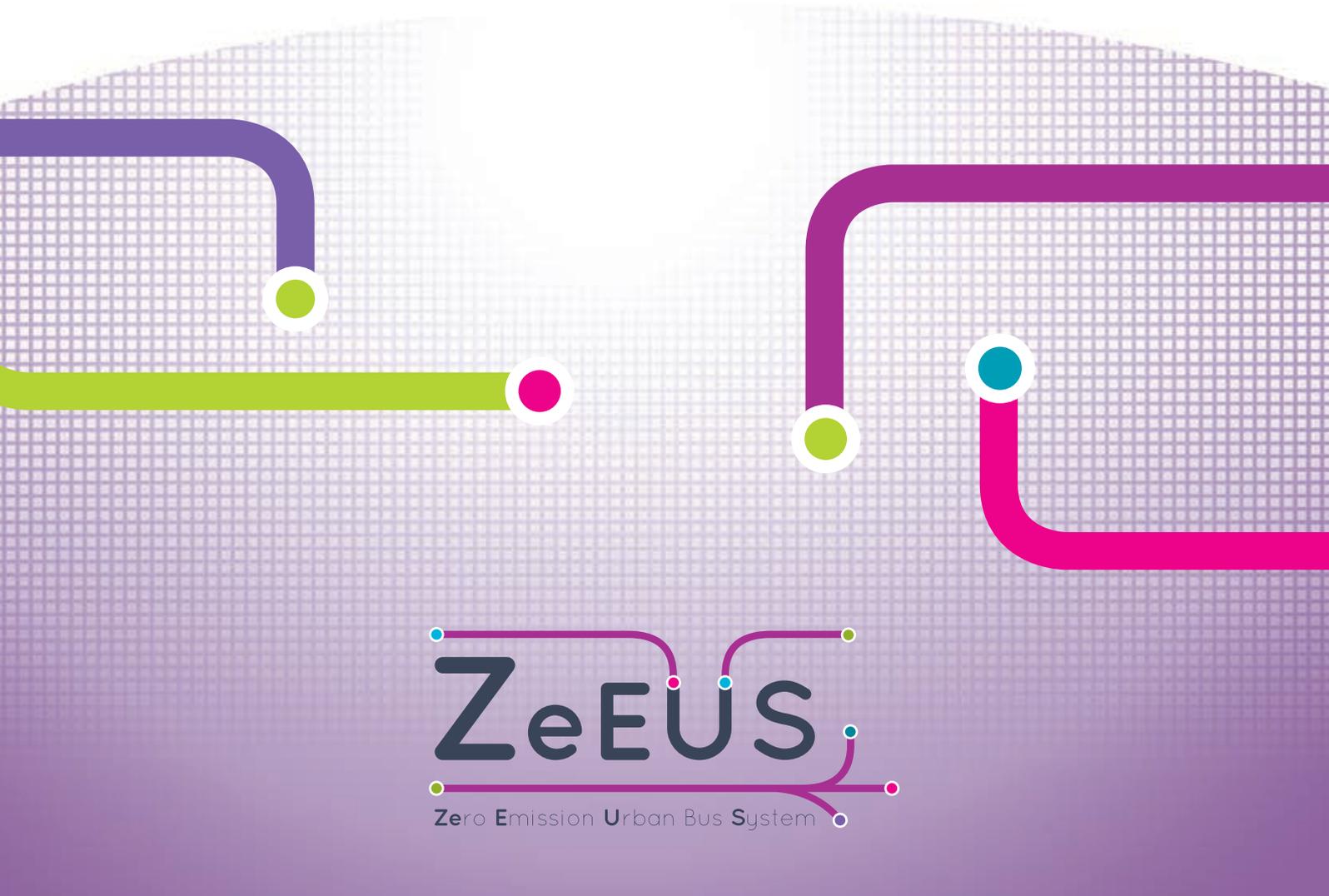


# ZeEUS eBus Report #2

An updated overview of  
electric buses in Europe



ZeEUS

Zero Emission Urban Bus System

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An updated overview of  
electric buses in Europe



## FOREWORD TO ZEEUS REPORT 2017

Profound changes in how we enjoy mobility are under way. Traditional approaches are being transformed through shared mobility services and easier shifts between transport modes. Technology and societal needs continue to drive change. Digitalisation, automation and alternative energy sources are challenging traditional features and creating new opportunities linked with resource efficiency and the collaborative and circular economy. However, such changes can also be disruptive. While they create new jobs, they can also make others obsolete. They call for new skills, good working conditions and need anticipation, adaptation and investment.

Transport needs to develop along a more sustainable path. With the COP21 Paris Climate agreement, efforts to reduce greenhouse gas emissions are becoming even more urgent. An energy-efficient, decarbonised transport sector is needed. An ambitious climate policy is integral part of Energy Union with a target of at least 27 percent share of renewable energy consumed in the EU in 2030.

Decarbonisation requires the development of technologies. The Commission is pushing forward the electrification of all modes of transport – road, rail, air and sea – using clean, renewable energy sources. Electrification of transport is one of the key technologies that will support progress towards improved energy efficiency, greater use of renewable energy and lower CO<sub>2</sub> emissions targets.

Recent events regarding diesel technology clearly show the limits of current technologies to achieve our goals and show the need for a clear technological shift.

Research should accompany this technological shift, making the technologies available for all, at a reasonable price (mass-market deployment), and helping the transition towards transport electrification. In this respect, ZeEUS is an excellent project which leads the way for the electrification of urban buses and which serves as a lighthouse to guide the transition towards low and zero emission urban mobility.

Innovation is crucial to support growth and jobs in the EU and to ensure the competitiveness of our industry. This revolution is not only about new technologies, but also about new business models and services offered to citizens.

Keeping the status quo is not an option. We need to move steadily towards an intelligent, energy-efficient, decarbonised, multi-modal, inclusive, affordable and safe transport system.

On 13 July 2017, the Commission launched the European Clean Bus Deployment Initiative. Further actions are underway to accompany the political commitments from public authorities, operators and manufacturers. Concrete support measures will be put in place to enable procurement of vehicles. Additional commitment from public authorities will be ensured through a number of events in the coming months. Together with the European Investment Bank, a Cleaner Transport Finance Facility has been established to enable more innovative financing.

At the beginning of an era of connected and automated vehicles, shared mobility, zero emissions, and easy shifts between transport modes, it is high time to prepare the future of mobility in Europe. Europe must move from the fragmented transport networks that exist today towards an integrated, modern and sustainable mobility system, which is connected to the energy and digital networks. Citizens and businesses must be offered safe, smart and seamless mobility solutions across Europe, and European infrastructure must be among the most advanced of the major global economies.

The Commission has put forward an agenda for the future of mobility in the EU, for jobs, growth and a socially fair transition. The comprehensive package of regulatory and support measures can make clean, competitive and connected mobility for all a reality and allow Europe to be a global leader in shaping the future of mobility.

To be effective in delivering on electromobility, all parties need to engage. We need long-term commitment by Member States and companies: partnerships, exchanges of best practice, research and innovation efforts. Industry must continue to innovate and make forward-looking business choices.

ZeEUS is a shining example of stakeholder commitment to deliver on electromobility and the efforts deployed by the project partners over the last years lay the foundations of future developments in the use of e-buses in the urban context.

**Claire Depré**

Head of Unit, "Sustainable and Intelligent Transport"  
Directorate-General for Mobility and Transport  
European Commission



## SHAPING THE NEW MOBILITY THROUGH INTEGRATED CLEANER BUS SYSTEMS

With COP23 upcoming, discussions on how we shape our cities and towns remain as vivid as ever. Buses represent a significant part of any public transport system and are often the only public transport mode in many cities. Although the transport sector contributes almost a quarter of Europe's greenhouse gas emissions, bus fleets contribute to city pollution only in very small part, responsible for 8% of transport emissions. However, the fact remains that almost 50% of buses across the EU are still of Euro III standard or older; this leaves much room for improvement.

In this context, UITP has signed the Clean Bus Declaration in order to promote the large-scale deployment of clean, alternatively fuelled buses in Europe. This places fleet renewal at the top of the political agenda.

A cleaner bus system offers a sustainable solution that public transport operators are committed to deliver. Therefore cities should put in place clear policies that promote the shift towards a more sustainable and integrated mobility, easing and encouraging the deployment of Public Transport dedicated infrastructure. This should favour the combination of mass transport with soft modes like cycling and walking as well as with shared modes such as bike sharing or car sharing. The objective should be to create a multiplier effect on quality of life and the liveability of cities.

Specific reduction targets for air pollution and noise levels combined with financial supporting schemes at regional, national and/or EU level have proven highly effective in supporting modal shift as well as clean bus deployment and fleet renewal.

As the ZeEUS project coordinator, UITP leads the way in supporting zero-emission transportation as a sustainable and efficient form of public mobility in our regions and cities.

The ZeEUS project and UITP provide the knowledge and materials to assist public transport stakeholders in choosing the right solution for their operational scenario and implementing a suitable strategy to reduce urban transport emissions.

The ZeEUS eBus Report #2 aims to provide an updated overview of the European market for electric buses. With 90 cities already included in the publication and over 20 million km driven in electric mode, there is a clear, growing trend towards electrification of buses. With more than 100 new cities committed to deploying electric buses in their fleets in the coming months\*, we are seeing a genuine breakthrough towards cleaner and quieter cities.

We would like to express our deepest gratitude to all public transport operators, authorities, manufacturers and suppliers for their invaluable contribution to this unique report. Above all, we thank them for taking up the e-bus challenge and being true pioneers in the transition to zero-carbon transport systems for our cities and regions.

\* see map at the end of the report

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Director of Research & Innovation  
UITP

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## ACKNOWLEDGMENTS



# CHAPTER 1: INTRODUCTION

# What is an electric bus?

While electric buses (or 'e-buses') come in different types, the name always refers to a motor road vehicle that is mostly emission free at the point of operation. Because they are battery-driven and have a lower environmental impact than an internal combustion engine bus, they are usually viewed as 'clean' and 'green', particularly when charged with electricity derived from renewable energy sources.<sup>1</sup>

**In line with the ZeEUS project scope, the current report focuses on the following categories of e-buses. However, we acknowledge that other categories are in operation with different propulsion schemes (hybrids, or fuel cells) and/or capacity (mini and midi buses).**

## (1) The ZeEUS project focuses on:

**a. Plug-in hybrid buses** (PHEVs) are hybrid electric vehicles that use rechargeable batteries or other energy storage devices that can be recharged by connecting them to an external electric power source. PHEVs share the characteristics of both a conventional hybrid electric vehicle, with an electric motor and an internal combustion engine (ICE) and an all-electric vehicle equipped with a plug or other device to connect to the electrical grid. Diesel hybrids (as they exist in the current bus market) are excluded from the scope of the project and from this publication.

**b. Full battery electric buses** (BEVs) are all-electric or purely electric vehicles with an electric propulsion system that uses chemical energy stored in rechargeable battery packs. BEVs use electric motors and motor controllers for propulsion in place of internal combustion engines (ICEs). They have no internal combustion engine, fuel cell or fuel tank and derive all their power from their battery packs. Battery buses are charged statically using mechanical and electrical equipment.

**c. Battery trolleybuses: also referred to as dual-mode trolleybuses** (China) or hybrid trolleybuses (Germany). These are bus-type vehicles propelled by an electric motor, drawing power from overhead wires via connecting poles called trolleys. Power is supplied either from a central power source that is not onboard the vehicle or via on-board rechargeable batteries. This enables the vehicles to run electrically while independent of the overhead wires for part of their route while maintaining full operational capability. Battery trolleybuses are charged dynamically using the existing trolleybus catenary, or in when static with a device for connecting to the electrical grid. Trolleybuses with auxiliary-only batteries are considered proven technology and are therefore excluded from the scope of the project and from this publication.

(2) The ZeEUS project focuses its activities on high-capacity buses, for which there is no current legal definition. The UITP Secretariat's definition of 'high capacity' is a bus that can carry **at least 55 passengers**, including both standing and sitting. Proven commercial solutions for smaller electric buses (minibuses and midibuses) have existed in the market for some time and hence are excluded from this publication.

(3) The vehicles included are currently **in full revenue operation** or will be ready for exploitation by December 2017 at the latest.

## Towards a more efficient and equitable use of scarce resources

As a minimum requirement, deploying alternatively fuelled or electric buses should not reduce overall service quality, reliability, passenger comfort, etc.

To reduce CO<sub>2</sub> emissions in cities, the key strategy of 'avoid/shift/improve'<sup>2</sup>, involves encouraging people to shift from individual transport to public transport and 'soft transport modes'. In part, this is done by making urban buses, the backbone of public transport, more appealing.<sup>3</sup> In this regard, supporting fleet renewal with clean vehicles, as well as policies in favour of a shift towards public transport, should help achieve cleaner cities and improve urban mobility. In other words, moving away from polluting and congestion-causing cars to clean and space-saving buses is extremely desirable.

1 "We define 'Green Vehicles' as vehicles with 'new' technologies, seen as 'green'. Technologies as fuel cell electric vehicles (FCEV) or hydrogen driven vehicles, hybrid electric vehicles (HEV) or fully electric vehicles (EV) with or without plug-in devices, vehicles powered by gas, bio-fuels or dedicated new Internal Combustion Engines (ICE) with a strong reduction on environmental impact." European Road Transport Research Advisory Council, European Roadmap: Infrastructure for Green Vehicles (October 2012), p. 5: [http://www.ertrac.org/uploads/documents\\_publications/Roadmap/Infrastructure-for-green-vehicles\\_final-october-2012\\_65.pdf](http://www.ertrac.org/uploads/documents_publications/Roadmap/Infrastructure-for-green-vehicles_final-october-2012_65.pdf)  
2 <http://www.uitp.org/sites/default/files/Decarbonisation%20-%20the%20public%20transport%20contribution.pdf>  
3 [http://www.uitp.org/sites/default/files/cck-focus-papers-files/UITP\\_PositionPaper\\_Bus%20Systems%202015.pdf](http://www.uitp.org/sites/default/files/cck-focus-papers-files/UITP_PositionPaper_Bus%20Systems%202015.pdf)

# Moving forward to define the future

Growing concerns among the general public and governments over urban congestion, air pollution and its associated health threats have led to calls for policies to curb the emissions from transport. Influenced by national energy policies and more driven by environmental and societal requirements than by commercial considerations, low- and zero-emissions transport systems are increasingly favoured, triggering significant developments in the deployment of electric buses in recent years.

The growing interest from urban mobility stakeholders in deploying clean buses was already highlighted in the first version of the ZeEUS eBus Report: over 40% of the operators and authorities surveyed were keen to switch to electric traction options and, within that category, mainly to hybrid and fully electric with batteries<sup>4</sup>. Exploring this further, ZeEUS and the UITP VEI Committee investigated scenarios for how the urban bus market will evolve in Europe by propulsion technology (Fig. 1). The results showed an increasing trend for pure electric powertrains such as battery-electric and fuel cells, while clean diesel showed a marked decrease. Technologies such as diesel-hybrid and CNG and/or biogas retained a stable percentage of the market.

For the demand side in Europe, it appears to indicate a preference for battery-electric buses among operators and authorities, with almost 75% of the current e-bus stock powered by batteries alone<sup>5</sup>.

At ZeEUS, we believe that part of the current mobility challenges faced by our cities can be addressed through the contribution of public transport, particularly by advanced bus systems. These will contribute to reducing emissions and help achieve a modal shift from private cars to public transport.

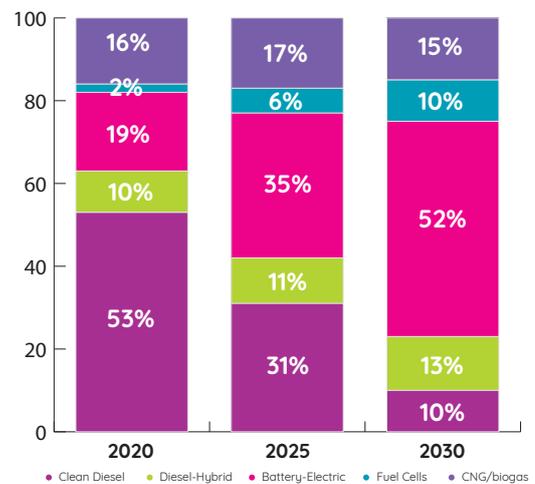


Fig. 1: European Urban Bus Market Evolution  
Source: ZeEUS and UITP VEI Committee

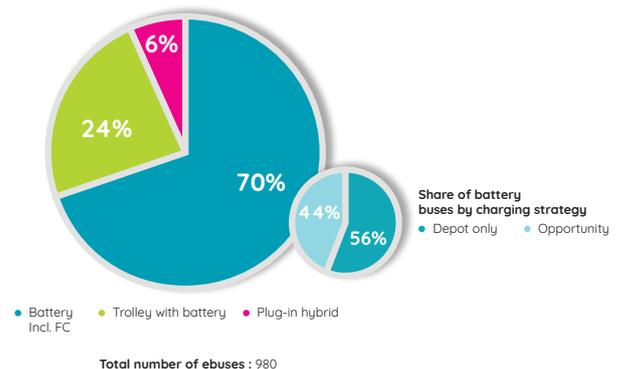


Fig. 2: Electric bus technologies in Europe in 2017  
Source: Alexander Dennis Limited

## What urban transport are we aiming for?

“An endless number of green vehicles does not make a sustainable transport system”<sup>16</sup>

Public transport and urban buses are a vital component of city life; the quality of life and the attractiveness of a city is regularly reflected in the standard of its public transport. While urban mobility needs continue to grow, designing a public transport system capable of attracting citizens and visitors is a major goal for ensuring the sustainability of our cities.

To be efficient, urban buses must be approached as a coherent system that embraces the vehicle, the infrastructure, the operation and the users. This system should act as part of the backbone of the entire mobility chain, integrating with the various transport modes available, thus ensuring that combined mobility is inclusive, efficient, user-friendly and safe.

The ZeEUS project is making a crucial contribution to boosting the market uptake of e-buses by providing the tools that support decision-making and creating networks for knowledge exchange. Transport authorities, operators, the energy industry and academia have joined forces to establish the base for the effective electrification of public transport. This will lead to healthier, more attractive and more liveable city environments.

4 3iBS project co-funded by the European Commission under the 7th Research and Technological Development Framework Programme (FP7), Research and Innovation Directorate-General, www.3ibs.eu, 2013

5 eBus technologies considered are battery buses (depot only and opportunity charged), plug-in hybrid buses, trolleybuses with batteries for off-wire operation). Countries included are: Austria, Belarus, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Italy, Latvia, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom

6 Paraphrasing Jan Gehl, Gehl Architects, on green cities.

A successful transition to a low- and zero-carbon transport system is now more pressing than ever. The rapid growth of urbanisation affects the city resources and infrastructure. Effective and prompt action is needed to put mobility solutions in place able to address the needs of users and society sustainably.

Choosing the right technology and using it in its ideal operational conditions is fundamental to achieving this goal. Currently, the propulsion technologies used in the bus sector are diverse. Although there has been some progress in greening bus fleets, almost 50% of the buses in use across Europe are Euro III or older<sup>7</sup>. In total, 80% of bus fleets are still running with diesel engines. These are becoming cleaner, meanwhile the European bus sector has heavily invested in developing cleaner propulsion technologies; biofuels, biowaste, natural gas, fuel cells and electric buses.

In Europe, 40-50% of public transport is already powered by electricity<sup>8</sup>. As well as trolleybuses, hybrid electric buses are on the verge of becoming a reliable technology (although fully electric buses are still viewed as an experimental technology<sup>9</sup>); a solution is still being researched, developed and tested. However, in many cities public transport operators and authorities are demonstrating their commitment to electrifying part of, or even their entire, fleets. In those densely-populated and megacities facing severe pollution threats, local authorities have begun using both their procurement plans and tenders to force and/or support the introduction of cleaner vehicles for public transport services<sup>10</sup>.

UITP considers that new propulsion technologies should be developed continuously and tested under local, real-life conditions in order to increase their availability and reliability. Furthermore, UITP also encourages exchanging test results and examining their transferability. Most importantly, to make the transition effective following local testing, UITP supports accelerated deployment and fleet replacement measures.

# Worldwide market update: observed dynamics and trends

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The last decade has seen progressive and positive developments in e-bus technology, led mainly by China, closely followed by Europe and the USA.

The successful deployment of the first full battery e-buses during the Olympic Games in Beijing in 2008, followed by the launch of a 12m full-battery electric bus with a range of 250-300 km in 2010, opened up the e-bus market for Chinese manufacturers. American and European bus manufacturers rapidly developed their own e-bus models, which were initially tested in small-scale pilots of one or two vehicles. Subsequently, the operations matured into larger schemes and shifted entire bus lines from ICEs to electrical power.

In recent years, cities including London, Nottingham, Eindhoven, Amsterdam, Paris and Warsaw have placed larger orders for e-buses. Other cities are expected to follow, heralding a ramp-up in production to address the increasing demand.

At the same time, the high number of products launches by e-bus manufacturers, and the appearance of new manufacturers, are indicative of the increasing level of competition within the sector. Public transport operators are beginning to focus more on the long-term than the upfront costs, thanks to funding backup from governments and venture capitalists.<sup>11</sup>

With China, the USA and Europe as frontrunners, many other pioneering countries are joining the transition to the electrification of the bus systems.

The global sales for e-buses are expected to grow at a rate of 33.5% annually for the period 2017- 2025, reaching an estimated volume of 33,854 units by 2020.<sup>12</sup>

7 3iBS Priority actions for the fast development of innovative Bus Systems in European cities, year of publication? <http://www.3ibs.eu/uploads/fichiers/publications/priority-actions-for-the-fast-development-of-innovative-bus-systems-in-european-cities.pdf>.

8 Decarbonisation: the public transport contribution, UITP Paper.

9 3iBS Priority actions for the fast development of innovative Bus Systems in European cities, <http://www.3ibs.eu/uploads/fichiers/publications/priority-actions-for-the-fast-development-of-innovative-bus-systems-in-european-cities.pdf>.

10 For more details about these cities, please see Chapter 2: Cities.

11 Persistence Market Research PVT. LTD. (2017): "Global Electric Bus Market Size, Share, Development, Growth and Demand Forecast to 2025 - Industry Insights by Technology (Pure Electric, Parallel Hybrid, Series Parallel Hybrid, and Series Hybrid), by Size (Above 10 Meters, and Below 10 Meters)".

12 Persistence Market Research Report (2016): "Global Market Study on Electric Bus: Asia Pacific to Witness Highest Growth by 2020".

According to the IEA Report – Global EV Outlook 2017<sup>13</sup>, the global battery-powered electric bus stock grew to approximately 345,000 units in 2016 (an increase of 100% over 2015), with China emerging as global leader. The stock of electric vehicles in China reached 343,500 units in 2016, including around 300,000 battery-electric vehicles.

The production volume of New Energy Buses (the Chinese policy term referring to battery electric, hybrid plug-in electric and fuel cell electric buses) reached 135,305 units in 2016. The main New Energy Bus manufacturers include BYD, FOTON, Nanjing Golden Dragon Bus, Yinlong, Zhengzhou Yutong and Zhongtong Bus.

In **Europe**, total estimated electric bus stock reached 1,273 units in 2016 (an increase of 100% over 2015), while the United States accounted for 200 units. The increase in European stock suggests that the European market is moving beyond the demonstration phase into commercial development. According to a market forecast exercise carried out in the frame of ZeEUS on the evolution of the urban bus market, by 2030 the share of battery-electric buses is expected to reach 50%.<sup>14</sup>

The United Kingdom, the Netherlands, France and Poland are the major European markets for e-buses. In May 2015, for example, Transport for London (TfL) announced the electrification of its route 312, operated by Arriva. Initial trials were undertaken using two Optare MetroCity single-deck electric buses to establish whether the technology could endure the rigours of operating in an intense urban environment such as London. Immediately following the trial, in 2016, TfL announced they would introduce five fully-electric double-decker buses on Route 98, which passes through a well-known pollution hotspot. Additionally, a large fleet of battery e-buses has been developed through a successful cooperation between BYD, which provided electric technology, and Alexander Dennis, which provided the bus body. This collaboration has seen more than 50 e-buses already in operation, with more are coming soon, including double-deckers.

Another example is the Paris transport operator, and partner of the ZeEUS project, RATP. It launched its first electric bus line in 2016. RATP is now preparing to broaden the electrification of the bus lines, with plans to replace 80% of its existing fleet (about 4,000 buses) with e-buses by 2025.

In the **USA**, the e-bus manufacturer Proterra doubled its sales in 2016; however overall sales remain modest, with 380 e-buses sold since the company's foundation in 2004. The electrification of the mass transit fleets is steadily progressing, particularly on the west coast, with increasing numbers of transit agencies announcing new purchases of electric buses with the goal of achieving full-electric fleets in the near future. In addition, Chinese competitor BYD has entered the US market with some success. BYD delivered its first 18-m fully-electric bus earlier in 2017, the first of 13 e-buses it will deliver to Antelope Valley Transit Authority (AVTA) in Los Angeles County, as part of AVTA's award-winning campaign to fully electrify its fleet by 2018.<sup>15</sup>

**China** is one of the few developing economies worldwide that has taken initiatives to curb air pollution by introducing electric buses. Growth in the electric bus market remains strong and the charging infrastructure is developing dynamically, supported by favourable subsidies from central government. In 2016, for example, the Chinese Ministry of Transport provided manufacturers of new energy buses with subsidies and tax benefits as well as grants of \$81,600 per electric bus purchase.

This has stimulated growth in new energy vehicles<sup>16</sup>, particularly in bus fleets. According to the Chinese Ministry of Transport the number of sold in 2016 of e-buses exceeded 160,000 units. In the same period, the number of e-vehicles dedicated to urban logistics reached 94,000 units and taxis more than 18,000 units. Following this growth phase, the central government has now reduced subsidies for purchasing electric buses by 20% and the subsidy will be reduced further year-on-year until 2020. The national annual sales of new energy buses by 2020 is expected to reach 200,000 units, while the fleet of urban logistics vehicles and taxis should reach 100,000 units.<sup>17</sup>



▲ Shenzhen e-bus fleet is fully electric  
Source: Shenzhen Commercial Daily / Shenzhen Bus Group Co., Ltd.



▲ Fully-electric double-decker bus crosses Westminster Bridge  
Source: BYD

<sup>13</sup> <https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf>.

<sup>14</sup> Market share scenarios for clean diesel, hybrid, battery-electric, fuel-cells and CNG buses by 2020, 2025 and 2030, carried out by ZeEUS in cooperation with the UITP Vehicles and Equipment Industry Committee.

<sup>15</sup> <https://electrek.co/2017/05/04/byd-all-electric-bus/>

<sup>16</sup> The term "new energy vehicles" refers to vehicles that are fully or partially powered by electricity (2011, World Bank & PRM Management Consultants, Inc. : «The China New Energy Vehicles Program. Challenges and Opportunities»)

<sup>17</sup> <http://finance.people.com.cn/n1/2017/0227/c1004-29111030.html>.

Shenzhen City remains at the front of the electrification of the bus sector. The city is about to complete the electrification of its fleet and is expected to have reached over 16,000 e-buses by the end of September 2017. In addition, the subsidies provided for charging infrastructure have doubled in 2017. Shenzhen City has 32 charging operators, 166 charging stations and 1,832 fast charging points for e-buses. The charging infrastructure for electric cars consists of 2,365 fast-charging points and 19,232 slow-charging points.

By 2020, Shenzhen City is expected to have 8,246 fast-charging points for e-buses, capable of charging between 16,500 and 24,738 pure electric buses.

Shenzhen Bus Group Co. Ltd. is one of the three major bus operators in Shenzhen. In June 2017, it achieved the full electrification of its fleet and currently operates 5,698 pure electric buses on 364 lines.<sup>18</sup>

Regarding the automobile sector, the China Association of Automobile Manufacturers (CAAM) forecasts that China's low-emissions vehicle sales will hit 800,000 in 2017. Of these, passenger vehicles account for approximately 70%, up from 65% last year. Based on these figures, new-energy commercial vehicle sales volume are likely to reach 240,000 in 2017, including up to 190,000 new-energy buses. In view of bus market growth from urbanisation as well as increased penetration in the highway bus market following technology maturation and cost reductions, China's new-energy bus sales volume is predicted to exceed 250,000 units by 2020.<sup>19</sup>

Led by China, the Asia-Pacific region accounted for the greatest number of shipments in the global e-bus market in 2016. The Chinese e-bus market is expected to continue to grow significantly in the coming years as a consequence of increasing urbanisation and development of several newly-built advanced public transport systems in its smart cities.

The demand for wirelessly-charged buses, globally speaking, is relatively slow. Nevertheless some experience in the field has been undertaken in **South Korea**, where a wirelessly charged electric bus, called an 'on-line electric vehicle' (OLEV bus system), was launched to test induction charging for e-buses. The technology was developed by the Korea Advanced Institute of Science and Technology in 2014. Two buses began commercial operations, first in Gumi City on a 24km route with 500m of power supply lane then later in Sejong City. However, the current state of these projects is unknown.<sup>20</sup>

The Land Transport Authority of **Singapore** initiated a trial on three bus routes using a BEV (model BYD K9) operated by Go-Ahead Singapore to assess the suitability of e-buses for public transport. The pilot, which ran from November 2016 to May 2017, could lead to the introduction of further e-buses into the region's public transport system.

Trolleybuses with an autonomous off-wire stand-alone course, equipped with batteries – also known as dual-mode trolleybuses – have been tested in a number of cities in **Russia, Belarus, Moldova and Kyrgyzstan**. A dual-mode trolleybus, able to run up to 15 km independently of its connecting poles, was operationally tested in Saint Petersburg in 2014. New trolleybuses with extended autonomous runs 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.<sup>21</sup> In Belarus, the Minsktrans public transport operator has confirmed an order for charging stations and e-buses, in accordance with their 2017 plan.

During 2016, Moscow transport operator Mosgortrans tested a range of electric bus technologies from Russian, Belarusian, Finnish and Chinese manufacturers, in order to define the final requirements for Moscow's e-buses. In September 2017, the Technical Council on the Prospects of Electric Transport Development in the Moscow region met in Vidnoye to discuss the draft document elaborated by Mosgortrans, which described the technical specifications for introducing e-buses in Moscow. More than 150 manufacturers, researchers and transport experts discussed the features of e-buses, batteries and concepts for implementation. In addition they considered the specific needs for efficient operation on the Moscow routes, where the challenging climatic conditions have an impact on battery performance. The plan is to open a tender for the provision of 300 e-buses by the end of 2017.

Mostransavto, the transport operator of the Moscow region, announced the development of trials of the KAMAZ trolleybus in Odintsovo. Further tests are planned with the new Trolza-5265 trolleybus model with dynamic charging. In the Moscow region, trolleybuses operate in the cities of Khimki, Vidnoye and Podolsk.

In addition, the city of Dnipro in **Ukraine** launched a new trolleybus route in August 2017, connecting the city centre to residential areas. The trolleybuses are equipped with lithium-ion batteries, allowing them to run autonomously for at least 15 km. The remainder of the route is performed with power from the overhead network.

In **Turkey**, Istanbul's operator IETT has experience with hybrid Bus Rapid Transit (BRT) and has previously tested e-buses. In early 2017, IETT announced the purchase of 200 e-buses. In 2016, Konya became the first city in Turkey to introduce e-buses for mass transit. Since then, the country has increasingly turned to electric vehicle production, with several companies developing electric cars as well as making deals for production overseas. Despite the limited number of



E-Karat in operations  
Source: [www.btgunlugu.com](http://www.btgunlugu.com)

18 [http://www.sznews.com/news/content/2017-08/09/content\\_16960311.htm](http://www.sznews.com/news/content/2017-08/09/content_16960311.htm) (accessed August 2017).

19 [http://www.chinadaily.com.cn/business/motoring/2017-01/03/content\\_27842725.htm](http://www.chinadaily.com.cn/business/motoring/2017-01/03/content_27842725.htm).

20 [http://cleanairasia.org/wp-content/uploads/2016/09/05-KOTI\\_Electric-Bus-System-in-Korea\\_JinYoungPark.pdf](http://cleanairasia.org/wp-content/uploads/2016/09/05-KOTI_Electric-Bus-System-in-Korea_JinYoungPark.pdf).

21 <http://www.eurasia.uitp.org/sankt-peterburg-trolleybus-tests>.

electric vehicles deployed in public transport, Turkish cities are progressively adopting the new technology. The Turkish manufacturing sector is also developing. The first 100% Turkish e-bus, the E-Karat, manufactured by Bozankaya, was launched at the IAA Hannover Fair in 2014 and began carrying passengers in Konya and Eskisehir in 2016. An agreement between two Turkish companies to produce a further 900 new E-Karat e-buses in the province of Bursa has been announced.<sup>22</sup> Meanwhile, as well as Bozankaya, the manufacturer Otokar has also developed its electric bus offerings.

The e-bus market in **India** is still at a nascent stage, although the strong push from the national government to promote electric mobility is beginning to deliver results. A few hybrid and biogas buses are in operation and most of the cities are currently conducting pilots for electric buses. However, to date there are no examples of commercial operation.

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 Chinese company, the Bangalore Metropolitan Transport Corporation (BMTTC) has announced that it intends to purchase 150 electric buses by the end of September 2017. With this, Bangalore is likely to be the first city in India to launch bus transport operations with such a sizeable fleet of electric buses. The Indian government initiated the 'Faster Adoption and Manufacturing of Hybrid and Electric Vehicles' (FAME) scheme to promote the adoption of electric buses. The focus areas for the FAME scheme are fiscal and tax subsidies, purchase of electric (and hybrid) vehicles, e-bus city trials and development of infrastructure.

Other operators have also initiated procurement actions to set up their e-bus fleets. For example, supported by the FAME scheme, Navi Mumbai Municipal Transport has acquired five Volvo 8400 hybrid buses. In addition, the Mumbai Metropolitan Region Development Authority has procured 25 Tata Starbus Diesel Series hybrid electric buses.

BEST Mumbai received funding to retro-fit six buses with AV Motors and procure an additional six 30-seater electric buses with a range of 210 km from Impact Automotive Solutions Limited (a subsidiary of KPIT), supported by a grant from the Brihanmumbai Municipal Corporation. In addition, the corporation has placed an order with BYD-Goldstone to set up the buses as feeder services to the train and metro stations.

Finally, Thane Municipal Transport has approved a plan to introduce 100 e-buses using a Public-Private Partnership model. The private operator will purchase and operate these buses for 10 years on selected routes.

In June 2017, India's leading bus and truck manufacturer, Ashok Leyland, tested 'Circuit', the first 'made in India' fully-electric bus for the Metropolitan Transport Corporation (MTC) in Chennai. As of July 2017, Ashok Leyland also announced a strategic partnership with SUN Mobility to develop a battery-swapping system for e-buses in an initial step for intra-city buses. Tata Motors, another Indian company, completed its first commercial pilot of an electric bus in April 2017.

JBM Solaris, the joint venture between JBM Auto and the Solaris Bus & Coach SA, is planning to manufacture India's first 100% electric buses, called Ecolife. This e-bus was unveiled at the 13th Auto Expo Show in February 2016. Production will commence in 2017 at Kosi, Uttar Pradesh.<sup>23</sup>



Electric bus in Bangalore  
Source: Ramesh NG, Bangalore



Electric bus in the Ola e-fleet in Nagpur  
Source: auto.ndtv.com

In Nagpur (Maharashtra), the leading utility vehicle manufacturer Mahindra and app-based taxi service provider Ola Cabs entered into a partnership with the Indian government to introduce 200 electric vehicles (buses, cars, taxis and rickshaws) using the Ola platform. A number of manufacturers, including Tata Motors, BYD and TVS, are also contributing to the initiative. The pilot project also includes installation of over 50 charging stations across the city to support the pilot.<sup>24</sup>

In September 2017, Shri Nitin Gadkari, Union Minister for Road Transport and Highways, announced the launch of a fleet of electric buses, taxis, cars and rickshaws in Gurgaon by the end of the year. This demonstrated the Government's commitment to reducing pollution and dependence on fossil fuels. The fleet will be operated by Treasure Vase Ventures Private Ltd, in partnership with Delhi Metro, under the SmartE brand.<sup>25</sup>

The e-bus sector is gaining pace in the **US** market, particularly on the West Coast. In recent months, increasing numbers of operators have announced the launch of new electric lines and approved plans for new purchases of e-buses. This has been further supported by the announcement of ambitious goals to fully electrify their fleets by 2030. For example, the Regional Transit District of San Joaquin in California opened

22 <https://www.dailysabah.com/automotive/2017/03/28/karsan-bozankaya-to-produce-electric-buses>.

23 <http://in.telematicswire.net/jbm-solaris-to-introduce-electric-buses-in-india-invests-rs-300-crore/#URgF9pD5rFPcReKq.99> (accessed Sep 2017).

24 <https://auto.ndtv.com/news/mahindra-and-ola-to-power-indias-first-electric-mass-mobility-ecosystem-1704437> (accessed Sep 2017).

25 <http://in.telematicswire.net/electric-fleet-on-roads-by-end-of-this-year-promises-nitin-gadkari/#AfhQwW6YyyP3HVoX.99> (accessed Sep 2017).

the first all-electric BRT line in the USA in August 2017. The Proterra e-buses can travel up to 40 miles (65 km) or two hours on a single charge, which takes about 10 minutes to deliver.

The Los Angeles County Metropolitan Transportation Authority (Metro Los Angeles) is one of the largest transit agencies in the USA and operates one of the largest fleets, with 2,200 buses (entirely CNG (Compressed Natural Gas) buses). In August 2017, the Metro Board approved an order to purchase 95 new e-buses: 60 x 12m BYD, and 35 x 18 m articulated New Flyer. Metro also announced its goal of achieving a fully-electric fleet by 2030. With this new purchase, the share of e-buses in the fleet will reach 5%, double of the current number of e-buses in operation in California.

Ambitious plans are also ongoing at King County Metro Transit in Seattle. In March 2017, the agency released a report stating that the transition to a full-electric fleet would be possible by 2034, and at minimum cost increases. The current fleet has 1,400 buses, mainly trolleybuses and diesel hybrid e-buses. These efforts to green the fleet are enhanced by the announcement of the purchase of 120 vehicles by 2020 (of which 72 will be Proterra e-buses). After 2020, all new purchases will be electric. Further plans include the purchase of up to nine long-range e-buses (\$7 million) from a variety of manufacturers to test the battery technology with a range of about 140 miles (225 km). Metro is calling upon the industry to develop 60-foot (18m) buses, better suited for replacing the articulated buses that make up 55% of its fleet.<sup>26</sup>

The Electric Program of Foothill Transit is likewise paving the way to a zero-emissions bus system in Los Angeles. The agency is promoting its plan to be fully electric by 2030 and is in the process of purchasing 17 Catalyst E2 Proterra e-buses, which entered service in June 2017. By October 2017, 10% of the Foothill Transit fleet will be electric.<sup>27</sup>

Approximately 200 full battery electric buses were delivered in the **USA** during 2016, with the greatest number currently operated by Foothill Transit in the Los Angeles region (California).<sup>28</sup>The North American market is also characterised by the presence of American, Canadian and Chinese OEMs.

Last year, the US Department of Transportation announced \$55m in competitive grants to encourage deployment of more zero-emission buses across the country<sup>29</sup>. 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 establishes a demonstration and purchase requirement for zero-emission technologies for large transit agencies. As operators gain experience with zero-emission bus technology and as the technology evolves, purchase requirements are expected to increase with the goal of transforming the state-wide transit bus fleet by 2040<sup>30</sup>.

In **Canada**, the Société de Transport de Laval (STL) purchased an electric bus in 2012 and tested it during 2013-14 before entering 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 came 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) purchased three full-electric buses and installed two fast-charging stations and four slow-charging stations, in order to test the technology in a real life operating context between 2016-2019, as demonstrated at the UITP Global Summit in May 2017.

STM has been operating 51 biodiesel-electric hybrid buses since the end of 2016. By 2018, these should represent about 12% of the overall fleet.<sup>31</sup> Since June 2017, STM has also been testing three e-buses as a first step towards the full electrification of its fleet by 2025. Fast-charging stations will allow opportunity charging between routes; the buses will also be fully charged overnight. STM has assessed how the e-bus technology performs on the current network and during Montreal's harsh winters and is now ready to use it to carry passengers.<sup>32</sup>

Metro Vancouver also began tests with e-buses in April 2017. The Metro Committee approved C\$7 million to buy four e-buses and two charging systems to join TransLink's fleet as part of a pilot program. TransLink already has electric buses in its fleet, but the battery-powered buses



King County new battery-electric bus  
Source: King County



STM Pantograph charging station in Montreal  
Source: CBC

26 <http://www.kingcounty.gov/elected/executive/constantine/news/release/2017/January/10-battery-buses.aspx> (accessed Sep 2017).

27 <http://www.sgvtribune.com/general-news/20170325/the-tesla-of-bus-makers-arrives-in-southern-california-as-metro-considers-buying-electric-buses> (accessed Sept 2017).

28 List of cities/regions operating full battery electric buses in the USA: Worcester, MA (7); Philadelphia, PA (25); Delaware (6); City of Seneca, SC (7); Tallahassee, FL (5); Nashville, TN (9); Louisville, KY (16); Lexington, KY (6); Moline, IL (2); Shreveport, LA (5); Port Arthur, TX, (6); San Antonio, TX (3); Dallas, TX (7); Duluth, MN (7); Missoula, MT (2); Park City, UT (6); Pomona, CA (31); San Jose, CA (5); Stockton, CA (11); Reno, NV (8); Lakewood, WA (3); Seattle, WA (76); Everett, WA (4); Bremerton, WA (1); Fresno, CA (7); Visalia, CA (4); Chicago, IL (10); Moline, IL (2); Springfield, MA (3); Morrisville, NC (4); Tallahassee, FL (4).

