-floor each) in day-to-day operation on a number of urban bus lines. Both buses were equipped with low-floor technology, ticket vending machines and air conditioning systems to ensure they met the usual standard for urban buses operated by BSAG. The electric buses are charged at the depot alone, using a charging infrastructure leased from SILEO that can be used only for their vehicles. The energy is supplied with power from the medium-voltage network of the local energy supplier and thus uses no energy from the existing DC tram infrastructure at the depot. The SILEO 12m bus was in operation on the combined bus lines 29 and 52 from July 2016 to May 2017. From April 2017, both buses ran on different lines: line 51/ 53 (12m bus for a total of 50,000km) and line 20/63 (18m bus for a total of 30,000km).

RESULTS AND LESSONS LEARNT

In general, both the passengers and the drivers were satisfied with using and operating the electric buses. Noise generation, particularly while standing and during the bus stop approach, could be reduced as the driving noise of the electric bus wasn't lower compared to a diesel bus. The electric recharging at the depot requires different management from current refueling procedure (diesel bus = 10 minutes vs. electric bus = 5-8 hours). However, the charging infrastructure is easier to manage when not located in a public space, as there are fewer regulations and statutory provisions that need to be taken into account. The availability of electric buses does not correspond to that of diesel buses (e.g. the 12m electric bus had run around 11,000km in ten months, while a diesel bus would have run about 68,000km over the same period). As the electric buses are run on a full-service leasing basis, there is very little to be said about maintenance.

FUTURE PLANS

The two electric buses (12m and 18m) currently in operation will be returned to SILEO when the leasing contract ends in 2019/2020. The overnight charging infrastructure at the depot will be dismantled at the same time. BSAG intends to begin the procurement of series electric buses from 2019 onwards. The goal is to operate at least 55 electric buses until the year 2025. In addition, BSAG is preparing to extend its e-car sharing service in cooperation with the company 'Move About' located in Bremen, Germany.

> **Our aim is to offer passengers a sustainable mobility chain along with our local partners. However, this is only possible with sustainable local public transport as the backbone.**
>
> Hajo Müller, Commercial Director Bremer Straßenbahn AG

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Brussels

PROGRESSIVE ELECTRIFICATION OF HYBRID BUS NETWORK, USING EXISTING TRAM AND METRO INFRASTRUCTURE

OPTIMISED BRAKING ENERGY RECOVERY IN LIGHT RAIL NETWORK

USE CASE DESCRIPTION

Brussels public transport operator STIB worked on two use cases during the ELIPTIC project. The first, “Optimised braking energy recovery in light rail networks”, consisted of improving the energy efficiency of the Brussels tram network, with a focus on braking energy technologies. Tram lines 7, 19 and 94 have been studied in detail through an in-depth measurement process and the development of models and simulations. The second use case, “Progressive electrification of hybrid bus network using existing tram and underground electric infrastructure” consisted of a study undertaken jointly by STIB and VUB (Vrije Universiteit Brussel) to prepare for the pending electrification of the city bus lines. The two main objectives were to understand the operational implications of electrification and to evaluate its financial impact. The results of the study, made in the framework of ELIPTIC, directly influenced three recent electric bus tenders, shaping the vehicle and infrastructure requirements.

RESULTS AND LESSONS LEARNT

The first use case began with measuring the amount of energy dissipated by the tram braking resistors and analysing the energy flows. When applied through an energy model, the results showed that the majority of the braking energy is already reused, with a small portion of energy dissipated via the braking resistors. The study provides a clear message that the main focus to improve the tram network energy efficiency has to be concentrated on vehicle’s auxiliary consumption.

The second use case actions began by thoroughly measuring energy consumption on three bus lines. Based on this, VUB provided an eBus operating model that was used to estimate the entire fleet consumption in order to study the impact on the electrical grid. The study concluded that the grid is sufficiently robust to recharge the entire bus fleet overnight. Other potential impacts on infrastructure and operations were also addressed, helping STIB develop a strategy for its eBus migration.