Source: <https://www.proterra.com/our-story/our-customers/>

29 A list of all funded projects is available at <https://www.transit.dot.gov/funding/grants/low-or-no-emission-vehicle-deployment-program-project-selections>

30 <https://www.arb.ca.gov/msprog/bus/bus.htm>

31 [http://www.stm.info/en/about/major\\_projects/bus-network-electrification/electric-bus](http://www.stm.info/en/about/major_projects/bus-network-electrification/electric-bus).

32 <http://www.cbc.ca/news/canada/montreal/stm-montreal-electric-bus-fleet-1.4128347>.

do not use overhead wires. The pilot project will be carried out alongside similar ones in York Region and Brampton in Ontario. The three projects are being coordinated by the Canadian Urban Transit Research and Innovation Consortium, to test the feasibility and ability of battery-powered buses to operate during winter conditions in Canada.<sup>33</sup>

In **Australia**, a free solar-electric bus service was set up in Adelaide, where buses have 18 hours to charge and 6 hours of operation per day.<sup>34</sup> Transport Canberra are also trialling three e-buses across the ACTION bus network of school, suburban and rapid services. The vehicles began a 12-month trial in August 2017, which will compare the economic, environmental and operational performance of electric buses in the network against diesel buses.

Also in Adelaide, Precision Buses, the joint venture between Bustech and Precision Components Australia, successfully attracted a A\$2 million South Australian Government grant to locally develop and build two e-buses as well as Australia's first two Euro 6 low-emission diesel buses. The buses will be tested in Adelaide, with particular focus on performance in Australia's harsh operating climate.

Carbridge, the Australian bus manufacturer and logistic company, announced plans to build a fleet of 40 new e-buses in partnership with Gemilang Coachworks and BYD. The Electric BLU Toro bus, which has 70 seats and a range of 500km (or up to 100 transfer journeys on a single charge), is the product of this joint venture. These new buses joined a smaller fleet of six that have been in operation at Sydney Airport for nearly four months, having replaced the airport's existing diesel bus fleet servicing the 7km shuttle route.

In **New Zealand**, the transport authorities are investigating ways of achieving an efficient transition from diesel to electric propulsion. This is particularly attractive in the country as 85% of electricity generation is renewable.<sup>35</sup>

In February, 2017 NZ Bus began a trial with its new BYD e-bus, first in Auckland and then in Wellington, as part of its strategy to transition to electric-powered public transport in New Zealand. The e-bus is expected to meet the specific requirements of the bus network and the topographical landscapes in both cities.<sup>36</sup>

In July 2017, the Greater Wellington Regional Council signed contracts with Transit and Uzabus to provide e-buses for mass transportation on nine bus routes in Wellington from July 2018. A total of 32 double-decker e-buses will be progressively introduced up to 2021, supporting the council's ultimate goal of a full-electric fleet. By mid-2018, 80% of the fleet will be new and the majority of the buses will comply with the latest Euro 6 emissions standards.<sup>37</sup>

The high price of e-buses (on average 30% higher than CNG buses) is a major barrier to their large-scale adoption in public transport systems. This is particularly the case within developing countries, where regional governments are focusing more on low-emission natural gas powered buses. Ivory Coast, Uruguay and Brazil are expected to be the early adopters in of electric buses in the **Africa and Latin-America regions**.

In contrast with other continents, the electric bus sector in **Africa** is not highly developed. However, some operational experience is ongoing, including a French-based company that has used electric buses for student transport in Cameroon and Ivory Coast since 2014.<sup>38</sup> There are three buses in use at the University of Yaoundé (Cameroon) and three at Felix Houphouet Boigny University of Abidjan (Ivory Coast). In Uganda, engineers have built a 35-seater solar-powered electric bus, the 'Kayoola', which 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.<sup>39</sup>

In **South Africa**, the City of Cape Town the tender for the procurement of 11 battery-powered electric buses and ancillary equipment for the MyCiti service has been awarded to BYD SA Company. With service entry planned for 2018, Cape Town will be the first municipality in the country to introduce e-buses in a BRT fleet. As the buses are being assembled locally, the city will also benefit from new jobs, as the contractor will employ local staff and source some of the bus components from local suppliers. In addition to the buses, the plan will also provide charging stations and data management systems, technical support and training for drivers and mechanical staff, fleet maintenance services as well as replacement of the energy storage system.<sup>40,41</sup>



Electric BLU bus in Sydney Airport  
Source: [www.electric-vehiclenews.com](http://www.electric-vehiclenews.com)



MyCiti electric bus in operation  
Source: [www.thegreentimes.co.za](http://www.thegreentimes.co.za)

33 <http://www.cbc.ca/news/canada/british-columbia/battery-bus-vancouver-1.4076487>.

34 <http://ecolocalizer.com/2013/09/04/adelaide-has-worlds-first-solar-powered-public-transport-system/>.

35 Source: Tim Brown, H.R.L. Morrison & Co

36 Auckland and Wellington - New Zealand - BYD tests: <http://evtalk.co.nz/electric-bus-trial-begins-in-auckland-and-wellington/>.

37 <http://www.emove360.com/new-zealand-electric-buses-confirmed-for-wellington-transport-fleet/>.

38 <http://www.bollere-africa-logistics.com/en/media/press-releases/bluebus-in-cameroon.html>.

39 <http://www.bbc.com/news/world-africa-35458465>.

40 <http://www.capetownmagazine.com/myciti-buses-go-green>.

41 <http://www.engineeringnews.co.za/article/cape-towns-e-buses-to-arrive-at-end-2017-e-bus-plant-on-track-2017-02-28>.

The 10 e-buses will be introduced in the N2 MyCiti Express line in Cape Town and will measure their competitiveness against diesel buses. The e-buses can travel at least 250km on a single charge. The remaining e-bus will be probably be loaned to the City of Windhoek in Namibia, as part of an exchange programme to test e-buses viability in the Namibian city. Mauritius is also considering acquiring an e-bus fleet, and the Cape Town Transport and Urban Development Authority is discussing the demand for e-buses with other Southern African countries. The objective is to stimulate sufficient demand to create Africa's first electric bus factory. The plant would be most likely established at the Atlantis Green Technology Industrial Park in Cape Town.<sup>42</sup>



Trolleybus in Marrakech  
Source: News.cn

In the **North African region**, the Morocco's Energy Investment Company (SIE) will launch production of its locally-made electric buses in 2017 for both local and international markets. Marrakech has also announced the introduction of electric buses as part of its transportation system. This follows initial plans on the occasion of the COP22, held in Marrakech in 2016. Tests are ongoing and the trolleybuses were officially inaugurated in October 2017.<sup>43</sup>

In **Latin America**, developments have also been rather modest. In Brazil, Itajaí Transportes Coletivos, a private bus operator in Campinas, began operation of 11 battery electric buses after a test period in November 2015. In future, according to the Mayor of Campinas, at least 10% of the municipal bus fleet shall be electric. The number of full electric buses will grow from

the current 11 e-buses to 150 by 2020. The acquisition of these new e-buses will be part of the procurement process recently launched by the municipality. Hortolândia, a municipality that is part of the Metropolitan Region of Campinas, began a test with a battery-electric bus in March 2017. If the results are positive, the municipality is considering electrification of the entire fleet. The implementation of electric buses is one of the goals of the new management strategy. Besides Campinas, Curitiba and the Federal District of Brazil also operate electric buses.<sup>44</sup>

In parallel, a municipal law introduced in Sao Paulo in 2009 aims to combat air pollution. This provides for replacing all fossil fuel vehicles with alternatively-fuelled, less polluting vehicles by 2020. The electric drive has been presented as one of the most advantageous solutions among the available technologies. Sao Paulo, which already has a large fleet of BRT (bus rapid transit)<sup>45</sup> trolleybuses in operation, is currently considering investment in battery trolleybuses.

At the same time, the 22 signatory cities of the C-40 Clean Bus Declaration<sup>46</sup> of 2015 are sending clear signals to the market about their commitment to transitioning to low- or zero-emission bus fleets. Many cities in the region, including Bogotá and Santiago, are preparing to renew parts of their bus fleets in the coming years. This presents an opportunity to adopt zero- and low-emission buses. However, adoption is still at an early stage across the region. Urban bus fleets remain for the most part diesel-fuelled. Compared to global leaders like China, Europe and USA, adoption is very slow. Santiago only tested its first electric bus in 2013, while in 2015 Campinas acquired 10 electric buses, making it the largest fleet in Brazil.<sup>47</sup>

In terms of volume, Europe is second to Asia with about 2,000 electric buses delivered or on order.<sup>48</sup> This figure includes battery buses (overnight and opportunity charged), plug-in hybrid buses, trolleybuses with batteries for off-wire operation and fuel cell buses.

The greatest number of electric buses of the above types (Fig. 3) can be seen in the United Kingdom, with 17% of the total European fleet, followed by the Netherlands with 14%, Poland, France, Germany and Italy with around 8% each. Belgium, the Czech Republic, Sweden, Ukraine and Spain have shares of 3-6%.



Electric bus in Campinas  
Source: BYD

42 <http://www.itssa.org/blog/2017/02/28/cape-towns-e-buses-to-arrive-at-end-2017-e-bus-plant-on-track/>.

43 <http://northafricapost.com/19277-marrakech-first-moroccan-city-introduce-electrical-buses.html>.

44 [http://correio.rac.com.br/\\_conteudo/2017/03/campinas\\_e\\_rmc/472938-prefeitura-planeja-frota-de-150-onibus-eletricos.html](http://correio.rac.com.br/_conteudo/2017/03/campinas_e_rmc/472938-prefeitura-planeja-frota-de-150-onibus-eletricos.html).

45 BRT: bus rapid transit, a type of limited-stop service developed in the 1970s in South America and enjoying popularity elsewhere since the 1990s. It is operated on exclusive lanes that are physically separated from other road traffic, except at junctions. A BRT line combines intelligent transportation systems technology, priority at junctions, and rapid and convenient fare collection, and is integrated with land-use policy in order to substantially upgrade bus system performance.

46 [http://c40-production-images.s3.amazonaws.com/other\\_uploads/images/233\\_C40\\_CITIES\\_CLEAN\\_BUS\\_DECLARATION\\_OF\\_INTENT\\_FINAL\\_AUG27.original.pdf?1440690557](http://c40-production-images.s3.amazonaws.com/other_uploads/images/233_C40_CITIES_CLEAN_BUS_DECLARATION_OF_INTENT_FINAL_AUG27.original.pdf?1440690557)

47 <https://www.greenbiz.com/article/what-are-roadblocks-latin-americas-clean-bus-transition>.

48 Vehicles > 8t GVW and > 9m in length. Small numbers of trial vehicles have been withdrawn.

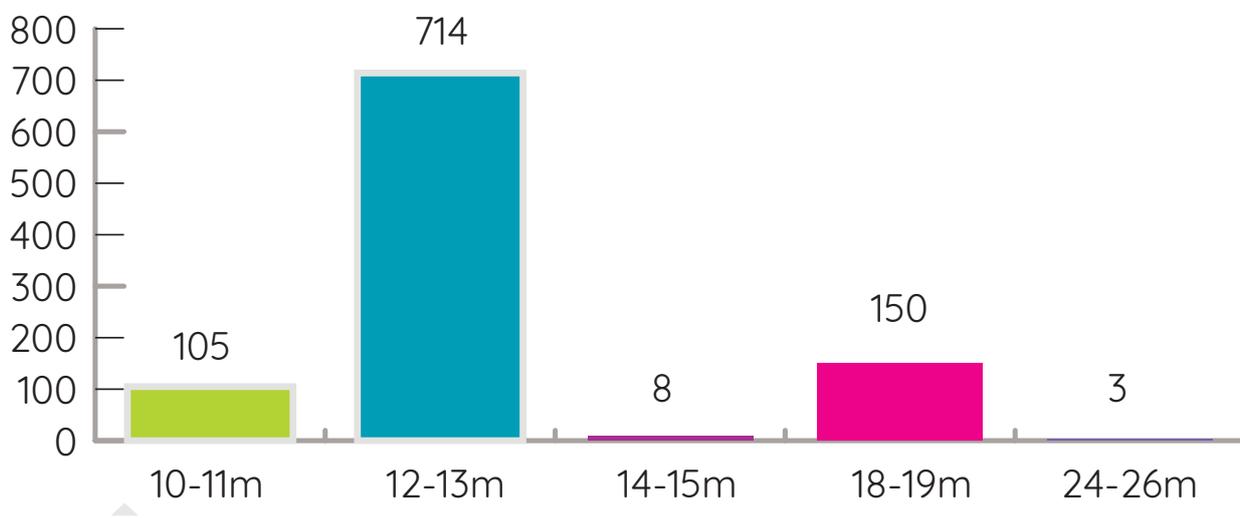


Fig. 3: Distribution of European urban electric bus models, by vehicle length  
Source: Alexander Dennis Limited

In order to accelerate deployment, the European Commission launched the European Clean Bus Deployment Initiative<sup>49</sup> in 2017, with a Declaration of Intent on promoting large-scale uptake of clean, alternatively fuelled buses.<sup>50</sup>

The Declaration is the first part of a three-step process of the Clean Bus Deployment Initiative. First, declaration of the endorsement of the signing cities, industry players, and sector associations, among them UITP, to accelerate the roll-out of clean buses. Second, creation of a Deployment Platform that brings together public authorities, transport operators, manufacturers and financing organisations to exchange knowledge and issue recommendations on guiding the process now under development. Last, creation of an Expert Group, of which UITP is member, bringing together stakeholders from the demand and supply sides to consolidate expertise on the technological, financial and organisational issues needed to accelerate the deployment of clean buses across Europe.

Member States including France<sup>51</sup>, The Netherlands<sup>52</sup>, Germany<sup>53</sup>, Italy<sup>54</sup>, the UK<sup>55</sup> and Poland 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 deployment of electric buses. A number of funding and financing schemes have been identified as supporting this trend. In southern Europe, Spain has developed a new scheme, the Integral Strategy for Alternative Energies Vehicle Support (MOVEA), which replaces the previous schemes MOVELE and PIMA Aire.<sup>56</sup>

49 [https://ec.europa.eu/transport/themes/urban/cleanbus\\_en](https://ec.europa.eu/transport/themes/urban/cleanbus_en)

50 <https://ec.europa.eu/transport/sites/transport/files/2017-05-05-european-clean-bus-deployment-initiative-declaration.pdf>

51 Article 37 of Transition énergétique pour la croissance verte, published 17/08/2015, [https://www.legifrance.gouv.fr/affichTexteArticle.do;jsessionid=51B1B679A-A96A41956077488B7AD621C.tpdila12v\\_1?cidArticle=JORFARTI000031044848&cidTexte=JORFTEXT000031044385&dateTexte=29990101&categorieLien=id](https://www.legifrance.gouv.fr/affichTexteArticle.do;jsessionid=51B1B679A-A96A41956077488B7AD621C.tpdila12v_1?cidArticle=JORFARTI000031044848&cidTexte=JORFTEXT000031044385&dateTexte=29990101&categorieLien=id)

52 [http://www.ipo.nl/files/9514/6072/3581/Bestuursakkoord\\_zero\\_emissie\\_bussen\\_DEFINITIEF\\_in\\_pdf.pdf](http://www.ipo.nl/files/9514/6072/3581/Bestuursakkoord_zero_emissie_bussen_DEFINITIEF_in_pdf.pdf)

53 Paragraphs 1-8 of the E Mobility Law, published in 2013.

54 Article 7 of D.Lgs. 03-mar-2011 n.24, Attuazione della direttiva 2009/33/CE relativa alla promozione di veicoli a ridotto impatto ambientale e a basso consumo energetico nel trasporto su strada, published on 24/03/2011, <http://www.gazzettaufficiale.it/gunewsletter/dettaglio.jsp?service=1&data-gu=2011-03-24&task=dettaglio&numgu=68&redaz=011G0063&tmstp=1301302373955>; Article 9 of D.M. 19-dic-2011 n.735, published on 05/06/2012; Article 70 of D.L. 83/2012 Testo del decreto-legge 22 giugno 2012, n. 83 (in supplemento ordinario n. 129/L alla Gazzetta Ufficiale serie generale - n. 147 del 26 giugno 2012), coordinato con la legge di conversione 7 agosto 2012, n. 134 (in questo stesso supplemento ordinario alla pag. 1), recante: "Misure urgenti per la crescita del Paese", published on 11/08/2012, <http://www.minambiente.it/normative/decreto-ministeriale-19-dicembre-2011-n-735-che-istituisce-un-programma-di-finanziamenti>; Article 9 of D. M. 1 dicembre 2015, n. 219 - Regolamento recante sistema di riqualificazione elettrica destinato ad equipaggiare autoveicoli M e N1, published on 11/01/2016, [http://www.gazzettaufficiale.it/atto/serie\\_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2016-01-11&atto.codiceRedazionale=15G00232&elenco30giorni=false](http://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2016-01-11&atto.codiceRedazionale=15G00232&elenco30giorni=false); Article 79 of EGGE 28 dicembre 2015, n. 221 Disposizioni in materia ambientale per promuovere misure di green economy e per il contenimento dell'uso eccessivo di risorse naturali, published on 18/01/2016, <http://www.gazzettaufficiale.it/eli/id/2016/1/18/16G00006/sg>.

55 Part II Paragraph 142 of the Transport Act published in 2000.

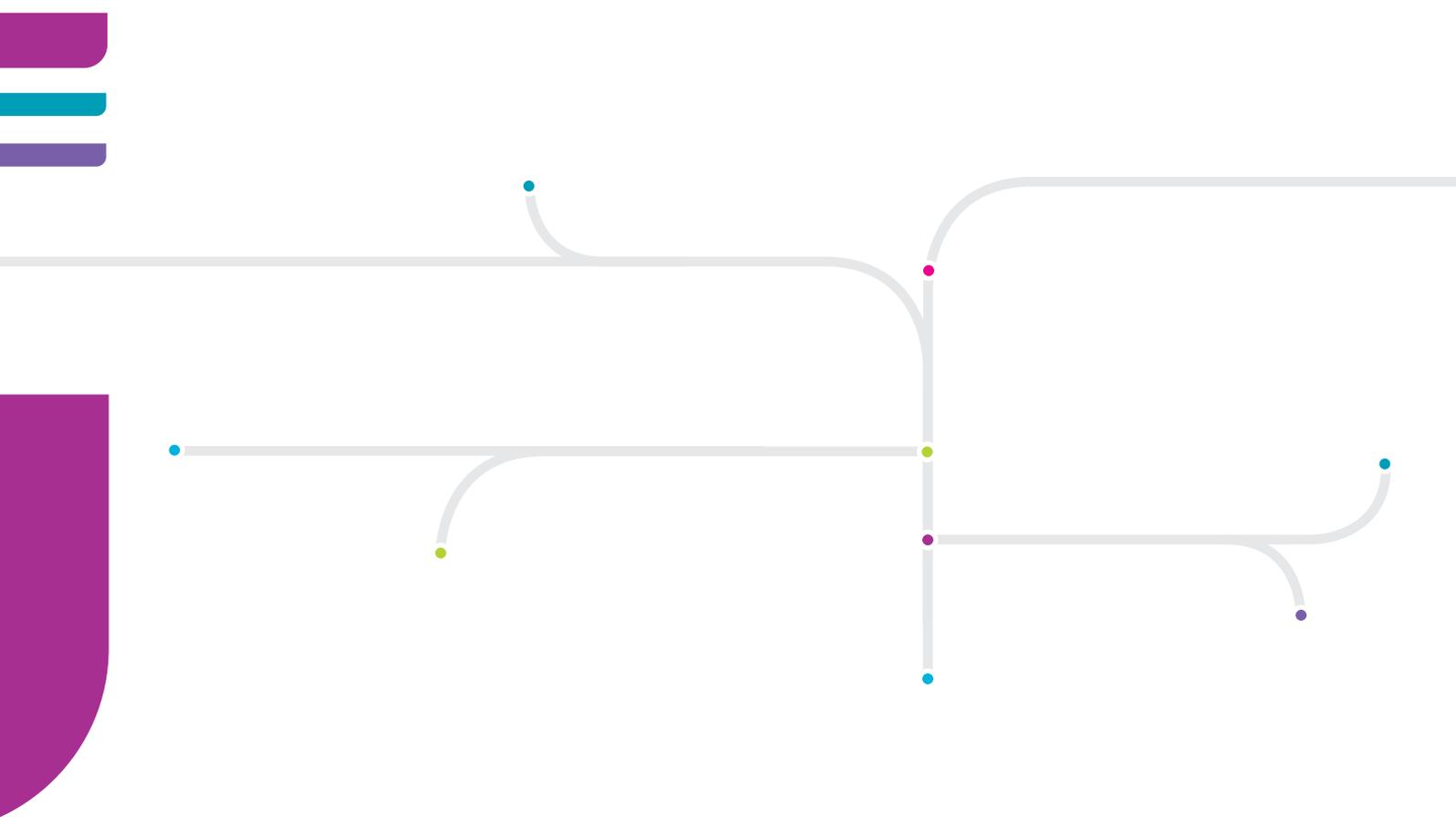
56 <http://corrienteelctrica.renault.es/asi-sera-el-plan-movea-2017-para-coches-y-vehiculos-electricos/>

## IMPORTANT NOTE TO THE READER

The ZeEUS eBus Report gives an overview of the electric buses in operation in Europe today, along the different solutions currently available on the market.<sup>57</sup> It is obvious that the electrification of public transport is high on the priority list of both cities and public transport agencies and operators worldwide.

A variety of vehicle specifications are collected and shown in this report, but we wish to emphasise that some of the specifications are meant to be indicative only; these can vary according to local conditions and local contexts of operation. An example is the 'range' of an electric bus, which is the theoretical maximum distance that it can be driven on a fully charged battery. The actual range of a fully-charged battery can depend on a number of parameters, including vehicle efficiency, weight/number of passengers, weather conditions, the route characteristics, air conditioning and driving style. Moreover, different charging strategies can change the way we define range. For example, a broad network of high-power opportunity charging infrastructure can provide almost infinite range, even with a smaller battery on board.

A wide range of technological solutions exist for the electrification of public transport. However, each choice is dependent on the local situation and can result in a different total cost of ownership. Therefore this report aims to provide the reader with an overview of experiences from various cities and to demonstrate the feasibility of implementing e-buses in an urban context.



<sup>57</sup> The ZeEUS eBus Report is a collective effort, produced thanks to the authors and contributors listed in the acknowledgements.

# CHAPTER 2: CITIES

Companies featured in this chapter are the ones providing the data and may not be the operator of the vehicles.

# GRAZ (AT)

HOLDING GRAZ - KOMMUNALE DIENSTLEISTUNGEN GMBH

"Holding Graz has a focus on next-generation energy/ power storage technologies and systemic, open and more sustainable solutions. We do not repeat electric bus tests already made in other cities, but try to capitalise on those experiences to provide the best possible solution for Graz."

**Vehicles:** 2 x 12m Chariot Motors ebus

**Charging:** Fast-charging at the terminal and selected bus stops

**Line:** 50

**Total operation time/day:** 15h

**Duration:** Oct 2016 - Nov 2017

**Nature of experience:** Testing different technologies

**Funding:** City, industry



Chariot Motors e-bus

**Vehicles:** 2 x 18m CRRC articulated bus

**Charging:** Fast-charging at the terminal and selected bus stops, slow-charging at the depot

**Line:** 34E

**Total operation time/day:** 13h

**Duration:** Oct 2016 - Nov 2017

**Nature of experience:** Testing different technologies

**Funding:** City, industry



CRRC articulated bus  
Source: CRRC

## DESCRIPTION

As a part of the E-mobility Graz strategy, Holding Graz operates two different brands of electric bus, Chariot Motors and CRRC, with supercapacitors. The tests aim to demonstrate the utility of electric buses as a replacement for diesel buses, without changing operational setup, as well as to gain acceptance with the relevant public and the staff of Holding Graz. The implementation of different technologies and validation of the test results will inform the strategy process of Holding Graz, as it seeks to decarbonise its bus fleet and the inner city of Graz.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x Chariot Motors	2 x CRRC
<b>Vehicle Model</b>	Ebus	Articulated bus
<b>Vehicle Length</b>	12m	18m
<b>Total passenger capacity</b>	90	135
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Pantograph at the terminal and selected bus stops (0.5-2min)	
<b>Overnight charging</b>	No	Plug at the depot (0-120min)
<b>On-board energy storage capacity</b>	32kWh (supercapacitors)	24kWh (supercapacitors) + 25kWh (batteries)

## LINE SPECIFICATIONS

<b>Route number</b>	50	34E
<b>Typology of the line</b>	City centre	
<b>Topography of the line</b>	Flat	
<b>Length of the bus line</b>	3.5km	3.5km
<b>Average commercial speed</b>	20km/h	20km/h
<b>Total daily hours of operation</b>	15h	13h
<b>Total daily hours operated in full electric</b>	15h	13h
<b>Total km driven/vehicle/day</b>	203km	188km

## CLIMATE

The climate in Graz is moderate. There is significant rainfall, with an annual average of 819mm. The average annual temperature in Graz is 10.8°C. Temperatures are highest on average in July, at around 21.5°C. January is the coldest month, with temperatures averaging -0.5°C.

# KLAGENFURT (AT)

STADTWERKE KLAGENFURT

**Vehicle:** 1 x 8,9m Solaris Urbino 8.9 LE electric

**Charging:** Slow-charging at the depot

**Line:** 43

**Total operation time/day:** 8h

**Duration:** July 2013 – Aug 2018

**Nature of experience:** Test different technologies

**Funding:** Self-funded, EU



Solaris Urbino 8.9 LE electric

## DESCRIPTION

Stock Company purchased a Solaris Urbino 8.9 LE electric prototype in order to test its suitability for everyday operation. At the end of the trial, the bus will operate on a different route. The test is also a part of a CO<sub>2</sub> reduction policy.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Solaris
<b>Vehicle Model</b>	Urbino 8.9 LE electric
<b>Vehicle Length</b>	8.9m
<b>Total passenger capacity</b>	51
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Overnight charging</b>	Plug at the depot (4h)
<b>On-board energy storage capacity</b>	120kWh

## LINE SPECIFICATIONS

<b>Route number</b>	43
<b>Typology of the line</b>	City centre
<b>Topography of the line</b>	Flat
<b>Length of the bus line</b>	7.5km
<b>Average commercial speed</b>	19km/h
<b>Total daily hours of operation</b>	8h
<b>Total daily hours operated in full electric</b>	4-4.8h
<b>Total km driven/vehicle/day</b>	110km

## CLIMATE

Klagenfurt has a continental climate with cold winters. The average temperature is 9.3°C. The daily mean temperature in January is -4.0°C and 18.8°C in July. The heaviest precipitation is during the period from June to September.

# BRUGES (BE)

DE LIJN



"The biggest challenge to overcome was power availability, mainly because we use fast-charging at 170kW at both stations. For that reason we had to install a transformer station. We have to take into account that buses and infrastructure are closely related and should be seen as a concept rather than as individual items."

**Vehicles:** 3 x 9.65m Van Hool A308 citybus

**Charging:** Fast- and slow-charging at the depot

**Line:** 12

**Total operation time/day:** 10h

**Duration:** Oct 2015 – March 2016, service continued upon demand

**Nature of experience:** Demonstration

**Funding:** Regional (EVTecLab)

## DESCRIPTION

Within the Flemish Government's EVTecLab demonstration project, De Lijn purchased and operated three A308 Citybuses manufactured by Van Hool. Energy supply is via an inductive fast charging system provided by Bombardier. At the end of the test, the buses will continue to operate on the same route.

## VEHICLE SPECIFICATIONS

Vehicle Brand	3 x Van Hool
Vehicle Model	A308 citybus
Vehicle Length	9.65m
Total passenger capacity	55
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Induction at depot (12min)
Overnight charging	Plug at the depot (2.5h)
On-board energy storage capacity	36.4kWh

## LINE SPECIFICATIONS

Route number	12
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	5.5km
Average commercial speed	14km/h
Total daily hours of operation	10h
Total daily hours operated in full electric	10h
Total km driven/vehicle/day	50-60km



Van Hool A308 citybus

## CLIMATE

The climate is mild and generally warm. Rainfall in Bruges is significant, with precipitation averaging 925mm. The average temperature is 12.7°C. With an average temperature of 19.9°C, July is the hottest month of the year. At 5.6°C on average, January is the coldest month of the year.

# NAMUR (BE)

TEC



"Now and in the future, we want to follow a new paradigm: we buy a transport system, and not only vehicles. This change needs a much more coordinated approach between an increasing number of stakeholders, like suppliers, operators, city authorities and network operators, which is challenging but is a winning strategy in the long run."

**Vehicles:** 11 x 12m Volvo 7900 Electric Hybrid

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 2, 8 and 9

**Total operation time/day:** line 2 - 11h, line 8 - 16h, line 9 - 13h

**Duration:** Jan 2017 - Dec 2033

**Nature of experience:** Pilot

**Funding:** Self-funded



Volvo 7900 Electric Hybrid

## DESCRIPTION

For 15 years, the TEC Group has been focusing on reducing local pollution, by renewing its fleet with the cleanest available diesel technologies. In a changing context, where control of global warming is now the main objective, the TEC Group decided in 2016 to increase the energy efficiency of its bus fleet, and to decrease its use of fossil fuels. The objective of this strategy is to contribute strongly to the reduction of greenhouse gas emissions by 2030.

The first pilot-project described in this form will be followed by a more ambitious one, in which almost 300 hybrid buses (90 using opportunity charging and 208 autonomous ones) will be put in operation between September 2017 and November 2019.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	11 x Volvo
<b>Vehicle Model</b>	7900 Electric Hybrid
<b>Vehicle Length:</b>	12m
<b>Total passenger capacity</b>	94
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Pantograph with a descending arm at the terminal (< 6m)
<b>Overnight charging</b>	Plug at the depot (< 2h)
<b>On-board energy storage capacity</b>	19kWh

## LINE SPECIFICATIONS

Route number	2	8	9
<b>Typology of the line</b>	City centre	City centre	City centre
<b>Topography of the line</b>	Moderate	Hilly	Moderate
<b>Length of the bus line</b>	9.5km	15km	13.2km
<b>Average distance between stops</b>	319m	359m	394m
<b>Average commercial speed</b>	18km/h	16km/h	19km/h
<b>Total daily hours of operation</b>	11h	16h	13h
<b>Total daily hours operated in full electric</b>	6.9h	6.5h	5.9h
<b>Total km driven/vehicle/day</b>	145km	183km	139km

## CLIMATE

The climate in Namur is warm and temperate. The average annual temperature is 9.8°C. Rainfall averages 819mm annually. The warmest month of the year is July with an average temperature of 17.4°C. The lowest average temperatures in the year occur in January, when it is around 1.7°C.

# SOFIA (BG)

CHARIOT MOTORS



"Sofia has implemented a unique ultracapacitor ebus pilot, a technology that had not yet been tested in any other European city at that time. The biggest challenge was the correct operation of the electric bus ultracapacitor. The bus itself was well-accepted by passengers and staff."

**Vehicle:** 1 x 12m Higer Chariot e-bus

**Charging:** Fast-charging at both the terminal and depot

**Line:** 11

**Total operation time/day:** 8.5h

**Duration:** May 2014 – Sept 2015

**Nature of experience:** Pilot

**Funding:** Self-funded



Higer Chariot e-bus

## DESCRIPTION

Sofia plans to promote e buses in 2016-2017. A Higer Chariot ebus, purchased from Chariot Motors, has been in operation on line 1 (11.2km). The line has two charging stations at terminals, each with capacity of 150kW. The Chariot ebus has accumulated around 25,000km to date, as a result of 8-hour daily shift operations, excluding national holidays and weekends. The charging time at each terminal is within the range of 6min, with the possibility of even faster charging if a more powerful charging station is installed.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Higer
Vehicle Model	Chariot e-bus
Vehicle Length	12m
Total passenger capacity	91
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at the terminal (5-6min) and at the depot (5-6min)
On-board energy storage capacity	21kWh-32kWh

## LINE SPECIFICATIONS

Route number	11
Typology of the line	City centre, suburban area
Topography of the line	Flat including a hilly section
Length of the bus line	11.2km
Average commercial speed	16.1km/h
Total daily hours of operation	8.5h
Total daily hours operated in full electric	8.5h
Total km driven/vehicle/day	88km

## CLIMATE

Sofia has a humid, continental climate, with an average annual temperature of 10.6°C. Winters are cold and snowy. In January, the daily average temperature is -0.5°C. On average, there are annually 58 days of snow cover. Summers are warm and sunny but Sofia is slightly cooler than other parts of Bulgaria. The average daily temperature in July is 21.2°C. The city receives average precipitation of 581mm a year, reaching its peak in late spring and early summer.

# HRANICE (CZ)

CSAD Frýdek-Místek a.s.



"Our bus operation fleet only deploys electric buses, meaning that the city urban transport is fully electrified, with major advantages for the environment and our customers. The greatest challenges to overcome were preparing the documents for a subsidy application as well as building the required charging infrastructure."

**Vehicles:** 6 x m SOR EBN 9.5

**Charging:** Fast-charging and slow-charging at the depot

**Line:** 1, 2, 3, 4, 5, 7, 8, 12 and 13

**Total operation time/day:** 8.5h

**Duration:** From Oct 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** EU



SOR EBN 9.5

## DESCRIPTION

The first fully electric operated bus urban transport in both the Czech Republic and in a Central Europe region. From October 2017, all urban transport lines in the city of Hranice are served by electric buses only. Zero emission vehicles will decrease smog and will contribute to protecting the local environment and the health of inhabitants in Hranice and neighbourhood.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	6 x SOR
<b>Vehicle Model</b>	EBN 9.5
<b>Vehicle Length</b>	9.7m
<b>Total passenger capacity</b>	69
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Plug at the depot (20min.)
<b>Overnight charging</b>	Plug at the depot (6h)
<b>On-board energy storage capacity</b>	172kWh

## LINE SPECIFICATIONS

Route number	1	2	3	4	5	7	8	12	13
<b>Typology of the line</b>	City centre	Mixed	Mixed	City centre	Mixed	City centre	City centre	Mixed	Mixed
<b>Topography of the line</b>	Moderate	Hilly	Moderate	Hilly	Moderate	Moderate	Moderate	Moderate	Moderate
<b>Length of the bus line</b>	11km	10km	13km	21km	5km	10km	13km	12km	11km
<b>Average distance between stops</b>	530m	510m	863m	641m	950m	710m	620m	491m	727m
<b>Average commercial speed</b>	26.4km/h	23.7km/h	32.1km/h	24.3km/h	29.2km/h	36.1km/h	24.6km/h	29.2km/h	30.2km/h
<b>Total daily hours of operation</b>	13h	15h	14h	11h	12h	8h	10h	16h	13h
<b>Total daily hours operated in full electric</b>	13h	15h	14h	11h	12h	8h	10h	16h	13h
<b>Total km driven/vehicle/day</b>	254km	145km	161km	105m	105km	46km	110km	120km	49km

## CLIMATE

Hranice's climate is warm and temperate, with an average annual temperature of 8.4°C. Rainfall is significant and averages 654mm annually. On average, the temperature are highest in July at around 17.9°C. January is the coldest, at -2.5°C.

# KRNOV (CZ)

ARRIVA MORAVA

"We are committed to making our region's bus fleets greener, however the cost of e-buses are still a major hurdle for us. The next steps depend on the local authorities and on their economic support for these initiatives."

**Vehicles:** 2 x 10.3m SOR EBN 10,5

**Charging:** Slow-charging at the depot

**Line:** 801

**Total operation time/day:** 18h

**Duration:** From January 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded

## DESCRIPTION

This is the first and relatively small project in comparison to Trinec. However, as with Trinec, these are the first low-emission vehicles and are positively perceived by both passengers and local authorities.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x SOR
Vehicle Model	EBN 10,5
Vehicle Length	10.3m
Total passenger capacity	72
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (8h)
On-board energy storage capacity	172kWh



SOR EBN 10,5

## LINE SPECIFICATIONS

Route number	801
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	11.5km
Average distance between stops	575m
Average commercial speed	18.64km/h
Total daily hours of operation	18h
Total daily hours operated in full electric	18h
Total km driven/vehicle/day	130km

## CLIMATE

The climate is cold and temperate in Krnov with an average annual temperature of 7.8°C. The rainfall is significant and averages 658mm annually. The warmest month of the year is July, with an average temperature of 17.0°C; the in January, at around -2.6°C.

# PLZEN (CZ)

ŠKODA AND PLZENSKÉ MESTSKÉ  
DOPRAVNÍ PODNIKY



Plzeňské městské  
dopravní podniky **PMDP**

"Unlike other cities, beside e-buses, Plzen already boasts a large network of electric traction vehicles (trams and trolleybuses) as well as e-buses. In total, around two-thirds of the public transport is eco-friendly. The city's strategy is to convert several bus lines to battery-hybrid trolleybus using battery technologies."

**Vehicles:** 2 x 12m Škoda PERUN HP

**Charging:** Fast-charging at the terminal, slow charging at the depot

**Lines:** 27

**Total operation time/day:** 7.5-18.5h

**Duration:** May 2015 – April 2017

**Nature of experience:** Demonstration

**Funding:** City, regional, EU



ŠKODA PERUN HP

**Vehicles:** 16 x 12m Škoda 26 Tr

**Charging:** Fast-charging in motion, slow-charging at the depot

**Lines:** 12, 13

**Total operation time/day:** 12.25h

**Duration:** Since Feb 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded



ŠKODA 26 TR

## DESCRIPTION

The strategy of the public transport operator and authority in Plzen is to clean city public transport by increasing the share of electric modes from 64% to 85% by 2030. This means converting performance of 3.2 million km from diesel to electric mode annually. The clean transformation is based on deploying modern battery-hybrid trolleybus technology, partial widening of the trolleybus infrastructure and opening one new tram extension.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x Škoda	16 x Škoda
<b>Vehicle Model</b>	PERUN HP	26 Tr
<b>Vehicle Length</b>	12m	12m
<b>Total passenger capacity</b>	82	94
<b>Air Conditioning</b>	Yes	No
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Articulated arm at the terminal (7min)	Overhead wires via connecting poles on route
<b>Overnight charging</b>	Plug at the depot (5h)	Overhead with automatic pole system (15 min., mostly for battery balancing)
<b>On-board energy storage capacity</b>	75kWh	45.4kWh

## LINE SPECIFICATIONS

<b>Route number</b>	12	13	27
<b>Typology of the line</b>	Mixed	Mixed	City centre, suburban area
<b>Topography of the line</b>	Hilly	Hilly	Hilly
<b>Length of the bus line</b>	14.5km	12km	6km
<b>Average distance between stops</b>	505m	450m	N/A
<b>Average commercial speed</b>	17km/h	18km/h	25km/h
<b>Total daily hours of operation</b>	19.5h	19h	7.5-18.5h
<b>Total daily hours operated in full electric</b>	19.5h (on battery 4.7h)	19h (on battery 3.5h)	7.5-18.5h
<b>Total km driven/vehicle/day</b>	199.8km	302.5km	80-200km

## CLIMATE

In Plzen, the climate is warm and temperate with an annual temperature of 8.0°C. Around 604mm of precipitation falls annually. The temperatures are highest on average in July, at around 17.7°C; the lowest in January at -2.2°C.

# PRAGUE (CZ)

DOPRAVNÍ PODNIK HL.M. PRAHY



Dopravní podnik  
hlavního města Prahy

"With no opportunity for subsidies, we had to fund the project ourselves, which led to a simple and cost-efficient solution. The key part of the project has been synergy and close cooperation between the bus and tram departments of our public transport company. As the next step, we plan to fully electrify line 207 by 2018, which will involve 14 12m ebuses."

**Vehicle:** 1 x 11.1m SOR EBN 11

**Charging:** Fast-charging at the terminal, slow charging at the depot

**Lines:** 124, 163, 188, 213

**Total operation time/day:** 18h

**Duration:** Sept 2015 – Aug 2017

**Nature of experience:** Pilot

**Funding:** Self-funded



SOR EBN 11

**Vehicle:** 1 x 12m SOR NS 12 - Electric

**Charging:** Fast-charging at the terminal, slow charging at the depot

**Lines:** 109, 239

**Total operation time/day:** 6h-18h

**Duration:** From Oct 2017 and ongoing

**Nature of experience:** Pilot

**Funding:** Self-funded



SOR NS 12 - Electric

## DESCRIPTION

As a part of the Czech National Action Plan for Clean Mobility, the Prague area Sustainable Mobility Plan and DPP company strategy, DPP is working on testing two-pole opportunity charged e-bus in real operation. After 2 years of successful operation of SOR/Cegelec EBN 11 vehicle (operated in total 144.000 km), pilot project continues with new generation vehicle SOR NS 12 - Electric. Project condition are again one year leasing of vehicle with the possibility of an extension. There is change of line of operation since October 2017, because charging station is moved to terminal Palmovka, where is available for this pilot project and also for another pilot - in-motion charging tests.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x SOR	1 x SOR
<b>Vehicle Model</b>	EBN 11	NS 12 - Electric
<b>Vehicle Length</b>	11.1m	12m
<b>Total passenger capacity</b>	93	102
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Pantograph at the terminal, using energy from the tram supply network (10-30min)	Roof mounted pantograph at the terminal, using energy from the tram supply network (10-30min)
<b>Overnight charging</b>	Plug at the depot (1-6h)	Plug at the depot (1-7h)
<b>On-board energy storage capacity</b>	172kWh	225kWh

## LINE SPECIFICATIONS

<b>Route number</b>	109	124	163	188	213	239
<b>Typology of the line</b>	Metropolitan area					
<b>Topography of the line</b>	moderate	hilly	flat	moderate	moderate	moderate
<b>Length of the bus line</b>	9.2km	13.4km	17.5km	13.9km	11km / 18.1km	16.8km
<b>Average commercial speed</b>	18.2km/h	14.3km/h	19.4km/h	16.6km/h	14.9km/h	18.2km/h
<b>Total daily hours of operation</b>	18h					6h (peak line)
<b>Total daily hours operated in full electric</b>	18h					6h (peak line)
<b>Total km driven/vehicle/day</b>	260-280km	265km	340km	265km	265km	260-280km

## CLIMATE

Prague's climate is somewhere between maritime and humid continental. The winters are relatively cold, with average temperatures at about freezing point and with very little sunshine. Snow cover can be common between mid November and late March. Summers usually bring plenty of sunshine and an average temperature high of 24°C. Precipitation in Prague is rather low (just over 500mm per year).

# TRINEC (CZ)

ARRIVA MORAVA

"We have just begun this new project and are currently collecting data and information to better understand the potential of electric buses."

**Vehicles:** 10 x 12m ŠKODA PERUN HE

**Charging:** Slow-charging at the depot

**Line:** 701, 703 and 708

**Total operation time/day:** 7h

**Duration:** From April 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** EU



ŠKODA PERUN HE

## DESCRIPTION

Currently, this is the first and largest electric bus project in the Czech Republic. In the future, we plan to increase the numbers of these buses in our fleet. There is heavy industry in the town of Trinec which has a major environmental impact; therefore this project is widely appreciated by both the passengers and the city.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	10 x ŠKODA
<b>Vehicle Model</b>	PERUN HE
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	72
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Plug at the depot and in selected bus stops (planned in near future)
<b>Overnight charging</b>	Plug at the depot (8h)
<b>On-board energy storage capacity</b>	222kWh

## LINE SPECIFICATIONS

	701	703	708
<b>Route number</b>	701	703	708
<b>Typology of the line</b>	City centre	City centre	City centre
<b>Topography of the line</b>	Moderate	Moderate	Moderate
<b>Length of the bus line</b>	8.4km	4.54km	7.2km
<b>Average distance between stops</b>	640m	562m	553m
<b>Average commercial speed</b>	20.16km/h	18km/h	17.28km/h
<b>Total daily hours of operation</b>	7h	7h	7h
<b>Total daily hours operated in full electric</b>	7h	7h	7h
<b>Total km driven/vehicle/day</b>	145km	145km	145km

## CLIMATE

The climate in Trinec is cold and temperate with an annual temperature of 8.4°C. The rainfall is significant and averages 789mm annually. The warmest month of the year is July, with an average temperature of 18.3°C; the lowest is in January, at around -3.4°C.

# COPENHAGEN (DK)

TRAFIKSELSKABET MOVIA AND CITY OF COPENHAGEN

**movia**



CITY OF COPENHAGEN

"All municipalities and regions in eastern Denmark (Movia operation area) want buses to be fossil free by 2030. Electric buses are key to achieve this goal in dense urban areas like City of Copenhagen."

**Vehicles:** 2 x 12.81m Linkker 12+ LE

**Charging:** Fast-charging at the terminals, slow charging at the depot

**Lines:** 3A

**Total operation time/day:** 16h

**Duration:** Aug 2016 – Jan 2019

**Nature of experience:** Demonstration

**Funding:** Self-funded



Linkker 12+ LE

**Vehicles:** 2 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Lines:** 3A, 141/149

**Total operation time/day:** 3A, 10-12h; 141, 7-12h

**Duration:** Jan 2014 – Dec 2015

**Nature of experience:** Pilot

**Funding:** Danish Transport Authority's test scheme for clean vehicles



BYD K9 (Variant of BYD 12m Overseas)

## DESCRIPTION

The City of Copenhagen wants all new buses entering operation from 2019 onwards to be electric or to offer similar environmental and noise properties. The target by 2031 at the latest is to have 100% electric or similar bus operation. Movia and City of Copenhagen trials electric buses with overnight (2014-2015) and opportunity charging (2016-2019). Final report for overnight charging is available from Movia. The first full electric bus line with more than 20 buses will start operation in fall 2019.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x BYD	2 x Linkker
<b>Vehicle Model</b>	K9 (Variant of BYD 12m Overseas)	12+ LE
<b>Vehicle Length</b>	12m	12.81m
<b>Total passenger capacity</b>	61	80
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes, wabasto	Yes, electric
<b>Opportunity charging</b>	-	Roof-mounted pantograph at the terminus stops (1.5-3min.)
<b>Overnight charging</b>	Plug at the depot (5h)	Plug at the depot (30 min.)
<b>On-board energy storage capacity</b>	324kWh	55kWh

## LINE SPECIFICATIONS

<b>Route number</b>	141/149	3A	
<b>Typology of the line</b>	Suburban area	Urban area	
<b>Topography of the line</b>	Flat	Flat	
<b>Length of the bus line</b>	10.8km/9.1km	8.8-9.4km	
<b>Average distance between stops</b>	300m		
<b>Average commercial speed</b>	22.3km/h	15 km/h (BYD K9)	15 km/h (Linkker 12+)
<b>Total daily hours of operation</b>	7-12h	10-12h	14h (target: 22h)
<b>Total daily hours operated in full electric</b>	7-12h	10-12h	14h (target: 22h)
<b>Total km driven/vehicle/day</b>	210-260km	210-260km	170km (target: 300 km)

## CLIMATE

The climate in Copenhagen is cool and temperate with an average annual temperature of 8°C. About 613mm of precipitation falls annually. The temperatures are highest on average in July, at around 20.4°C; the lowest in February, at around -0.1°C.

# ESPOO (FI)

HELSINKI REGION TRANSPORT HSL



"We plan to move from the pilot to commercial tendering of the electric bus system; the final decision on the type of pantograph to be used will be made during 2017."

**Vehicles:** 2 x 12.8m Linkker 12+ LE

**Charging:** Fast-charging at the terminal

**Line:** 11

**Total operation time/day:** 17h

**Duration:** April 2016 – June 2020

**Nature of experience:** Pilot

**Funding:** PTA, city and national

## DESCRIPTION

Helsinki Region Transport (HSL) has launched a pre-commercial pilot project, 'ePELI', involving operation of 12 fully electric buses and their fast-charging opportunity systems. The objective of the project is to be ready to move to commercial tenders for electric bus systems and services when commencing roll-out according to the HSL strategy in the near future. For the pilot, HSL has directly procured 12 buses from Linkker. The first of these has been in real route operation since spring 2016, while the last buses will enter service during autumn 2017 or early in 2018. In total, five different bus routes are planned for the pilot operation.

HSL's strategy is to increase the electric bus fleet to 30% of the total of roughly 1400 by 2025. The procurement of transport services and charging equipment for the first commercial electric bus routes will commence in 2018.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Linkker
Vehicle Model	12+ LE
Vehicle Length	12.8m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Roof mounted pantograph at the terminal (5 min.)
On-board energy storage capacity	55kWh

## LINE SPECIFICATIONS

Route number	11
Typology of the line	Suburban
Topography of the line	Flat
Length of the bus line	10.4km
Average distance between stops	385m
Average commercial speed	25km/h
Total daily hours of operation	17h
Total daily hours operated in full electric	17h
Total km driven/vehicle/day	240km



Linkker 12+ LE

## CLIMATE

Espoo's climate is classified as warm and temperate, with an average annual temperature of 5.1°C. Rainfall is significant, with an annual average of 638mm. The temperatures are highest on average in July, at around 16.9°C; February has the lowest, around -6.0°C.

# HELSINKI (FI)

HELSINKI REGION TRANSPORT HSL



"The next step we plan is to move forward from the pilot to commercial tendering of the electric bus systems. HSL's strategy is to increase the electric bus fleet to 30% of the total fleet of roughly 1400 buses by 2025."

**Vehicles:** 6 x 12.8m Linkker 12+ LE

**Charging:** Fast-charging at the terminal and selected bus stops

**Line:** 23, 51 and 55

**Total operation time/day:**  
20h, 19h and 19h respectively

**Duration:** April 2016 – Jun 2020

**Nature of experience:** Pilot

**Funding:** PTA, city of Helsinki, national



Linkker 12+ LE

## DESCRIPTION

Helsinki Region Transport (HSL) has launched a pre-commercial pilot project, 'ePELI', involving operation of 12 fully electric buses and their fast-charging opportunity systems. The objective of the project is to be ready to move to commercial tenders for electric bus systems and services when commencing roll-out according to the HSL strategy in the near future. For the pilot, HSL has directly procured 12 buses from Linkker. The first of these has been in real route operation since spring 2016, while the last buses will enter service during autumn 2017 or early in 2018. In total, five different bus routes are planned for the pilot operation.

HSL's strategy is to increase the electric bus fleet to 30% of the total of roughly 1400 by 2025. The procurement of transport services and charging equipment for the first commercial electric bus routes will commence in 2018.

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Linkker (4 more to come)
Vehicle Model	12+ LE
Vehicle Length	12.8m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Roof-mounted pantograph at the terminal and selected bus stops (5min.)
On-board energy storage capacity	55kWh

## LINE SPECIFICATIONS

Route number	23	51	55
Typology of the line	City centre	City centre	City centre
Topography of the line	Moderate	Moderate	Moderate
Length of the bus line	9.1km	18km	8.9km
Average distance between stops	380m	370m	400m
Average commercial speed	18km/h	21km/h	21km/h
Total daily hours of operation	20h	19h	19h
Total daily hours operated in full electric	20h	19h	19h
Total km driven/vehicle/day	244km	N/A	245km

## CLIMATE

In Helsinki, the climate is cold and temperate with an average annual temperature of 5.1°C. The city has a significant amount of rainfall during the year, which averages 650mm. The warmest month of the year is July, with an average temperature of 17.0°C; February is the coldest, at -5.8°C.

# TAMPERE (FI)

TAMPEREEN KAUPUNKILIIKENNE

"Our main challenge has been defining new responsibilities for all parties in practical day-to-day issues. Electric buses do not fully fit into the organisational form created for diesel bus operations. The maintenance of opportunity charging stations as a new and crucial element of system needs particular emphasis."

**Vehicles:** 4 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 2

**Total operation time/day:** 16.8h

**Duration:** From Dec 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** City and national



Solaris Urbino 12 electric

## DESCRIPTION

City bus line number 2 in Tampere has operated solely with fully electric buses since the beginning of 2017. Open public procurement process of buses and charging station was carried out during autumn 2015. The objective of this full-scale commercial pilot is to evaluate the local technical and economic constraints involved in fully electric bus operations.

## VEHICLE SPECIFICATIONS

Vehicle Brand	12 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	70
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Roof mounted pantograph at the terminal (4min.)
Overnight charging	Plug at the depot (1-2h)
On-board energy storage capacity	70kWh

## LINE SPECIFICATIONS

Route number	2
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	4.4km
Average distance between stops	336m
Average commercial speed	13.58km/h
Total daily hours of operation	16.8h
Total daily hours operated in full electric	16.8h
Total km driven/vehicle/day	190km

## CLIMATE

The climate in Tampere is cold and temperate, with an average annual temperature of 3.7°C. Rainfall averages 576mm annually. The warmest month of the year is July, with an average temperature of 16.0°C. The lowest average temperatures, of around -8.2°C, are in February.

# TURKU (FI)

TURKU REGION TRAFFIC FÖLI

"One of our biggest challenges has been to have reliable charging available all the time, and we successfully overcome it. Now we want to investigate how electric vehicles could be used on other lines."

**Vehicles:** 6 x 12.8m Linkker 12+ LE

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 1

**Total operation time/day:** 18h

**Duration:** Since Oct 2016 until 2023 or later

**Nature of experience:**  
Procurement

**Funding:** Self-funded, city, national



Linkker 12+ LE

## DESCRIPTION

Objective is to collect knowledge from electric bus operation in practice, understand electric bus operation as a system and to improve operating models for further electric bus lines. Passengers' feedback has been positive as most of the passengers appreciate lower noise, lower energy consumption and reduced emissions.

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Linkker
Vehicle Model	12+ LE
Vehicle Length	12.8m
Total passenger capacity	47
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph with a descending arm at both terminals (5min)
Overnight charging	Plug at the depot (4h)
On-board energy storage capacity	55kWh

## LINE SPECIFICATIONS

Route number	1
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	12.4km
Average distance between stops	300m
Average commercial speed	20km/h
Total daily hours of operation	19h
Total daily hours operated in full electric	19h
Total km driven/vehicle/day	350km

## CLIMATE

The climate is cold and temperate in Turku. The average annual temperature is 5.2°C. The rainfall averages 670mm. The warmest month of the year is July, with an average temperature of 17.0°C. The lowest average temperatures in the year occur in February, when it is around -5.7°C.

# GAILLAC (FR)

SAFRA

Safra

"Given the potential of the area, we believe that the area of Gaillac will be increasing and therefore the presence of the public transport is crucial. We want it to be sustainable to respect the surrounding vineyards."

**Vehicles:** 1 x 10.5m Safra Businova Midibus

**Charging:** Slow-charging at the depot

**Line:** D988

**Total operation time/day:** 8.5h

**Duration:** April 2016 – Dec 2017

**Nature of experience:** Demonstration

**Funding:** City level funded, local authority (other than city) funding

## DESCRIPTION

Gaillac is a small town where Businova is used in a commercial operation as a Bus with a High Level of Services (BHLS). The demonstration period was used for the development of the bus, as of April 2017 the bus will be part of the public transport fleet.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Safra
Vehicle Model	Businova Midibus
Vehicle Length	10.5m
Total passenger capacity	53
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (5-6h)
On-board energy storage capacity	135kWh

## LINE SPECIFICATIONS

Route number	D988
Typology of the line	City centre, suburban area
Topography of the line	Moderate
Length of the bus line	10km
Average commercial speed	12km/h
Total daily hours of operation	8.5h
Total daily hours operated in full electric	6h
Total km driven/vehicle/day	100km



Safra Businova Midibus

## CLIMATE

Gaillac's climate is classified as warm and temperate. The rainfall is significant, with the annual average of 732mm. The temperature here averages 13.1°C. The temperatures are highest on average in July, at around 21.2 °C. At 5.0°C on average, January is the coldest month of the year.

# GRENOBLE (FR)

SYNDICAT MIXTE DES TRANSPORTS EN COMMUN

SMTC

"Before writing the tender specifications, we decided to experiment with a few vehicles from different manufacturers in order to test them in real conditions."

## DESCRIPTION

SMTC experimented with four electric buses between October 2016 and February 2017 to test the reliability and the autonomy of these vehicles and their potential in achieving the goal of eliminating diesel from the bus fleet by 2021.

**Vehicles:** 1 x 12m Yutong E12LF  
**Charging:** Slow-charging at the depot  
**Line:** C3/C4  
**Total operation time/day:** 7h  
**Duration:** Oct 2016-Fev 2017  
**Nature of experience:** Regular operation  
**Funding:** Local authority



Yutong E12LF

**Vehicles:** 1 x 12m IRIZAR i2e  
**Charging:** Slow-charging at the depot  
**Line:** P16  
**Total operation time/day:** 7h  
**Duration:** Nov 2016 – Dec 2016  
**Nature of experience:** Demonstration  
**Funding:** Local authority



Irizar i2e

**Vehicles:** 1 x 12m Heuliez GX 337 ELEC  
**Charging:** Slow-charging at the depot  
**Lines:** C3/C4  
**Total operation time/day:** 7h  
**Duration:** Jan 2017 – March 2017  
**Nature of experience:** Regular operation  
**Funding:** Local authority



Heuliez GX 337 ELEC

**Vehicles:** 1 x 12m Solaris Urbino 12  
**Charging:** Slow-charging at the depot  
**Line:** P16  
**Total operation time/day:** 7h  
**Duration:** Dec 2016 – Feb 2017  
**Nature of experience:** Regular operation  
**Funding:** Local authority

# GRENOBLE (FR)

SYNDICAT MIXTE DES TRANSPORTS EN COMMUN



## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Yutong	1 x Solaris	1 x IRIZAR	1 x Heuliez
<b>Vehicle Model</b>	E12LF	Urbino 12 electric	i2e	GX 337 ELEC
<b>Vehicle Length</b>	12m	12m	12m	12m
<b>Total passenger capacity</b>	92	70	66	92
<b>Air Conditioning</b>	Yes	No	No	No
<b>Heating</b>	Yes	Yes	Yes	Yes
<b>Overnight charging</b>	Plug at the depot (5-6h)			
<b>On-board energy storage capacity</b>	230kWh	240kWh	376kWh	199kWh

## LINE SPECIFICATIONS

<b>Route number</b>	C3/C4	P16
<b>Typology of the line</b>	Mixed	Mixed
<b>Topography of the line</b>	Flat	Hilly
<b>Length of the bus line</b>	5.5-6.5km	13.5km
<b>Average distance between stops</b>	319-386m	330m
<b>Average commercial speed</b>	14.5km/h	16.8km/h
<b>Total daily hours of operation</b>	7h	7h
<b>Total daily hours operated in full electric</b>	7h	7h
<b>Total km driven/vehicle/day</b>	78-155km	78-116km

## CLIMATE

Grenoble's climate is classified as warm and temperate with an average annual temperature of 11.2°C. Around 856mm of precipitation falls annually. The temperatures are highest on average in July, at around 20.2°C, lowest in January, at around 1.7°C.

# MARSEILLE (FR)

Régie des Transports de Marseille



"Our biggest challenges were to adapt the power supply at the depot and to respond to the commercial environment. The outcome is a fully electric line, thanks to which we can see the behaviour of the vehicle during real commercial conditions as well as the behaviour of the electrical grid when we connect the whole fleet for charging."

**Vehicles:** 6 x 12m Irizar i2e

**Charging:** Slow-charging at the depot

**Line:** 82

**Total operation time/day:** 14-16h

**Duration:** Dec 2015 – Dec 2016

**Nature of experience:** Pilot

**Funding:** Self-funded

## DESCRIPTION

With the city council's decision to electrify transport and become carbon neutral by 2040, this is a pilot of six electric buses to gain experience of electric buses, with the aim of procuring electric buses in future tenders for bus operation. At the same time, this is a real procurement for the operation of bus line 1 and the buses will be operating the whole line for the whole contract period (7+3 years).

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Irizar
Vehicle Model	i2e
Vehicle Length	12m
Total passenger capacity	64
Air Conditioning	Yes
Heating	Yes
Overnight charging	Slow plug-in charging at the depot (5-7h)
On-board energy storage capacity	339kWh

## LINE SPECIFICATIONS

Route number	82
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	5.5km
Average commercial speed	10km
Total daily hours of operation	14-16h
Total daily hours operated in full electric	14-16h
Total km driven/vehicle/day	141km



IRIZAR i2e

## CLIMATE

Marseille has a Mediterranean climate with mild, humid winters and warm, mostly dry summers. In January, the average temperature is around 12°C; in July, it is around 29°C. Marseille is also one of the driest major cities in Europe, with only 512mm of precipitation annually.

# NICE AIRPORT (FR)

TRANSDEV FRANCE



**Vehicle:** 1 x 12m Heuliez Bus GX 337 ELEC

**Charging:** Fast-charging at the bus stops, slow-charging at the depot

**Line:** Airport shuttle

**Total operation time/day:** 9h

**Duration:** Nov 2014-May 2016

**Nature of experience:** Test

**Funding:** National (ADEME)



Heuliez BUS GX 337 ELEC

## DESCRIPTION

Nice Airport is testing one electric bus in normal operation alongside conventional buses. The aim is to validate the feasibility of an ultra-fast charging system.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Heuliez
Vehicle Model	Bus GX 337 ELEC
Vehicle Length	12m
Total passenger capacity	107
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Articulated arm at bus stops (20sec)
Overnight charging	Onboard charger (2h)
On-board energy storage capacity	1.2kWh supercapacitor on board

## LINE SPECIFICATIONS

Route number	Airport shuttle
Typology of the line	Airport shuttle
Topography of the line	Flat
Length of the bus line	3.9km
Average commercial speed	18km/h
Total daily hours of operation	9h
Total daily hours operated in full electric	9h
Total km driven/vehicle/day	200km

## CLIMATE

Nice's climate is classified as warm and temperate. The average annual rainfall is 811mm. The average annual temperature is 14.8°C. Temperatures are highest on average in July, at around 22.3°C. The lowest average temperatures in the year occur in January, when it is around 8.0°C.

# PARIS (FR)

RÉGIE AUTONOME DES TRANSPORTS PARISIENS  
ÎLE-DE-FRANCE MOBILITÉS



“By 2025, Île-de-France Mobilités and RATP plan to roll out a 100% eco-friendly bus fleet, including electric and biogas buses, in the most polluted urban areas of the Île-de-France region. With the Grand Paris des Bus programme of Île-de-France Mobilités and the bus2025 programme by RATP, Île-de-France Mobilités and RATP will fully engage in the energy transition phase for the bus fleet and completely transform its bus depots.”

**Vehicles:** 23 x 12m Bluebus 12m

**Charging:** Slow-charging at the depot

**Line:** 341

**Total operation time/day:** 14h

**Duration:** Since May 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded, local authority



Bluebus 12m

## DESCRIPTION

The buses were purchased as part of the Grand Paris des Bus Île-de-France Mobilités programme and RATP's bus2025 programme, which promise a complete transformation of the bus fleet in the Paris region to clean buses (hybrid, electric, biogas). The objectives are to test the batteries (battery life) and the drivetrain and also to analyse how the line's operations and maintenance are affected. The buses operate in the north-west of Paris all year round, Monday to Friday, from 07:00 to 20:30. The line carries more than 8,800 passengers per day. The early feedback from passengers and drivers is very positive.

## VEHICLE SPECIFICATIONS

Vehicle Brand	23 x Bluebus
Vehicle Model	12m
Vehicle Length	12m
Total passenger capacity	92
Air Conditioning	No
Heating	Yes
Overnight charging	Plug at the depot (5h)
On-board energy storage capacity	240kWh

## LINE SPECIFICATIONS

Route number	341
Typology of the line	Mixed
Topography of the line	Moderate
Length of the bus line	10km
Average commercial speed	10km/h
Total daily hours of operation	14h
Total daily hours operated in full electric	14h
Total km driven/vehicle/day	180km

## CLIMATE

The climate is mild, and generally warm and temperate. Rainfall in Paris is significant, with an annual average of 637mm. The average annual temperature is 11.3°C. With an average temperature of 19.4°C, July is the hottest month of the year. At 3.3°C on average, January is the coldest month of the year.

# STRASBOURG (FR)

YUTONG



**Vehicles:** 1 x 12m Yutong E12LF

**Charging:** Slow-charging at the depot

**Line:** 10

**Total operation time/day:** 12h-14h

**Duration:** From 18 to 29 April 2016

**Nature of experience:**  
Demonstration



Yutong E12LF

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Yutong
Vehicle Model	E12LF
Vehicle Length:	12m
Total passenger capacity	77
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (3.5h)
On-board energy storage capacity	295kWh

## LINE SPECIFICATIONS

Route number	10
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	6.2km
Average distance between stops	310m
Average commercial speed	9.2km/h
Total daily hours of operation	12-14h
Total daily hours operated in full electric	12-14h
Total km driven/vehicle/day	110km

## CLIMATE

Strasbourg's climate is mild, generally warm and temperate with an average annual temperature of 10.1°C. The city has significant rainfall, averaging 657mm annually. The warmest month is July, with an average temperature of 19.2°C; the lowest is January, at around 0.9 °C.

# VERSAILLES (FR)

ALSTOM, KEOLIS and  
ÎLE-DE-FRANCE MOBILITÉS

île de France  
mobilités

ALSTOM

Keolis

"This experimentation, alongside the other experiments in the Grand Paris area, will allow the PTA to better evaluate the costs of electric bus systems. Since the APTIS bus has its specific characteristics and introduces major innovations, it is crucial to test it and identify the most relevant and appropriate way to deploy it on bus networks."

**Vehicles:** 1 x 12m ALSTOM APTIS

**Charging:** Slow-charging at the depot

**Line:** 23

**Total operation time/day:** 6.25h

**Duration:** Sept 2017 – Sept 2018

**Nature of experience:**  
Demonstration

**Funding:** Self-funded



ALSTOM APTIS

## DESCRIPTION

The Aptis bus operated by Keolis in Versailles provides enhanced passenger experience with low floor, tramway-type doors, driver assistance for improved accessibility at bus stops, increased glass surface, 3 doors, USB charging docks, Wifi, AC, ... Keolis and Alstom under the authority of Ile-de-France Mobilités have developed a partnership to test the APTIS bus in operation. The experimentation began in September 2017 and will end in autumn 2018. If the experimentation is successful, it is contemplated to fully deploy the system on line 23.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x ALSTOM
Vehicle Model	APTIS
Vehicle Length	12m
Total passenger capacity	77
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (6-8h)
On-board energy storage capacity	330kWh

## LINE SPECIFICATIONS

Route number	23
Typology of the line	Mixed
Topography of the line	Hilly
Length of the bus line	Approx. 12km
Average distance between stops	460m
Average commercial speed	18-22km/h
Total daily hours of operation	6.25h
Total daily hours operated in full electric	6.25h
Total km driven/vehicle/day	90km

## CLIMATE

In Versailles, the climate is warm and temperate, with an average annual temperature of 10.6°C. Around 651mm of precipitation falls annually. The temperatures are highest on average in July, at around 18.4°C. January has the lowest average temperature of 3.0°C.

# AALEN (DE)

OVA - OMNIBUS-VERKEHR AALEN

**OVA**  
Damit fahr ich...

"Hopefully, in the near future e-buses will be produced in larger numbers, reducing the unit cost. This will have a substantial impact, making the purchase of these vehicles more attractive and less expensive."

**Vehicles:** 1 x 12m SILEO S12

**Charging:** Slow-charging at the depot

**Line:** Different

**Total operation time/day:** 9h

**Duration:** Dec 2016 - Dec 2024

**Nature of experience:** Regular operation

**Funding:** Self-funded, regional

## DESCRIPTION

Our goal is to see whether an electric bus can perform well in our environment. We want to learn how to operate electric buses. We want to be prepared for the future.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x SILEO
Vehicle Model	S12
Vehicle Length	12m
Total passenger capacity	76
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (6h)
On-board energy storage capacity	230kWh

## LINE SPECIFICATIONS

Route number	Different
Typology of the line	Mixed
Topography of the line	Hilly
Average distance between stops	500m
Average commercial speed	22km/h
Total daily hours of operation	9h
Total daily hours operated in full electric	9h
Total km driven/vehicle/day	200km



Sileo S12

## CLIMATE

Aalen's climate is classified as warm and temperate with an average annual temperature of 8.4°C. Around 709mm of precipitation falls annually. The temperatures are highest on average in July, at around 17.3°C; January has the lowest, around -1.1°C.

**Vehicle:** 1 x 10.7m Bozankaya  
Sileo S10

**Charging:** Slow-charging at the  
depot

**Line:** 16

**Total operation time/day:** 12h

**Duration:** June 2016-June 2020

**Nature of experience:** Pilot

**Funding:** City, local authority,  
regional

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Bozankaya
<b>Vehicle Model</b>	Sileo S10
<b>Vehicle Length</b>	10.7m
<b>Total passenger capacity</b>	66
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Overnight charging</b>	Plug at the depot (8h)
<b>On-board energy storage capacity</b>	230KWh

## LINE SPECIFICATIONS

<b>Route number</b>	16
<b>Typology of the line</b>	Urban
<b>Topography of the line</b>	Moderate
<b>Length of the bus line</b>	4.6km
<b>Average commercial speed</b>	28km/h
<b>Total daily hours of operation</b>	12h
<b>Total daily hours operated in full electric</b>	12h
<b>Total km driven/vehicle/day</b>	200km

## CLIMATE

The climate is mild, and generally warm. There is significant rainfall throughout the year, with precipitation averaging 547mm. The average annual temperature is 8.4°C. With an average temperature of 17.3°C, July is the hottest month of the year. In January, the average temperature is -0.6°C, which is the lowest average temperature of the year.

# BERLIN (DE)

BERLINER VERKEHRSBETRIEBE

BVG

"We are proud to have successfully electrified a full line with inductive charging. The fully functioning system was a challenge, but we have delivered."

**Vehicles:** 4 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal and at selected bus stops, slow-charging at the depot

**Line:** 204

**Total operation time/day:** 22h

**Duration:** Aug 2015 – Sept 2016 and continued

**Nature of experience:** Pilot

**Funding:** Local authority, regional, EU



Solaris Urbino 12 electric

## DESCRIPTION

The 'E-Bus Berlin' project is one of about 30 core projects funded by the Federal Ministry of Transport and Digital Infrastructure. Berlin is the first capital in the world to introduce a fully electric line in Germany, operating with four electric buses and inductive opportunity charging at the terminals. The conclusions obtained on the suitability and marketability of e-buses will contribute to a wider strategy regarding overall environmental decarbonisation and nitrogen oxides reduction.

## VEHICLE SPECIFICATIONS

Vehicle Brand	4 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	87
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Induction at terminal, selected bus stops and depot (6-8min)
Overnight charging	Plug at the depot (4h)
On-board energy storage capacity	90kWh

## LINE SPECIFICATIONS

Route number	204
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	6km
Average commercial speed	12km/h
Total daily hours of operation	22h
Total daily hours operated in full electric	22h
Total km driven/vehicle/day	168km

## CLIMATE

Berlin has a maritime temperate climate. Summers are warm and sometimes humid, with average daily temperatures of 17-19°C. Winters are cool, with average daily temperatures of 0-2°C. Annual precipitation is 570mm, with moderate rainfall throughout the year.

# BONN (DE)

STADTWERKE BONN VERKEHRS GmbH



"We strive for overnight charging. In terms of the efficacy of this procedure, we are far ahead of other cities."

**Vehicles:** 6 x 12m Bozankaya Sileo S12

**Charging:** Slow-charging at the depot

**Line:** 607

**Total operation time/day:** 13h

**Duration:** Feb 2016-Feb 2028

**Nature of experience:** Demonstration

**Funding:** Self-funded

## DESCRIPTION

The demonstration in the city of Bonn focuses on 12m battery buses, which operate on different lines in order to gain a comprehensive overview of the operational possibilities. The overall objective of the demonstration is to evaluate both the feasibility of the operation of 12m battery buses and their technical suitability, not least in combination with the charging infrastructure. Recharging takes place at the Bonn-Friesdorf bus depot. We will use the experience of the project to take a decision in 2017 on adopting e buses across the entire bus network, particularly against the background of sustainability in Bonn and the wider region.

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Bozankaya Sileo
Vehicle Model	S12
Vehicle Length	12m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (5.5h)
On-board energy storage capacity	230kWh

## LINE SPECIFICATIONS

Route number	607
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	17.2km
Average commercial speed	15km/h
Total daily hours of operation	13h
Total daily hours operated in full electric	13h
Total km driven/vehicle/day	200km



Bozankaya Sileo S12

## CLIMATE

Bonn's climate is classified as warm and temperate. The city has significant rainfall, with an annual average of 742mm. The average annual temperature in Bonn is 10.0°C. The temperatures are highest on average in July, at around 18.1°C. January is the coldest month, with temperatures averaging 2.0°C.

# BRAUNSCHWEIG (DE)

VERBAND DEUTSCHER VERKEHRSUNTERNEHMEN  
BRAUNSCHWEIGER VERKEHRS GMBH

VDV Die Verkehrs-  
unternehmen



**Vehicles:** 1 x 12m Solaris Urbino 12 electric; 4 x 18m Solaris Urbino 18 electric

**Charging:** Fast-charging at the terminal and at selected bus stops

**Line:** 1

**Total operation time/day:** 18h

**Duration:** Since March 2014 and ongoing

**Nature of experience:** Research project

**Funding:** Self-funded, city, local authority, regional, national

## DESCRIPTION

Within an EMIL (electro mobility by inductive charging) project, an electric powered 12m and 18m buses run with passengers on the 12km M19 bus route. The vehicles use high-power wireless (inductive) charging. The daily service runs with virtually no disturbance or problems. The buses replaced most of the diesel-powered buses on this specific line.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Solaris	4 x Solaris
<b>Vehicle Model</b>	Urbino 12 electric	Urbino 18 electric
<b>Vehicle Length</b>	12m	18m
<b>Total passenger capacity</b>	78	123
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Induction at the terminal (8-10m) and selected bus stops (1-2)	
<b>On-board energy storage capacity</b>	60kWh	90kWh

## LINE SPECIFICATIONS

<b>Route number</b>	1
<b>Typology of the line</b>	City centre
<b>Topography of the line</b>	Moderate
<b>Length of the bus line</b>	12km
<b>Average commercial speed</b>	23km/h
<b>Total daily hours of operation</b>	18h
<b>Total daily hours operated in full electric</b>	18h
<b>Total km driven/vehicle/day</b>	250km

## CLIMATE

Braunschweig falls climatically into the north temperate zone of central Europe. The average annual temperature is 8°C. The warmest month is August, with an average temperature of 19.5°C. The coolest month is January, with an average temperature of 0°C.

# BREMEN (DE)

BREMER STRAßENBAHN AG



**Vehicle:** 1 x 12m Bozankaya Sileo S12

**Charging:** Slow-charging at the depot

**Line:** 29/52 (two combined full lines)

**Total operation time/day:** 10.5h

**Duration:** Aug 2016-Aug 2019

**Nature of experience:** Pilot

**Funding:** Self-funded, local authority, EU (H2020 project ELIPTIC)



Bozankaya Sileo S12

## DESCRIPTION

The Bremer Straßenbahn AG (BSAG) is testing (over a period of three years) one standard 12m bus in regular operation. It is equipped with low-floor technology, ticket vending machines and air conditioning to maintain the usual standard for urban buses operated by BSAG.

An overall dissemination strategy is under way, in which the electromobility strategy of BSAG will be conveyed to the citizens and stakeholders of Bremen.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Bozankaya Sileo
Vehicle Model	S12
Vehicle Length	12m
Total passenger capacity	79
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (2h)
On-board energy storage capacity	230kWh

## LINE SPECIFICATIONS

Route number	Combination of two lines 29 and 52
Typology of the line	City area, outside the city centre
Topography of the line	Flat
Length of the bus line	30km
Average commercial speed	21km/h
Total daily hours of operation	10.5h/day
Total daily hours operated in full electric	10.5h/day
Total km driven/vehicle/day	300km

## CLIMATE

Bremen has a moderate maritime climate. The annual average temperature is 9.2°C, with an average of 17.4°C in July and 1.4° C in January. The city receives on average 671.3mm of precipitation per year.

# COLOGNE (DE)

KOELNER VERKEHRS - BETRIEBE



"Electromobility is still in the early stages of its development. Many technical specifications of the data sheet had to be developed during our one-year test phase. Additionally, employees had to learn how to use the new technology. The challenge of this project was to ensure successful ebus operation in Cologne by using a new technology, with the target of achieving customer service quality on a par with that of conventional diesel buses."

**Vehicles:** 8 x 18.1m VDL Citea SLFA-180 Electric

**Charging:** Fast-charging at the terminal and at selected bus stops; slow-charging at the depot

**Line:** 133

**Total operation time/day:** 18h

**Duration:** Oct 2015-Dec 2016

**Nature of experience:** Test

**Funding:** Self-funded, regional

## DESCRIPTION

As a part of the 'Köln mobil 2025' strategy, KVB purchased eight VDL Citea SLFA electric buses and is currently testing the vehicles on a route from the city centre to suburban areas. Following the test, the buses will continue to operate on the same route.

## VEHICLE SPECIFICATIONS

Vehicle Brand	8 x VDL
Vehicle Model	Citea SLFA-180 Electric
Vehicle Length	18.1m
Total passenger capacity	139
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at the terminal and selected bus stops (8-15min)
Overnight charging	Pantograph at the depot (5-7h)
On-board energy storage capacity	123kWh

## LINE SPECIFICATIONS

Route number	133
Typology of the line	City centre to suburban areas
Topography of the line	Flat
Length of the bus line	6.7-7.0km
Average commercial speed	16-18km/h
Total daily hours of operation	18h
Total daily hours operated in full electric	18h
Total km driven/vehicle/day	120km



VDL Citea SLFA-180 Electric

## CLIMATE

Cologne is one of the warmest cities in Germany, with relatively mild winters and warm summers. Its average annual temperature is 10.3°C. In January, the mean temperature is 2.6°C, while the mean temperature in July is 18.8°C. Precipitation is spread evenly throughout the year.

# DRESDEN (DE)

DRESDNER VERKEHRSBETRIEBE AG



"We plan a future bus system for Dresden with electric drive, a combined depot and line loading concept. Together with the 'TU Dresden', DVB has undertaken investigations that show particular articulated bus routes with the highest potential for ecological improvements."

**Vehicles:** 1 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 79

**Total operation time/day:** 16h

**Duration:** From June 2015 and ongoing

**Nature of experience:** Regular operation

**Funding:** National



Solaris Urbino 12 electric

## DESCRIPTION

In 2011, the federal government decided to support electric mobility. This has been undertaken through a publicity programme called the 'Electric Mobility Showcase', which integrates the technologies into large scale demonstration and pilot plans in four selected regions. Through cooperation between science, industry, operator and central government, innovative elements of electric mobility will be developed. The DVB project 'Electric Bus Line 79' is one of 40 projects supported in the showcase region Bavaria-Saxony "Electromobility Connects". Line 79 is one of the shortest lines in the DVB network is at 5.2km. It is ideal for testing electric buses and was the first e-bus line in Saxony Sachsen in 2015.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	70
Air Conditioning	No
Heating	Yes
Opportunity charging	Pantograph with a descending arm at the terminal (4 minutes)
Overnight charging	Plug at the depot (6h)
On-board energy storage capacity	200kWh

## LINE SPECIFICATIONS

Route number	79
Typology of the line	Suburban
Topography of the line	Flat
Length of the bus line	5.2km
Average distance between stops	346m
Average commercial speed	19.5km/h
Total daily hours of operation	16h
Total daily hours operated in full electric	16h
Total km driven/vehicle/day	240km

## CLIMATE

Dresden's climate is classified as warm and temperate with an average annual temperature of 9.0°C. Rainfall is significant, with an annual average of 592mm. The temperatures are highest on average in July, at around 18.4°C; January has the lowest, at -0.8°C.

**Vehicle:** 1 x 18m Solaris Trollino 18

**Charging:** Fast-charging at the terminal/depot and en route

**Line:** 4

**Total operation time/day:** 18h

**Duration:** Since May 2014 and ongoing

**Nature of experience:** Test

**Funding:** Self-funded, national, EU (ELIPTIC)

## DESCRIPTION

The battery trolleybus operating in Eberswalde is the first vehicle of its kind in Europe. The target for the operator is to expand the wireless operation area in the city. The plan is then to acquire the next generation of battery trolleybus.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Solaris
<b>Vehicle Model</b>	Trollino 18
<b>Vehicle Length</b>	18m
<b>Total passenger capacity</b>	146
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Connecting poles at the depot (22min) and overhead wires via connecting poles en route
<b>On-board energy storage capacity</b>	72kWh

## LINE SPECIFICATIONS

<b>Route number</b>	4
<b>Typology of the line</b>	Suburban area
<b>Topography of the line</b>	Moderate
<b>Length of the bus line</b>	18km
<b>Average commercial speed</b>	24km/h
<b>Total daily hours of operation</b>	18h
<b>Total daily hours operated in full electric</b>	18h
<b>Total km driven/vehicle/day</b>	250km



Solaris Trollino 18

## CLIMATE

The climate is mild, and generally warm and temperate. Eberswalde is a city with significant rainfall, and the annual average is 546mm. The average annual temperature is 8.9°C. With an average temperature of 18.4°C, July is the hottest month of the year. January is the coldest month, with temperatures averaging -1.1°C.

# HAMBURG (DE)

VERBAND DEUTSCHER VERKEHRSUNTERNEHMEN  
HAMBURGER HOCHBAHN AG

**VDV** Die Verkehrs-  
unternehmen

**HOCHBAHN**

"The biggest challenge is to increase the operating distances of the buses in order to ensure a similar productivity as compared to conventional buses."

**Vehicles:** 3 x 12m Solaris Urbino  
12 electric, 3 x 12m Volvo 7900  
Electric

**Charging:** fast charging at the  
terminal, slow charging at the  
depot

**Line:** 109

**Total operation time/day:** 20h

**Duration:** Dec 2014 – Jan 2020

**Nature of experience:**  
Regular operation

**Funding:** National funding



Volvo 7900 electric



Solaris Urbino 12 electric

## DESCRIPTION

Within a period of only ten to fifteen years, HOCHBAHN will have switched over its bus fleet, comprising some 1,000 vehicles, entirely to zero emission drives. In order to provide higher incentives and investment security for the vehicle manufacturers and to speed up the development of zero emission buses with innovative propulsion systems for regular services, HOCHBAHN has launched a joint procurement initiative together with public transport operators in Berlin, Cologne, Düsseldorf, Stuttgart, Munich and Darmstadt. Together, the companies are currently working on reaching a common definition of suitable concepts.

## VEHICLE SPECIFICATIONS

Vehicle Brand	3 x Solaris	3 x Volvo
Vehicle Model	Urbino 12 electric	7900 Electric
Vehicle Length	12m	12m
Total passenger capacity	71	75
Air Conditioning	Yes	Yes
Heating	Yes	Yes
Opportunity charging	Pantograph with a descending arm at the terminal (3.5min)	Pantograph with a descending arm at the terminal (8min)
Overnight charging	Plug at the depot (2h)	Plug at the depot (3-6h)
On-board energy storage capacity	100kWh	19 kWh

## LINE SPECIFICATIONS

Route number	109
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	10km
Average commercial speed	18km/h
Total daily hours of operation	20h
Total daily hours operated in full electric	20h
Total km driven/vehicle/day	40-250km

## CLIMATE

The climate is mild and generally warm. The rainfall in Hamburg is significant with an annual average of 738 mm. The average annual temperature is 8.5 °C. At an average temperature of 17.3 °C, July is the hottest month of the year. At -0.2°C on average, January is the coldest month of the year.