FUTURE PLANS

Future plans for the first use case include projects to study the HVAC performance (including different regulation of heating and cooling temperatures), CO2 measurements, door-opening regulation and energy consumption reduction at the terminus. Future vehicles will include the possibility for a remote metering system that will allow STIB to balance automatically the energy. For the second use case, key aspects that will be considered in detail during the eBus deployment include grid stability and quality during charging, battery ageing during fast charging, safety aspects and interoperability of charging systems and electric buses.

> **“The various essential lessons learned during the ELIPTIC project will continue to significantly influence the Brussels bus electrification strategy for the coming decade.”**
>
> Benjamin Roelands, eBus Program Manager, STIB, Brussels

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Eberswalde

REPLACING DIESEL BUS LINES BY EXTENDING TROLLEYBUS NETWORK WITH TROLLEY-HYBRIDS (INCL. DEMO OF AUTOMATIC (DE)WIRING)

USE CASE DESCRIPTION

Barnimer Busgesellschaft is the public transport operator for the county of Barnim and in a part of Märkisch-Oderland. The company intends to convert its current diesel bus line 910 between Eberswalde and Finowfurt into a fully electric operation. This will use hybrid trolleybuses with sufficiently large energy storage rather than auxiliary diesel power units. One out of the 12 trolleybuses is already equipped with such energy storage; this served as a blueprint for the vehicle configuration used in the Eberswalde use case. The hybrid trolley bus is charged while it drives under the catenary, so-called “In-Motion-Charging”. With the existing catenary it is possible to recharge on the route, meaning there is no need for depot charging.

RESULTS AND LESSONS LEARNT

The Eberswalde studies show that hybrid trolleybuses are able to drive without a catenary. Public transport companies are able to enlarge the existing trolleybus operation without the high investment required for the catenary system. The battery configuration study shows that the charging power technical requirement is the most critical point for covering the route without catenaries. For Barnimer Busgesellschaft, trolley buses need a larger battery capacity to recharge for the next ride. Even weather conditions have to be taken into account. Under normal weather conditions, there is no problem for the hybrid trolley bus; however, in the event of cold winter days, the heating system can easily double the energy consumption. In future, it would be preferable to use efficient ways to heat the bus so as to avoid diesel heating systems.

FUTURE PLANS

The results of the feasibility study led to a second analysis with a modified energy storage concept. These batteries feature significantly increased charging power of up to 357 kW and a usable energy content of 38 kW. Using this vehicle configuration, hybrid trolleybus operation on line 910 is possible, as the battery can always be recharged while driving under the catenaries. Given these results, batteries will be installed in the entire fleet in a follow-up project between 2018 and 2019.

> **“The hybrid trolley system is the most sustainable solution for public transport. Existing trolley systems can be extended to the outskirts of cities, providing fully electric public transport.”**
>
> Frank Wruck, Managing Director of the Barnimer Busgesellschaft mbH (BBG)

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Gdynia

OPPORTUNITY (RE)CHARGING OF EBUSES CONNECTING TRI-CITY AGGLOMERATION BASED ON TROLLEYBUS INFRASTRUCTURE

REPLACING OF DIESEL BUS LINES BY EXTENDING TROLLEYBUS NETWORK WITH TROLLEY-HYBRIDS

OPTIMISED BRAKING ENERGY RECOVERY IN TROLLEYBUS NETWORK

USE CASE DESCRIPTION

The main objective of ELIPTIC project use cases in the city of Gdynia was to explore the possibilities of further public transport electrification in the city of Gdynia and neighbouring Sopot. These were jointly implemented by trolleybus transport operator PTK and the University of Gdansk. The use cases were based on the concept of in-motion charging of battery trolley hybrids from the trolleybus grid and extending existing trolleybus lines without having to build new wired infrastructure. As well as extending the existing lines off-wire, potentially replacing current diesel bus lines with battery trolley hybrids was also analysed. These would be charged in-motion from a trolleybus infrastructure, going off wire to cover former diesel bus routes. Within the project, PKT has also explored the benefits of installing a dual-power supply system. This software is placed at two spots of the trolleybus network, joining two pairs of substations and improving grid operation.