# HANOVER (DE)

ÜSTRA HANNOVERISCHE VERKEHRSBETRIEBE AG

ÜSTRA

"Compared to other cities, we operate on a very demanding line: inner city, frequent stops, just one terminus (Ring-line), only one recharging-point and a short layover time. We were able to replace conventional buses on this line without any change to the schedule, showing that the same concept can be adopted on all other urban bus lines in Üstra."

**Vehicles:** 3 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the depot, slow-charging at the depot

**Line:** 100/200

**Total operation time/day:** Approx. 20h

**Duration:** From April 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** National



Solaris Urbino 12 electric

## DESCRIPTION

The battery electric buses are in regular service on one of the most demanding lines in Hanover. This offers a real test to demonstrate their feasibility. The buses are recharged within the regular layover time at the terminus. The overall goal: the electric bus should show its ability to replace diesel buses without any adjustments to the number of vehicles, the number of drivers or to the schedule. To date, experience and feedback from drivers and passengers have been very positive.

## VEHICLE SPECIFICATIONS

Vehicle Brand	3 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	73
Air Conditioning	No
Heating	Yes
Opportunity charging	Roof mounted pantograph at the depot (4-6 min.)
Overnight charging	Plug and roof mounted pantograph
On-board energy storage capacity	125kWh

## LINE SPECIFICATIONS

Route number	100/200
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	16km
Average distance between stops	390m
Average commercial speed	18km/h
Total daily hours of operation	Approx. 17h
Total daily hours operated in full electric	Approx. 17h
Total km driven/vehicle/day	300km

## CLIMATE

Hannover's climate is classified as warm and temperate with an average annual temperature of 8.8°C. Around 666mm of precipitation falls annually. On average, the temperatures are highest in July, at around 17.1°C, lowest in January, at around 0.3°C.

# LEIPZIG (DE)

LEIPZIGER VERKEHRSBETRIEBE GMBH



"Our greatest challenge has been the technical implementation of installing the charging station with connection to the urban power supply system at the terminal bus stop in Leipzig/Connewitz. In the near future, we want to convert our entire fleet (approx. 160 buses) to e-buses. An external partner is preparing a feasibility study and the first results should be available at the end of 2017."

**Vehicles:** 1 x 12m Göppel Go4City G58

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 89

**Total operation time/day:** 8.5h

**Duration:** From March 2015 and ongoing

**Nature of experience:** Pilot

**Funding:** Self-funded

## DESCRIPTION

The application of the first battery coach of the Leipzig Transport Services is a common research plan with Fraunhofer Institute of Traffic and Infrastructure System, Dresden. A principal objective of this test Company is to collect the experience with the energy supply from 600 streetcars energy supply network. The test Company by the first battery coach is continued first until the end of June 2018 on line 89.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Göppel
<b>Vehicle Model</b>	Go4City G58
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	58
<b>Air Conditioning</b>	No
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Roof mounted pantograph at the terminal (approx. 12 minutes)
<b>Overnight charging</b>	Plug at the depot (4-10h)
<b>On-board energy storage capacity</b>	86kWh

## LINE SPECIFICATIONS

<b>Route number</b>	89
<b>Typology of the line</b>	City centre/metropolitan area
<b>Topography of the line</b>	Flat
<b>Length of the bus line</b>	A-B 5km, B-A 5.7km
<b>Average distance between stops</b>	A-B 318m, B-A 341m
<b>Average commercial speed</b>	14-18km/h
<b>Total daily hours of operation</b>	8.5h
<b>Total daily hours operated in full electric</b>	8.5h
<b>Total km driven/vehicle/day</b>	80km



Göppel Go4City G58

## CLIMATE

Leipzig's climate is warm and temperate with an average annual temperature of 8.9°C. Rainfall is significant and averages 518mm annually. The temperatures are highest on average in July, at around 18.1°C; January is the coldest month, averaging -0.3°C.

# LÜBECK (DE)

STADTVERKEHR LÜBECK GMBH AND  
LÜBECK-TRAVEMÜNDER VERKEHRSGESELLSCHAFT

"Having two e-buses in our fleet provides an opportunity to explore new methods of mobility and to see the challenges they pose. The city of Lübeck is oriented to sustainable development, with public transport playing a key role."

**Vehicles:** 2 x 12m Sileo S12

**Charging:** Slow-charging at the depot

**Line:** 21, 33

**Total operation time/day:**  
14-14.5h

**Duration:** From June 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** National

## DESCRIPTION

By operating e-buses, we are seeking to reduce gas emission and the level of noise in the centre of Lübeck. In addition, this also provides an opportunity to test new alternative vehicles in order to create a more rational transport system in the future.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Sileo
Vehicle Model	S12
Vehicle Length	12m
Total passenger capacity	79
Air Conditioning	No
Heating	Yes
Overnight charging	Plug at the depot (4-8h)
On-board energy storage capacity	260kWh

## LINE SPECIFICATIONS

Route number	21	33
Typology of the line	Mixed	Mixed
Topography of the line	Flat	Flat
Length of the bus line	Approx. 12km	25.5km
Average distance between stops	Approx. 500m	500m
Average commercial speed	16km/h	Approx. 18km/h
Total daily hours of operation	14.5h	Approx. 14h
Total daily hours operated in full electric	14.5h	Approx. 14h
Total km driven/vehicle/day	186km Mon-Fri, 206km Sat-Sun	Approx. 220km



Sileo S12

## CLIMATE

The climate is warm and temperate in Lübeck, with an average annual temperature of 8.6°C. Rainfall averages 673mm annually. The warmest month of the year is July, with an average temperature of 17.5°C; the lowest are in February, at around -0.1°C.

# MANNHEIM (DE)

RHEIN-NECKAR-VERKEHR



"The biggest achievement was the successful integration of the charging infrastructure in a sensitive area of the city. In particular, underground facilities had to be installed for various supply lines (pipes for gas, water and electricity)."

**Vehicles:** 2 x 12m Hess SWISS PRIMOVE

**Charging:** Fast-charging at the terminal, selected bus stops and at the depot

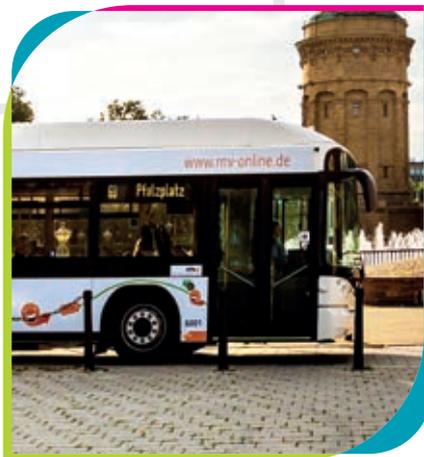
**Line:** 63

**Total operation time/day:** 15h

**Duration:** June 2015 – June 2016, ongoing in normal service

**Nature of experience:** Pilot

**Funding:** National (Leuchttürme der Elektromobilität)



Hess Swiss Primove

## DESCRIPTION

By operating a line with two fully electric buses and an inductive charging system, RNV is testing their suitability for everyday passenger services. The service on inner-city bus line 63 will enable RNV to determine the conditions under which electric buses can replace the entire diesel bus service on a line. Based on the results of this pilot project, RNV will consider the installation of further electric bus lines. After the end of the trial, the buses will continue to operate on the same route.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Hess
Vehicle Model	Swiss Primove
Vehicle Length	12m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Induction at the terminals and selected bus stops (30sec-4min)
Overnight charging	Induction using energy from tram supply network (14min)
On-board energy storage capacity	60kWh

## LINE SPECIFICATIONS

Route number	63
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	4.5km
Average commercial speed	13.4km/h
Total daily hours of operation	15h
Total daily hours operated in full electric	15h
Total km driven/vehicle/day	190km

## CLIMATE

Mannheim's climate is classified as warm and temperate. The city has significant rainfall and the annual average is 644mm. The average annual temperature is 10.1°C. The temperatures are highest on average in July, at around 19.1°C. January is the coldest month, with temperatures averaging 1.0°C.

# MÜNSTER (DE)

RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE  
AACHEN

"Introducing electric buses in the city brings positive long-term effects for the environment. Reductions in noise and exhaust gas offer significant improvements for quality of life in Münster."

**Vehicles:** 4 x 12m VDL Citea SLF-120 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 14

**Total operation time/day:** 14h

**Duration:** Sept 2015-April 2017

**Nature of experience:**  
Demonstration

**Funding:** EU (FP7 ZeEUS project)

## DESCRIPTION

In Münster, five fast-charging electric buses were used to electrify one bus line. Four vehicles are being tested within the ZeEUS project and one complements the electrification of the line. True fast-charging of up to 500kW is a key technology for achieving all-day bus operation. Following the demonstration, the buses will continue to operate on the same line.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	4 x VDL
<b>Vehicle Model</b>	Citea SLF-120 Electric
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	80
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Pantograph at the terminal (5min)
<b>Overnight charging</b>	Plug at the depot (3h)
<b>On-board energy storage capacity</b>	62.5kWh

## LINE SPECIFICATIONS

<b>Route number</b>	14
<b>Typology of the line</b>	City centre
<b>Topography of the line</b>	Flat
<b>Length of the bus line</b>	10km
<b>Average commercial speed</b>	15km/h
<b>Total daily hours of operation</b>	14h
<b>Total daily hours operated in full electric</b>	14h
<b>Total km driven/vehicle/day</b>	200km



VDL Citea SLF-120 Electric

## CLIMATE

In Münster, the climate is warm and temperate. There is a great deal of rainfall, with an annual average of 802mm. The average temperature is 9.2°C. With an average of 17.1°C, July is the warmest month. The lowest average temperatures in the year occur in January, when it is around 1.3°C.

# OBERHAUSEN (DE)

STADTWERKE OBERHAUSEN

**STOAG**  
Stadtwerke Oberhausen GmbH

"The objective of the test has been charging an ebus using tram infrastructure, while bearing in mind the most important aspect – a safe and reliable ebus operation."

**Vehicles:** 2 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at selected bus stops, slow-charging at the depot

**Lines:** 962, 966

**Total operation time/day:** 18.25h and 11.5h respectively

**Duration:** Since Oct 2015 and ongoing

**Nature of experience:** Demonstration

**Funding:** Self-funded, regional, EU (ELIPTIC), industry (Energieversorgung Oberhausen)



SOLARIS Urbino 12 electric

## DESCRIPTION

In order to reduce dependency on fossil fuels and reduce levels of nitrogen oxide and noise pollution in urban areas, the public transport operator Stadtwerke Oberhausen GmbH (STOAG) electrified two urban lines, 962 and 966. For fast-charging, the existing DC tram infrastructure is used to charge the battery buses in operation. The required charging stations have been built at Oberhausen-Sterkrade train station (line 962) and Neumarkt station (line 966). In Sterkrade the charging energy is taken from the tram catenary and at Neumarkt station the energy is taken from the tram sub-station. Currently, studies are being undertaken to examine the conversion of additional bus lines to electric operation, which can be fed from existing charging stations.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x Solaris
<b>Vehicle Model</b>	Urbino 12 electric
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	70
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Pantograph at selected bus stops, using energy from tram supply network (10min)
<b>Overnight charging</b>	Plug at the depot (5h)
<b>On-board energy storage capacity</b>	200kWh

## LINE SPECIFICATIONS

<b>Route number</b>	962	966
<b>Typology of the line</b>	City centre	City centre
<b>Topography of the line</b>	Flat	Flat
<b>Length of the bus line</b>	15.6km	13.3km
<b>Average commercial speed</b>	21km/h	21km/h
<b>Total daily hours of operation</b>	18.25h	11.5h
<b>Total daily hours operated in full electric</b>	18.25h	11.5h
<b>Total km driven/vehicle/day</b>	300km	170km

## CLIMATE

The climate is warm and temperate. There is a great deal of rainfall in Oberhausen, with an annual average of 813mm. The average annual temperature is 10.0°C. July is the warmest month of the year, averaging 18.1°C. The lowest average temperatures in the year occur in January, when it is around 1.9°C.

# STUTTGART AIRPORT (DE)

STUTTGART AIRPORT



**Vehicles:** 6 x 14m Cobus Industries eCobus 3000

**Charging:** Fast-charging at the depot

**Lines:** Airport area

**Total operation time/day:** 17h

**Duration:** Oct 2015-Dec 2016

**Nature of experience:** Pilot

**Funding:** EU



CobusIndustries eCobus 3000

## DESCRIPTION

Stuttgart Airport deployed the first six electric airport buses, type eCobus 3000. Forty percent of its bus fleet has become electric with this step. A full service contract has been signed for eight years. Stuttgart Airport's goal is to fully electrify the bus fleet by 2017, as the results in availability and energy efficiency are very encouraging.

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Cobus Industries
Vehicle Model	eCobus 3000
Vehicle Length	14m
Total passenger capacity	120
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the depot (1.5h)
On-board energy storage capacity	85kWh

## LINE SPECIFICATIONS

Route number	Airport area, airside
Typology of the line	Airport
Topography of the line	Flat
Length of the bus line	Different routes
Average commercial speed	35km/h
Total daily hours of operation	17h
Total daily hours operated in full electric	17h
Total km driven/vehicle/day	90km

## CLIMATE

Stuttgart's climate is classified as warm and temperate. The city has significant rainfall, and the annual average is 674mm. The average annual temperature in Stuttgart is 9.3°C. The temperatures are highest on average in July at around 18.0°C. January is the coldest month with temperatures averaging 0.1°C.

# BUDAPEST (HU)

BUDAPESTI KÖZLEKEDÉSI KÖZPONT and BKV Zrt.



"We are operating 20 e-buses which are the first series of Modulo C68e from a Hungarian manufacturer."

**Vehicles:** 20 x 7.98m evopro Modulo C68e

**Charging:** Slow-charging at the depot

**Lines:** 15, 16A, 39, 102, 115, 116 and 191

**Total operation time/day:** N/A

**Duration:** From May 2016 and ongoing

**Nature of experience:** Regular Operation

**Funding:** National

## DESCRIPTION

Budapesti Közlekedési Központ (BKK) is aiming to increase the clean vehicle fleet within the bus sector. This will be achieved, among others, by using electric buses. BKV, the municipality owned urban public transport operator, is running 20 e-buses on daily basis. The investment in these buses has been made using national subsidies generated as a result of sales of the CO<sub>2</sub> quota.

## VEHICLE SPECIFICATIONS

Vehicle Brand	20 x evopro
Vehicle Model	Modulo C68e
Vehicle Length	7.98m
Total passenger capacity	53
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (2.5-3h)
On-board energy storage capacity	141kWh



evopro Modulo C68e

## LINE SPECIFICATIONS

Route number	15	16A	39	102	115	116	191
Typology of the line	City centre	City centre	City centre	Feeder line	City centre	City centre	Feeder line
Topography of the line	Flat	Hilly	Hilly	Hilly	Flat	Hilly	Hilly
Length of the bus line	11.3km	1.4km	3.3km	4.5km	10.36km	1.8km	3.2km
Average distance between stops	405m	325m	373m	363m	337m	310m	461m
Average commercial speed	10.5km/h	9.0km/h	9.7km/h	9.0km/h	9.7km/h	9.5km/h	8.9km/h
Total daily hours of operation	N/A						
Total daily hours operated in full electric	N/A						
Total km driven/vehicle/day	148km	125.3km	171.7km	127.4km	148km	125.3km	78.9km

## CLIMATE

The climate is warm and temperate in Budapest with an annual average of 11.0°C. It has a significant amount of rainfall - 564mm - during the year. The warmest month is July, with an average temperature of 21.2°C; January has the lowest, at around -0.9°C.

# SZEGED (HU)

SZEGEDI KÖZLEKEDÉSI KFT.



"As the next step, we would like to lead the provision of clean public transport in Szeged. We can set a good example for citizens and decision-makers, which would inform future expectations for Szeged transportation."

**Vehicles:** 13 x 18.75m Ikarus-Skoda Tr187.2

**Charging:** Fast-charging en route

**Lines:** 77A, 10 and 19

**Total operation time/day:** 18-19h

**Duration:** April 2016-Sept/Oct 2016

**Nature of experience:**

Demonstration

**Funding:** EU



Ikarus-Skoda Tr187.2

## DESCRIPTION

In Szeged, we are demonstrating the replacement of diesel bus lines by extending the trolley bus network with trolley-hybrids, without the need for additional infrastructure. In 2013, SZKT purchased battery-equipped trolleybuses for the demonstration. The charging came from the existing catenary network and the battery trolleybuses ran in accumulator mode in between the existing and extended network.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	13 x Ikarus-Skoda
<b>Vehicle Model</b>	Tr187.2
<b>Vehicle Length</b>	18.75m
<b>Total passenger capacity</b>	125
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Overhead wires via connecting poles en route, plug charging is possible (not used)
<b>On-board energy storage capacity</b>	81kWh

## LINE SPECIFICATIONS

<b>Route number</b>	77A (with a section without overhead wires)	10	19
<b>Typology of the line</b>	City centre - residential area	City centre and suburban area	City centre and suburban area
<b>Topography of the line</b>	Flat	Flat	Flat
<b>Length of the bus line</b>	13.2km	9.2km	15.8km
<b>Average commercial speed</b>	18km/h	15km/h	17km/h
<b>Total daily hours of operation</b>	18h	19h	18h
<b>Total daily hours operated in full electric</b>	18h	19h	18h
<b>Total km driven/vehicle/day</b>	237km	117km	176km

## CLIMATE

Szeged's climate is classified as warm and temperate. The city has significant rainfall and the annual average is 518mm. The average annual temperature is 10.8°C. Temperatures are highest on average in July, at around 20.8°C. January is the coldest month, with temperatures averaging -1.4°C.

# TEL AVIV (IL)

DAN BUS



חברה לתחבורה ציבורית בע"מ

"Our next step will be to purchase additional electrical buses, as directed and instructed by the Israel Transportation Regulator."

**Vehicle:** 1 x 12m BYD K9A (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Lines:** 5, 61, 279

**Total operation time/day:** 14h

**Duration:** Aug 2013-Dec 2014

**Nature of experience:** Pilot

**Funding:** Self-funded, national

## DESCRIPTION

DAN's policy is to operate an alternative energy public transport system in collaboration with the Ministry of Environment and local authorities. The ebus operated mainly in crowded areas and was successfully integrated into the Tel Aviv metropolis. The ebus has a 160km range limit, so the greatest achievement was to find lines that suit that limitation, in order to operate successfully for the entire day.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x BYD
Vehicle Model	K9A (Variant of BYD 12m Overseas)
Vehicle Length	12m
Total passenger capacity	58
Air Conditioning	Yes
Heating	No
Overnight charging	Plug at the depot (5h)
On-board energy storage capacity	324kWh



BYD K9A (Variant of BYD 12m Overseas)

## LINE SPECIFICATIONS

Route number	5	61	279
Typology of the line	Crowded urban area		
Topography of the line	Flat		
Length of the bus line	18km	38km	23km
Average commercial speed	12km/h	12km/h	12km/h
Total daily hours of operation	14h		
Total daily hours operated in full electric	14h		
Total km driven/vehicle/day	160km		

## CLIMATE

The climate here is mild, and generally warm and temperate. Average annual rainfall amounts to 562mm. The average annual temperature is 20.2°C. With an average temperature of 27.0°C, August is the hottest month of the year. January has the lowest average temperature of the year, at 13.5°C.

# CAGLIARI (IT)

CTM SpA



"Thanks to the existence of a vast and consolidated trolley wire network (39km, three lines), between 2012 and 2016 CTM renewed its entire trolleybus fleet with 32 latest generation vehicles. Six of these have an auxiliary battery system."

**Vehicles:** 2 x 12m Solaris T12; 4 x 12m Kiepe Van Hool A330T

**Charging:** Fast-charging at the terminal and en route

**Line:** 5 ZeEUS

**Total operation time/day:** 15-18h

**Duration:** July 2014-Dec 2017

**Nature of experience:**  
Demonstration

**Funding:** EU (Jessica, ZeEUS project), Ministry of Environment



Solaris Trollino T12



Van Hool A330T

## DESCRIPTION

CTM was tasked with evaluating the efficiency, reliability and performance of six fully electric ZEV trolleybus during a scheduled service. Additionally, the performance of these vehicles in the stretches without catenary will be compared with those of another ten trolleybuses, equipped with diesel engines and two traditional buses equipped with internal combustion engines. All 18 vehicles travel the line simultaneously under the same operational conditions.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x Solaris	4 x Kiepe Van Hool
<b>Vehicle Model</b>	T12	A330T
<b>Vehicle Length</b>	12m	12m
<b>Total passenger capacity</b>	82	86
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Overhead wires en route and at the terminal via trolley poles (8-10min)	
<b>Overnight charging</b>	Trolley poles at the depot (0.2-0.5h), plug available	
<b>On-board energy storage capacity</b>	37kWh	23kWh

## LINE SPECIFICATIONS

<b>Route number</b>	5 ZeEUS
<b>Typology of the line</b>	Urban area (city centre) and seafront road
<b>Topography of the line</b>	Moderate
<b>Length of the bus line</b>	8.8km (winter configuration) 13.6km (summer configuration)
<b>Average commercial speed</b>	13.3km/h
<b>Average distance between stops</b>	300m
<b>Total daily hours of operation</b>	15-18h
<b>Total daily hours operated in full electric</b>	2-3h (winter configuration) 7-9h (summer configuration)
<b>Total km driven/vehicle/day</b>	180-220km

## CLIMATE

The climate in Cagliari is warm and temperate. The winter months are much wetter than the summer months, with around 419mm of precipitation annually. The average annual temperature is 16.2°C. August is the warmest month of the year, with an average temperature of 24.2°C. January is the coldest month, with temperatures averaging 9.8°C.

# MILAN (IT)

AZIENDA TRASPORTI MILANESI SPA



"We were the first European customers of BYD and we developed the electric three-door bus version in cooperation with BYD, according to EU standards. The greatest achievement has been to obtain the European homologation and the final authorisation for passenger service."

**Vehicles:** 2 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Line:** 84

**Total operation time/day:** 10h

**Duration:** From March 2014 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded

## DESCRIPTION

Azienda Trasporti Milanese is inspired by environmental responsibility principles, with a genuine commitment to those new technologies able to reduce emissions, save energy and use renewable energy. Within this context, ATM's plan is to increase the percentage of services powered by electric energy, through the procurement of new electric buses that are charged overnight in depot.

Our experience with this kind of vehicle is encouraging; passengers and drivers appreciate the comfort offered by electric buses, while citizens value the reduced noise and emissions.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x BYD
Vehicle Model	K9 (Variant of BYD 12m Overseas)
Vehicle Length	12m
Total passenger capacity	75
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (4-5h)
On-board energy storage capacity	324kWh

## LINE SPECIFICATIONS

Route number	84
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	9.41km (A-B), 11.54km (B-A)
Average distance between stops	340m
Average commercial speed	13.5km/h
Total daily hours of operation	10h
Total daily hours operated in full electric	10h
Total km driven/vehicle/day	Approx. 120km



BYD K9 (Variant of BYD 12m Overseas)

## CLIMATE

In Milan, the climate is warm and temperate, with an average annual temperature of 13.1°C. Rainfall averages 1013mm annually. The warmest month of the year is July, with an average temperature of 23.8°C. The lowest average temperatures, of around 1.9°C, occur in January.

# TURIN (IT)

GRUPPO TORINESE TRASPORTI



"Our biggest challenge in operating e-buses is vehicle maintenance, which is different from other types of buses. Setting up a correct charging procedure is vital, as well as training the drivers on the specifics of the vehicle, such as charging correctly and respecting the scheduled shifts."

**Vehicles:** 20 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Line:** : 19, CP1 and SE1/2

**Total operation time/day:** 14h-19h

**Duration:** From Sept 2017 and ongoing

**Nature of experience:**  
Regular operation

**Funding:** Regional

## DESCRIPTION

Gruppo Torinese Trasporti (GTT) has a long history of electric bus service, which started in 2003 with 8m electric buses. In November 2016, GTT purchased 20 high-capacity buses that enlarged the e-bus fleet. These began operations in September 2017 on three lines connecting the city centres with suburban areas. These 12-metre e-buses help reduce air and noise pollution while carrying the same amount of passengers as a standard diesel bus.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	20 x BYD
<b>Vehicle Model</b>	K9 (Variant of BYD 12m Overseas)
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	83
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes (diesel)
<b>Overnight charging</b>	Plug at the depot (5h)
<b>On-board energy storage capacity</b>	324kWh



BYD K9 (Variant)

## LINE SPECIFICATIONS

<b>Route number</b>	19	CP1	SE1/2
<b>Typology of the line</b>	City centre	Suburban	Suburban
<b>Topography of the line</b>	Flat	Flat	Flat
<b>Length of the bus line</b>	6km	10km	7.5km
<b>Average distance between stops</b>	340m	386m	403m
<b>Average commercial speed</b>	14.7km/h	22.8km/h	22.1km/h
<b>Total daily hours of operation</b>	15h	14h	19h
<b>Total daily hours operated in full electric</b>	15h	14h	19h
<b>Total km driven/vehicle/day</b>	Approx. 140km	Approx. 225km	Approx. 196km

## CLIMATE

The climate in Turin is warm and temperate, with an average annual temperature of 12.6°C. Rainfall averages 846mm annually. The warmest month of the year is July, with an average temperature of 23.6°C; the lowest are in February, at around 1.4°C.

# ASSEN (NL)

OV-BUREAU GRONINGEN DRENTHE

"In the implementation phase, it is important to remember that for us it goes beyond simply funding a technical solution. For example, we also have to manage training of drivers, mechanics and security services. Our next steps? By 2018, we want to add a further ten 18-metre VDL buses and two 12-metre hydrogen buses to our fleet."

**Vehicles:** 2 x 12m Ebusco 2.1 HV

**Charging:** Slow-charging at the depot

**Line:** 100

**Total operation time/day:** 16h

**Duration:** From July 2017, ongoing

**Nature of experience:**  
Regular operation

**Funding:** Self-funded



Ebusco 2.1 HV

## DESCRIPTION

Our main short-term objective is to achieve a CO<sub>2</sub> reduction of 4% per passenger kilometre in 2018 compared to 2016. Our long-term objective is to contribute to the national development of zero emission bus fleet in 2025. In 2018, we plan to have an additional ten 18-metre electric buses and two 12-metre hydrogen buses operational alongside the two Ebusco buses described in this form.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Ebusco
Vehicle Model	2.1 HV
Vehicle Length	12m
Total passenger capacity	95
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (3-5h)
On-board energy storage capacity	311kWh

## LINE SPECIFICATIONS

Route number	100
Typology of the line	Mixed
Topography of the line	Flat
Length of the bus line	15.5km
Average distance between stops	9km
Average commercial speed	30km/h
Total daily hours of operation	Approx. 8h
Total daily hours operated in full electric	Approx. 8h
Total km driven/vehicle/day	Approx. 161.3km

## CLIMATE

The climate in Assen is warm and temperate with an average annual temperature of 8.7°C. Around 787mm of precipitation falls annually. The temperatures are highest on average in August, at around 16.1°C; January has the lowest, around 1.3°C.

# ROTTERDAM (NL)

ROTTERDAMSE ELEKTRISCHE TRAM



"Clean buses need electric infrastructure. The greatest achievement was to develop a cooperative setting and to work together with people from various disciplines and sectors that were not yet familiar with each other."

**Vehicles:** 2 x 12m VDL/e-Traction Citea

**Charging:** Slow-charging at the depot

**Line:** 70

**Total operation time/day:** 19h

**Duration:** Jan 2015-Dec 2019

**Nature of experience:** Pilot

**Funding:** Self-funded, city, regional, national



VDL/e-Traction Citea

## DESCRIPTION

RET wants to contribute to the goals of regional authorities in Rotterdam and The Hague on reduction of CO<sub>2</sub> and improvement of air quality. The two electric buses operate services on line 70. This is a frequently-used bus route of 12km on the Rotterdam's South Bank, a high-density area with local problems of air quality. The aim is to transition to a fully zero-emission bus fleet (250 vehicles) within the next 10-15 years.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x VDL/e-Traction
Vehicle Model	Citea
Vehicle Length	12m
Total passenger capacity	59
Air Conditioning	Yes
Heating	Yes
Opportunity charging	None
Overnight charging	Plug at the depot (8h)
On-board energy storage capacity	100kWh

## LINE SPECIFICATIONS

Route number	70
Typology of the line	Mixed metropolitan area
Topography of the line	Flat
Length of the bus line	12km
Average commercial speed	16.25km/h
Total daily hours of operation	19h
Total daily hours operated in full electric	2.8h
Total km driven/vehicle/day	200km

## CLIMATE

The climate of Rotterdam is mild and relatively warm. Significant rainfall is recorded throughout the year, with an annual average of 782mm. The annual average temperature is 9.6°C. With an average temperature of 16.9°C, August is the hottest month. The coldest month of the year is January, with an average temperature of 2.5°C.

# SCHIERMONNIKOOG (NL)

ARRIVA NEDERLAND

*"When we received the six BYD buses, they all were equipped with a large battery, which meant that we could not carry many passengers. We realised that we did not need the extra battery capacity, so we removed one of the three packs from five of the six buses. We can now transport sufficient passenger numbers."*

**Vehicles:** 6 x 12m BYD K9  
(Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Line:** N/A

**Total operation time/day:** N/A

**Duration:** Feb 2013–Dec 2020

**Nature of experience:**  
Full operation

**Funding:** Regional

## DESCRIPTION

Schiermonnikoog is a tourist island, coming to life only during the summer season. Arriva operates electric BYD buses purchased by the local authority and is satisfied regarding the driveline of the bus. Passengers also provide positive feedback about the vehicles.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	6 x BYD
<b>Vehicle Model</b>	K9 (Variant of BYD 12m Overseas)
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	70
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Overnight charging</b>	Plug at the depot (5h)
<b>On-board energy storage capacity</b>	220kWh



BYD K9 (Variant of BYD 12m Overseas)

## LINE SPECIFICATIONS

Schiermonnikoog is a flat island with rural topography. The buses operate on different lines without a fixed timetable, which does not allow for operational data.

## CLIMATE

The climate is warm and temperate. Schiermonnikoog is an island with significant rainfall, and an annual average of 806mm. The average temperature is 8.6°C. The warmest month of the year is August, with an average temperature of 16.2°C. January is the coldest month, with temperatures averaging 1.6°C.

# SCHIPHOL AIRPORT (NL)

SCHIPHOL AMSTERDAM AIRPORT



**Vehicles:** 35 x 12m BYD (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

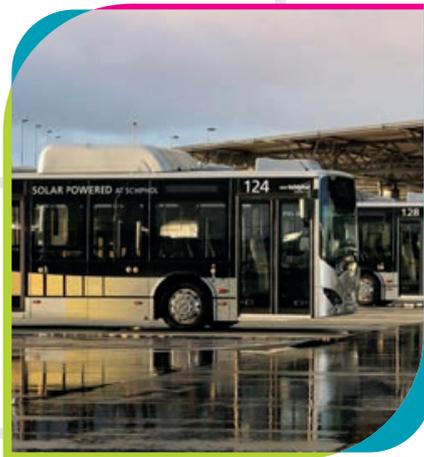
**Line:** Airport area

**Total operation time/day:** 19h

**Duration:** Jan 2015-April 2016

**Nature of experience:** Demonstration

**Funding:** Self-funded



12m BYD (Variant of BYD 12m overseas)

## DESCRIPTION

Schiphol operates 35 electric buses produced by the Chinese bus manufacturer BYD. The buses carry passengers to and from the terminal and are charged at the solar panel park at the airport.

The buses are designed specifically for Schiphol, taking into account the limited space at the airport. Inside, there is a lot of room for luggage and passengers. Due to the quiet engine, every departure of the bus is announced in Dutch and English in order to avoid potential accidents with other vehicles or people on the tarmac.

## VEHICLE SPECIFICATIONS

Vehicle Brand	35 x BYD
Vehicle Model	Variant of BYD 12m Overseas
Vehicle Length	12m
Total passenger capacity	65
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (3.5h)
On-board energy storage capacity	216kWh

## LINE SPECIFICATIONS

Route number	Airport area
Typology of the line	Airport
Topography of the line	Flat
Length of the bus line	0.9km
Average commercial speed	17km/h
Total daily hours of operation	19h
Total daily hours operated in full electric	19h
Total km driven/vehicle/day	120km

## CLIMATE

The climate in Schiphol is warm and temperate. There is significant rainfall throughout the year, even in the driest month, with an annual average of 808mm. The average annual temperature is 9.3°C. August is the warmest month of the year, with an average temperature of 16.8°C. In January, the average temperature is 2.5°C, the lowest average temperature of the year.

# CITY OF 'S-HERTOGENBOSCH (NL)

CITY OF 'S-HERTOGENBOSCH



"Our greatest achievement in the implementation phase is that we organised a consortium based on mutual trust rather than on contracts. This is what was needed at the start of an innovation curve."

**Vehicle:** 1 x 12m Volvo 7700 (customised model)

**Charging:** Fast-charging at selected bus stops, slow-charging at the depot

**Line:** 80

**Total operation time/day:** 12h

**Duration:** From Dec 2010 and ongoing

**Nature of experience:** Scaling-up phase

**Funding:** EU (European Local Energy Assistance - ELENA), regional, local authority, city



VOLVO 7700 (customised model)

**Vehicles:** 10 x 12m VDL Citea SLF-120 Electric

**Charging:** Fast-charging at the terminal and selected bus stops, slow-charging at the depot

**Line:** 70

**Total operation time/day:** 12h

**Duration:** From June 2016 and ongoing

**Nature of experience:** Scaling-up phase

**Funding:** EU (ELENA), regional, city



VDL Citea SLF-120 Electric

## DESCRIPTION

As a part of the 'Zero emission city transport' and 'Climate neutral 2050' programmes, this demonstration aims to test using a series of e-buses within a regular bus timetable. Following the end of the trial, the buses will continue to operate on the same line, as the city of 's-Hertogenbosch plans to replace its full fleet with zero-emission buses before 2025

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Volvo	10 x VDL
<b>Vehicle Model</b>	7700 (customised model)	Citea SLF-120 Electric
<b>Vehicle Length</b>	12m	12m
<b>Total passenger capacity</b>	86	79
<b>Air Conditioning</b>	No	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Induction at selected bus stops (2min)	Pantograph at selected bus stops (2min)
<b>Overnight charging</b>	Plug at the depot (6h)	Plug at the depot (6h)
<b>On-board energy storage capacity</b>	120kWh	120kWh

## LINE SPECIFICATIONS

<b>Route number</b>	80	70
<b>Typology of the line</b>	Urban area	Urban area
<b>Topography of the line</b>	Flat	Flat
<b>Length of the bus line</b>	5.32km	5km
<b>Average commercial speed</b>	20km/h	20km/h
<b>Total daily hours of operation</b>	12h	12h
<b>Total daily hours operated in full electric</b>	12h	12h
<b>Total km driven/vehicle/day</b>	280km	100-150km

## CLIMATE

The climate is mild and generally warm. 's-Hertogenbosch has a significant amount of rainfall during the year, with an annual average of 786mm. The average annual temperature is 9.4°C. With an average temperature of 16.8°C, July is the hottest month of the year. January has the lowest average temperature of the year, at 2.0°C.

# UTRECHT (NL)

PROOV



"With good project management, documentation and selection of subcontractors, we had the complete infrastructure working in 16 weeks. We were able to limit civil works in public spaces to three days, so disturbance to the existing bus services was very low."

**Vehicles:** 3 x 10m Optare Solo EV

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 2

**Total operation time/day:** 18h

**Duration:** Dec 2013-Dec 2023

**Nature of experience:**  
Procurement

**Funding:** Self-funded



Optare Solo EV

## DESCRIPTION

The electric Optare buses are used on a bus line through the inner city of Utrecht. At the bus terminal at Centraal Station, an inductive charging system was installed for opportunity charging (IPT 2.0), delivering 60kW, thus allowing an unlimited range. The charging system is equipped with a monitoring system and has an availability of > 99.5%.

## VEHICLE SPECIFICATIONS

Vehicle Brand	3 x Optare
Vehicle Model	Solo EV
Vehicle Length	10m
Total passenger capacity	55
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Induction at the terminal (3-5min)
Overnight charging	Plug at the depot (2h)
On-board energy storage capacity	86kWh

## LINE SPECIFICATIONS

Route number	2
Typology of the line	City centre
Topography of the line	Flat
Length of the bus line	5km
Average commercial speed	20km/h
Total daily hours of operation	18h
Total daily hours operated in full electric	18h
Total km driven/vehicle/day	140km

## CLIMATE

The climate is warm and temperate in Utrecht. There is a great deal of rainfall, with an annual average of 804mm. The average annual temperature is 9.3°C. The warmest month of the year is July, with an average temperature of 16.6°C. The lowest average temperatures in the year occur in January, when it is around 2.2°C.

# ZUID-OOST-BRABANT (NL)

HERMES OPENBAAR VERVOER BV



"In Eindhoven, our network includes 43 e-buses that operate during the entire day, distinguishing us from other cities with fewer e-buses to manage. It was challenging to structure an efficient bus operation system that includes a charging scheme; however we managed to do this within 11 months."

**Vehicles:** 43 x 18.1m VDL Citea SLFA-181 Electric  
**Charging:** Fast- and slow-charging at the depot  
**Line:** 400-407  
**Total operation time/day:** 20h  
**Duration:** Dec 2016 – Dec 2026  
**Nature of experience:** Regular operation  
**Funding:** Leasing



VDL Citea SLFA-181

## DESCRIPTION

The Zuid-Oost-Brabant concession covers a region of 750.000 inhabitants with main cities being Eindhoven and Helmond. The fleet is composed of around 215 buses, among them the electric buses mentioned below. During the contract period the remaining diesel buses will be replaced by other electric buses (12m – 13m and midi's).

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	43 x VDL
<b>Vehicle Model</b>	Citea SLFA-181 Electric
<b>Vehicle Length</b>	18.15m
<b>Total passenger capacity</b>	136
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Roof mounted pantograph at the depot during the day (35-45min.)
<b>Overnight charging</b>	Roof mounted pantograph at the depot (4-5h)
<b>On-board energy storage capacity</b>	180kWh

## LINE SPECIFICATIONS

<b>Route number</b>	400	401	402	403	404	405	406	407
<b>Typology of the line</b>	City centre and suburban area							
<b>Topography of the line</b>	Flat							
<b>Length of the bus line</b>	4.4km	5.6km	8.2km	8.3km	9km	10.9km	11.5km	12.3km
<b>Average distance between stops</b>	383m	520m						
<b>Average commercial speed</b>	18.5-27.5km/h							
<b>Total daily hours of operation</b>	20h							
<b>Total daily hours operated in full electric</b>	20h							
<b>Total km driven/vehicle/day</b>	200 - 300km							

## CLIMATE

Eindhoven's climate is classified as warm and temperate with an average annual temperature of 9.4°C. Around 776mm of precipitation falls annually. The temperatures are highest on average in July, at around 16.8°C; January has the lowest, around 2.0°C.

# STAVANGER (NO)

KOLUMBUS AS



"Our bus operation fleet uses only electric buses, meaning that the city urban transport is fully electrified, with major advantages for the environment and our customers. The greatest challenges to overcome were preparing the documents for a subsidy application as well as building the required charging infrastructure."

**Vehicle:** 3 x 11.97m Ebusco 2.1

**Charging:** Fast- and slow-charging at the depot

**Line:** Various

**Total operation time/day:** 1.5-4h

**Duration:** From Jan 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** EU, local



Ebusco 2.1

**Vehicles:** 2 x 11.98m Ebusco 2.0

**Charging:** Fast- and slow-charging at the depot

**Line:** Various

**Total operation time/day:** 1.5-4h

**Duration:** From April 2015 and ongoing

**Nature of experience:** N/A

**Funding:** Local and national



Ebusco 2.0

## DESCRIPTION

Kolumbus has five electric buses. These run in normal traffic on our so-called city routes. They are part of a project to establish whether electric buses will be suitable for our routes.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	3 x Ebusco	2 x Ebusco
<b>Vehicle Model</b>	Ebusco 2.1	Ebusco 2.0
<b>Vehicle Length</b>	11.97m	11.98m
<b>Total passenger capacity</b>	95	80
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Plug at the depot (1.5h)	Plug at the depot (1h)
<b>Overnight charging</b>	Plug at the depot (3h)	Plug at the depot (3.5h)
<b>On-board energy storage capacity</b>	311kWh	150kWh

## LINE SPECIFICATIONS

<b>Route number:</b>	Example Line 1	Example Line 2
<b>Typology of the line</b>	Mixed	Mixed
<b>Topography of the line</b>	Moderate	Moderate
<b>Average distance between stops</b>	450m	450m
<b>Average commercial speed</b>	28.1km/h	30km/h
<b>Total daily hours of operation</b>	4h	1.5h
<b>Total daily hours operated in full electric</b>	4h	1.5h
<b>Total km driven/vehicle/day</b>	115.9km	47.9km

## CLIMATE

Stavanger's climate is warm and temperate, with an average annual temperature of 7.2°C. Rainfall is significant, averaging 1428mm annually. The temperatures are highest in August, averaging around 14.4°C; February is the coldest, at around 0.6°C.

# GDYNIA (PL)

PRZEDSIĘBIORSTWO KOMUNIKACJI TROLEJBUSOWEJ



"It has been difficult to phase out diesel buses from the city, particularly as the vehicles were still in good working order. However, thanks to the support of good policy making, Gdynia has had the opportunity to become one of the earliest predominantly electric public transport systems in Europe."

**Vehicle:** 38 x 12m Solaris Trollino 12

**Charging:** Fast-charging en route, at the depot and at selected bus stops

**Lines:** 21 and 29

**Total operation time/day:** 9h

**Duration:** Since May 2015 and ongoing

**Nature of experience:** Regular operation

**Funding:** City-level, EU



Solaris Trollino 12

## DESCRIPTION

Trolleybuses have been an indispensable part of public transport of Gdynia for many years; the citizens know this quieter and more sustainable version of a bus very well. Thanks to batteries, trolleybuses have also gained flexibility, since they are no longer dependent on overhead wires. These new trolleybuses operate in the city centre and go as far as the border of Gdynia and Sopot (a neighbouring city that, together with Gdansk and Gdynia, create the Tricity metropolitan area). In 2018-2020, we intend to further develop the battery trolleybus fleet and purchase an additional 30 vehicles.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	38 x Solaris
<b>Vehicle Model</b>	Trollino 12
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	81
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Overhead wires via connecting poles en route, plug at the depot and on selected bus stops (1.5-3h)
<b>On-board energy storage capacity</b>	27kWh/69kWh

## LINE SPECIFICATIONS

<b>Route number</b>	21	29
<b>Typology of the line</b>	Metropolitan area	City centre/suburban
<b>Topography of the line</b>	Moderate	Hilly/moderate
<b>Average distance between stops</b>	459m	449m
<b>Average commercial speed</b>	20km/h	50km/h
<b>Total daily hours of operation</b>	11h	17h
<b>Total daily hours operated in full electric</b>	11h	17h
<b>Total km driven/vehicle/day</b>	522km	980km

## CLIMATE

Gdynia's climate is classified as warm and temperate with an average annual temperature of 7.1°C. Around 563mm of precipitation falls annually. On average, the temperatures are highest in July, at around 16.8°C, the lowest in February, around -2.0°C.

# INOWROCLAW (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE  
SP. Z O.O. W INOWROCLAWIU



"Our passengers love the buses because they offer a quiet and comfortable ride. WiFi, air-conditioning, phone chargers, real-time information and ergonomic seats are additional incentives to hop on an ebus"

**Vehicles:** 2 x 12m Solaris Urbino 12 electric

**Charging:** Fast- and slow-charging at the depot

**Lines:** 3, 10, 16

**Total operation time/day:** 23h

**Duration:** Since Aug 2015 and ongoing

**Nature of experience:**  
Normal operation

**Funding:** EU, city, self-funded



SOLARIS Urbino 12 electric

## DESCRIPTION

The buses are in regular service carrying passengers and receive positive feedback from users and staff. As Inowrocław is a health resort, the air quality is an important matter for the city. The buses are the first fully electric models that will contribute to this goal.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	70
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the depot (2h)
Overnight charging	Plug at the depot (5h)
On-board energy storage capacity	201kWh

## LINE SPECIFICATIONS

Route number	3	10	16
Typology of the line	City centre, mixed traffic		
Topography of the line	Flat		
Length of the bus line	7km	14.2km	9.6km
Average commercial speed	13km/h	13km/h	13km/h
Total daily hours of operation	23h	23h	23h
Total daily hours operated in full electric	23h	23h	23h
Total km driven/vehicle/day	84km	168km	90km

## CLIMATE

In this area, the climate is temperate and cold. Inowrocław is a city with significant rainfall, averaging 531mm annually. The average annual temperature is 7.9°C. The average temperature of 18.1°C makes July the warmest month of the year. January is the coldest month, with temperatures around -3.4°C.

# JAWORZNO (PL)

PRZEDSIĘBIORSTWO KOMUNIKACJI MIEJSKIEJ SP. Z O. O.



"In October 2016, our company signed an agreement for delivery of 16 ebus with Solaris Bus & Coach. Delivery is expected by the end of September 2017. We are also finalising a tender procedure for the delivery of a further six ebus - the new agreement with Solaris will be signed by the end of 2016."

**Vehicle:** 1 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 313

**Total operation time/day:** 18h

**Duration:** Since March 2015 and ongoing

**Nature of experience:** Pilot

**Funding:** Self-funded



Solaris Urbino 12 electric

## DESCRIPTION

The first electric bus has been in service since March 2015. The experience has been satisfactory and therefore further 22 buses will be bought within the next two years. One third of our fleet will then consist of ebus.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at selected bus stops (1h)
Overnight charging	Plug at the depot (1.5h)
On-board energy storage capacity	160kWh

## LINE SPECIFICATIONS

Route number	313
Typology of the line	City centre, suburban area
Topography of the line	Moderate
Length of the bus line	16km
Average commercial speed	30km/h
Total daily hours of operation	18h
Total daily hours operated in full electric	18h
Total km driven/vehicle/day	250km

## CLIMATE

The climate in Jaworzno is cold and temperate. The city has significant rainfall - the annual average is 707mm. The average temperature is 8.2°C. With an average of 18.4°C, July is the warmest month. January is the coldest month, with temperatures averaging -3.6°C.

# KRAKOW (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE S.A.  
W KRAKOWIE



"We decided to introduce euses into our fleet mainly in order to reduce pollution in the city. We are happy to declare that line 154 is now fully electric. Regarding the noise aspect, funnily enough, our passengers commented that the bus is too quiet. In their opinion, a bus should be heard."

**Vehicle:** 1 x 12m Solaris Urbino 12 electric

**Charging:** Slow-charging at the depot

**Line:** 169

**Total operation time/day:** 13h

**Duration:** Since April 2014 and ongoing

**Nature of experience:** Regular service

**Funding:** Self-funded



Solaris Urbino 12 electric

**Vehicles:** 4 x 8.9m Solaris Urbino 8.9 LE electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 154

**Total operation time/day:** 11h

**Duration:** Since September 2016 and ongoing

**Nature of experience:** Regular service

**Funding:** Self-funded



Solaris Urbino 8.9 LE electric

## DESCRIPTION

Following a two-year test phase, MPK decided to purchase five euses to contribute to the sustainable plan for environmental protection and public transport development in the city. The buses run in regular service and their operation is planned until the end of the battery lifetime.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Solaris	4 x Solaris
<b>Vehicle Model</b>	Urbino 12 electric	Urbino 8.9 LE electric
<b>Vehicle Length</b>	12m	8.9m
<b>Total passenger capacity</b>	71	49
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	N/A	Pantograph at the terminal (20 min)
<b>Overnight charging</b>	Plug at the depot (4h)	
<b>On-board energy storage capacity</b>	210kWh	80kWh

## LINE SPECIFICATIONS

<b>Route number</b>	169 (Solaris Urbino 12 electric )	154 (Solaris Urbino 8.9 LE electric)
<b>Typology of the line</b>	City centre	City centre
<b>Topography of the line</b>	Flat	Flat
<b>Length of the bus line</b>	12.41km	11.82km
<b>Average commercial speed</b>	17km/h	17km/h
<b>Total daily hours of operation</b>	13h	11h
<b>Total daily hours operated in full electric</b>	13h	11h
<b>Total km driven/vehicle/day</b>	192km	146km

## CLIMATE

In Krakow, the climate is cold and temperate. There is a great deal of rainfall, with an annual average of 678mm. The average temperature in Krakow is 8.2°C. The warmest month of the year is July, with an average temperature of 17.9°C. The lowest average temperatures in the year occur in January, when it is around -3.6°C.

# LODZ (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE  
- LODZ SP. Z O.O.

**Vehicle:** 1 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Lines:** 79, 14

**Total operation time/day:** 6.5h

**Duration:** Oct 2015

**Nature of experience:**  
Short test

**Funding:** City

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	70
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the terminal (2h)
Overnight charging	Plug at the depot (4h)
On-board energy storage capacity	120kWh

## LINE SPECIFICATIONS

Route number	79	14
Typology of the line	City centre	City centre
Topography of the line	Flat	Flat
Length of the bus line	9.9km	7.3km
Average commercial speed	20.1km/h	19.7km/h
Total daily hours of operation	6.5h	6.5h
Total daily hours operated in full electric	6.5h	6.5h
Total km driven/vehicle/day	100km	100km

## CLIMATE

Generally, the climate in Lodz is cold and temperate. There is a great deal of rainfall, with an annual average of 564mm. The average annual temperature is 7.9°C. Temperatures are highest on average in July, at around 18.7°C. The lowest average temperatures occur in January, when it is around -4.8°C.

# LUBLIN (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE W LUBLINIE SP. Z O.O.  
AND ZARZĄD TRANSPORTU MIEJSKIEGO W LUBLINIE



## DESCRIPTION

MPK Lublin is the biggest operator in the city, providing 80% of public transport journeys. MPK owns 226 buses and 110 trolleybuses. Among these are one electric bus and 50 trolleybuses equipped with batteries to operate up to 5km independently of the wires. The electric bus operates mainly at peak hours on trolleybus route 159. The levels of comfort are similar on trolleybuses and on the electric bus; both are quiet and have a good rate of acceleration. The city transport authority (ZTM Lublin) is planning to purchase up to 70 electric buses and 40 trolleybuses equipped with batteries.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Ursus Ekovolt	38 x Ursus	12 x Solaris
<b>Vehicle Model</b>	E70110	T70116	Trollino 18
<b>Vehicle Length</b>	12m	12m	18m
<b>Total passenger capacity</b>	80	75	125
<b>Air Conditioning</b>	Yes	Yes	Yes
<b>Heating</b>	Yes	Yes	Yes
<b>Opportunity charging</b>	Pantograph at the depot (1h)	While running on electric power from overhead wires	While running on electric power from overhead wires
<b>Overnight charging</b>	Plug at the depot (6h)	No	No
<b>On-board energy storage capacity</b>	120kWh	13.6kWh	38kWh

## LINE SPECIFICATIONS

<b>Route number</b>	152	159	160	161
<b>Typology of the line</b>	Residential areas	City centre	City centre	Residential areas
<b>Topography of the line</b>	Flat	Moderate	Flat	flat
<b>Length of the bus line</b>	11km	12km	15km	15km
<b>Average commercial speed</b>	19km/h	19km/h	19km/h	21km/h
<b>Total daily hours of operation</b>	18h	7h (Ursus E70110)	18h (Solaris Trollino 18 and Ursus T70116)	18h
<b>Total daily hours operated in full electric</b>	18h	7h	18h	18h
<b>Total km driven/vehicle/day</b>	188km (9.5km using batteries)	110km	215km (35km using batteries)	280km (15km using batteries)

# LUBLIN (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE W LUBLINIE SP. Z O.O.  
AND ZARZĄD TRANSPORTU MIEJSKIEGO W LUBLINIE

**ZTM** ZARZĄD TRANSPORTU  
MIEJSKIEGO W LUBLINIE



**Vehicle:** 1 x 12m Ursus Ekovolt E70110

**Charging:** Fast- and slow-charging  
at the depot

**Line:** 159

**Total operation time/day:** 7h

**Duration:** Since July 2015 and ongoing

**Funding:** Self-funded



Ursus E70110

**Vehicles:** 38 x 12m Ursus T70116

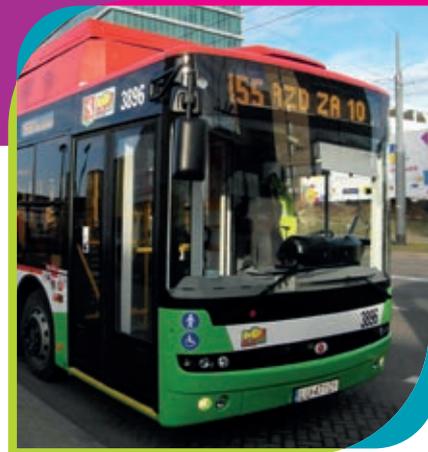
**Charging:** While running on electric  
power from overhead wires

**Lines:** 152, 159, 160, 161

**Total operation time/day:** 18h

**Duration:** Since Dec 2013 and ongoing

**Funding:** EU, city



Ursus T70116

**Vehicles:** 12 x 18m Solaris Trollino 18

**Charging:** While running on electric  
power from overhead wires

**Lines:** 159, 161

**Total operation time/day:** 18h

**Duration:** Since Dec 2013 and  
ongoing

**Funding:** EU, city



Solaris Trollino 18

## CLIMATE

The climate in Lublin is cold and temperate. There is a great deal of rainfall, with an annual average of 540mm. In Lublin, the average annual temperature is 7.6°C. With an average of 18.5°C, July is the warmest month. The lowest average temperatures occur in January, when it is around -5.6°C.

# RZESZOW (PL)

MIEJSKIE PRZEDSIĘBIORSTWO KOMUNIKACYJNE  
- RZESZOW SP Z O.O.



**Vehicle:** 1 x 12m Ursus Ekovolt E70110; 1 x 12m Solaris Urbino E12 Medcom

**Charging:** Slow-charging at the depott

**Lines:** 0

**Total operation time/day:** 8-9h

**Duration:** February 2016 (2 weeks), May 2016-June 2016 (2 weeks)

**Nature of experience:** Test

**Funding:** City, EU

## DESCRIPTION

MPK Rzeszow tested the buses to gain initial experience in this domain. Following this test phase, in April 2016, it was decided to announce a tender to purchase ten ebuses in order to fully electrify line 0, which runs through the city centre. The buses received positive feedback from both drivers and passengers.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Ursus Ekovolt	1 x Solaris
<b>Vehicle Model</b>	E70110	E12 Solaris Urbino-Medcom (Variant of Solaris Urbino 12 electric)
<b>Vehicle Length</b>	12m	12m
<b>Total passenger capacity</b>	80	80
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Overnight charging</b>	Plug-in (3h)	Plug at the depot (5h)
<b>On-board energy storage capacity</b>	170kWh	210kWh

## LINE SPECIFICATIONS

<b>Route number</b>	0
<b>Typology of the line</b>	City centre
<b>Topography of the line</b>	Flat
<b>Length of the bus line</b>	9.5km
<b>Average commercial speed</b>	16.5km/h
<b>Total daily hours of operation</b>	8-9h
<b>Total daily hours operated in full electric</b>	8-9h
<b>Total km driven/vehicle/day</b>	120km

## CLIMATE

In Rzeszow, the climate is cold and temperate. There is significant rainfall throughout the year, with an average of 615mm of precipitation annually. The average annual temperature is 7.5°C. The warmest month of the year is July, with an average temperature of 18.6°C. In January, the average temperature is -5.9°C, which is the lowest average temperature of the year.

# WARSAW (PL)

WARSAW MUNICIPAL BUS CO. LTD



**Vehicles:** 10 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 222

**Total operation time/day:** 16h

**Duration:** Since June 2015 and ongoing

**Nature of experience:** Pilot

**Funding:** Self-funded, city



Solaris Urbino 12 electric

**Vehicles:** 6 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Lines:** 222 and others

**Total operation time/day:** 17h

**Duration:** Nov 2014-June 2015 (4 vehicles, line 222); March 2016-Dec 2016 (2 vehicles, different lines)

**Nature of experience:**

Exploitation test

**Funding:** Self-funded, city



BYD K9 (Variant of BYD 12m Overseas)

## DESCRIPTION

MZA purchased 10 Solaris Urbino U12 e buses as the first step toward the electrification of the city centre. The buses today operate on line 222, which goes through the congested centre and the historic part of the city. The whole line is operated solely with e buses. Passengers appreciate the comfort and driving dynamics, even although it is sometimes crowded inside (for obvious reasons). An efficient HVAC system completes the positive overall opinion of the vehicle.

MZA also tests leased BYD K9 buses that operate on line 222. By the end of 2016, these will have been tested on different lines in the city centre.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	10 x Solaris	6 x BYD
<b>Vehicle Model</b>	Urbino 12 electric	K9 (Variant of BYD 12m Overseas)
<b>Vehicle Length</b>	12m	12m
<b>Total passenger capacity</b>	70	60
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Plug at the depot (2-3h), Pantograph at the terminal (planned for Dec 2016/Jan 2017)	Plug at the depot (2-3h) (overnight charging only in summer)
<b>Overnight charging</b>	Plug at the depot (5h)	Plug at the depot (5h)
<b>On-board energy storage capacity</b>	208kWh	324kWh

## LINE SPECIFICATIONS

<b>Route number</b>	222	
<b>Typology of the line</b>	City centre	
<b>Topography of the line</b>	Moderate	
<b>Length of the bus line</b>	10km	
<b>Average commercial speed</b>	12km/h	
<b>Total daily hours of operation</b>	16h (Solaris)	17h (BYD)
<b>Total daily hours operated in full electric</b>	16h	15-17h
<b>Total km driven/vehicle/day</b>	160km	170-200km

# LISBON (PT)

CARRIS

carris 

"Following difficult times brought about by the financial crisis, we want now to renew our fleet with modern technologies and employing alternative energy sources."

**Vehicle:** 1 x 12m Caetano e. City Gold

**Charging:** Slow-charging at the depot

**Lines:** 706, 758

**Duration:** Oct 2016 – Nov 2016

**Nature of experience:**  
Pilot operation

**Funding:** Self-funded

## DESCRIPTION

The test undertaken in 2016 was the first step in deploying electric buses in Lisbon. Our goal is to introduce sustainable transportation in the city through this renewal of the bus fleet and natural gas (contribution to reduce CO<sub>2</sub>). Carris plans to buy its first 15 electric buses in 2019.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Caetano
Vehicle Model	e. City Gold
Vehicle Length	12m
Total passenger capacity	85
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the depot (1.5h)
On-board energy storage capacity	70kWh



Caetano e. City Gold

## LINE SPECIFICATIONS

Route number	706	758
Typology of the line	City centre	City centre
Topography of the line	Hilly	Hilly/flat
Length of the bus line	18.66km	19.62km
Average distance between stops	290-341m	299-315m

## CLIMATE

The climate is warm and temperate in Lisbon with an average annual temperature of 16.9°C. Precipitation averages 691mm. On average, the temperatures are highest in August at around 22.7°C, lowest in January, at around 11.7°C.

# BUCHAREST (RO)

REGIA AUTONOMA DE TRANSPORT BUCURESTI



"Bucharest's electric surface public transport consists of trams and trolleybuses, which are based on mature technologies. As well as this, we need flexibility to adapt to passengers' travel needs and to new developments in the city. From this perspective, the fully electric buses, combined with existing trolleybuses and trams, can offer a practical alternative."

**Vehicle:** 1 x 10.5m SOR EBN 10.5,  
2 x 12m BYD K9 (Variant of BYD  
12m Overseas)

**Charging:** Slow-charging at the  
depot

**Lines:** 381, 104

**Total operation time/day:** 7-12h

**Duration:** March 2015-June 2015

**Nature of experience:**  
Short test

**Funding:** City



SOR EBN 10.5



BYD K9 (Variant of BYD 12m Overseas)

## DESCRIPTION

From March 2015 to the end of June 2015, two types of electric bus – SOR EBN 10.5m and BYD EBUS K9 12m – were tested in Bucharest's transport system.

The comfort of these buses and their environmental benefits were appreciated by users. These buses operate on two high-demand public transport lines in an urban area, alongside normal diesel Euro IV buses. Time-keeping is satisfactory but the operational range and transport capacity is lower than those of existing buses.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x SOR	2 x BYD
<b>Vehicle Model</b>	EBN 10.5	K9 (Variant of BYD 12m Overseas)
<b>Vehicle Length</b>	10.5m	12m
<b>Total passenger capacity</b>	85	85
<b>Air Conditioning</b>	No	No
<b>Heating</b>	No	No
<b>Overnight charging</b>	Plug at the depot (7h)	Plug at the depot (6h)
<b>On-board energy storage capacity</b>	172kWh	324KWh

## LINE SPECIFICATIONS

<b>Route number</b>	381	104
<b>Typology of the line</b>	City centre	City centre
<b>Topography of the line</b>	Flat	Flat
<b>Length of the bus line</b>	22.4km	23.5km
<b>Average commercial speed</b>	15.10km/h	14.29km/h
<b>Total daily hours of operation</b>	7-12h	7-12h
<b>Total daily hours operated in full electric</b>	7-12h	7-12h
<b>Total km driven/vehicle/day</b>	114-187km	114-187km

## CLIMATE

Bucharest has a humid continental climate. Winter temperatures often dip below 0°C, sometimes even to -20°C. In the summer, the average temperature is 23°C. Temperatures frequently reach 35-40°C in midsummer. The average annual precipitation is 595mm.

# BELGRADE (SR)

CITY PUBLIC TRANSPORT COMPANY – BELGRADE



"The biggest challenge for the company (JKP GSP Belgrade) was the professional advocacy of our ebus team, which was crucial to enabling the Mayor of Belgrade to introduce the first electric line in Belgrade."

**Vehicles:** 5 x 12m Higer KLQ6125GEV3

**Charging:** Fast-charging at the terminal and at the depot

**Line:** 1 EKO

**Total operation time/day:** 18h

**Duration:** Since Sept 2016 and ongoing

**Nature of experience:**  
Regular operation of the new ebus line

**Funding:** City, EU (EBRD)

## DESCRIPTION

Regular operation of the new ebus line 1 'EKO' is the first step towards wider ebus use. Once the city has gained operational experience, Belgrade plans to open further lines operated by e buses.

## VEHICLE SPECIFICATIONS

Vehicle Brand	5 x Higer
Vehicle Model	KLQ6125GEV3
Vehicle Length	12m
Total passenger capacity	81
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at the terminal (5-10min), pantograph at the depot (30-40min)
On-board energy storage capacity	20kWh



Higer KLQ6125GEV3

## LINE SPECIFICATIONS

Route number	1 EKO
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	8km
Average commercial speed	14.5km/h
Total daily hours of operation	18h
Total daily hours operated in full electric	18h
Total km driven/vehicle/day	185km

## CLIMATE

Belgrade is in a continuous zone of humid subtropical and humid continental climate. It receives uniformly spread precipitation. Monthly average temperatures range from 1.4°C in January to 23.0°C in July, with an annual mean of 12.5°C. Belgrade receives an average of 690mm of precipitation a year.

# KOŠICE (SK)

PUBLIC TRANSPORT COMPANY KOŠICE



**Vehicles:** 5 x 10.5m SOR EBN 10,5

**Charging:** Slow-charging at the depot

**Line:** 18, 20, 22, 26, 30, 32

**Total operation time/day:** 3-10h

**Duration:** From Oct 2014 and ongoing

**Nature of experience:** Pilot

**Funding:** Self-funded



SOR EBN 10.5

**Vehicles:** 9 x 11m SOR EBN 11

**Charging:** Slow-charging at the depot

**Lines:** 18, 20, 22, 30, 32

**Total operation time/day:** 3-10h

**Duration:** From July 2016 and ongoing

**Nature of experience:** Pilot

**Funding:** EU-funding

## DESCRIPTION

We introduced e buses in Košice and following almost three years of use, we are assessing their pros and cons. We are analysing how far they can travel with fully-charged batteries, how the terrain affects battery capacity (Košice has both flat and hilly terrain), the influence of the number of chargings on battery capacity, etc. This experience is a part of a wider project that aims to ensure the use of more electric vehicles in the future.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	5 x SOR	9 x SOR
<b>Vehicle Model</b>	EBN 10,5	EBN 11
<b>Vehicle Length</b>	10.4-10.5m	11-11.1m
<b>Total passenger capacity</b>	58	67
<b>Air Conditioning</b>	No	No
<b>Heating</b>	Yes	Yes
<b>Overnight charging</b>	Plug at the depot (11h)	Plug at the depot (11h)
<b>On-board energy storage capacity</b>	120kWh	120kWh

## LINE SPECIFICATIONS

Route number	18	20	22	26	30	32
<b>Typology of the line</b>	City centre	City centre/ Suburban	City centre	Suburban	City centre	City centre
<b>Topography of the line</b>	Partially hilly	Partially hilly	Partially hilly	Flat	Flat	Partially hilly
<b>Length of the bus line</b>	8.7/8.9km	33.9km	6.6-7km	3.7-3.8km	10.1km	14.9-15.8km
<b>Total daily hours of operation</b>	3-10h					
<b>Total daily hours operated in full electric</b>	3-10h					
<b>Total km driven/vehicle/day</b>	55-200km					

## CLIMATE

The climate is cold and temperate. Rainfall in Košice is significant, with an annual average of 624mm. The average temperature in Košice is 8.6°C. With an average temperature of 19.1°C, July is the hottest month of the year. At -3.4°C on average, January is the coldest month of the year.

# AZUQUECA DE HENARES (ES)

IRIZAR S. COOP



"The buses use the 'in motion' charging system, which is very efficient. In addition, we think that opportunity charging is more expensive than the system our buses have as they are charged while they are driving, with no requirement to modify their timetable."

**Vehicle:** 1 x 12m IRIZAR i2e

**Charging:** Slow-charging at the depot

**Lines:** 1

**Total operation time/day:** 14h-16h

**Duration:** From April 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded

## DESCRIPTION

The new service responds to a new commitment of quality. The buses run from Monday to Friday from 7.00 to 23.00. The vehicles will pass every 20 minutes on a line of 11.9km in length, which will encompass both the centre of the municipality and the surrounding neighbourhoods.

The new vehicles also ease the intermodal process, as the operator re-schedule the bus passing times to coordinate with other public transport systems in different key places of the city. This is critical as Azuqueca, a city of 35,000 inhabitants, is very close to Madrid.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Irizar
Vehicle Model	i2e
Vehicle Length	12m
Total passenger capacity	83
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (7h)
On-board energy storage capacity	376kWh

## LINE SPECIFICATIONS

Route number	1
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	15km
Average distance between stops	500m
Average commercial speed	10.4km/h
Total daily hours of operation	14-16h
Total daily hours operated in full electric	14-16h



IRIZAR i2e

## CLIMATE

The climate in Azuqueca De Henares is mild, generally warm and temperate with an average annual temperature of 13.4°C. Around 416mm of precipitation falls annually. The temperatures are highest on average in July, at around 23.7°C, lowest in January, at around 4.7°C.

# BARCELONA (ES)

TRANSPORTS METROPOLITANS DE BARCELONA (TMB)



"We believe that, regarding electric propulsion, communication must be robust between the bus, the charging station and the control centre, where we can monitor performance. Only in this way can we create a complete electric bus line."

**Vehicles:** 2 x 12m Irizar i2e

**Charging:** Slow-charging at the depot

**Lines:** L20, L34

**Total operation time/day:** 15-16h (winter), 12-13h (summer)

**Duration:** Sept 2014-April 2017

**Nature of experience:** Demonstration

**Funding:** EU (ZeEUS project)



IRIZAR i2e

## DESCRIPTION

Within the ZeEUS project, we are evaluating 12m Irizar i2e purely electric buses (overnight charging) and 18m Solaris Urbino purely electric buses (overnight slow-charging, with opportunity charging at line terminals). Additionally, we operate a BYD K9 bus to test different lines. Following the test, we will evaluate results and make a decision on whether to buy the vehicles. Testing is the only way to experience and understand the operational characteristic of an electric bus, as it is a completely new technology.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Irizar	1 x BYD	2 x Solaris
Vehicle Model	i2e	K9 (Variant of BYD 12m Overseas)	Urbino 18 electric
Vehicle Length	12m	12m	18m
Total passenger capacity	75	75	115
Air Conditioning	Yes	Yes	Yes
Heating	No	No	No
Opportunity charging	No	no	Pantograph at the terminal (6-8min)
Overnight charging	Plug at the depot (5-6h)	Plug at the depot (5-6h)	Plug at the depot (2.5h)
On-board energy storage capacity	352kWh	324kWh	125kWh

## LINE SPECIFICATIONS

Route number	L20	L34	L45	L47	H16
Typology of the line	City centre	City centre	City centre	City centre	City centre
Topography of the line	Flat and hilly	Flat and hilly	Flat and hilly	Flat and hilly	Flat
Length of the bus line	6.4km	10.9km	9.7km	9.3km	12.5km
Average commercial speed	12,5km/h	12.5km/h	12.5km/h	12.5km/h	12.5km/h
Total daily hours of operation	17h	16.75h	17h	17h	18h
Total daily hours operated in full electric	15-16h (winter) 12-13h (summer)	15-16h (winter) 12-13h (summer)	15h (winter) 12-13h (summer)	15-16h (winter) 12-13h (summer)	15-16h (winter) 12-13h (summer)
Total km driven/vehicle/day	Winter: 170km Summer: 138km	Winter: 180km Summer: 138km	Winter: 155km Summer: 130km	Winter: 155km Summer: 130km	-

# BARCELONA (ES)

TRANSPORTS METROPOLITANS DE BARCELONA (TMB)



**Vehicle:** 1 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Lines:** L45, L47

**Total operation time/day:** 15-16h (winter), 12-13h (summer)

**Duration:** Since Jan 2014–Dec 2016

**Nature of experience:**  
Demonstration

**Funding:** Self-funded

**Vehicles:** 2 x 18m Solaris Urbino 18 electric

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** H16

**Total operation time/day:** 15-16h (winter), 12-13h (summer)

**Duration:** May 2016–April 2017

**Nature of experience:**  
Demonstration

**Funding:** EU (ZeEUS project)



BYD K9 (Variant of BYD 12m Overseas)



SOLARIS Urbino 18 electric

## CLIMATE

The climate is warm and temperate in Barcelona. The rain falls mostly in winter, with relatively little rain in summer. The average annual rainfall is 612mm. The average annual temperature is 16.5°C. The warmest month of the year is July, with an average temperature of 24.1°C. At 9.8°C on average, January is the coldest month of the year.

# BARCELONA (ES)

AMB (BARCELONA METROPOLITAN AREA)

"Our e-bus operates a night service, which the inhabitants highly appreciate due to its quietness. This convinced us to continue to purchase electric buses for the night service and to begin with some electric buses in daily services."

**Vehicles:** 1 x 12m Irizar i2e

**Charging:** Slow-charging at the depot

**Lines:** N16

**Total operation time/day:** 8h

**Duration:** From May 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded



IRIZAR i2e

## DESCRIPTION

Within the ZeEUS project, we are evaluating 12m Irizar i2e purely electric buses (overnight charging) and 18m Solaris Urbino purely electric buses (overnight slow-charging, with opportunity charging at line terminals). Additionally, we operate a BYD K9 bus to test different lines. Following the test, we will evaluate results and make a decision on whether to buy the vehicles. Testing is the only way to experience and understand the operational characteristic of an electric bus, as it is a completely new technology.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Irizar
Vehicle Model	i2e
Vehicle Length	12m
Total passenger capacity	80
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (6-7h)
On-board energy storage capacity	275 kWh

## LINE SPECIFICATIONS

Route number	N16
Typology of the line	Metropolitan area
Topography of the line	Moderate
Length of the bus line	30km
Average distance between stops	200-300m
Average commercial speed	26km/h
Total daily hours of operation	8h
Total daily hours operated in full electric	8h
Total km driven/vehicle/day	150km

## CLIMATE

The climate is warm and temperate in Barcelona. The rain falls mostly in winter, with relatively little rain in summer. The average annual rainfall is 612mm. The average annual temperature is 16.5°C. The warmest month of the year is July, with an average temperature of 24.1°C. At 9.8°C on average, January is the coldest month of the year.

# BILBAO (ES)

IRIZAR S. COOP



"Bilbao is the first public road transport service in the Basque region to incorporate electric vehicles into its fleet. Once again, Bilbao is at the forefront of technological innovation."

**Vehicle:** 2 x 12m IRIZAR i2e

**Charging:** Slow-charging at the depot

**Lines:** Different lines

**Total operation time/day:** 14h-16h

**Duration:** From Dec 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** Self-funded

## DESCRIPTION

Bilbao is once again at the forefront of technological innovation in the provision of its services with a clear vocation. On one hand, it is delivering continuous improvement and on the other, it is boosting the territory. This initiative is part of the city's commitment to seeking solutions that reduce the impact of transport on the environment with sustainable alternatives.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x Irizar
Vehicle Model	i2e
Vehicle Length	12m
Total passenger capacity	83
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (7h)
On-board energy storage capacity	376kWh

## LINE SPECIFICATIONS

Route number	Different lines (average data)
Typology of the line	Mixed
Topography of the line	Moderate
Length of the bus line	Between 7 and 15km
Average commercial speed	12-16km/h
Total daily hours of operation	16h
Total daily hours operated in full electric	16h
Total km driven/vehicle/day	180-200km



IRIZAR i2e

## CLIMATE

The climate in Bilbao is warm and temperate with an average annual temperature of 14.1°C. Around 1174mm of precipitation falls annually. The temperatures are highest on average in July, at around 19.9°C; January has the lowest, at around 8.9°C.

# DONOSTIA/SAN SEBASTIÁN (ES)

DBUS



"The introduction of the drivers to the vehicles has been successful. Following a proper communication and training strategy, all staff have adapted to the new vehicles. The participation of unions in the design of the driver's cockpit area has also helped in the acceptance of the vehicles among staff."

**Vehicle:** 3 x 12m IRIZAR i2e

**Charging:** Slow-charging at the depot

**Lines:** Different lines in the city centre (150-200km)

**Total operation time/day:** 14h

**Duration:** From July 2014 (1 vehicle) and March 2016 (2 vehicles) and ongoing

**Nature of experience:** Demonstration

**Funding:** Self-funded, national, EU

## DESCRIPTION

Dbus is testing an Irizar I2E vehicle on various routes in the city centre (mainly line 26). The target is to adapt the vehicle to a line with no changes in the service, which would mean that the range of the vehicle was pushed to the limit every day. With this target in mind, the vehicle was designed in collaboration with Irizar and Dbus, setting the operational needs as a prerequisite. The bus will stay in operation until the end of its operational life (12 years).

## VEHICLE SPECIFICATIONS

Vehicle Brand	3 x Irizar
Vehicle Model	i2e
Vehicle Length	12m
Total passenger capacity	75
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (7h)
On-board energy storage capacity	340kWh

## LINE SPECIFICATIONS

Route number	26 (also 27, 17, 13)
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	13.2km
Average commercial speed	17.2km/h
Total daily hours of operation	15h
Total daily hours operated in full electric	15h
Total km driven/vehicle/day	150-200km



IRIZAR i2e

## CLIMATE

The city has a maritime climate with warm summers and cool, mild winters. The city averages 1650mm of precipitation annually. Average temperatures range from 8.4°C in January to 21.5°C in August.

# MADRID (ES)

EMT DE MADRID



"We plan to renew our bus fleet with more CNG hybrid buses in order to improve air quality in Madrid."

**Vehicles:** 13 x 11.3m Castrosua Tempus

**Charging:** Slow-charging at the depot

**Line:** 41, 119

**Total operation time/day:** 16h

**Duration:** Jan 2012-Jan 2014

**Nature of experience:** Pilot

**Funding:** Self-funded

## DESCRIPTION

Operating e-buses in Madrid has posed us some challenges. The greatest was coordinating maintenance at the depot with the four hour charging time needed for the bus; however, we have overcome this problem. We now we plan to start operating 12-metre fully electric buses in 2018 in order to improve the air quality in Madrid.

## VEHICLE SPECIFICATIONS

Vehicle Brand	13 x Castrosua
Vehicle Model	Tempus
Vehicle Length	11.3m
Total passenger capacity	81
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (4h)
On-board energy storage capacity	72kWh

## LINE SPECIFICATIONS

Route number	41	119
Typology of the line	City centre	City centre
Topography of the line	Moderate	Moderate
Length of the bus line	6.6km	8km
Average distance between stops	328m	285m
Average commercial speed	11.5km/h	12.6km/h
Total daily hours of operation	16.5h	16.5h
Total daily hours operated in full electric	4.5h	4.5h
Total km driven/vehicle/day	200km	200km



Castrosua Tempus

## CLIMATE

The climate is warm and temperate in Madrid, with an average annual temperature of 13.7°C. The rainfall averages 450mm. The warmest month is July, with an average temperature of 24.0°C; the lowest is January, at around 5.0°C.

# VALLADOLID (ES)

VECTIA MOBILITY S.L.



"VECTIA Plug-In Hybrid Technology allows a reduction in fossil fuel consumption of 30% and ensures zero-emission service at bus stops, the city centre, depots and the underground transport hub."

**Vehicles:** 5 x 12m Vectia Veris.12 Hybrid+

**Charging:** Fast-charging at the terminal

**Line:** 7

**Total operation time/day:** 16h

**Duration:** June 2016-July 2017

**Nature of experience:** Testing different technologies

**Funding:** City, EU (Lighthouse project - REMOURBAN)

## DESCRIPTION

The test consists of three different modes of operation of a plug-in hybrid 12m urban bus; hybrid mode (diesel-electric hybrid), partially full electric mode (100% electric in the zones and the remainder in hybrid mode, fast-charge at both ends of route) and fully electric mode (100% electric operation, fast-charge at both ends of route). The test will look at performance, total cost of ownership and pollutant emissions.

## VEHICLE SPECIFICATIONS

Vehicle Brand	5 x Vectia
Vehicle Model	Veris.12 Hybrid+
Vehicle Length	12m
Total passenger capacity	85
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at the terminal (3-5min)
On-board energy storage capacity	24kWh

## LINE SPECIFICATIONS

Route number	7
Typology of the line	City centre, metropolitan area including old town
Topography of the line	Flat
Length of the bus line	6km
Average commercial speed	10km/h
Total daily hours of operation	16h
Total daily hours operated in full electric	5.3h
Total km driven/vehicle/day	160km



Vectia Veris.12 Hybrid+

## CLIMATE

Valladolid has a Mediterranean climate with hot summers and cool, windy winters. The mean daytime temperature is 12.7°C. The July average temperature is 22.3°C. The January average temperature is 4.2°C. Average annual precipitation is 435mm.

# ALE MUNICIPALITY (SE)

ALE KOMMUN MUNICIPALITY



"Ale Kommun will continue to work to improve its bus fleet. The Västra Götalands Region is in charge of public transport in our region and we, as a municipality, will continue to campaign for more electric vehicles on our roads. We are helping to electrify the general vehicle fleet by installing public charging stations and by providing an electric car pool for our inhabitants."

**Vehicle:** 1 x 9.2m Optare Solo EV

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** Älvan

**Total operation time/day:** 10h

**Duration:** Since Dec 2014 and ongoing

**Nature of experience:**  
Demonstration

**Funding:** Regional

## DESCRIPTION

The electric bus operates around a dense urban area in Ale called Älvängen. The objective is to contribute to more sustainable transport within the area and to reduce the number of cars at the train station, from where the bus ('Älvan') operates. The service has been very successful and received positive feedback from passengers.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Optare
Vehicle Model	Solo EV
Vehicle Length	9.2m
Total passenger capacity	49
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the terminal (3h)
Overnight charging	Plug at the depot (6h)
On-board energy storage capacity	150kWh

## LINE SPECIFICATIONS

Route number	Älvan
Typology of the line	Suburban area
Topography of the line	Hilly
Length of the bus line	5km
Average commercial speed	20km/h
Total daily hours of operation	10h
Total daily hours operated in full electric	10h
Total km driven/vehicle/day	80km



Optare Solo EV

## CLIMATE

The climate in Ale is cold and temperate. Rainfall is significant, with precipitation averaging 631mm, March being the driest month and August the wettest. The average annual temperature is 4.4°C. The temperatures are highest on average in July, at around 16.0°C. At -7.0°C on average, January is the coldest month of the year.

**Vehicles:** 5 x 12m BYD K9-13C  
(Variant of BYD 12m Overseas)

**Charging:** Fast-charging at the depot

**Lines:** 1, 2 and 3

**Total operation time/day:** 13h

**Duration:** Jan 2016-Dec 2019

**Nature of experience:** Pilot

**Funding:** Regional



BYD K9-13C (Variant of BYD 12 m Overseas)

## DESCRIPTION

This pilot is part of the environmental strategy of Skånetrafiken (the local PTA), in order to evaluate the use of depot-charged battery buses in traffic systems in terms of total system efficiency, vehicle performance and customer appreciation. Eight urban buses are being tested, of which five are full battery electric buses leased by Nobina Fleet. Three remaining compressed natural gas (CNG) buses operate for reference. Following completion of the trial, the buses will continue to operate on the same route.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	5 x BYD
<b>Vehicle Model</b>	K9-13C (Variant of BYD 12m Overseas)
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	70
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Overnight charging</b>	Plug at the depot (4.5h)
<b>On-board energy storage capacity</b>	292kWh

## LINE SPECIFICATIONS

<b>Route number</b>	1	2	3
<b>Typology of the line</b>	City centre/ suburban area	City centre/ suburban area	City centre/ suburban area
<b>Topography of the line</b>	Flat	Flat	Flat
<b>Length of the bus line</b>	7.1km	14.2km	9.7km
<b>Average commercial speed</b>	18.5km/h	18.5km/h	18.5km/h
<b>Total daily hours of operation</b>	13h	13h	13h
<b>Total daily hours operated in full electric</b>	13h	13h	13h
<b>Total km driven/vehicle/day</b>	250km	250km	250km

## CLIMATE

In Ängelholm, the climate is warm and temperate. There is significant rainfall throughout the year. The average temperature is 7.8°C and average annual rainfall is 703mm. With an average of 17.0°C, July is the warmest month. In February, the average temperature is -0.6°C, which is the lowest average temperature for the whole year.

# ESKILSTUNA (SE)

TRANSDEV SWEDEN AB



**Vehicles:** 2 x 12m BYD (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Line:** different lines

**Total operation time/day:** 11h

**Duration:** Since Nov 2015 and ongoing

**Nature of experience:** Pilot to test the buses during different conditions

**Funding:** Self-funded, city, local authority



12m BYD (Variant of BYD 12m overseas)  
Source: *bussmagazinet*

## DESCRIPTION

Eskilstuna is one of the leading cities in developing a quiet, attractive and climate-friendly bus fleet. The drivers who drove the electric buses during the pilot were satisfied and the buses passed the test in both winter cold and summer heat. The results of this pilot are so successful that the municipality, Transdev and Sörmlands Public Transportation Authority decided to purchase another 10 vehicles.

## VEHICLE SPECIFICATIONS

Vehicle Brand	2 x BYD
Vehicle Model	Variant of BYD 12m Overseas
Vehicle Length	12m
Total passenger capacity	72
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (3h)
On-board energy storage capacity	280-330kWh

## LINE SPECIFICATIONS

Route number	Several different lines
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	N/A
Average commercial speed	25km/h
Total daily hours of operation	11h
Total daily hours operated in full electric	11h
Total km driven/vehicle/day	250km

## CLIMATE

In Eskilstuna, the climate is cold and temperate. There is a great deal of rainfall with a year average of 574mm. The temperature here averages 6.2°C. The warmest month of the year is July, with an average temperature of 17.0°C. The lowest average temperatures in the year occur in February, when it is around -3.7°C.