RESULTS AND LESSONS LEARNT

Following the analysis of the trolleybus lines best suited to off-wire extensions served by battery trolley hybrids (batteries on lithium cells), other trolleybus lines are now being considered to be extended (the first extension was a 2km extension of the line 21 launched in 2012 within the ELIPTIC forerunner project – CIVITAS DYN@MO). A trolleybus line extension successfully implemented within ELIPTIC was line 29 which began its extra 4km off-wire operation in December 2016 servicing the quiet residential Gdynia district of Fikakowo (the residents clearly expressed a wish to have a low noise and emission public transport service in place). There are a number of lines currently under consideration for the potential extension or replacement of diesel buses with battery trolley hybrids. In addition, installation of the dual-power supply system on the trolleybus network produced tangible results, increasing braking energy recovery, reducing overall energy consumption by 2-5%, levelling of voltage drops and stabilising the network.

FUTURE PLANS

The city of Gdynia is currently in the process of purchasing a fleet of 30 new trolley battery hybrids including 18 articulated models (the contract with the producer was signed in April 2018). In addition, it will exchange the old types of batteries in 21 trolleys currently in operation allowing them to be upgraded to trolley battery hybrids. In the near future, the city will be equipped with a substantial fleet of state-of-the-art battery trolleys hybrids able to cover many more off-wire courses, offering considerable potential for the wider electrification of public transport in Gdynia.

“ ELIPTIC project opened up new possibilities for greater public transport electrification in the city of Gdynia based on the currently-operating trolleybus transport and latest technological innovations implemented as part of the project. ”

Tomasz Labuda, Vice President of the Board, PKT GDYNIA

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Lanciano

LIGHT RAIL (TRAM) OPERATION FOR RURAL RAIL TRACK

USE CASE DESCRIPTION

TUA SpA, the transport operator for both bus and rail services in Regione Abruzzo, is evaluating the possibility of using the now-abandoned historic route of the “Sangritana” railway for a rural tram-train service. This would cross the city of Lanciano, connecting the areas of Marcianese (on the southwest side of city) and Santa Rita (on the north side of Lanciano), with a further extension from Santa Rita towards the town of Marina San Vito on the Adriatic coast. The length of the route will be 5.26km between Marcianese and Santa Rita, mainly within an urban environment with an additional extension of 9.18km between Santa Rita and Marina San Vito, mainly within an extra urban environment). A further extension beyond Marcianese as far as the village of Crocetta - inside the municipality of Castel Frentano - is also planned and will be implemented in a subsequent phase. The catchment of this system covers a population of around 45,000 inhabitants.

RESULTS AND LESSONS LEARNT

The results of the use case have still to be implemented. TUA SpA expects the system to become the backbone of the local public transport thanks to the regularity of the service and competitive travel times. The following benefits are expected:

- Improved environmental quality, due to the modal shift towards public transport
- Improved urban quality, provided by salvaging previously abandoned infrastructure
- Improved overall perception of public transport, since Lanciano currently has a weak and underused public transport system. Constructing the light tram-train system would represent a major breakthrough over the existing scenario

Introduction and management of the system should not present any major technological difficulties especially taking into account TUA’s specific experience in the sector as a railway operator.

FUTURE PLANS

The next steps will be pursue the practical implementation of the system. Further developments can be foreseen following two potential thematic areas. One within the scope of ELIPTIC: optimising the electric traction installations for compatibility with existing systems, energy recovery and interactions with other electrified systems. The other, outside ELIPTIC: innovative and low-cost technologies for safe operation of the system (controlling level crossings, potential interactions with satellite systems, etc.).

> **“The implementation of a modern tram-train system will be a great opportunity to introduce a positive image of public transport that is capable of reinventing citizens’ approach to personal mobility.”**
>
> Sandro Imbastaro, TUA manager and project coordinator

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Leipzig

OPPORTUNITY (RE)CHARGING OF EBUSES (USING TRAM INFRASTRUCTURE)

USE OF TRAM NETWORK SUB-STATION FOR (RE)CHARGING E-VEHICLES

USE CASE DESCRIPTION

The (re)charging of e-buses using tram infrastructure study aimed at evaluating all bus lines of the “Leipziger Verkehrsbetriebe” (LVB). These lines are predominantly served by 12m buses.

The work was based on both data measured on LVB bus lines 89, 74 line group 80 and on information on typical energy consumption figures from a Fraunhofer IVI data base. The objective was to identify the energy feasibility of battery bus operation for existing lines in Leipzig.

The criteria for evaluating the results covered both technical and economic feasibility. This analysis allowed for a step-by-step approach to allow LVB to progressively procure battery buses and their corresponding charging infrastructure.

LVB also conducted a study of existing energy law and regulatory questions on using public transport DC power grids for charging buses and for selling power to end users.

RESULTS AND LESSONS LEARNT

Using suitable bus operation schedules identified the demand for vehicles and charging stations. This allowed suggestions for the step-by-step replacement of mainly diesel buses with battery buses with opportunity charging. In addition, it was assessed whether stops were suitable for establishing charging stations.

Constructing the network of charging stations could be undertaken step by step. The goal was to match the maximum number of buses with the minimum number of charging stations required. For lines and line groups with less than three buses per charging station, the conversion is uneconomical.

The study of using tram network sub-station for (re)charging e-vehicles, led to a number of policy recommendations. An overview of the existing German legal framework for charging buses and electromobility was also undertaken.

FUTURE PLANS

The LVB plans to introduce its first battery-bus in 2019. Both AC and DC grid charges will be provided. The feasibility study made it clear that there is the potential for substituting approximately 35 of the existing 12m buses with battery buses during the next five to six years.

However, the use of multi-purpose electric public transport infrastructure currently poses a challenge, due to contradictory legal provisions that need to be harmonised.

> **“The conversion of city bus lines to e-buses can help the city of Leipzig achieve its strict environmental goals.”**
>
> Eberhard Nickel, Leipziger Verkehrsbetriebe (LVB) GmbH

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London

OPPORTUNITY (RE)CHARGING OF EBUSES AND/OR PLUG-IN HYBRID BUSES (USING METRO INFRASTRUCTURE)

USE OF METRO SUB-STATION FOR (RE)CHARGING TFL FLEET VEHICLES (E-CARS & E-VANS) AND ZERO-EMISSION CAPABLE TAXIS

USE CASE DESCRIPTION

The Transport for London (TfL) study on opportunity (re)charging of ebuses and plug-in hybrid buses using metro infrastructure aimed to understand the requirements for delivering scheduled services using fully electric buses.

The second TfL use case consisted of the use of the London Underground alternating current (AC) grid to supply energy for the recharging of electric vehicles other than buses, principally the support fleet vehicles TfL engineers use to go about their business and taxis.

RESULTS AND LESSONS LEARNT

The opportunity (re)charging of ebuses and plug-in hybrid buses study showed that the optimum strategy may be to combine overnight depot charging with short-interval opportunity charging at the ends of bus routes. Adopting this strategy would allow the route identified for the case study, which operates around the clock, to be served by the same number of vehicles as used currently by the diesel bus fleet at the same service levels even when factors such as battery degradation and heating of the passenger compartment were included.

As a result of the ELIPTIC trial, charging infrastructure for electric vehicles other than buses connected to the London Underground grid has been accepted for long term use and the vehicles that collectively use these charge points will reduce tailpipe CO2 emissions of the TfL support fleet by more than 13 tonnes annually.

FUTURE PLANS

TfL are in discussions to consider a large scale trial of using the London Underground electricity grid to recharge fully electric buses. This possible trial is far larger in scope than was proposed under ELIPTIC. If this project is successful it would open the possibility of wider use of the London Underground power infrastructure to support electric bus charging across London.

The work undertaken to use a metro sub-station for (re)charging e-vehicles has demonstrated there are circumstances in which using the London Underground AC network is both safe and economically viable.

As a result of the ELIPTIC trial, charging infrastructure for electric vehicles other than buses connected to the London Underground grid has been accepted for long term use.