# GOTHENBURG (SE)

VÄSTTRAFIK AB



"Our project combines both electric hybrids and fully electric buses that run together on line 55. The biggest challenge to overcome for us was working together in a partnership with 15 stakeholders, as there were many different perspectives and focuses. We aim to create an electric bus line that can make a difference for our customers and the environment."

**Vehicles:** 4 x 10,7m Volvo (prototype), 7 x 12m Volvo 7900 Electric Hybrid

**Charging:** Fast charging at two bus stops and slow charging at the depot

**Line:** 55

**Total operation time/day:** 13h

**Duration:** June 2015 - Dec 2020

**Nature of experience:** demonstration in regular operation

**Funding:** EU funding – EBSF\_2



Volvo Concept



Volvo 7900 Electric Hybrid

## DESCRIPTION

Seven plug in hybrids and four fully electric buses operate on route 55 in Gothenburg, as part of the ElectriCity project\*. Project objectives include establishing new, sustainable, attractive public transport solutions and opening up new opportunities for travel and urban planning in the future. Route 55 has approximately 100,000 passengers per month and receives high marks from both customers and drivers. As indicated in a Västtrafik customer satisfaction survey (Q1 2017), 99% of the passengers were satisfied with their most recent journey.

\*For more information about the project, please visit <https://www.goteborgelectricity.se>

## VEHICLE SPECIFICATIONS

Vehicle Brand	4 x Volvo	7 x Volvo
Vehicle Model	Concept	7900 Electric Hybrid
Vehicle Length	10,7m	12m
Total passenger capacity	47	70
Air Conditioning	Yes	Yes
Heating	Yes	Yes
Opportunity charging	Pantograph with a descending arm at two bus stops (3-6min) and at the depot	
Overnight charging	Plug at the depot (3h)	
On-board energy storage capacity	76kWh	19kWh

## LINE SPECIFICATIONS

Route number	55
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	7,4km
Average distance between stops	462,5m
Average commercial speed	15km/h
Total daily hours of operation	13h (weekdays only)
Total daily hours operated in full electric	9h (Volvo Hybrid 12m) and 13h (Volvo fully electric 10,7m)
Total km driven/vehicle/day	120km

## CLIMATE

Gothenburg has an oceanic climate. Despite its northern latitude, temperatures are quite mild throughout the year and warmer than places in similar latitude. Summers are warm and pleasant with average high temperatures of 19°C to 20°C, although temperatures of 25-30°C occur on many days during the summer. Winters are cold and windy with average temperatures of around 0°C, however, it rarely drops below -15°C. The annual precipitation is about 800mm.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x Optare	1 x Ebusco	1 x BYD
<b>Vehicle Model</b>	Solo SR EV	2.0	Variant of BYD 12m Overseas
<b>Vehicle Length</b>	9m	12m	12m
<b>Total passenger capacity</b>	49	90	87
<b>Air Conditioning</b>	Yes	Yes	Yes
<b>Heating</b>	Yes	Yes	Yes
<b>Opportunity charging</b>	15min	N/A	N/A
<b>Overnight charging</b>	Plug at the depot (8h)	N/A	N/A
<b>On-board energy storage capacity</b>	92kWh	311kWh	220kWh

## LINE SPECIFICATIONS

<b>Route number</b>	Göksäterlinjen
<b>Typology of the line</b>	Rural areas
<b>Topography of the line</b>	Moderate
<b>Length of the bus line</b>	50km
<b>Average commercial speed</b>	40km/h
<b>Total daily hours of operation</b>	9h
<b>Total daily hours operated in full electric</b>	9h
<b>Total km driven/vehicle/day</b>	150km (Optare Solo SR EV), 400km (Ebusco 2.0), 250km (BYD Overseas)

## CLIMATE

The climate is mild and generally warm and temperate. Orust has a significant amount of rainfall during the year, with an annual average of 724mm. The average temperature is 7.2°C. With an average temperature of 16.3°C, July is the hottest month of the year. February has the lowest average temperature of the year, at -1.7°C.

"Stockholm County has set ambitious targets for reducing greenhouse gas emissions. Therefore it is investing significant effort in transitioning the bus fleet to renewable energy sources."

**Vehicle:** 1 x 12m Scania Citywide LE4x2

**Charging:** Fast-charging at a bus stop, slow-charging at the depot

**Lines:** 755

**Total operation time/day:** 12h

**Duration:** Dec 2016 – Dec 2017

**Nature of experience:**  
Demonstration

**Funding:** Self-funded, national

## DESCRIPTION

Stockholms Läns Landsting (SLL) is testing induction-charged plug-in hybrid bus in Södertälje, with overnight conductive charging at the depot. The purpose of the project is to ascertain whether this new charging technology is applicable on a larger scale. The operation supports the objective of a reduction in energy consumption from public transport.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Scania
Vehicle Model	Citywide LE4x2
Vehicle Length	12m
Total passenger capacity	75
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Induction at one selected bus stop (7min.)
Overnight charging	Plug at the depot (overnight)
On-board energy storage capacity	56kWh

## LINE SPECIFICATIONS

Route number	755
Typology of the line	Mixed
Topography of the line	Moderate
Length of the bus line	5km
Average distance between stops	630m
Average commercial speed	16.6km/h
Total daily hours of operation	12h
Total daily hours operated in full electric	12h (if charging accomplished)
Total km driven/vehicle/day	190km



Scania Citywide LE4x2

## CLIMATE

In Södertälje, the climate is warm and temperate, with an average annual temperature is 6.8°C. It has a significant amount of rainfall during the year, averaging 525mm. The July is the warmest month, with an average temperature of 17.4°C. February has the lowest average temperature at, -2.9°C.

# STOCKHOLM (SE)

STOCKHOLMS LÄNS LANDSTING – TRAFFIC ADMINISTRATION



Stockholm  
Public Transport

"Stockholm has set ambitious targets for climate gases and has therefore put significant effort into transferring the bus fleet towards renewable fuel. Today 100% of the buses run on renewable fuel."

**Vehicles:** 8 x 12m Volvo 7900  
Electric Hybrid

**Charging:** Fast-charging at selected bus stops, slow-charging at the depot

**Line:** 73

**Total operation time/day:** 14.75h

**Duration:** March 2015-Dec 2016

**Nature of experience:**  
Demonstration

**Funding:** Self-funded, EU

## DESCRIPTION

Within the framework of the ZeEUS project SLL tested plug-in hybrid buses with fast charging stations in terminals and overnight charging at the depot. The operation supported the objective of 87% of the bus fleet running on renewable fuel by the end of 2016

## VEHICLE SPECIFICATIONS

Vehicle Brand	8 x Volvo
Vehicle Model	7900 Electric Hybrid
Vehicle Length	12m
Total passenger capacity	71
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Pantograph at selected bus stops (6min)
Overnight charging	Plug at the depot (2h)
On-board energy storage capacity	19kWh

## LINE SPECIFICATIONS

Route number	73
Typology of the line	Metropolitan area
Topography of the line	Moderate
Length of the bus line	7km
Average commercial speed	13km/h
Total daily hours of operation	14.75h
Total daily hours operated in full electric	10.9-12.5h
Total km driven/vehicle/day	100km



Volvo 7900 Electric Hybrid

## CLIMATE

The climate is warm and temperate. Stockholm has a significant amount of rainfall during the year, with an annual average of 527mm. The average annual temperature in Stockholm is 7.0°C. The warmest month of the year is July, with an average temperature of 17.9°C. February has the lowest average temperature of the year, at -2.6°C.

# UMEÅ (SE)

UMEÅ KOMMUNFÖRETAG AB (PART OF UMEA MUNICIPALITY)



"Umeå Municipality plans to replace all diesel vehicles on our biggest routes with fully electric buses. This will require at least 24 additional electric buses, which will cover 80% of the services."

**Vehicles:** 6 x 12m Hybricon Artic Whisper HAW 12 LE;  
3 x 18m Hybricon Artic Whisper HAW 18 LE 4WD

**Charging:** Fast-charging at selected bus stops, slow-charging at the depot

**Lines:** 6, 9, 80

**Total operation time/day:** 18h

**Duration:** Since Oct 2015 and ongoing

**Nature of experience:** Demonstration

**Funding:** Self-funded



Hybricon Artic Whisper HAW 12 LE



Hybricon Artic Whisper HAW 18 LE 4WD

## DESCRIPTION

As long ago as 2010, Umeå Municipality recognised the positive impact of electrical technology and in particular fully electric buses. This has created opportunities for us in Umeå to solve growing environmental problems, at both local and global levels. For Umeå - which has been experiencing strong growth for several decades - the introduction of quickly rechargeable electric buses is an opportunity to solve local environmental and noise-related problems in the city centre.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	6 x Hybricon Artic Whisper	3 x Hybricon Artic Whisper
<b>Vehicle Model</b>	HAW 12 LE	HAW 18 LE 4WD
<b>Vehicle Length</b>	12m	18m
<b>Total passenger capacity</b>	65	100
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Pantograph at selected bus stops (3-5min)	Pantograph at selected bus stops (3-5min)
<b>Overnight charging</b>	Plug at the depot (4h)	Plug at the depot (4h)
<b>On-board energy storage capacity</b>	80kWh	80kWh

## LINE SPECIFICATIONS

<b>Route number</b>	6	9	80
<b>Typology of the line</b>	City centre, suburban area	City centre, suburban area	City centre, suburban area
<b>Topography of the line</b>	Moderate	Moderate	Moderate
<b>Length of the bus line</b>	15km	16km	14km
<b>Average commercial speed</b>	20km/h	20km/h	30km/h
<b>Total daily hours of operation</b>	18h	18h	18h
<b>Total daily hours operated in full electric</b>	18h	18h	18h
<b>Total km driven/vehicle/day</b>	250km	250km	260km

## CLIMATE

The climate is cold and temperate. There is significant rainfall throughout the year in Umeå, with an annual average of 572mm. The average temperature is 2.7°C. Temperatures are highest on average in July, at around 15.9°C. The lowest average temperature of the year is in January, at -9.7°C.

# VÄRNAMO (SE)

JÖNKÖPINGS LÄNSTRAFIK

Länstrafiken 

"As a small town, the greatest challenge we had to overcome was the infrastructure investments required, which are expensive. However, we were able to completely change the bus concept rapidly, due to the small fleet size (only four buses)."

**Vehicle:** 4 x 12m Volvo 7900 Electric Hybrid

**Charging:** Fast-charging at selected bus stops, slow-charging at the depot

**Lines:** 51, 52 and 53

**Total operation time/day:**

Approx. 15.5h

**Duration:** From Sept 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** Regional



Volvo 7900 Electric Hybrid

## DESCRIPTION

In Värnamo, by converting the whole fleet to e-buses, we are providing the town with silent and clean public transportation. This first test represents an initial experience, which will be very valuable for the future and can help us to collect data for further e-bus projects.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	4 x Volvo
<b>Vehicle Model</b>	7900 Electric Hybrid
<b>Vehicle Length</b>	12m
<b>Total passenger capacity</b>	95
<b>Air Conditioning</b>	Yes
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Pantograph with a descending arm at selected bus stops (5-7min.)
<b>Overnight charging</b>	Plug at the depot (7h)

## LINE SPECIFICATIONS

Route number	51	52	53
<b>Typology of the line</b>	City centre	City centre	City centre
<b>Topography of the line</b>	Moderate, flat	Flat	Flat
<b>Length of the bus line</b>	9.1km	7.1km	8.6km
<b>Average commercial speed</b>	18.2 km/h	14.2 km/h	17.2km/h
<b>Total daily hours of operation</b>	Approx. 17.5h Mon-Fri, 11.5h Sat, 10.5h Sun	Approx. 17h Mon-Fri, 11.5h Sat, 10.5h Sun	Approx. 17h Mon-Fri, 11.5h Sat, 10.5h Sun
<b>Total daily hours operated in full electric</b>	Approx. 80% of running time	Approx. 80% of running time	Approx. 80% of running time
<b>Total km driven/vehicle/day</b>	309km Mon-Fri, 109km Sat, 100km Sun	241km Mon-Fri, 85km Sat, 78km Sun	292km Mon-Fri, 103km Sat, 95km Sun
<b>Total km driven/vehicle/day</b>	Approx. 140km	Approx. 225km	Approx. 196km

## CLIMATE

Värnamo's climate is classified as warm and temperate, with an average annual temperature of 6.3°C. Around 718mm of precipitation falls annually. The temperatures are highest on average in July, at around 15.7°C; the lowest is January, at around -2.5°C.

# VÄSTERÅS (SE)

VÄSTERÅS LOKALTRAFIK AB



"This step towards electrical operation was made without the infrastructure being ready, and we needed a bigger battery than normally required. However, the experience we gained will help us to develop an optimal infrastructure in the near future."

**Vehicle:** 1 x 12m Solaris Urbino 12 electric

**Charging:** Fast-charging at the terminal and the depot

**Lines:** 4

**Total operation time/day:** 9h

**Duration:** From Dec 2014 and ongoing

**Nature of experience:** Pilot

**Funding:** EU – Baltic biogas bus

## DESCRIPTION

Västerås Lokaltrafik runs a fully electric bus with biogas heating. When ordered, this was the first of its kind; its operating range and function with biogas heating were theoretical, so the bus needed live testing in real-world traffic conditions and climate. The data obtained to date is satisfactory, even in winter. The pilot is a part of a sustainable strategy for the Region of Västmanland.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Solaris
Vehicle Model	Urbino 12 electric
Vehicle Length	12m
Total passenger capacity	65
Air Conditioning	Yes
Heating	Yes
Opportunity charging	Plug at the terminal (1h)
Overnight charging	Plug at the depot (2h)
On-board energy storage capacity	160kWh

## LINE SPECIFICATIONS

Route number	4
Typology of the line	Urban area
Topography of the line	Flat
Length of the bus line	12.3km
Average commercial speed	25km/h
Total daily hours of operation	9h
Total daily hours operated in full electric	9h
Total km driven/vehicle/day	100km



Solaris Urbino 12 electric

## CLIMATE

The climate is cold and temperate. There is a great deal of rainfall in Västerås, with an annual average of 570mm. The average annual temperature is 6.0°C. July is the warmest month of the year, with an average temperature of 16.8°C. The lowest average temperatures occur in February, when it is around -4.1°C, with lowest temperatures reaching -25°C.

# GENEVA (CH)

TRANSPORTS PUBLICS GENEVOIS

stpg

"The biggest challenge was to coordinate the various partners around an innovative idea – manufacturer, operator and authorities. Innovation success is based on human success stories."

**Vehicle:** 1 x 18.75m TOSA articulated bus

**Charging:** Fast-charging at the terminal and at selected bus stops, slow-charging at the depot

**Line:** Airport shuttle

**Total operation time/day:** 8h

**Duration:** May 2013-May 2016

**Nature of experience:** Pilot

**Funding:** Self-funded, local authority, national



TOSA articulated bus

**Vehicles:** 33 x 18.61m Van Hool/Vossloh Kiepe Exqui.City 18T

**Charging:** Overhead wires via connecting poles en route, slow-charging at the depot

**Line:** 7

**Total operation time/day:** 20h

**Duration:** April 2015-May 2016

**Nature of experience:** Daily operation

**Funding:** Self-funded



Van Hool/Vossloh Kiepe Exqui.City 18T

## CLIMATE

Geneva's climate is classified as warm and temperate. Rainfall in the city is significant, with an annual average of 934mm. The average annual temperature is 10.3°C. The temperatures are highest on average in July, at around 19.7°C. At 1.1°C on average, January is the coldest month of the year.

## DESCRIPTION

As part of the electric mobility development strategy, TPG – a local operator in Geneva – purchased one articulated bus from TOSA and is conducting a pilot test. Following a three-year trial, TPG plans to continue to operate the vehicle and to introduce a 12km line with charging at stops and terminals.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	1 x TOSA	33 x Van Hool/Vossloh Kiepe
<b>Vehicle Model</b>	Articulated bus	Exqui.City 18T
<b>Vehicle Length</b>	18.75m	18.61m
<b>Total passenger capacity</b>	133	131
<b>Air Conditioning</b>	Yes	Yes
<b>Heating</b>	Yes	Yes
<b>Opportunity charging</b>	Articulated arm at the terminal (5min) and selected bus stops (20s)	Overhead wires via connecting poles en route
<b>Overnight charging</b>	Articulated arm at the depot (30-40min)	On line at the depot with connection poles for batteries cells balancing (15-25min)
<b>On-board energy storage capacity</b>	40kWh	28kWh

## LINE SPECIFICATIONS

<b>Route number</b>	Shuttle between airport and exhibition centre	7
<b>Typology of the line</b>	City centre	City centre
<b>Topography of the line</b>	Moderate	Moderate
<b>Length of the bus line</b>	1km	10km
<b>Average commercial speed</b>	16.75km/h	16.75km/h
<b>Total daily hours of operation</b>	8h	20h
<b>Total daily hours operated in full electric</b>	8h	20h
<b>Total km driven/vehicle/day</b>	30km	10km

# INTERLAKEN (CH)

POSTBUS SWITZERLAND



PostBus

"Our goal is to go for a complete emission free system (including electric heating and air conditioning). To do so, we want first to see the limits and the possible challenges of a whole electric bus fleet, therefore this first experience with an e-bus is going to be extremely useful for us."

**Vehicle:** 1 x 12m Ebusco 2.1

**Charging:** Slow-charging at the depot

**Line:** 31.102, 31.103

**Total operation time/day:** 14h

**Duration:** Oct 2017 – Aug 2020

**Nature of experience:**  
Regular Operation

**Funding:** Self-funded



Ebusco 2.1

## DESCRIPTION

We want to gain experience with the supplier and the needed infrastructure. Furthermore, we will investigate if the implementation of electric buses in the public transport is applicable for PostBus.

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Ebusco
Vehicle Model	2.1
Vehicle Length	12m
Total passenger capacity	84
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (6h)
On-board energy storage capacity	311kWh

## LINE SPECIFICATIONS

	31.102	31.103
Route number	31.102	31.103
Typology of the line	Suburban	Suburban
Topography of the line	Moderate/flat	Moderate/flat
Length of the bus line	10km	5km
Average distance between stops	500m	800m
Average commercial speed	<40km/h	<40km/h
Total daily hours of operation	14h	14h
Total daily hours operated in full electric	14h	14h
Total km driven/vehicle/day	200-250km	

## CLIMATE

The climate in Interlaken is warm and temperate. The average annual temperature is 8.8°C. Rainfall averages 911mm annually. The warmest month of the year is July with an average temperature of 17.8°C. The lowest average temperatures in the year occur in January, when it is around -0.1°C.

# LUCERNE (CH)

VERKEHRSBETRIEBE LUZERN AG

vbl

verkehrsbetriebe  
luzern  
verbindet uns

"In the near future, we wish to continue to operate trolleybuses. Batteries for trolleybuses will become more powerful in the future, allowing for greater flexibility in the system and for improved customer comfort. In addition, we are also interested in developing hybrid and electric buses."

**Vehicle:** 4 x 18.74m HESS SwissTrolley BGT-N2D  
**Charging:** In motion charging with trolleybus overhead line  
**Lines:** 7  
**Total operation time/day:** 19.9h  
**Duration:** From Oct 2016 and ongoing  
**Nature of experience:** Regular operation  
**Funding:** Self-funded



HESS SwissTrolley BGT-N2D

## VEHICLE SPECIFICATIONS

Vehicle Brand	4 x HESS	26 x HESS
Vehicle Model	SwissTrolley BGT-N2D	Light Tram BGGT-N2D
Vehicle Length	18.74m	24.72m
Total passenger capacity	147	221
Air Conditioning	Yes	Yes
Heating	Yes	Yes
Opportunity charging	In motion charging with trolleybus overhead line	
On-board energy storage capacity	21kWh	23kWh

## LINE SPECIFICATIONS

Route number	1	2	7
Typology of the line	City centre	City centre	City centre
Topography of the line	Moderate	Hilly	Hilly
Length of the bus line	7.9km	5.6km	5.2km
Average distance between stops	290m	330m	235m
Average commercial speed	16km/h	16km/h	14km/h
Total daily hours of operation	20.6h	20.1h	19.9h
Total daily hours operated in full electric	20.6h	20.1h	19.9h
Total km driven/vehicle/day	170km	170km	170km

## CLIMATE

Lucerne's climate is warm and temperate. The average annual temperature is 9.2°C. Rainfall is significant and averages 1123mm annually. The highest average temperature is in July at around 18.3°C. January is the coldest month, with temperatures averaging 0.2°C.

**Vehicle:** 26 x 24.72m HESS LightTram Trolley BGGT-N2D  
**Charging:** In motion charging with trolleybus overhead line  
**Lines:** 1 and 2  
**Total operation time/day:** 20.1-20.6h  
**Duration:** From June 2014 and ongoing  
**Nature of experience:** Regular operation  
**Funding:** Self-funded



HESS Light Tram BGGT-N2D

# INVERNESS (UK)

STAGECOACH NORTH SCOTLAND



**Vehicles:** 6 x 10.2m Optare Solo EV

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 7

**Total operation time/day:** 10-12h

**Duration:** June 2015-June 2018

**Nature of experience:** Testing different technologies

**Funding:** Self-funded, national



Optare Solo EV

## DESCRIPTION

As a part of the 'Zero emissions within the city' strategy, Stagecoach North Scotland purchased six Solo EV buses, manufactured by Optare, to test whether the technology can deliver the required mileage and reliability in a challenging climate. Following the trial, the buses will continue to operate on the same route.

## VEHICLE SPECIFICATIONS

Vehicle Brand	6 x Optare
Vehicle Model	Solo EV
Vehicle Length	10.2m
Total passenger capacity	49
Air Conditioning	N/A
Heating	Yes
Opportunity charging	Plug at the terminal (1h)
Overnight charging	Plug at the depot (6h)
On-board energy storage capacity	150kWh

## LINE SPECIFICATIONS

Route number	7
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	39km
Average commercial speed	N/A
Total daily hours of operation	10-12h
Total daily hours operated in full electric	10-12h
Total km driven/vehicle/day	160km

## CLIMATE

Inverness has a maritime climate, but it is one of the driest areas in Scotland. There are around 18.3 days of falling snow per year. In January, the average high temperature is 6.9°C and in July it is 18.9°C.

# LIVERPOOL (UK)

YUTONG



**Vehicles:** 1 x 12m Yutong E12LF

**Charging:** Slow-charging at the depot

**Line:** 26

**Total operation time/day:** 10h

**Duration:** Feb 2017 – May 2017

**Nature of experience:**  
Demonstration



Yutong E12LF

## VEHICLE SPECIFICATIONS

Vehicle Brand	1 x Yutong
Vehicle Model	E12LF
Vehicle Length:	12m
Total passenger capacity	73
Air Conditioning	Yes
Heating	Yes
Overnight charging	Plug at the depot (3.5h)
On-board energy storage capacity	295kWh

## LINE SPECIFICATIONS

Route number	26
Typology of the line	City centre
Topography of the line	Moderate
Length of the bus line	14.8km
Average distance between stops	548m
Average commercial speed	17km/h
Total daily hours of operation	10h
Total daily hours operated in full electric	10h
Total km driven/vehicle/day	150km

## CLIMATE

The climate in Liverpool is warm and temperate, with an average annual temperature of 9.4°C. Rainfall averages 796mm annually. The warmest month of the year is July, with an average temperature of 15.5°C. The lowest average temperature, of around 3.5°C, is in February.

# LONDON (UK)

TRANSPORT FOR LONDON



Transport  
for London

"The next steps will be to introduce the first fully electric bus route – route 507/521. At the same time, we will continue to explore other low-emission technologies, such as pantograph charging and harnessing energy from existing grid power sources, such as the Underground network."

## DESCRIPTION

There are currently 71 pure electric buses in the London fleet, and with a further six routes to be converted to electric, three by spring 2018 and a further three between 2018 and 2019, bringing the total pure electric bus fleet to 170.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	2 x BYD	51 x BYD/ADL	5 x BYD	13 x Optare	2 x Irizar	3 x ADL
<b>Vehicle Model</b>	K9A (Variant of BYD 12m Overseas)	Enviro200EV	K8SR (Variant of BYD Double Decker)	Metrocity EV	i2e	Enviro400VE
<b>Vehicle Length</b>	12m	12m	10.9m	10.6m	12m	10.3m
<b>Total passenger capacity</b>	60	86	87	60	60	83
<b>Air Conditioning</b>	No	No	No	No	No	No
<b>Heating</b>	Yes	Yes	Yes	Yes	Yes	Yes
<b>Opportunity charging</b>	No	No	No	No	No	Induction at the terminals (10min)
<b>Overnight charging</b>	Plug at the depot (6h)	Plug at the depot (6h)	Plug at the depot (6h)	Plug at the depot (6h)	Plug at the depot (6h)	Plug at the depot (6h)
<b>On-board energy storage capacity</b>	324-350kWh	324kWh	324kWh	92kWh	282kWh	60kWh

## LINE SPECIFICATIONS

<b>Route number</b>	507/521	312	H98	98	69	108
<b>Typology of the line</b>	City urban					City centre/urban
<b>Topography of the line</b>	Flat	Moderate	Moderate	Moderate	Flat	Moderate
<b>Length of the bus line</b>	11km	9km	13km	11km	11km	17km
<b>Average distance between stops</b>	350m-400m					
<b>Average commercial speed</b>	12km/h	15km/h	15km/h	10km/h	12km/h	16km/h
<b>Total daily hours of operation</b>	11.2h-12.8h					
<b>Total daily hours operated in full electric</b>	11.2h-12.8h					
<b>Total km driven/vehicle/day</b>	150-250km					

# LONDON (UK)

TRANSPORT FOR LONDON



**Vehicles:** 2 x 12m BYD K9A (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot  
**Line:** 507/521

**Total operation time/day:** 16h

**Duration:** Dec 2013-Sept 2016

**Nature of experience:** Demonstration

**Funding:** Self-funded



BYD K9A (Variant of BYD 12m Overseas)

**Vehicles:** 51 x 12m BYD/ADL Enviro200EV

**Charging:** Slow-charging at the depot  
**Line:** 507/521

**Total operation time/day:** 16h

**Duration:** Aug 2016-2030

**Nature of experience:** Regular service

**Funding:** Bus contract



BYD slash ADL Enviro200EV

**Vehicles:** 5 x 10.9m BYD K8SR (Variant of BYD Double Decker)

**Charging:** Slow-charging at the depot  
**Line:** 98

**Total operation time/day:** 16h

**Duration:** Since April 2016 and ongoing

**Nature of experience:** Demonstration

**Funding:** Self-funded



BYD K8SR (Variant of BYD Double Decker)

**Vehicles:** 13 x 10.6m Optare Metrocity

**Charging:** Slow-charging at the depot  
**Lines:** 312 and H98

**Total operation time/day:** 16h

**Duration:** Since April 2014, Dec 2014 and Sept 2015 and ongoing

**Nature of experience:** Demonstration, regular operation

**Funding:** Self-funded



Optare Metrocity EV

**Vehicles:** 2 x 12m Irizar i2e

**Charging:** Slow-charging at the depot  
**Line:** 108

**Total operation time/day:** 16h

**Duration:** Since April 2016 and ongoing

**Nature of experience:** Regular operation

**Funding:** Bus contracts



Irizar i2e

**Vehicles:** 3 x 10.2m ADL E400H

**Charging:** Fast-charging at terminals, slow-charging at the depot  
**Line:** 69

**Total operation time/day:** 16h

**Duration:** Nov 2015 - April 2017

**Nature of experience:** Demonstration

**Funding:** Self-funded, EU, contracts



ADL E400H

## CLIMATE

The climate is warm and temperate. London has a significant amount of rainfall during the year, with an annual average of 621mm. The average annual temperature is 11.1°C. The warmest month of the year is July, with an average temperature of 18.7°C. January has the lowest average temperature of the year, at 4.9°C.

# MANCHESTER (UK)

TRANSPORT FOR GREATER MANCHESTER



Transport for  
Greater Manchester

"The Greater Manchester Transport Strategy 2040 places a strong emphasis on low-emission growth and smart mobility. The Strategy includes the ambition that, by 2040, TfGM will deliver a low-emission transport system to meet the ambitious carbon reduction targets and to eradicate poor air quality caused by transport in Greater Manchester."

**Vehicles:** 3 x 9.5m Optare Versa EV

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Lines:** MS1, MS2, MS3

**Total operation time/day:** 12h

**Duration:** Since April 2003 and ongoing

**Nature of experience:** Regular city centre link service

**Funding:** Local authority, national funding

## DESCRIPTION

TfGM provides a free Metro-shuttle bus service linking main rail stations, car parks, shopping areas and businesses in Manchester city centre. There are three circular routes, carrying a combined average of 30,000 passengers per week, and operated by 20 Optare low-carbon emission buses, three of which are fully electric.

## VEHICLE SPECIFICATIONS

<b>Vehicle Brand</b>	3 x Optare
<b>Vehicle Model</b>	Versa EV
<b>Vehicle Length</b>	9.5m
<b>Total passenger capacity</b>	57
<b>Air Conditioning</b>	No
<b>Heating</b>	Yes
<b>Opportunity charging</b>	Plug at the terminal (2h)
<b>Overnight charging</b>	Plug at the depot (6h)
<b>On-board energy storage capacity</b>	Two packs assembled in series, consisting of 26 lithium iron magnesium phosphate batteries per pack

## LINE SPECIFICATIONS

<b>Route number</b>	MS1	MS2	MS3
<b>Typology of the line</b>	City centre	City centre	City centre
<b>Topography of the line</b>	Flat	Flat	Flat
<b>Length of the bus line</b>	6km	6km	6km
<b>Average commercial speed</b>	18km/h	18km/h	18km/h
<b>Total daily hours of operation</b>	12h	12h	12h
<b>Total daily hours operated in full electric</b>	12h	12h	12h
<b>Total km driven/vehicle/day</b>	150km	150km	150km



Optare Versa EV

## CLIMATE

The climate here is mild, and generally warm and temperate. Manchester has a significant amount of rainfall during the year, with an annual average of 929mm. The average annual temperature is 10.5°C. With an average temperature of 17.8°C, July is the hottest month of the year. January has the lowest average temperature of the year, at 4.3°C.

# NOTTINGHAM (UK)

NOTTINGHAM CITY COUNCIL



Nottingham  
City Council

*“Despite the government funding available for electric buses, this still leaves the problem of meeting the match-funding requirements. The cuts in government grants to local authorities have made this more difficult. We have found funding from the workplace parking levy (a type of congestion charge for companies), as well as using the low carbon emission bus grant provided by the government.”*

## DESCRIPTION

We began purchasing our pure electric buses in 2010 and commenced operations with them in 2012. We currently have a fleet of 54 ebuses, run by one operator. Thirteen further long-range electric buses will be delivered shortly. We have worked closely with vehicle and charging equipment manufacturers to improve performance over the years.

## VEHICLE SPECIFICATIONS

Vehicle Brand	35 x Optare	10 x Optare	13 x BYD
Vehicle Model	Solo EV	Versa EV	K9 (Variant of BYD 12m Overseas)
Vehicle Length	9.5m	10.5m	12m
Total passenger capacity	43	57	65
Air Conditioning	Driver only	Driver only	Driver only
Heating	Yes	Yes	Yes
Opportunity charging	Plug at the terminal and depot (2h)	Plug at the terminal and depot (2h)	-
Overnight charging	Plug at the depot (6h)	Plug at the depot (6h)	Plug at the depot (4.5h)
On-board energy storage capacity	95kWh	95kWh	345kWh

## LINE SPECIFICATIONS

Route number	Medilink	Localink L1	Centrelink	Ecolink
Typology of the line	Suburban, ring road	City centre, suburban	City centre	City centre
Topography of the line	Moderate	moderate	Moderate	Moderate
Length of the bus line	24km	19.7km	5.84km (A-B), 5.74km (B-A)	9.41km (A-B), 7.50km (B-A)
Average distance between stops	N/A	N/A	1005m	423m
Average commercial speed	17.5km/h	No data	22km/h	Approx. 22km/h
Total daily hours of operation	15h	8.16h	13h Mon-Fri, 12h Sat	14h
Total daily hours operated in full electric	15h	8.16h	13h Mon-Fri, 12h Sat	14h
Total km driven/vehicle/day	100km	100km	183km Mon-Fri, 170.28km Sat	228.51km Mon-Fri, 91.88km Sat

# NOTTINGHAM (UK)

NOTTINGHAM CITY COUNCIL



Nottingham  
City Council

**Vehicles:** 35 x 9.5m Optare Solo EV; 10 x 10.5m Optare Versa EV

**Charging:** Fast-charging at the terminal and depot, slow-charging at the depot

**Lines:** Locallink L1, Medilink

**Total operation time/day:** 15h

**Duration:** Since June 2012 and ongoing

**Nature of experience:**  
Commercial operation

**Funding:** City, regional, national, EU

**Vehicles:** 13 x 12m BYD K9 (Variant of BYD 12m Overseas)

**Charging:** Slow-charging at the depot

**Line:** Centrelink, Ecolink

**Total operation time/day:** 13h Mo-Fri, 12h Sat and 14h respectively

**Duration:** From January 2017 and ongoing

**Nature of experience:** Regular operation

**Funding:** Local



Optare Solo EV



Optare Versa EV



BYD K9 (Variant of BYD 12m Overseas)

## CLIMATE

The climate is cold and temperate in Nottingham. The average annual temperature is 9.8°C. The rainfall averages 648mm. The warmest month of the year is July, with an average temperature of 17.2°C. The lowest average temperatures in the year occur in January, when it is around 2.9°C.

# YORK (UK)

FIRST YORK

First  York

"The greatest challenge has been to ensure that drivers and staff embrace this new technology and apply smart energy management together with energy efficient driving techniques. In the future, we wish to introduce new low/zero-emission vehicles and develop the first fully electric double-deck bus in the region."

**Vehicle:** 12 x 11.1m Optare Versa EV

**Charging:** Fast-charging at the terminal, slow-charging at the depot

**Line:** 9, 59

**Total operation time/day:** 13-15h

**Duration:** From May 2014 and ongoing

**Nature of experience:** Regular Operation

**Funding:** National, self-funded



Optare Versa EV

## VEHICLE SPECIFICATIONS

Vehicle Brand	12 x Optare
Vehicle Model	Versa EV
Vehicle Length	11.1m
Total passenger capacity	58
Air Conditioning	No
Heating	Yes (diesel heater)
Opportunity charging	Plug at the terminal (50min.)
Overnight charging	Plug at the depot (6-7h)
On-board energy storage capacity	92kWh

## LINE SPECIFICATIONS

Route number	9	59
Typology of the line	City centre	City centre
Topography of the line	Flat	Flat
Length of the bus line	11km	13km
Average distance between stops	2,000m	2,500m
Average commercial speed	15km/h	20km/h
Total daily hours of operation	15h	13h
Total daily hours operated in full electric	15h	13h
Total km driven/vehicle/day	200km	180km

## CLIMATE

York's climate is classified as warm and temperate, with an average annual temperature of 9.3 °C. The city has significant rainfall, averaging 621mm annually. The warmest month of the year is July, with an average temperature of 15.6 °C; the lowest is January, at around 3.4 °C.



# CHAPTER 3: MANUFACTURERS

## COMPANY PROFILE

Alexander Dennis Limited (ADL) is the UK's leading bus and coach manufacturer, employing around 2,500 people at facilities in the UK, North America and Asia. One of the fastest-growing bus and coach builders in western Europe, ADL produces a wide range of innovative and fuel-efficient, low-floor single- and double-decker buses, including low- and zero-emission vehicles.



ADL Enviro400VE



BYD ADL Enviro200EV

## CONTACT

**Company website:**  
[www.alexander-dennis.com](http://www.alexander-dennis.com)

**Contact: Stefan Baguette**  
[stefan.baguette@alexander-dennis.com](mailto:stefan.baguette@alexander-dennis.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	ADL Enviro400VE	BYD ADL Enviro200EV	BYD ADL Enviro200EV
Vehicle type	PHEV	BEV	BEV
Length	10.3m	12m	10.8m
Total Passengers capacity	83	90	78
Gross vehicle weight	18,000kg	18,600kg	18,600kg
Top speed	70km/h	70km/h	70km/h
Airco	Electric air chill	Electric	Electric
Heating	Conventional or electric	Conventional or electric	Conventional or electric
Fuel economy or range	Up to 30km range in zero-emission electric mode without recharging	Over 250km range (London routes 507 and 521)	Over 250km range (Central London)
European Market introduction	December 2015	September 2016	October 2017

## ELECTRIC MOTOR

Suppliers	BAE Systems	BYD	BYD
Type	Central motor	Integrated in axle	Integrated in axle
Power peak	175kW	180kW	180kW
Torque	870Nm	700Nm	700Nm

## BATTERY

Suppliers	Akasol	BYD	BYD
Total energy	61kWh	324kWh	307kWh
Type	Nickel manganese cobalt	Lithium iron phosphate	Lithium iron phosphate
Warranty	Depending on contract	Depending on contract	Depending on contract

## CHARGING SYSTEM

Charging System	Inductive	Manual	Manual
Charge Rate	100kW	80kW	80kW
Charge Time	5min	4h	4h



APTIS



APTIS

## CONTACT

**Company website:**  
[www.newtl.com](http://www.newtl.com)  
[www.alstom.com](http://www.alstom.com)

**Contact: Benjamin Bailly**  
[benjamin.bailly@alstomgroup.com](mailto:benjamin.bailly@alstomgroup.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	APTIS	APTIS
Vehicle type	BEV	BEV
Length	12m	12m
Total Passengers capacity	77	77
Gross vehicle weight	NC	NC
Top speed	70km/h	70km/h
Airco	No	Yes
Heating	Yes - electric air conditioning	Yes - GTL
Fuel economy or range	200km	120km
European Market introduction	2017	2017

## ELECTRIC MOTOR

Suppliers	Alstom	Alstom
Type	Permanent magnet	Permanent magnet
Power peak	180kW	180kW
Torque	970Nm nominal	970Nm nominal

## BATTERY

Suppliers	Fiamm	Fiamm
Total energy	346kWh	272kWh
Type	Sodium Nickel	Sodium Nickel
Warranty	N/A	N/A

## CHARGING SYSTEM

Charging System	NC	NC
Charge Rate	NC	NC
Charge Time	7-8h	6h

## COMPANY PROFILE

Bluebus is a subsidiary of the Bolloré Group, best known for its Lithium Metal Polymer (LMP) battery technology. LMP batteries are used in mobile applications (cars, buses, trams and boats) and stationary applications.



Bluebus 12m, Source: RATP - Denis Sutton

## CONTACT

**Company website:**  
[www.bluebus.fr](http://www.bluebus.fr)

**Contact: Yves Labesse**  
[yves.labesse@blue-solutions.com](mailto:yves.labesse@blue-solutions.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	12m
Vehicle type	BEV
Length	12m
Total Passengers capacity	97
Gross vehicle weight	20,000kg
Top speed	70km/h
Airco	No
Heating	Webasto and electric
Fuel economy or range	180km measured on Line 21 RATP
European Market introduction	May 2016

## ELECTRIC MOTOR

Suppliers	Siemens
Type	Permanent magnet
Power peak	160kW
Torque	2,500Nm

## BATTERY

Suppliers	BlueSolutions
Total energy	240kWh
Type	Lithium metal polymer
Warranty	7 years

## CHARGING SYSTEM

Charging System	Manual
Charge Rate	50kW
Charge Time	5h

## COMPANY PROFILE

Bozankaya is a pioneer in the development of electric drive systems for buses. We are creating a future-oriented mobility alternative for public transport with our intelligent battery management systems and charging technologies that are tailored to individual fleet operations.



Sileo S10



Sileo S12



Sileo S18

## CONTACT

**Company website:**  
[www.bozankaya.com.tr](http://www.bozankaya.com.tr);  
[www.sileo-ebus.com](http://www.sileo-ebus.com)

**Contact:**

**Emrah Dal**  
 emrahdal@bozankaya.com

**Frank Goldacker**  
 goldacker@sileo-ebus.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Sileo S10	Sileo S12	Sileo S18	Sileo S24
Vehicle type	BEV	BEV	BEV	BEV
Length	10.7m	12m	18m	24m
Total Passengers capacity	78	79	137	-
Gross vehicle weight	18,000kg	18,000kg	28,000kg	-
Top speed	75km/h	75km/h	75km/h	-
Airco	Electric HVAC system, Spheros Citisphere			
Heating	Diesel/electric (opt.)	Diesel/electric (opt.)	Diesel/electric (opt.)	Diesel/electric (opt.)
Fuel economy or range	0.85kWh/km	0.88kWh/km	1.15kWh/km	Range: min. 250km/d
European Market introduction	2015	2015	September 2016	December 2016

## ELECTRIC MOTOR

Suppliers	ZF/Siemens	ZF/Siemens	ZF/Siemens	ZF/Siemens
Type	AC asynchronous	AC asynchronous	AC asynchronous	AC asynchronous
Power peak	2 x 120 = 240kW	2 x 120 = 240kW	4 x 120 = 480kW	4 x 120 = 480kW
Torque	21,000Nm	21,000Nm	42,000Nm	42,000Nm

## BATTERY

Suppliers	Bozankaya BC&C	Bozankaya BC&C	Bozankaya BC&C	Bozankaya BC&C
Total energy	200kWh	200 or 230kWh	300kWh	380kWh
Type	Lithium iron phosphate	Lithium iron phosphate	Lithium iron phosphate	Lithium iron phosphate
Warranty	4 years	4 years	4 years	4 years

## CHARGING SYSTEM

Charging System	Manual (plug-in)	Manual (plug-in)	Manual (plug-in)	Manual (plug-in)
Charge Rate	4-100kW	4-100kW	4-200kW	Undefined
Charge Time	2-7h	2-8h	3-8h	Undefined

## COMPANY PROFILE

BYD is the world's largest producer of full-size purely electric buses. It is also the world's largest manufacturer of rechargeable batteries. Its technology is fully proven and safe and delivers outstanding range. All BYD electric buses are designed to complete a full duty cycle on a single charge. BYD has 220,000 employees and a turnover of €11.2bn in 2015.