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Oberhausen

OPPORTUNITY (RE)CHARGING OF EBUSES (TRAM CATENARIES AND SUB-STATIONS)

FAST-CHARGING STATIONS FOR E-CARS POWERED FROM THE TRAM NETWORK

USE CASE DESCRIPTION

The public transport operator Stadtwerke Oberhausen GmbH (STOAG) introduced in cooperation with transport association Verkehrsverbund Rhein-Ruhr on 4th October 2015 the purely electric operation of electric buses in the city on the urban bus lines 962 (line length 15,6 km) and 966 (line length 13,3 km). The deployed electric vehicles are SOLARIS Urbino 12 – one for each line - with low-floor technology and electric air conditioning systems. The drive takes place by the electric wheel hub motor ZF axle AVE 130 with two asynchronous motors. The charging energy (220 kW) is either taken transformed from the tram catenary at the train station Sterkrade (bus line 962) or from the sub-station at the station Neumarkt (bus line 966). During regular operation the electric buses are charged at the terminus stop. Charging at the bus depot during operation is not foreseen (just overnight slow-charging).

RESULTS AND LESSONS LEARNT

Both the passengers and the drivers are very satisfied with the electric buses as it comes to driving comfort, interior/exterior noise, riding comfort (acceleration, breaking) and aspects about environmental-friendly mobility and innovative technology. For the year 2017 approx. 17,000 litres of diesel were saved (based on 45% availability). Electricity costs are around €8,600 for the year 2017, compared to around €15,000 for diesel costs. It was possible to integrate the e-mobility strategy into day-to-day operations without major adaptations and investments. However considerable training sessions are required for drivers and other personnel (maintenance, control centre) to ensure the drivers qualification and trust into the new technology. Furthermore to be considered is that the characteristic of each urban bus routes require flexible and not unified solutions e.g. for various charging time and required energy. Desirable would be if a greater number of suppliers (e.g. charging infrastructure), would offer their products and services, and there would be common solutions for the pantograph and data communication available on the market.

FUTURE PLANS

From the beginning of winter 2018, four new electric buses will operate on bus line 979 jointly with the neighbouring public transport operator Vestische Straßenbahnen. Three of the four new buses will be purchased by STOAG and one by Vestische Straßenbahnen. These new electric buses are from the original equipment manufacturer VDL and have installed a charging technology differing from the current technology. Thus the decision was taken to charge the new electric buses solely at Sterkrade train station and the already operated buses at the station Neumarkt only.

> **“The use of the existing tram power system to charge our electric buses is an innovative solution. It contributes to support the aspirations of the city of Oberhausen for a clean environment in a sustainable way.”**
>
> Werner Overkamp, Managing Director
> STOAG Stadtwerke Oberhausen GmbH

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Szeged

REPLACING DIESEL BUS LINES BY EXTENDING TROLLEYBUS NETWORK WITH TROLLEY-HYBRIDS

MULTIPURPOSE USE OF INFRASTRUCTURE FOR (RE)CHARGING TROLLEY-HYBRIDS & E-VEHICLES

USE CASE DESCRIPTION

Szegedi Közlekedési Kft (SZKT) used 13 articulated IKARUS-SKODA trolleybuses with 80 kWh capacity batteries and 30kW charging power from the current collectors to replace diesel buses with hybrid trolleybuses. SZKT substituted the buses on route 77A (13.2km/7.4km battery moving) with the IKARUS-SKODA trolleybuses for two 15-day demonstration periods. During these demonstrations the University of Szeged conducted passenger surveys to explore social acceptance of the hybrid trolley technologies.

SZKT planned to install and test the first public electric multipurpose charging station for trolleybus hybrids, e-bikes and e-cars in the city of Szeged. In spring 2018, SZKT opened the multipurpose charger in the trolleybus depot in Szeged as a demonstration. The aim was to connect it to the commercial electric network at different locations, far from the trolleybus catenary (i.e. at the outer termini of the battery-trolleybus routes), and to give the possibility for recharging trolleybuses as well as e-bikes and e-cars as a park and ride service.