BYD 12m China



BYD 12m Overseas city bus



BYD 12m Overseas airport bus



BYD ADL Enviro200EV 12m



BYD Double Decker



BYD 18m Articulated



BYD 12m Coach

## CONTACT

Company website:  
www.byd.com

Contact: Hao Yin  
edison.yin@byd.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	BYD 12m China	BYD 12m Overseas	BYD midi bus	BYD 10.8m Variants	BYD Double Decker	BYD 18m Articulated	BYD 12m coach
Vehicle type	BEV low entry/low floor						BEV
Length	12m		8.7m	9.6 - 11.5m	10.2-12m	18m	12m
Total Passengers capacity	75	Up to 95	Up to 54	Up to 90	Up to 95	Up to 150	Up to 59
Gross vehicle weight	18,000kg	19,000kg	13,000kg	Up to 19,000 kg	Up to 20,000kg	28,000kg	19,000kg
Top speed	70km/h	70/80km/h	70km/h	70/80km/h	70km/h	70km/h	90km/h
Airco available	Yes - BYD climate control system or other assigned suppliers						
Heating available	Yes- electric or diesel heating						
Fuel economy or range	300km under SORT	320km under SORT	200km under SORT	About 340km under SORT	About 330km under SORT	200km under SORT	200km under SORT
Market introduction	2013	2013	Introduction in 2017		2015	2016	2016

## ELECTRIC MOTOR

Suppliers	BYD						
Type	Wheel-hub motor (PNSM)						
Power peak	2x90kW	2x 90/150kW	2x90kW	2x 90/150kW	2x150kW		2x180kW
Torque	2x350Nm	2x 350/550Nm	2x350Nm	2x 350/550Nm	2x350Nm		2x1,500Nm

Electric bus model name	BYD 12m China	BYD 12m Overseas	BYD midi bus	BYD 10.8m Variants	BYD Double Decker	BYD 18m Articulated	BYD 12m coach
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## BATTERY

Suppliers	BYD
Type	Iron-Phosphate battery
Warranty	5 years

## CHARGING SYSTEM

Charging System	Plug-in				Pantograph & Plug-in	Plug-in
Charge Rate	2x40kW				Plug-in 2x40kW	2x40kW
Charge Time	4 - 4.5h	2h	4 - 4.5h	4.5h	Up to 3h	3h

## COMPANY PROFILE

CaetanoBus is the most important manufacturer of buses and coaches in Portugal. The majority of our products are intended for export and are now transporting people all over the world. It is a company that uses tradition, innovation and design to remain one step ahead, closer to the future. We manufacture buses and bodies mounted on chassis of various brands and with different specifications for urban, tourism and airport service, as well as other products that provide unique solutions for niche markets. We are world leaders in the airport bus sector with the Cobus brand. In this sector, we developed the first electric bus exclusive to airports.



e. City Gold



eCobus

## CONTACT

**Company website:**  
[www.caetanobus.pt/pt](http://www.caetanobus.pt/pt)

**Contact: Rui Miguel Rodrigues Pinto**  
[rui.pinto@salvadorcaetano.pt](mailto:rui.pinto@salvadorcaetano.pt)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	e. City Gold	eCobus
Vehicle type	Fully electric	Fully electric
Length	11.995m	13.92m
Total Passengers capacity	88	112
Gross vehicle weight	19,000kg	20,000kg
Top speed	70km/h	Airport - 50km/h
Airco	Roof (27kW or 40kW cooling capacity)	Roof
Heating	Electric water heater	Electric water heater
Fuel economy or range	Up to 200km	Up to 70km
European Market introduction	June 2016	2013

## ELECTRIC MOTOR

Suppliers	Siemens	Siemens
Type	Synchronous motor	Synchronous motor
Power peak	160kW	160kW
Torque	1,500Nm	1,500Nm

## BATTERY

Suppliers	-	Actia
Total energy	50-250kWh	85kWh
Type	Lithium titanate or Nickel Manganese Cobalt Power	Lithium titanate
Warranty	5 years	8 years

## CHARGING SYSTEM

Charging System	Manual/overhead	Manual
Charge Rate	50kW-150kW/350kW	60kW
Charge Time	Depends on the configuration of the batteries used in the vehicle. To manually charge a 100kWh vehicle, a full charge takes 40min	Manual charge: full charge in 1h 15min

# CHARIOT MOTORS



## COMPANY PROFILE

Chariot Motors was established in 2009 to design, develop and bring into commercial operation a unique ultracapacitor-based electric bus. The Chariot ebus is based on the world's most advanced ultracapacitor technology, developed by Aowei. As a result, Chariot Motors has developed ultracapacitor electric buses that comply with the Western markets' strict requirements and European mandatory homologation certification. The Chariot ebus is the only electric bus model in commercial operation in Europe powered solely by ultracapacitors, without employing any batteries.



Chariot ebus Belgrade



Chariot ebus Tel Aviv



Chariot ebus Sofia

## CONTACT

**Company website:**  
www.chariot-electricbus.com

**Contact: Milen Milev**  
milen@chariot-electricbus.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Chariot ebus	Chariot ebus	Chariot ebus	Chariot ebus
Vehicle type	Ultracapacitor electric bus	Ultracapacitor electric bus	Ultracapacitor electric bus	Ultracapacitor electric bus
Length	12m	12m	12m	-
Total Passengers capacity	91	91	91	91
Gross vehicle weight	19,000kg	19,000kg	19,000kg	19,000kg
Top speed	70km/h	70km/h	70km/h	70km/h
Airco	Thermoking	NTC	Spheros	NTC
Heating	Spheros	NTC	Spheros	NTC
Fuel economy or range	0.95kWh/km (SORT 2 conditions)	0.95kWh/km (SORT 2 conditions)	To be tested	0.95kWh/km (SORT 2 conditions)
European Market introduction	May 2014	August 2016	October 2016	July 2017

## ELECTRIC MOTOR

Suppliers	Siemens	Siemens	ZF Ave 130	Siemens
Type	Asynchronous	Synchronous (permanent magnet)	Synchronous	Synchronous (permanent magnet)
Power peak	67 x 2kW	180kW	76 x 2kW	180kW
Torque	430 x 2Nm	2,500Nm	11,000 x 2Nm	2,500Nm

## BATTERY

Suppliers	Ultracapacitors by Aowei	Ultracapacitors by Aowei	Ultracapacitors by Aowei	Ultracapacitors by Aowei
Total energy	21kWh	21kWh	32kWh	32kWh
Type	Graphene ultracapacitors	Graphene ultracapacitors	Graphene ultracapacitors	Graphene ultracapacitors
Warranty	8 years' full warranty	8 years' full warranty	8 years' full warranty	8 years' full warranty

## CHARGING SYSTEM

Charging System	Overhead fast-charging pantograph system	Overhead fast-charging pantograph system	Overhead fast-charging pantograph system	Overhead fast-charging pantograph system
Charge Rate	150kW	150kW	340kW	340kW
Charge Time	Charged up to 85% in 5min	Charged up to 85% in 5min	Charged up to 85% in 3min	Charged up to 85% in 3min

# DANCERBUS



## COMPANY PROFILE

Dancerbus is a Lithuanian and German capital company developing renewable energy powered electric systems for international markets. The company is developing ultra light fully electric city bus – Dancer, with innovative technologies and fast charging system.



Dancer

## CONTACT

**Company website:**  
[www.dancerbus.com](http://www.dancerbus.com)

**Contact: Tadas Kubilius**  
[tku@dancerbus.com](mailto:tku@dancerbus.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Dancer
Vehicle type	BEV
Length	12m
Total Passengers capacity	93
Gross vehicle weight	6.5t
Top speed	70km/h
Airco	2 Zones HVAC
Heating	Electric heat pump with integrated waste heat recovery system and additional electric heater
Fuel economy or range	0.5kW/km
European Market introduction	2017

## ELECTRIC MOTOR

Suppliers	ZF
Type	Asynchronous
Power peak	2 wheels 125kW each
Torque	2 wheels 11,000Nm each

## BATTERY

Suppliers	ICTP (Toshiba SCiB)
Total energy	29.2kWh per pack
Type	Lithium Titanate
Warranty	15,000 charge cycles @ 5C, 80% leftover

## CHARGING SYSTEM

Charging System	3-phase 400VAC (or optional variable high voltage DC)
Charge Rate	500kW
Charge Time	6-10min.

## COMPANY PROFILE

Ebusco is a Dutch bus manufacturer focused on the development, marketing and sales of fully electric buses for the European market. Ebusco is a pioneer in the development of electric bus transport and was the first European company to receive full European approval for a fully electric bus. Since 2012, Ebusco has gained extensive practical experience through following a normal timetable all day. All buses are equipped with live monitoring systems to support safe and economically optimal public transport.



### CONTACT

Company website:  
[www.ebusco.eu](http://www.ebusco.eu)

Contact: Patrick Heuts  
[patrick@ebusco.eu](mailto:patrick@ebusco.eu)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Ebusco 2.1 HV LF-311-HV-2/3	Ebusco 18M HV LF-414-HV-3/4
Vehicle type	BEV	BEV
Length	12m	18m
Total Passengers capacity	90	125
Gross vehicle weight	12,000kg	19,500kg
Top speed	80km/h	80km/h
Airco	Thermoking	Thermoking
Heating	Thermoking and optional Spheros	Thermoking and optional Spheros
Fuel economy or range	0.85kWh/km	1.275kWh/km
European Market introduction	October 2014	November 2017

## ELECTRIC MOTOR

Suppliers	Ebusco	ZF
Type	Asynchronous	Asynchronous
Power peak	220kW	2 x 125kW
Torque	3,000Nm	2 x 11.000Nm (including gear)

## BATTERY

Suppliers	Ebusco	Ebusco
Total energy	311kWh	414kWh
Type	Lithium iron phosphate	Lithium iron phosphate

## CHARGING SYSTEM

Charging System	Plug-in	Plug-in
Charge Rate	75kW/120kW	75kW/120kW
Charge Time	4.5/3h	6/4h

## COMPANY PROFILE

ELECTRON CORPORATION is the leading Ukrainian public transport manufacturer founded in 2011. ELECTRON has modern engineering plants of flexible full-scale production, specializing in design and production of innovative, zero-emission low-floor electric buses, trolleybuses and light rail vehicles. Structural features of Electron electric vehicles embrace efficient arrangement of instruments and controls that meet the safety requirements. An integrated diagnostic system for operational control of functioning of all car units and systems provides excellent energetic and dynamic characteristics. Low operating cost, zero-emissions and easy maintenance make Electron electric vehicles the most promising type of passenger transport in a up-to-date city.



Electron E19 Electric

## CONTACT

**Company website:**  
[www.en.eltrans.electron.ua](http://www.en.eltrans.electron.ua)

**Contact: Volodymyr Budzan**  
[commerce@eltrans.electron.ua](mailto:commerce@eltrans.electron.ua)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Electron E19 electric
Vehicle type	BEV
Length	12.1m
Total Passengers capacity	90
Gross vehicle weight	19,000kg
Top speed	70km/h
Airco	Depending on contract
Heating	Diesel, optional electric
Fuel economy or range	Up to 200km (Lviv route 9)
European Market introduction	2017

## ELECTRIC MOTOR

Suppliers	ZF
Type	2 x asynchronous
Power peak	2 x 125kW = 250kW
Torque	2 x 11,000Nm (Output torque max.)

## BATTERY

Suppliers	Winston Battery
Total energy	225kWh
Type	Lithium Iron Phosphate
Warranty	Depending on contract

## CHARGING SYSTEM

Charging System	Plug-in
Charge Rate	40kW
Charge Time	6h

## COMPANY PROFILE

evopro Bus LLC is the member of the evopro Group and was established in 2012, when it was separated from evopro LLC Engineering. Our focus is on research and development that advances both society and industry. Several innovative developments in transportation technology, embedded systems, high-performance computing and mobile informatics made by evopro are now available on the market as services or products. These include the dynamic railway diagnostic system and the composite structured electrical bus family for urban use. The unique solution of the composite structured modular electric bus family (Modulo) provides evopro Bus with the opportunity to revolutionise urban traffic.



## CONTACT

**Company website:**  
[www.evopro-group.com](http://www.evopro-group.com)

**Contact: Donát Dékány**  
[donat.dekany@evopro-group.com](mailto:donat.dekany@evopro-group.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Modulo C68e	Modulo C88e
Vehicle type	BEV	BEV
Length	7.982m	9.457m
Total Passengers capacity	55 (8 person/m <sup>2</sup> )	74 (8 person/m <sup>2</sup> )
Gross vehicle weight	10,350kg	11,050kg
Top speed	65km/h	65km/h
Airco	Eberspächer Hydronic M12 (diesel heating, optional electric heating)	Eberspächer Hydronic M12 (diesel heating, optional electric heating)
Heating	Thermoking and optional Spheros	Thermoking and optional Spheros
Fuel economy or range	0.62kWh/km; Range (SORT 2 cycle): 200-230km	0.7kWh/km; Range (SORT 2 cycle): 120-140km
European Market introduction	May 2016	May 2016

## ELECTRIC MOTOR

Suppliers	Siemens	Siemens
Type	1DB2016 - 1NB06 synchron motor	1DB2016 - 1NB06 synchron motor
Power peak	Max. 160kW	Max. 160kW
Torque	1,019Nm	1,019Nm

## BATTERY

Suppliers	Valence	Valence
Total energy	144kWh	84kWh
Type	Lithium iron phosphate	Lithium iron phosphate
Warranty	5 years	5 years

## CHARGING SYSTEM

Charging System	Conductive	Conductive
Charge Rate	60kW	60kW
Charge Time	5h	5h

## COMPANY PROFILE

Manufacturing vehicles is fascinating, because it calls for an ability to see the big picture - from individual components to highly sophisticated transport systems, as well as environmental and climate issues. Of course, we never lose sight of the most important aspect; people and their mobility needs. Hess transport solutions keep the world on the move. Therefore, we work closely with competent local partners and are always aware of specific local conditions. Our high-quality Co-Bolt modular system, originating in the public transport paradise of Switzerland, further guarantees dependable operation and advanced technology.



TOSA BGT-N2D



SwissTrolley BGT-N2D



lighTram Trolley BGGT-N2D

## CONTACT

**Company website:**  
[www.hess-ag.ch](http://www.hess-ag.ch)

**Contact: Hans-Jörg Gisler**  
[hans-joerg.gisler@hess-ag.ch](mailto:hans-joerg.gisler@hess-ag.ch)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	TOSA BGT-N2D	SwissTrolley BGT-N2D	lighTram Trolley BGGT-N2D
Vehicle type	BEV	Trolley	-
Length	18.74m	18.74m	24.72m
Total Passengers capacity	142	147	221
Gross vehicle weight	29,000kg	29,500kg	39,400kg
Top speed	80km/h	65km/h	65km/h
Airco	Fully electric	Fully electric	Fully electric
Heating	Fully electric water heating	Fully electric water heating	Fully electric water heating
Fuel economy or range	2.4kW/h with AC and heating	2.5kW/h with AC and heating	2.9kW/h with AC and heating
European Market introduction	May 2013	November 2016	June 2014

## ELECTRIC MOTOR

Suppliers	ABB	TSA	TSA
Type	PEM	Asynchronous	Asynchronous
Power peak	240kW	240kW	320kW
Torque	1,520Nm	-	-

## BATTERY

Suppliers	ABB	VKD	VKD
Total energy	70kWh	20kWh	32kWh
Type	Lithium titanate	Lithium iron phosphate	Lithium iron phosphate
Warranty	> 5 years	> 2 years	> 2 years

## CHARGING SYSTEM

Charging System	Conductive pantograph	Overhead in-motion charging	Overhead in-motion charging
Charge Rate	600kW	> 600kW	> 600kW
Charge Time	Flash, 15s; terminus, 3min	-	-

## COMPANY PROFILE

Heuliez Bus is a French bus manufacturer manufacturing midibuses, standard and articulated buses. Powertrains available are Diesel Euro VI and hybrid. Heuliez Bus has been involved in developing and manufacturing at industrial scale alternative drive, since 2000 with trolleybuses, hybrid since 2011. Heuliez Bus electric buses are derived from the hybrid versions.

## CONTACT

**Company website:**  
www.heuliezbus.com

**Contact:**

**Jean-Marc Boucheret**  
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**Rémy Foyer**  
remy.foyer@heuliezbus.com



HEULIEZ BUS GX 337 ELEC



HEULIEZ BUS GX 437 ELEC

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	HEULIEZ BUS GX 337 ELEC	HEULIEZ BUS GX437 ELEC
Vehicle type	BEV	Electric Opportunity Charge
Length	12 m	18 m
Total Passengers capacity	94	155
Gross vehicle weight	20.000kg	30.000kg
Top speed	80km/h	80km/h
Airco	electric	electric
Heating	water circuit heater by boiler, electric or with diesel or biofuel	electric
Fuel economy or range	200 km in typical heavyduty bus routes, such as in Paris/RATP	No limitation of range, thanks to opportunity charge
European Market introduction	June 2017	November 2017

## ELECTRIC MOTOR

Suppliers	BAE Systems	BAE Systems
Type	Permanent Magnet	Permanent Magnet
Power peak	120/190kW	160/200kW
Torque	1,610/3,300Nm	2,400/5,100Nm

## BATTERY

Suppliers	Foresee	Foresee
Total energy	349kWh	106kWh
Type	NMC	LTO
Warranty	depending on contract	depending on contract

## CHARGING SYSTEM

Charging System	manual plug Combo 2, CCS protocol	pantograph, CCS protocol
Charge Rate	50 to 100kW (overnight slow charge), 150kW (mid-day faster charge)	300 to 450kW
Charge Time	3 to 5 hours	few minutes depending on charging power

## COMPANY PROFILE

Our company is the first and major electric and energy-efficient buses manufacturer in China. Thanks to the proprietary rail transit equipment technologies (converting & electric drive & controlling) supported by our parent company CRRC Corporation Limited, our company has developed green buses including pure electric and hybrid. The annual production capacity is 10,000 buses and 20,000 sets drive train. By the end of 2016, a total of 20,000 new energy buses and 50,000 sets of electric drive systems have been put on the market. In addition to mainland China, these products have been sold to Taiwan, Belarus, New Zealand and North America. And they have been serviced for many big events, like 2008 Beijing Olympic Games and 2014 Brazil World Cup.

## CONTACT

**Company website:**  
www.tev.crrczic.cc

**Contact: Yuan Xiaoxing  
(Cherry Yuan)**  
yuanxx@csrzic.com;  
crrctev@csrzic.com



TEG6125BEV03

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

<b>Electric bus model name</b>	<b>TEG6125BEV03</b>
<b>Vehicle type</b>	BEV
<b>Length</b>	12m
<b>Total Passengers capacity</b>	When 18000kg, 81+1 - When 19000kg, 94+1
<b>Gross vehicle weight</b>	18000kg; 19000kg
<b>Top speed</b>	70km/h
<b>Airco</b>	yes – electric air conditioning
<b>Heating</b>	Independent fuel heating system
<b>Fuel economy or range</b>	1.2kWh/km. Max range 115km (full loaded, air-conditioned, city bus cycle)
<b>European Market introduction</b>	2017

## ELECTRIC MOTOR

<b>Suppliers</b>	Hunan CRRC Times Electric Vehicle Co.,Ltd
<b>Type</b>	Permanent magnet synchronous motor
<b>Power peak</b>	150Kw
<b>Torque</b>	2500Nm

## BATTERY

<b>Suppliers</b>	Offnenbach	CATL
<b>Total energy</b>	201kWh	182.5kWh
<b>Type</b>	Nickel manganese cobalt ternary batteries	Lithium iron phosphate
<b>Warranty</b>	Battery Warranty (years or km) : TBD	TBD

## CHARGING SYSTEM

<b>Charging System</b>	Manual	Manual
<b>Charge Rate</b>	99-137kw	150kw
<b>Charge Time</b>	2h (100kW charger)	1h

# HYBRICON BUS SYSTEM AB



## COMPANY PROFILE

Hybricon Bus Systems AB (HYCO) develops and manufactures the world's most energy-efficient, clean and quiet system for public transport buses. Hybricon Ultrafast Charged® buses run around the clock on clean electric power. Hybricon's headquarters, where the company's production facility is also located, is in Holmsund, outside Umeå (Sweden). Given the relative proximity to the Arctic Circle, this provides a perfect environment for cold-testing the company's products. Energy efficiency, ultra-fast charging and modularised key components together constitute a set of unique features of the company's buses.



Hybricon Arctic Whisper HAW  
18 LE 4WD



Hybricon Arctic Whisper HAW  
18 LE 4WD

## CONTACT

**Company website:**  
[www.hybricon.se](http://www.hybricon.se)

**Contact:**  
[info@hybricon.se](mailto:info@hybricon.se)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Hybricon Arctic Whisper HAW 18 LE 4WD	Hybricon City bus HCB 12 LF	-
Vehicle type	BEV, ultra-fast charge	BEV, fast charge	BEV, fast charge
Length	12m	12m	12m
Total Passengers capacity	79	62	N/A
Gross vehicle weight	28,000kg	18,000kg	18,000kg
Top speed	80km/h	80km/h	80km/h
Airco	ThermoKing	Yes	Yes
Heating	Electric, heat pump and diesel	Electric and diesel	Electric and diesel
Fuel economy or range	1.3 to 2.2kW/km based on practical experience in Umeå, northern Sweden, over one year	TBD	TBD
European Market introduction	June 2016	N/A	N/A

## ELECTRIC MOTOR

Suppliers	Ziehl-Abegg	Ziehl-Abegg	Ziehl-Abegg
Type	SM530.60AL-30 direct drive	SM530.60AL-30 direct drive	SM530.60AL-30 direct drive
Power peak	4x157kW (628kW)	2 x 157kW (314kW)	2 x 157kW (314kW)
Torque	6,000Nm max per wheel, 2,100Nm nominal	6,000Nm max per wheel, 2,100Nm nominal	6,000Nm max per wheel, 2,100Nm nominal

Electric bus model name	Hybricon Arctic Whisper HAW 18 LE 4WD	Hybricon City bus HCB 12 LF	-
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## BATTERY

Suppliers	Altair-Nano	BMZ	BMZ
Total energy	40-120kWh	38-265kWh	38-265kWh
Type	Lithium titanate	Nickel manganese cobalt	Nickel manganese cobalt
Warranty	3 years, extendable to 10 years	2 years, extendable to 10 years	2 years, extendable to 10 years

## CHARGING SYSTEM

Charging System	Overhead/depot manual	Overhead/depot manual	Overhead/depot manual
Charge Rate	20-650kW	20-200kW	20-200kW
Charge Time	4.5min, 4h depot The shorter time given assumes 20km route consumption and maximum charging power (effective charging time). The longer time is the recommended depot charge time.	TBD	TBD

## COMPANY PROFILE

Irizar e-mobility is the Group's new company, created in 2016, whose business is focused on offering integral electromobility solutions for vehicles as well as their main components and systems for cities.



Irizar i2e



Irizar i2e

## CONTACT

**Company website:**  
[www.irizar.com/en/irizar-e-mobility](http://www.irizar.com/en/irizar-e-mobility)

**Contact: Hector Olabe**  
[holabe@irizar.com](mailto:holabe@irizar.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Irizar ie bus (previously i2e)	Irizar ie tram (previously i2e 18m)
Vehicle type	BEV	BEV
Length	11.98m	18.73m
Total Passengers capacity	80	150 (up to client's request)
Gross vehicle weight	20,000kg	28,000kg
Top speed	85km/h	85km/h
Airco	Hispacold electric and fully automated air conditioning	Hispacold electric and fully automated air conditioning
Heating	Hispacold electric and fully automated heat ventilation system	Hispacold electric and fully automated heat ventilation system
Fuel economy or range	1,5kWh/km with air conditioning	-
European Market introduction	2014	2017

## ELECTRIC MOTOR

Suppliers	Siemens	Siemens
Type	Synchronous motor	Synchronous motor
Power peak	180kW (nominal)	230kW (nominal)
Torque	1,800Nm (nominal)	2,350Nm (nominal)

Electric bus model name

Irizar i2e

Irizar i2e 18m

BATTERY

Suppliers	FIAMM	Multiple suppliers
Total energy	376kWh	from 120-180kWh
Type	ZEBRA	Lithium ion
Warranty	Standard: 2 years Possibility of extension	Standard: 2 years Possibility of extension

CHARGING SYSTEM

Charging System	Manual Combo 2	Opportunity charging: pantograph Depot charging: Combo 2
Charge Rate	80-100kW	Opportunity charging: up to 500kW Depot charging: 80-100kW
Charge Time	6-7h	Opportunity charging: 5-10min Depot charging: 2h

## COMPANY PROFILE

Linkker Oy provides energy-efficient electric buses and electric bus systems. The optimised concept enables low total cost of ownership, already competitive with current diesel vehicles.



Linkker 12+ LE

## CONTACT

**Company website:**  
[www.linkkerbus.com](http://www.linkkerbus.com)

**Contact: Kimmo Erkkilä**  
[kimmo.erkkila@linkkerbus.com](mailto:kimmo.erkkila@linkkerbus.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Linkker 12+ LE
Vehicle type	BEV
Length	12.8m
Total Passengers capacity	80
Gross vehicle weight	16,000kg
Top speed	80km/h
Airco	Yes – options heat pump/electric heater/diesel auxiliary heater
Heating	Yes – options heat pump/electric heater/diesel auxiliary heater
Fuel economy or range	0.711kWh/km in Braunschweig cycle, 2,000kg payload. 1.11kWh/km in Braunschweig with full load. Typically 0.8-1.2kWh/km on average in commercial use. Mileage 300-400km per day with opportunity charging.
European Market introduction	2016

## ELECTRIC MOTOR

Suppliers	Visedo
Type	Permanent magnet
Power peak	180kW
Torque	7,800Nm

## BATTERY

Suppliers	Actia IM+E
Total energy	55-79kWh
Type	LTO
Warranty	Case specific; typically between 5-10 years and 500,000-1 million km

## CHARGING SYSTEM

Charging System	Overhead roof mounted or inverted pantograph
Charge Rate	6C, 300-480kW
Charge Time	Typically 2-5 minutes in normal operation

## COMPANY PROFILE

Optare is a leading British manufacturer of urban buses employing around 350 people with a modern assembly facility near Leeds, Yorkshire. Its award-winning range of buses feature an integral design and efficient diesel engines, as well as an industry-leading choice of electric units using the latest low-carbon technology.



Optare Metrocity EV



Optare Versa EV



Optare Metrodecker EV

## CONTACT

**Company website:**  
www.optare.com

**Contact: Rebecca Green**  
rebecca.green@optare.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Optare Solo EV	Optare Metrocity EV	Optare Versa EV	Optare Metrodecker EV
Vehicle type	BEV	BEV	BEV	BEV
Length	9.2m and 9.9m	10.8m	10.4m and 11.1m	10.5m
Total Passengers capacity	55	58	58	99
Gross vehicle weight	11,300kg	12,960kg	12,480kg	18,000kg
Top speed	80km/h	80km/h	80km/h	80km/h
Airco	Not currently available	Not currently available	Not currently available	Chiller system
Heating	Diesel combustion heater/electric heating	Diesel combustion heater/electric heating	Diesel combustion heater/electric heating	Electric heating
Fuel economy or range	0.51kWh/km - from independent testing by the LowCVP in conjunction with DfT on the Millbrook London Transbus Bus cycle (MLTB - route 159) and LowCVP UK Bus drive cycle (LUB)	0.67kWh/km based on the London City route, UK	0.67kWh/km based on in-service data from the park and ride service in York, UK	1.0KWh/Km based on data from the park and ride and city services in York, UK
European Market introduction	August 2012	March 2014	October 2013	In service trials from August 2017

## ELECTRIC MOTOR

Suppliers	Magtec	Magtec	Magtec	Magtec
Type	-	-	-	-
Power peak	150kW	150kW	150kW	200kW
Torque	2,000Nm	2,000Nm	2,000Nm	3,570Nm

Electric bus model name	Optare Solo EV	Optare Metrocity EV	Optare Versa EV	Optare Metrodecker EV
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## BATTERY

Suppliers	Valence	Valence	Valence	TBC
Total energy	2 pack - 92kWh 3 pack - 138kWh	2 pack - 92kWh 3 pack - 138kWh	2 pack - 92kWh 3 pack - 138kWh	200kWh
Type	Lithium iron magnesium phosphate	Lithium iron magnesium phosphate	Lithium iron magnesium phosphate	Lithium iron magnesium phosphate
Warranty	5 years	5 years	5 years	TBC

## CHARGING SYSTEM

Charging System	Plug-in	Plug-in	Plug-in	Plug-in
Charge Rate	42kW	42kW	42kW	40kW
Charge Time	2.5h	2.5h	2.5h	6h

## COMPANY PROFILE

Being one of the major automotive manufacturers in Turkey, Otokar has been providing solutions specifically answering to the needs of its customers with its own technology, design and applications both in commercial and military range since 1963. It is operating with over 2,000 employees at the factory built on a land of 552,000m<sup>2</sup> in Sakarya. Otokar has been manufacturing buses for public transportation, semi-trailers for transportation and logistics industry and tracked armoured vehicles and tactical armoured vehicles for the defense industry. With a hundred percent Turkish capital, Otokar is today present in the automotive and defense industries with products of which intellectual property rights are owned by it. Being a leader in the bus industry and the land vehicles in the defense industry in Turkey, Otokar is the main contractor in the Design and Prototype Development Project of ALTAY, the national battle tank of Turkey and is one of the companies of Koç Group.



Otokar Electra

## CONTACT

**Company website:**  
www.otokar.com

**Contact: Berkan Saglam**  
bsaglam@otokar.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Otokar Electra
Vehicle type	BEV
Length	9m
Total Passengers capacity	55
Gross vehicle weight	13,500kg
Top speed	80km/h
Airco	yes
Heating	yes
Fuel economy or range	1kWh/km - 170km (city cycle)
European Market introduction	-

## ELECTRIC MOTOR

Suppliers	-
Type	asynchronous
Power peak	103kW
Torque	380Nm

## BATTERY

Suppliers	Valence
Total energy	170kWh
Type	LFP
Warranty	-

## CHARGING SYSTEM

Charging System	manual
Charge Rate	32kW
Charge Time	8h

## COMPANY PROFILE

Since 1945, Rampini is a leader in the design and manufacture of specialty vehicles and urban buses with special features built into them (diesel, electric and hydrogen). In addition, Rampini designs and manufactures highly technological vehicles for specific applications: chassis intended for special uses, OB vehicles, vehicles for satellite broadcasts, special equipments for the armed forces, levelling systems, and much more.



Rampini E12

## CONTACT

**Company website:**  
[www.rampini.it/en/](http://www.rampini.it/en/)

**Contact: Stefano Rampini**  
[stefano@rampini.it](mailto:stefano@rampini.it)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Rampini E12
Vehicle type	BEV
Length	12m
Total Passengers capacity	70
Gross vehicle weight	19,000kg
Top speed	70km/h
Airco	yes
Heating	yes
Fuel economy or range	120km/130km public urban service
European Market introduction	2016

## ELECTRIC MOTOR

Suppliers	Siemens
Type	A/C
Power peak	150 - 160kW
Torque	980 - 2,180Nm

## BATTERY

Suppliers	winston battery
Total energy	180kWh
Type	LFP
Warranty	2 years

## CHARGING SYSTEM

Charging System	manual (plug) / pantograph
Charge Rate	15 - 30kW
Charge Time	3 - 6h

## COMPANY PROFILE

The Safra commercial body shop specialises in the provision of equipment and the fitting out and heavy maintenance of urban passenger transport vehicles. Specialising in the renovation of standard and articulated buses, Safra has recently extended its expertise to the rail sector; trams, underground trains and rail carriages. Since 2010, Safra has also been a bus manufacturer, with an innovative programme, Businova, an urban transport vehicle that gives excellent results in terms of technical, economic and ecological performance.



Businova Midibus



Businova Standard

## CONTACT

**Company website:**  
[www.safra.fr/en](http://www.safra.fr/en)

**Contact:**  
[contact@businova.com](mailto:contact@businova.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Businova Midibus	Businova Standard
Vehicle type	PHEV	PHEV
Length	10.5m	12m
Total Passengers capacity	70	100
Gross vehicle weight	19,000kg	20,000kg
Top speed	70km/h	70km/h
Airco	Reversible heat pump	Reversible heat pump
Heating	Reversible heat pump	Reversible heat pump
Fuel economy or range	120km fully electric and 200km with range extender on 2/3 SORT 1 and 1/3 SORT 2	120km fully electric and 200km with range extender on 2/3 SORT 1 and 1/3 SORT 2
European Market introduction	June 2017	June 2017

## ELECTRIC MOTOR

Suppliers	TM4	TM4
Type	LSM200 - permanent magnet	LSM200 - permanent magnet
Power peak	200kW	200kW
Torque	2,105Nm	2,105Nm

## BATTERY

Suppliers	EVE System	EVE System
Total energy	132kWh	132kWh
Type	Lithium iron phosphate	Lithium iron phosphate
Warranty	5 years	5 years

## CHARGING SYSTEM

Charging System	On board	On board
Charge Rate	18-22kW	18-22kW
Charge Time	4-6h	4-6h

## COMPANY PROFILE

Škoda Electric is a world-leading manufacturer of electric drives and traction motors for trolleybuses, tramways, locomotives, suburban train units, metro, mine cars, etc. The company continues a long-standing tradition of electrical engineering production at Škodové závody in Plzeň, which commenced in 1901. The high technical level of Škoda Electric products, our lengthy experience in manufacturing and the quality of our technology, along with the high productivity of our employees, offer effective conditions for successful production for both domestic and foreign markets. Škoda has been a traditional producer of complete trolleybuses since 1936, with more than 15,000 vehicles delivered to customers around the world. Škoda is now also focusing on the production of complete hybrid buses and electric buses including charging infrastructure.



SKODA PERUN HE



SKODA PERUN HP



SKODA 26TR



SKODA 27TR

## CONTACT

**Company website:**  
www.skoda.cz

**Contact: Pavel Kuch**  
pavel.kuch1@skoda.cz

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Skoda Perun HE	Skoda Perun HP	Skoda 26Tr	Skoda 27Tr
Vehicle type	BEV	BEV	Trolleybus	Trolleybus
Length	12m	12m	12m	18m
Total Passengers capacity	82	82	85	125
Gross vehicle weight	18,600kg	18,600kg	18,000kg	29,000kg
Top speed	70km/h	70km/h	70km/h	70km/h
Airco	Electric	Electric	Electric	Electric
Heating	Electric water boiler	Electric water boiler	Electric water boiler	Electric water boiler
Fuel economy or range	1.4kWh/km	1.4kWh/km	1.5kWh/km	2.4kWh/km
European Market introduction	2013	2014	2013	2014

## ELECTRIC MOTOR

Suppliers	Skoda	Skoda	Skoda	Skoda
Type	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Power peak	160kW	160kW	160kW	250kW
Torque	1800Nm	1800Nm	1800Nm	2,500Nm

## BATTERY

Suppliers	Various	Various	Various	Various
Total energy	230kWh	80kWh	50kWh	80kWh
Type	Lithium iron phosphate	Lithium titanate	Lithium titanate	Nickel manganese cobalt
Warranty	4 years	4 years	4 years	4 years

## CHARGING SYSTEM

Charging System	Plug-in	Overhead automatic	Overhead trolley	Overhead trolley
Charge Rate	Up to 100kW	Up to 600kW	Up to 200kW	Up to 200kW
Charge Time	4-6h	Up to 10min	N/A	N/A

## COMPANY PROFILE

Solaris Bus & Coach S.A. is a Europe-wide leading manufacturer of Solaris Urbino city buses, Solaris Trollino trolleybuses, InterUrbino intercity buses, special buses and Solaris Tramino trams. Since production commenced in 1996, the firm has manufactured over 14,000 vehicles supplied to over 600 cities in 30 countries all around the world. The company successfully launched low-floor buses onto the Polish market and quickly became the market leader in its sector, a position that it retains to this day. In 2011, Solaris introduced the electric version of the Urbino city bus, which has become one of the most successful products in the manufacturer's portfolio. The company employs 2,300 people in Poland and nearly 500 in overseas offices.



Solaris Urbino 8,9 LE electric



Solaris Urbino 12 electric



Solaris Urbino 18 electric  
Source: Ylli Hajdaraj



Solaris Trollino 12



Solaris Trollino 18

## CONTACT

Company website:  
[www.solarisbus.com](http://www.solarisbus.com)

Contact: Anna Kordylas  
[anna.kordylas@solarisbus.com](mailto:anna.kordylas@solarisbus.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Solaris Urbino 8,9 LE electric	Solaris Urbino 12 electric	Solaris Urbino 18 electric	Solaris Trollino 12	Solaris Trollino 18/18,75
Vehicle type	BEV	BEV	BEV	Trolley	Trolley
Length	8.95m	12m	18m	12m	18m/18.75m
Total Passengers capacity	Up to 65 depending on specifications	Up to 90	Up to 129	Up to 83	Up to 139
Gross vehicle weight	14,500-16,000kg	18,000-19,000kg	28,000-30,000kg	18,000- 19,000kg	28,000-30,000kg
Top speed	Up to 80km/h	Up to 80km/h	Up to 80km/h	Up to 70km/h	Up to 70km/h
Airco	AC with electric compressor (3 x 400V)	AC with electric compressor (3 x 400V)	AC with electric compressor (3 x 400V)	AC with electric compressor (3 x 400V)	AC with electric compressor (3 x 400V)
Heating	Electric boiler and/or diesel heater	Electric boiler and/or diesel heater	Electric boiler and/or diesel heater	Electric boiler	Electric boiler
Fuel economy or range	0.8kWh/km according to test procedure PB-23, based on SORT 2	0.9kWh/km according to test procedure PB-23, based on SORT 2	1.3kWh/km according to test procedure PB-23, based on SORT 2	Range on battery mode: up to 50% of the length of line	Range on battery mode: up to 50% of the length of line
European Market introduction	2011	2012	2013	2005	2005

Electric bus model name	Solaris Urbino 8.9 LE electric	Solaris Urbino 12 electric	Solaris Urbino 18 electric	Solaris Trollino 12	Solaris Trollino 18/18,75
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## ELECTRIC MOTOR

Suppliers	TSA	TSA, ZF	TSA, ZF	Škoda/TSA/EMIT	Škoda/TSA/EMIT
Type	Asynchronous motor 160kW	Asynchronous motor 160kW, asynchronous 2 x 60kW nominal	Asynchronous motor 240kW	Asynchronous motor 160kW/ 160kW/ 175kW	Asynchronous motor 250kW/ 251kW/ 240kW
Power peak	170kW	2 x 125kW	270kW	280kW/215kW	280kW/ 296kW
Torque	903Nm (nominal)	2x11,000Nm (axle output torque max.)	1,304Nm	1,800Nm/ 2,266Nm (max.)	3,750Nm/ 4,200Nm (max.)

## BATTERY

Suppliers	Solaris	Solaris	Solaris	Solaris, Škoda	Solaris, Škoda
Total energy	Up to 160kWh depending on technology	Up to 240kWh depending on technology	Up to 240kWh depending on technology	Up to 69kWh depending on technology	Up to 69kWh depending on technology
Type	Lithium iron phosphate/ Lithium titanate				
Warranty	Up to 5-10 years	Up to 5-10 years	Up to 5-10 years	Up to 10 years	Up to 10 years

## CHARGING SYSTEM

Charging system	Plug-in/ pantograph	Plug-in/ pantograph/ induction	Plug-in/ pantograph/ induction	In-motion charging	In-motion charging
Charge rate	Plug-in: up to 120kW Pantograph: up to 300kW	Plug-in: up to 120kW Pantograph: up to 450kW Induction: 200kW	Plug-in: up to 120kW Pantograph: up to 450kW Induction: 200kW	50-60kW	50-60kW
Charge time	Plug-in: 1.33kWh/min Pantograph: 5kWh/min	Plug-in: 1.33kWh/min Pantograph: 7.5kWh/min Induction: 3.33kWh/min	Plug-in: 1.33kWh/min Pantograph: 7.5kWh/min Induction: 3.33kWh/min	Approx. 1kWh/min	Approx. 1kWh/min
Warranty	Up to 5-10 years	Up to 5-10 years	Up to 5-10 years	Up to 10 years	Up to 10 years

## COMPANY PROFILE

SOR is a Czech bus producer. The company was founded in 1991. It produces all types of buses – city, intercity and coaches and manufactures buses for all types of engine – electric, diesel, CNG. Production of electric buses started in 2009. To date, SOR has manufactured 35 electric bus units, currently operating in the Czech Republic, Slovakia, Germany and Switzerland.