RESULTS AND LESSONS LEARNT

The short-term objective of replacing diesel buses by hybrid trolleybuses was to demonstrate the technological feasibility of hybrid trolley lines. During the surveys, SZKT discovered in particular a wide social acceptance for the trolleybuses, and generally new developments for electric transportation. The demonstrations were successful (almost 14,000km hybrid test runs in real-world operation) without any major technical issues. The articulated hybrid trolleys are too large for hybrid lines outside the city, so smaller buses would be necessary for permanent service.

At the outset of the multipurpose charger project, there were no public e-chargers in Szeged. Now SZKT has its own experience with the technology and operates two public chargers. The key for extending the line may prove to be a trolleybus charger for hybrid buses. However, existing standard electric car chargers available on the market do not fit trolleybuses. It is essential to push ahead and investigate the use of hybrid trolleybuses with standard charging solutions.

FUTURE PLANS

In the Electric Mobility Europe Trolley 2.0 project, SZKT, together with the University of Szeged and Evopro Bus Kft., plans to test in real world a prototype composite-frame hybrid trolleybus with an extended range that has been optimised for Szeged.

The next step in the development plan is to design a test line of autonomous charging battery driven trolleybuses, including the procurement of five vehicles. This project is designed to test and demonstrate in-motion charging and charging at the end-station with a multipurpose charger.

> **“The ELIPTIC demonstrations prove that the hybrid trolley extension with end-station trolleybus charger is a real and viable progress of the electric public transportation in Szeged.”**
>
> Dr. Zoltan Ádám Németh, public transport and railway safety director, Szeged Transport Ltd

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Warsaw

USE OF /TRAM
INFRASTRUCTURE FOR
RECHARGING E-BUSES

USE CASE DESCRIPTION

The municipal bus operator – Miejskie Zakłady Autobusowe Sp. z o. o., together with the Przemysłowy Instytut Motoryzacji (PIMOT, the Automotive Industry Institute) were involved in the ELIPTIC Project to assess the multi-purpose use of electric infrastructure belonging to other municipal transport operators. The aim was to use existing tram infrastructure for recharging ebuses, thus diversifying the electricity sources for e-vehicles. Use Case leaders have taken up and resolved all issues relating to implementing the project, specifically the legal (permits and agreements) and technical (design and implementation) issues, in order to allow the design, construction and operation of an electric plug-in bus charger. Warsaw has had a fully electric bus line passing through the most representative area in the city since 2015. Now, the ELIPTIC project is providing the opportunity for testing different charging options without the need to return to the depot; for example, electric buses can be charged during operational hours with electricity from the tram catenary. The research by PIMOT showed that charging from the tram network adds to financial savings.

RESULTS AND LESSONS LEARNT

The ELIPTIC Warsaw Use Case coincides with the long-term development strategy of the city, which involves major investment in developing and exploiting the benefits of environmental-friendly vehicles. Implementation of the project by MZA and PIMOT provided practical insights and valuable operational data on using electric bus chargers with power sources other than commercial electricity providers. Testing new models for the charging issue was essential for the public transport operator. We aim to create more places in Warsaw to charge e-buses and to develop the network of chargers both in the bus depots and on the bus routes. As predicted at the outset, the tram catenary is proving the cheapest energy source for electric buses. The experience gained in procedural and administrative processes while implementing this project provides valuable lessons for any future users of such a technological approach.

FUTURE PLANS

Warsaw, like every large city in Poland, faces problems with the air pollution. The strategy of the city is to strictly limit access for cars in the centre, develop public transport networks and increase the number of low-emission buses on the streets. In 2018 there will be already more than 30 ebuses in operation. In the years 2019 - 2020 MZA plans to purchase a further 130 articulated buses – this will increase the fleet of these electric buses to over 160 vehicles. Accommodating this number of new ebuses requires planning the development of charging infrastructure based on pantograph chargers located on the ends of the bus lines. Our goal is to streamline multimodal transport and support environmentally-friendly solutions in public transport.

“Each innovative solution is worth considering, because it is a challenge and helps create the future. The ELIPTIC Project demonstrated that we are able to diversify the sources of electricity for our e-buses.”

Jan Kuźmiński, President of the Board,
Miejskie Zakłady Autobusowe

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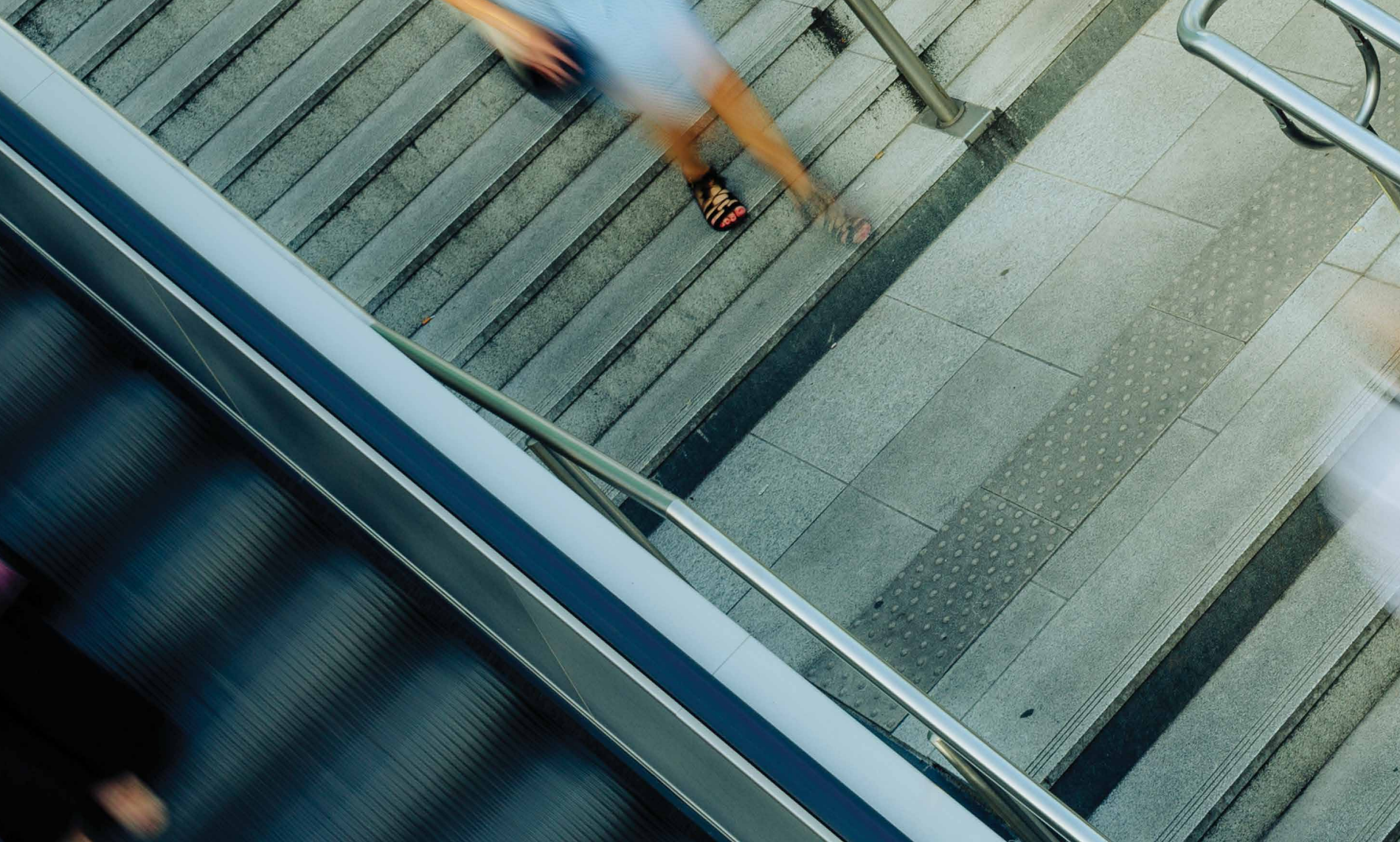

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