SOR EBN 11



SOR EBN 10,5

## CONTACT

Company website:  
[www.sor.cz](http://www.sor.cz)

Contact: Jirí Dansa  
[dansa@sor.cz](mailto:dansa@sor.cz)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	SOR EBN 11	SOR EBN 10,5
Vehicle type	BEV	BEV
Length	11.1m	10.37m
Total Passengers capacity	90	82
Gross vehicle weight	16,500kg	16,500kg
Top speed	80km/h	80km/h
Airco	Heating pump	Driver
Heating	Heating pump and electric heating	Independent diesel heating
Fuel economy or range	1.1kW/h (on average)	0.9-1kW/h (on average)
European Market introduction	September 2015	October 2014

## ELECTRIC MOTOR

Suppliers	Pragoimex	Pragoimex
Type	Asynchronous	Asynchronous
Power peak	120kW	120kW
Torque	968Nm	968Nm

## BATTERY

Suppliers	Winston Battery	Winston Battery
Total energy	172kW	172kW
Type	Lithium ion	Lithium ion
Warranty	Depending on contract	Depending on contract

## CHARGING SYSTEM

Charging System	Overhead, manual	Manual
Charge Rate	100-150kW	22kW
Charge Time	1-2h (fully charged)	7h (fully charged)

## COMPANY PROFILE

Temsa, one of Turkey's leading automotive companies, manufactures and distributes buses and coaches under its own brand in domestic and international markets. The company's manufacturing facility in Adana has a single-shift annual production capacity of 4,000 buses and coaches and 7,500 light trucks, totalling 11,500 vehicles per year. It offers a range of products that help customers navigate through changing environments and adapt their fleet to new passenger requirements and travel trends. Temsa vehicles, designed and manufactured with in-house expertise, are sold to the world's leading automotive markets as well as to the Turkish market, having expanded to 64 countries. Temsa's strategy is to develop products that respond to customers' changing needs, to introduce a modular approach to production and to deliver a well-designed line of buses of the highest quality. Although producing buses in the bus market it leads, Temsa retains its vision of becoming an innovative and entrepreneurial technology enterprise, producing smart transportation solutions and making a difference.

As a high-performance, successful venture, Temsa constantly pursues sustainable and profitable business growth and is proud of being an innovation-oriented organisation, focusing on creative ideas for high value products in order to always exceed customer expectation. The Temsa Innovation and Entrepreneurship programme sponsors and deploys projects to continuously enhance the safety, comfort, durability and operating performance of its products. Temsa's innovation efforts can be summarised in four dimensions: Safety, Environmental Awareness, Smart Mobility and Operational Excellence.



Temsa MD9 electriCITY



Temsa Avenue EV

## CONTACT

**Company website:**  
www.temsa.com

**Contact:**

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burak.onur@temsa.com

**Mert Özkaynak**  
mert.ozkaynak@temsa.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Temsa MD9 electriCITY	Temsa Avenue EV
Vehicle type	BEV	BEV
Length	9.3m	12m
Total Passengers capacity	65	90
Gross vehicle weight	14,000kg	19,000kg
Top speed	90km/h	90km/h
Airco	Electrical	Electrical
Heating	Electrical	Electrical
Fuel economy or range	1kwh/km - SORT 1	1.5kwh/km - SORT 1
European Market introduction	March 2017	March 2017

## ELECTRIC MOTOR

Suppliers	TM4	TM4
Type	PEM	PEM
Power peak	200kW	270kW
Torque	2,200Nm	2,700Nm

Electric bus model name

Temsa MD9 electriCITY

Temsa Avenue EV

BATTERY

Suppliers	Mitsubishi	Microvast
Total energy	200kWh	75kWh
Type	Nickel manganese cobalt	Lithium titanate
Warranty	2 years	2 years

CHARGING SYSTEM

Charging System	Manual plug	Overhead/manual plug
Charge Rate	120kW	450kW
Charge Time	2.5h	7min



## COMPANY PROFILE

Ursus Bus company was created one year ago as joint venture between Ursus S.A. and AMZ-Kutno S.A., drawing on the experiences of both companies in ebus production. Before joining forces, both organisations had acquired experience in manufacturing e buses. The purpose of joining forces was to create a company focused solely on e buses and to scale up production.



Ursus Bus Ekovolt



Ursus Bus City Smile 8,5m



Ursus Bus City Smile 10m



Ursus Bus City Smile 12m with ZIEHL-ABEGG



Ursus Bus City Smile 12m with TM4



Ursus Bus City Smile 18m

## CONTACT

Company website:  
[www.ursusbus.com](http://www.ursusbus.com)

Contact: Grzegorz Stawicki  
[grzegorz.stawicki@ursus.com](mailto:grzegorz.stawicki@ursus.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Ursus Bus Ekovolt	Ursus Bus City Smile				
Vehicle type	BEV	BEV	BEV	BEV	BEV	BEV
Length	11.96m	8.5m	9.95m	12m	12m	18m
Total Passengers capacity	81	61	84	82	62	104
Gross vehicle weight	18,000kg	16,000kg	18,000kg	18,000kg	18,000kg	28,000kg
Top speed	70km/h	70km/h	70km/h	70km/h	100km/h	100km/h
Airco	Safkar DKE-26-KSO17	No	No	Safkar DKE-26-KSO17	Thermo King Athenia	Thermo King Athenia
Heating	Spheros Thermo 30kW	Spheros Thermo 30kW	Spheros Thermo 30kW	Strocco 35.02	Strocco 35.02	Strocco 35.02
Fuel economy or range	0.97kWh/km SORT 2	Not tested	Not tested	0.8kWh/km SORT 2	Not tested	Not tested
European Market introduction	March 2015	June 2014	July 2013	June 2016	October 2013	May 2015

## ELECTRIC MOTOR

Suppliers	TM4	TM4	TAM	TM4	Ziehl-Abegg	Ziehl-Abegg
Type	LSM280AHV-3400-A1	LSM280AHV-3400-A1	1052C6B	LSM280AHV-3400-A1	SM 530.60AL-30	SM 530.60AL-30
Power peak	170kW	170kW	120kW	170kW	226kW	452kW
Torque	1,100Nm	1,100Nm	835Nm	1,100Nm	5,400Nm	10,800Nm

Electric bus model name	Ursus Bus Ekovolt	Ursus Bus City Smile				
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## BATTERY

Suppliers	Impact	BMZ	EVC	Impact	Hybricon Bus Systems	Hybricon Bus Systems
Total energy	120kWh	175kWh	210kWh	175kWh	105kWh	105kWh
Type	Lithium iron phosphate	Nickel manganese cobalt	Lithium iron phosphate	Lithium iron phosphate	Lithium titanate	Lithium titanate
Warranty	5 years	6 years	5 years	5 years	15 years	15 years

## CHARGING SYSTEM

Charging System	Manual	Manual	Manual	Manual	Overhead	Overhead
Charge Rate	150kW	30kW	240kW	30kW	625kW	625kW
Charge Time	1h	7h	1h	7h	10min	10min

## COMPANY PROFILE

Van Hool of Belgium manufactures approximately 1,400 buses and coaches and as many as 4,000 commercial vehicles annually, of which 80% are exported worldwide. With a workforce of over 4,000, Van Hool is a major European bus manufacturer, offering a complete range of buses for public transport for international markets, from a 9m midibus to a 25m double articulated low-floor bus. For over 65 years, Van Hool has developed a reputation for designing and building high-quality, state-of-the-art customised products.



Van Hool Exqui.City 18m  
100% Battery



Van Hool A330T ZEV



Van Hool A308E

## CONTACT

**Company website:**  
[www.vanhool.be](http://www.vanhool.be)

**Contact: Dirk Snauwaert**  
[dirk.snauwaert@vanhool.be](mailto:dirk.snauwaert@vanhool.be)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Van Hool Exqui.City 18m 100% Battery	Van Hool Exqui.City 18m Trolley	Van Hool Exqui.City 24m Trolley
Vehicle type	BEV	Trolley	Trolley
Length	18.610m	18.610m	23.820m
Total Passengers capacity	117	131	149
Gross vehicle weight	28,000kg	29,000kg	36,500kg
Top speed	70km/h	60km/h	65km/h
Airco	Heatpump Eberspächer-Sütrak Typ AC136HP	Eberspächer/Sütrak AC136AE	Eberspächer-Sütrak Typ AC136 AE CA
Heating	Integrated in air con system	Eberspächer/Sütrak AC136AE	Integrated in air con system
Fuel economy or range	Up to 120km at 10°C, half-load, 50% SORT 1 - 50% SORT 2	-	Load: 2/3 Frequency at 1.5km 350 days/year respectively 30 scheduled trips/day
European Market introduction	October 2016	2014	2017

## ELECTRIC MOTOR

Suppliers	Siemens	Kiepe	Kiepe/TSA
Type	PEM 2016	Skoda, Asynchronous 3-phase	TMF 37-21-4
Power peak	2 x 160kW	120kW	2 x 160kW
Torque	1,500Nm	-	1,250Nm

Electric bus model name	Van Hool Exqui.City 18m 100% Battery	Van Hool Exqui.City 18m Trolley	Van Hool Exqui.City 24m Trolley
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## BATTERY

Suppliers	BFFT	Kiepe	Kiepe
Total energy	215kWh	35kWh	20kWh
Type	Lithium ion	Lithium titanate	Lithium ion
Warranty	5 years	-	5 years

## CHARGING SYSTEM

Charging System	Conductive in two ways: connector and inverted pantograph	Overhead catenary (trolleybus)	Overhead
Charge Rate	Connector, 80kW; pantograph, 250kW	-	Pantograph, 75kW
Charge Time	Connector, 4h; pantograph, 10min	-	-

## COMPANY PROFILE

VDL Bus & Coach is a frontrunner in the transition towards zero-emission public transport. With over 200 electric buses already in operation (Q4 2017), VDL has demonstrated that day-to-day zero-emission operations are already a valid option. The electric bus range is suitable for various types of city and suburban operations through a flexible approach on battery- and charging solutions. By retaining a clear focus on the transition at an operational level, VDL also offers full service packages including charge infrastructure, R&M, energy and implementation. With its vast experience in large-scale deployment of electric buses, VDL is a solid partner for all operators who foresee zero-emission public transport as the right way forward.



Citea LLE-99 Electric



Citea SLF-120 Electric



Citea SLFA-180 Electric



Citea SLFA-181 Electric

## CONTACT

**Company website:**  
[www.vdlbuscoach.com](http://www.vdlbuscoach.com)

**Contact: Michel Dekker**  
[m.dekker@vdlbuscoach.com](mailto:m.dekker@vdlbuscoach.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	VDL Citea LLE-99 Electric	VDL Citea SLF-120 Electric	VDL Citea SLFA-180 Electric	Citea SLFA-181 Electric
Vehicle type	BEV	BEV	BEV	BEV
Length	9.95m	12m	18m	18.15m
Total Passengers capacity	63	92	145	143
Gross vehicle weight	14,870kg	19,500kg	29,000kg	29,000kg
Top speed	80km/h	80km/h	80km/h	80km/h
Airco	Fully electric	Fully electric	Fully electric	Fully electric
Heating	Fully electric or (bio) diesel	Fully electric / Heat pump / (Bio)diesel	Fully electric / Heat pump / (Bio)diesel	Fully electric / Heat pump / (Bio)diesel
Fuel economy or range	Depending on configuration / operation	Depending on configuration / operation	Depending on configuration / operation	Depending on configuration / operation
European Market introduction	August 2016	August 2014	August 2015	August 2015

## ELECTRIC MOTOR

Suppliers	Siemens	Siemens	Siemens	Siemens
Type	Central mounted, permanent magnet	Central mounted, permanent magnet	Central mounted, permanent magnet	Central-mounted, permanent magnet
Power peak	153kW	153kW	210kW	210kW/h
Torque	2,500Nm	2,500Nm	3,800Nm	3,800Nm

Electric bus model name	VDL Citea LLE-99 Electric	VDL Citea SLF-120 Electric	VDL Citea SLFA-180 Electric	Citea SLFA-181 Electric
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## BATTERY

Suppliers	Multiple	Multiple	Multiple	Multiple
Total energy	180kWh	85-180kWh	85-248kWh	85-248kWh
Type	Various Li-Ion	Various Li-Ion	Various Li-Ion	Various Li-Ion
Warranty	Depending on contract/operation	Depending on contract/operation	Depending on contract/operation	Depending on contract / operation

## CHARGING SYSTEM

Charging System	Combo2, (inverted) pantograph	Combo2, (inverted) pantograph	Combo2, (inverted) pantograph	Combo2, (inverted) pantograph
Charge Rate	Up to 270kW	Up to 360kW	Up to 480kW	Up to 480kW
Charge Time	5min.-4.5h	5min.-4.5h	5min.-4.5h	5min.-4.5h

## COMPANY PROFILE

Vectia is a brand that has emerged to offer global solutions for more sustainable urban transport. At Vectia, we are committed to new solutions for urban transport; configurable hybrid and electric buses that are competitive, reliable and safe. Our innovative range is designed for cities looking to the future and working towards a better quality of life for their inhabitants through modern and sustainable transport in harmony with the environment, minimising environmental impact and promoting a healthier life for all. This project is a forward-looking response to the mobility challenges faced by our towns and cities. Vectia seeks to become a reference company, committed to society and the environment through knowledge-intensive technological activity, providing significant added-value and excellent service.



VECTIA VERIS.12 Plug-In



VECTIA VERIS.12 Plug-In

## CONTACT

**Company website:**  
[www.vectia.es/en/](http://www.vectia.es/en/)

**Contact: Javier Ramos**  
[javier.ramos@vectia.es](mailto:javier.ramos@vectia.es)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	VECTIA VERIS.12 Plug-In
Vehicle type	PHEV
Length	12m
Total Passengers capacity	90
Gross vehicle weight	13,360kg
Top speed	80km/h
Airco	Reversible heat pump
Heating	Reversible heat pump
Fuel economy or range	TBD
European Market introduction	July 2017

## ELECTRIC MOTOR

Suppliers	N/A
Type	PMSM
Power peak	210kW (180kW cont.)
Torque	1,500Nm

## BATTERY

Suppliers	N/A
Total energy	24kWh
Type	Lithium titanate
Warranty	5 years

## CHARGING SYSTEM

Charging System	Overhead
Charge Rate	150kW
Charge Time	3-5min



## COMPANY PROFILE

Leading the way with sustainable transport solutions, Volvo Buses is one of the world's leading brands of buses and coaches, operating in more than 140 countries. We are driven by a passion to help create the cities of the future, free from congestion, emissions and noise. Our mission is to help operators and communities offer people safe, clean and efficient transportation to and from work, around the city or across the continent. We do so by striving to be the ultimate provider of sustainable transport solutions.



Volvo 7900 Electric



Volvo 7900 Electric Hybrid

## CONTACT

**Company website:**  
www.volvobuses.com

**Contact: Magnus Broback**  
magnus.broback@volvo.com

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	Volvo 7900 Electric Hybrid	Volvo 7900 Electric
Vehicle type	PHEV	BEV
Length	12m	12m
Total Passengers capacity	71-98 depending on specifications	80-105 depending on specifications
Gross vehicle weight	12,100-12,900kg depending on specifications	11,400-12,000kg depending on specifications
Top speed	70km/h (software controlled)	80km/h (software controlled)
Airco	Spheros Revo E	Spheros Revo E
Heating	Auxiliary heater: fuel (diesel/HVO)	Auxiliary heater: fuel (diesel/HVO) and electric; heat pump
Fuel economy or range	LUB average (13,706kg): 10.24lit/100km + 0.53kWh/km Zero-emission operating range: 8.1km	LUB (13,182kg), 0.68/0.67kWh/km Braunschweig (15,040kg), 0.83/0.80kWh/km - SORT 2 (14,700kg), 0.79kWh/km
European Market introduction	June 2016	June 2017

## ELECTRIC MOTOR

Suppliers	In motion	In motion
Type	Permanent magnet	Permanent magnet
Power peak	150kW	155kW
Torque	400Nm	1,200Nm

Electric bus model name

Volvo 7900 Electric Hybrid

Volvo 7900 Electric

BATTERY

Suppliers	SAFT	SAFT
Total energy	19kWh	76kWh
Type	Lithium iron phosphate	Lithium iron phosphate
Warranty	Volvo offers a battery contract including performance monitoring over an agreed timeframe	Volvo offers a battery contract including performance monitoring over an agreed timeframe.

CHARGING SYSTEM

Charging System	Opportunity charging, overhead, conductive, pantograph on pole	Opportunity charging, overhead, conductive, pantograph on pole
Charge Rate	150kWh	300kW
Charge Time	3-6min	3-6min

## COMPANY PROFILE

Yutong Bus is the largest and most technologically advanced manufacturing base of medium and large-sized buses around the world. It has created a complete 5-metre – 25-metre bus line-up. The new energy bus plant has an annual output of 30,000 units and has become the world's largest manufacturing base of new energy buses.



E12LF for UK



E12LF



ICe 12

## CONTACT

Company website:  
[www.en.yutong.com](http://www.en.yutong.com)

Contact: Zhang Yiyi  
[zhangyiyi@yutong.com](mailto:zhangyiyi@yutong.com)

## ELECTRIC BUS SPECIFICATIONS - GENERAL INFORMATION

Electric bus model name	E12LF	NEW E12LF	E12LF for UK	ICe 12
Vehicle type	BEV	BEV	BEV	BEV
Length	12m	12m	12m	12m
Total Passengers capacity	75+2 (wheelchair)	75+2 (wheelchair)	72+1 (wheelchair)	69
Gross vehicle weight	19,100kg	19,100kg	18,000kg	19,400
Top speed	70-85km/h	70-85km/h	80km/h	100km/h
Airco	Fully electric	Fully electric	Fully electric	Fully electric
Heating	Electric heater/fuel heater option	Electric heater	Electric heater	Electric heater
Fuel economy or range	280km under sort	300km under sort	305km under sort	245km under sort
European Market introduction	2015	2017	2016	2017

## ELECTRIC MOTOR

Suppliers	YUTONG	YUTONG	YUTONG	YUTONG
Type	synchronous	synchronous	synchronous	synchronous
Power peak	350kW	350kW	350kW	350kW/h
Torque	1,200/2,600	1,200/2,600	1,200/2,600	1,200/2,600

## BATTERY

Suppliers	CATL	CATL	CATL	CATL
Total energy	295kWh	324kWh	295kWh	258kWh
Type	Lithium Iron Phosphate	Lithium Iron Phosphate	Lithium Iron Phosphate	Lithium Iron Phosphate
Warranty	5 years	5 years	5 years	5 years

## CHARGING SYSTEM

Charging System	Plug-in	Plug-in	Plug-in	Plug-in
Charge Rate	60kW	60kW	60kW	60kW
Charge Time	5h	5.5h	5h	4h



# CHAPTER 4: ELECTRIC SYSTEM SUPPLIERS

## COMPANY PROFILE

ABB (ABBN: SIX Swiss Ex) is a pioneering technology leader in electrical products, robotics and motion, industrial automation and power grids, serving customers in utilities, industry and transport & infrastructure globally. Building on more than 125 years of history in innovation, ABB is now writing the future of industrial digitalisation and driving the Energy and Fourth Industrial Revolutions. ABB operates in more than 100 countries with around 132,000 employees.

As part of its drive to promote sustainable mobility, ABB has provided charging solutions since 2010 and has sold more than 6,000 cloud-connected DC fast-chargers around the world for passenger cars and light commercial vehicles.



Heavy Vehicle Charger



TOSA

## CONTACT

### Company website:

[www.new.abb.com/abb-ability/transport/electric-vehicles/electric-vehicle-infrastructure](http://www.new.abb.com/abb-ability/transport/electric-vehicles/electric-vehicle-infrastructure)

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	Heavy Vehicle Charger	TOSA
<b>Product short description</b>	ABB Heavy Vehicle Charger (HVC) is an automated fast charging system that allows electric city buses to drive 24/7, thus enabling true zero emission public transport in cities. With its automated rooftop connection and typical charge time of 3-6 minutes, the system can easily be integrated into existing bus lines by installing chargers at endpoints, terminals, and/or intermediate stops.	TOSA is a flash and terminal charging system, which uses a power source on the wayside and an onboard charging system. The bus is connected via an automated pantograph (energy transfer system) that enables the bus to connect within one second to the infrastructure, since no communication is needed between bus and infrastructure. TOSA's main application will be eBRT systems with high frequency and short lay-over times, in combination with large capacity vehicles such as articulated and double-articulated buses.
<b>Suitable charging place</b>	Opportunity charging (at terminal or selected bus stops)	Opportunity charging (combination of charging at selected bus stops and at terminal)
<b>System</b>	Conductive, via pole-mounted pantograph	Conductive, via bus mounted energy transfer system with automatic alignment
<b>Max. output power range</b>	150kW, 300kW, 450kW, 600kW DC	400/600kW
<b>Charging Standard</b>	OppCharge	-
<b>Indoor and/or Outdoor use</b>	Indoor & outdoor	Indoor & outdoor
<b>Operating temperature range</b>	Standard: -10°C to +45°C Optional: -35°C to +50°C	Standard: -30°C to +40°C
<b>Compatible bus brands</b>	Volvo, Heuliez Bus, Iveco Bus, Ebusco, Solaris	Already mounted on HESS buses Can be adapted on other chassis
<b>Number of charges installed/planned</b>	51	26
<b>Examples of implementation</b>	In 2018, ABB will charge the single largest network of 101 electric buses in Europe and 15 ABB charging stations. In January, ABB inaugurated the first two OppCharge bus charging stations, to power eleven electric hybrid buses running within a new zero-emissions zone in the centre of the city of Namur. The stations will fully charge the electric hybrid buses with 150kW of power in 3-6 minutes during layover times at the bus route's end points. In 2017-2018, this project will be extended to charge 90 additional Volvo Electric Hybrid buses, including twelve 150kW charging stations in the Wallonia public transport system, operated by TEC Group. The project includes substations, switchgear, civil works, installation and a service contract.	In December 2017, the first TOSA line will be in commercial operation at TPG in Genève, 12 articulated Hess buses will run on the line, on each round trip the buses will be charged on 12 bus stops with 600kW for 20 seconds (equipped with energy storage to smooth the consumption at the electrical grid) and at the terminal with 400kW for 4-5 min. In 2018 the operator SEMITAN will equip an eBRT line with the TOSA system. On this line, 20 double articulated buses (24m) will be charged at the terminals with 600kW in combination with flash charges of few seconds (10-40s) at selected bus stops. All TOSA buses use the ABB drivetrain consisting of ABB traction and auxiliary converter, ABB permanent magnet motors and batteries.

## COMPANY PROFILE

With its flexible PRIMOVE portfolio, Bombardier offers the world's only one-stop shop for true e-mobility. The fully integrated system for electric rail and road vehicles allows for easy incorporation of electric mobility. PRIMOVE makes sustainable mobility a reality by reducing local CO<sub>2</sub> emissions to zero. It eliminates noise pollution and integrates seamlessly into the environment. For electric buses, the PRIMOVE package represents a major leap forward by creating a competitive alternative to diesel and hybrid systems. It offers a unique combination of fast inductive charging, light-weight batteries and a fully integrated propulsion system.



PRIMOVE charging 200



PRIMOVE charging 200

## CONTACT

**Company website:**

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	PRIMOVE charging 200
Product short description	PRIMOVE wireless charging is based on high power inductive energy transfer between components buried underground and receiving equipment installed beneath the vehicle. Wayside components 'communicate' with the vehicle to start the contactless charging process automatically as soon as the vehicle completely covers the charging segment.
Suitable charging place	Depot and/or opportunity charging (at terminal or selected bus stops)
System	Inductive
Max. output power range	DC output voltage: U <sub>out</sub> = 530 - 750 V DC Max. output power: P <sub>out</sub> =200 kW
Charging Standard	In progress: IEC6189, SAE J2954/2
Indoor and/or Outdoor use	Indoor & outdoor
Operating temperature range	-25°C to +40°C
Compatible bus brands	Solaris, Scania, Van Hool, Hess, Rampini
Number of charges installed/planned	20
Examples of implementation	<p>E-Bus Braunschweig: In Braunschweig, Germany, PRIMOVE completed its first PRIMOVE e-bus project for passenger operation, transforming a 12-kilometre section of the city's bus network into an eco-friendly electric route served by 12-metre and 18-metre PRIMOVE equipped e-buses.</p> <p>E-Bus Mannheim: In Mannheim, Germany, the commercial operation of fully electric buses – charged and powered by PRIMOVE – proves the system's suitability for everyday passenger services, even on demanding bus routes.</p> <p>E-Bus Berlin: Berlin is the first capital city to turn a complete bus line into an eco-friendly route using e-buses with the wireless BOMBARDIER PRIMOVE charging system and the compact PRIMOVE battery system.</p> <p>E-Bus Bruges: Clean, quiet and convenient, the PRIMOVE wireless charging system is perfectly suited for Bruges, Belgium, with its well preserved historic city centre attracting millions of tourists every year.</p> <p>E-Bus Södertälje: An electric hybrid bus equipped with Bombardier's innovative PRIMOVE inductive charging system is running in Södertälje, Sweden, making it the first municipality in Scandinavia to feature a wirelessly charged bus line.</p>

## COMPANY PROFILE

Ekoenergetyka-Polska is a supplier of high power charging infrastructure for electric vehicles. Since 2011 it has been supplying electric bus charging systems and is one of the leading companies in Europe in this domain. The company specialises in intelligent, customised charging solutions for full electrification of depots and bus lines.



QuickPOINT Mobile Charger



QuickPOINT Depot Charger

## CONTACT

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	quickPOINT Mobile Charger	quickPOINT Depot Charger
Product short description	20kW charger equipped with wheels, practical for depots, garages and demonstrations. The charger works within 200-800V range and can charge buses compatible with DIN 70121/ISO 15118. Lightweight - it weighs only 60kg - and easily transportable, it requires a simple 63A and thus can be used in almost any context.	QuickPOINT Depot Charger is a modular and flexible DC charger for bus depots - both its charging power and the casing can be flexible adjusted to suit the needs of a given bus depot. Operating within 200-800V range it can provide a bus with 40kW to 400kW of charging power. Equipped with up to four Combo 2 connectors it can charge up to 4 buses simultaneously. It is compatible with international charging standards and can be integrated both with pole- as well as bus-mounted pantograph. Depending on the needs the depot charging system can be scaled up and flexibly adjusted to the need of a given depot.
Suitable charging place	Depot charging	Depot charging
System	Conductive via Combo 2	Conductive via Combo 2
Max. output power range	20kW	20kW-250kW-400kW
Charging Standard	CCS/ Combo 2, Pantograph, Oppcharge	CCS/ Combo 2, Pantograph, Oppcharge
Indoor and/or Outdoor use	Indoor & outdoor	Indoor & outdoor
Operating temperature range	-25°C to +40°C	-25°C to +40°C
Compatible bus brands	Solaris Bus & Coach, VDL, Linkker Bus, Vossloh Electric, Ursus	
Number of charges installed/planned	Total deployed: +100/ Planned: +40	
Examples of implementation	Private depots (data confidential)	City of Innowroclaw in Poland deployed a two-connector, 80kW DC charger with basic intelligent charging functionality. The charger can either charge a single bus with 80kW or two vehicles with 40kW each. It is deployed in the bus depot and provides overnight charging to the city's first electric buses.



QuickPOINT City Charger



QuickPOINT Column Charger

Product name	quickPOINT City Charger	quickPOINT Column Charger	quickPOINT Pole Charger
<b>Product short description</b>	DC charger with modular power destined for bus stops and end of line that can charge an individual bus with up to 700kW. Intelligent power management functionality means it can power multiple pantographs and hence multiple vehicles at the same time, and its charging power can be modified depending on the need in a given moment. The charger follows international charging standards DIN 70121 and ISO 15118 and works within 200-800V range. It can be deployed in the open space near a bus stop, inside a building or underground.	QuickPOINT Column Charger is one of a kind DC e-bus opportunity charger, bringing together power electronics and charging pole into one device. With charging power of up to 400 kW it offers operators a charging station with 50% smaller footprint compared to chargers with separate charging mast, and an attractive design. It can integrate both types of pantographs and follows established communication standards for charging.	The only DC/DC e-bus opportunity charger that does not require any installation works, as it can be deployed directly on the tram traction pole. Small and lightweight, it offers charging power of up to 80kW and operates within voltage range of 200-800V. It follows international charging standards DIN 70121 and ISO 15118.
<b>Suitable charging place</b>	Opportunity charging	Opportunity charging	Opportunity charging
<b>System</b>	Conductive via bus or pole-mounted pantograph	Conductive via bus or pole-mounted pantograph	Conductive via bus or pole-mounted pantograph
<b>Max. output power range</b>	700kW	400kW	80kW
<b>Charging Standard</b>	CCS/ Combo 2, Pantograph, Oppcharge	Pantograph, OppCharge	Pantograph, OppCharge
<b>Indoor and/or Outdoor use</b>	Indoor & outdoor	Indoor & outdoor	Outdoor
<b>Operating temperature range</b>	-25°C to +40°C	-25°C to +40°C	-25°C to +40°C
<b>Compatible bus brands</b>			
<b>Number of charges installed/planned</b>	Total deployed: +100/ Planned: +40		
<b>Examples of implementation</b>	City of Tampere deployed 300kW opportunity charger together with Ekoenergetyka-designed and made charging mast holding a pantograph hood to serve its electric buses. The charger is operated by the public transport operator TKL and follows international charging standards for electric buses, meaning it can recharge any DIN 70121/ IEC 61851- 23/-24 compatible buses.	200kW quickPOINT Column Charger has been deployed in Warsaw on Spartanska street at the end of a bus line and will provide Warsaw electric buses with quick energy top ups during their daily operations. Thanks to its compact nature - the charger and charging mast in one device - its installation was much easier as only one foundation was required. Painted in the city colours, it is the first device of this kind in Europe.	80kW DC/DC opportunity charger has been hanged on a tram post on Pawia street in Kraków. It provides quick top ups via pantograph - deployed on a different tram post - to electric buses of the city. Thanks to its compact design and ability to hang in on a post the operator was able to deploy it in the city center, subject to the most stringent rules on urban architecture.

## COMPANY PROFILE

Heliox has over 30 years of professional power conversion experience and is present in the most demanding markets. Whether your e-bus operation deploys opportunity charging, depot charging or smart fleet charging, reliable charge infrastructure is crucial for your operations as a public transport operator. Heliox chargers are created with durability, reliability and maintainability in mind and serve your business case with +67% Faster Charge Power Curve Technology.

You benefit from optimised energy costs and the most efficient grid connection, with industry's highest charging efficiency (97%) and Heliox ZERO Reactive Current Technology. Keep your electric bus operations running with Heliox. If that is not enough, we also support you with charger care and connected services.

## CONTACT

**Company website:**  
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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	25kW CCS Fast DC MOBILE	2x30kW Fast DC Twin Charger	50kW Fast DC Charger
<b>Product short description</b>	Thanks to the highly compact dimensions, this mobile quick-charging station is particularly suitable for use in fleets, workshops or during driving events.	Charge any CCS-compatible set of two busses with up to 2 x 30kW. A fast and highly efficient solution for single vehicles or small fleet. With Heliox's Power Curve Technology, the bus at the depot is charged 67% quicker, whilst performing at industry's highest efficiency of 97%. Charger systems are future-proofed with V2G and smart grid functionality, and connect with a CCS-plug or alternatively with a pantograph, according to ISO 15118 / DIN70121 / IEC 61851. This secures all vehicle manufacturer compatibility.	Charge any CCS-compatible bus with up to 50kW. A fast and highly efficient solution for single vehicles or small fleets. With Heliox' Power Curve Technology the bus at the depot is charged 67% quicker, whilst performing at industry's highest efficiency 97%. Charger systems are future-proofed with V2G and smart grid functionality and connect with a CCS-plug and alternatively with a pantograph, according to ISO 15118 / DIN70121 / IEC 61851. This secures all vehicle manufacturer compatibility.
<b>Suitable charging place</b>	Depot charging	Depot charging	Depot charging
<b>System</b>	Conductive via connector CCS2	Conductive via a pole-mounted pantograph and conductive via bus-mounted pantograph and conductive via connector CCS2	Conductive via a pole-mounted pantograph and conductive via bus-mounted pantograph and conductive via connector CCS2
<b>Max. output power range</b>	25kW DC	2 x 30 kW DC parallel	50kW DC
<b>Charging Standard</b>	CCS	CCS and roof-mounted pantograph	CCS and roof-mounted pantograph
<b>Indoor and/or Outdoor use</b>	Indoor & outdoor	Indoor & outdoor	Indoor & outdoor
<b>Operating temperature range</b>	-20°C to 45°C	-30°C to 50°C	-30°C to 50°C
<b>Compatible bus brands</b>	All US and European bus manufacturers	All US and European bus manufacturers	All US and European bus manufacturers
<b>Number of charges installed/planned</b>	>250	>250	>250
<b>Examples of implementation</b>	Depot and workshop usage (Sweden, Germany, Netherlands, UK, Belgium)	Depot charging of opportunity-charged buses at multiple locations in Europe (Eindhoven, Amsterdam, Turkey, Turku, Espoo, Helsinki, Luxembourg, Köln, etc.)	Depot charging of opportunity-charged buses at multiple locations (Netherlands: Wadden-islands, 's-Hertogenbosch, Sweden, Finland: Turku, Helsinki, Germany: Köln, etc.)

Product name	150kW Fast DC Charger	300kW Opportunity Charger	450kW Opportunity Charger	600kW Opportunity Charger
<b>Product short description</b>	Charge any CCS compatible bus with up to 150kW. A fast and high-efficiency solution for single vehicles or small fleet. With Heliox' Power Curve Technology the bus at the depot is 67% charged faster, whilst performing at industry's highest efficiency 97%. Charger systems are prepared for the future with V2G and Smart Grid functionality and connect with CCS-plug and alternatively with pantograph according to ISO 15118 / DIN70121 / IEC 61851. This secures all vehicle manufacturer compatibility.	Heliox Power Curve Technology results in ultrashort charge sessions of 2-5 minutes of opportunity charging at maximum 300kW.	Heliox Power Curve Technology results in ultrashort charge sessions of 2-4 minutes of opportunity charging at maximum 450kW.	Future super high power charging system for Opportunity Charged Bus with ultra short overlay/charging times 1 to 2 minutes.
<b>Suitable charging place</b>	Depot charging	Opportunity charging (at terminal or selected bus stops)	Opportunity charging (at terminal or selected bus stops)	Opportunity charging (at terminal or selected bus stops)
<b>System</b>	Conductive via pole-mounted pantograph, conductive via bus-mounted pantograph and conductive via connector CCS2	Conductive via pole-mounted pantograph and conductive via bus-mounted pantograph	Conductive via pole-mounted pantograph and conductive via bus-mounted pantograph	Conductive via pole-mounted pantograph and conductive via bus-mounted pantograph
<b>Max. output power range</b>	150kW DC	300kW DC	450kW DC	600kW DC
<b>Charging Standard</b>	CCS, roof-mounted pantograph and Oppcharge	Roof-mounted pantograph and Oppcharge	Roof-mounted pantograph and Oppcharge	Roof-mounted pantograph and Oppcharge
<b>Indoor and/or Outdoor use</b>	Indoor & outdoor	Indoor & outdoor	Indoor & outdoor	Indoor & outdoor
<b>Operating temperature range</b>	-30°C to 50 °C	-30°C to 50 °C	-30°C to 50 °C	-30°C to 50 °C
<b>Compatible bus brands</b>	All US and European bus manufacturers	All US and European bus manufacturers	All US and European bus manufacturers	All US and European bus manufacturers
<b>Number of charges installed/planned</b>	>250	>150	>150	>150
<b>Examples of implementation</b>	Depot charging of Opportunity Charged Buses at multiple locations (Germany, Netherlands, UK, Belgium)	Large scale implemented system in Opportunity Charged Bus projects at multiple locations (Netherlands: Eindhoven, Wadden-islands, s-Hertogenbosch, Turkey, Sweden, Finland: Turku, Helsinki, Luxembourg, Germany: Köln, Kaldenkirchen, etc.)	Large scale implemented system in Opportunity Charged Bus projects at multiple locations (Eindhoven, Amsterdam, Turkey, Espoo, Singapore, etc.)	Future super high power charging system for Opportunity Charged Bus with ultra short overlay/charging time. Location confidential.

## COMPANY PROFILE

For 60 years, Jema Energy has been designing and manufacturing Static Power Converters for a variety of sectors, including power plants, oil and gas, plasma physics, particle accelerators, railways and renewable energy. We are customer-orientated, developing bespoke systems and solutions that meet specific requirements of each project. These are innovative solutions with a high technological content. The aim of Jema Energy is to be a leader in providing customised solutions based on power electronic systems. The company is part of Grupo Irizar (3,500 employees and an annual turnover of € 500 M). It is ISO-9001, ISO-140001 and OHSAS-18001 certified.

Activities related to electrical systems for buses include charging infrastructure for electric vehicles (overnight charge stations, opportunity charge stations and central unit controls to manage the charging of a fleet).



I2E\_DPI



I2E\_DPO



I2E\_OC

## CONTACT

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	I2E_DPI	I2E_DPO	I2E_OC
<b>Product short description</b>	IGBT based topology Voltage: 400Vac, 3Ph+E (+10%, -15%) Frequency: 50/60Hz DC Voltage Range: 410...900V 1900mm x 800mm x 800mm, 970kg, Galvanic isolation, Air forced Monitoring capability	IGBT based topology Voltage: 400Vac, 3Ph+E (+10%, -15%) Frequency: 50/60Hz DC Voltage Range: 410...900V 1850mm x 1200mm x 900mm, 1000kg Galvanic isolation, Air forced Monitoring capability	IGBT based topology Voltage: 400Vac, 3Ph + E (+10%, -15%) Frequency: 50/60Hz DC Voltage Range: 400...850V 2620mm x 6100mm x 2350mm, 6000kg Galvanic isolation, Air forced Monitoring capability Full equipped container
<b>Suitable charging place</b>	Depot charging	Depot charging	Opportunity charging (at terminal or selected bus stops)
<b>System</b>	Conductive via cable or pantograph	Conductive via cable or pantograph	Conductive via pantograph
<b>Max. output power range</b>	100kW DC	80kW DC	500kW DC
<b>Charging Standard</b>	CCS, IEC 61851, DIN70121, ISO 15118, OCCP	CCS, IEC 61851, DIN70121, ISO 15118, OCCP	CCS, IEC 61851, DIN70121, ISO 15118, OCCP
<b>Indoor and/or Outdoor use</b>	Indoor	Outdoor	Outdoor
<b>Operating temperature range</b>	-5°C to +45°C	-20°C to +50°C	-20°C to +50°C
<b>Compatible bus brands</b>	Any complying with DIN70121/ ISO 15118	Any complying with DIN70121/ ISO 15118	Any complying with DIN70121/ ISO 15118
<b>Number of charges installed/planned</b>	20	50	6
<b>Examples of implementation</b>	San Sebastian, Barcelona, Aduna, London, Marseille	Marseille, Madrid, Bilbao, Barcelona, Aduna	San Sebastian, Biarritz, Tarragona

## COMPANY PROFILE

Powerdale develops charging infrastructure and web application for the electromobility. We have recently installed several charging systems in Belgium and Luxemburg. Our key strengths is to combine electromobility and energy management solutions. By doing so, we enable our customer to charge the electric busses when it is most optimal to do so.



Nexxtender Advance



Nexxtender Advance Mobile

## CONTACT

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	Nexxtender Advance	Nexxtender Advance Mobile
<b>Product short description</b>	<p>The Nexxtender Advance is an effective and complete smart charging station. With a charging power from 3,7 kW up to 22 kW, the Nexxtender integrates electro-mobility into energy management.</p> <p>Thanks to its various communication features, the Nexxtender Advance makes access control, energy tracking, specific charging scenarios very easy to the user.</p> <p>The Nexxtender Advance communicates with OCPP platforms, making remote control and billing accessible to fleet managers.</p>	<p>You do not always have a charging station at your disposal and you want to keep track of your electromobility consumption, the Nexxtender Mobile is made for you.</p> <p>Plug one end in the wall and the other in the bus, the bus is charging. The consumption data are transmitted to the central system as if it was a charging station.</p> <p>The Nexxtender Mobile uses a new and low cost communication technology: Sigfox.</p>
<b>Suitable charging place</b>	Depot charging	Depot charging during maintenance activities
<b>System</b>	Conductive via cable T2	Conductive via cable T2
<b>Max. output power range</b>	22kW AC	3,7kW AC
<b>Charging Standard</b>	T2	T2
<b>Indoor and/or Outdoor use</b>	Indoor & outdoor use	Indoor & outdoor use
<b>Operating temperature range</b>	-20°C to +70°C	-20°C to +70°C
<b>Compatible bus brands</b>	Any that respect OCPP	Any that respect OCPP
<b>Number of charges installed/planned</b>	124	N/A
<b>Examples of implementation</b>	Ville de Luxemburg, Sales Lentz (Luxemburg), TEC Namur, TEC Charleroi	In testing at Ville de Luxemburg

## COMPANY PROFILE

The Schunk Group is an international technology group employing around 8,150 people in 29 countries worldwide. The Group has bundled its expertise in the development, manufacturing and application of carbon and ceramic solutions within the Schunk Carbon Technology Division. As a developer and supplier of the trend-setting Schunk Smart Charging system for electric vehicles, Schunk Bahn- und Industrietechnik (SBI) has developed systems for electric buses based on pantograph technology and other heavy duty applications. Therefore, the company is bringing its years of experience in the field of current-collector design for the rail sector to the street, opening up new market segments with great potential. With its groundbreaking Schunk Smart Charging system, SBI is a driving force behind the worldwide development of electrical mobility. This system guarantees the sustainable, reliable and rapid charging of the batteries installed in electric vehicles.



SchUNK Smart Charging SLS100



SchUNK Smart Charging SLS201



SchUNK Smart Charging SLS102

## CONTACT

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	SchUNK Smart Charging SLS100	SchUNK Smart Charging SLS201
<b>Product short description</b>	<p>The Schunk Smart Charging SLS100 is a 2-Pole Roof Mounted Pantograph which is designed for charging of Battery driven Vehicles with an insulated 2-Pole Contact head.</p> <p>The current rail interface of the pantograph allows compensation of parking tolerance and different angles of the bus as well as kneeling during the charging process.</p> <p>The contacts (positive, negative) set up the contact to trolley utility power lines allowing the current transmission from power lines to the energy storage on the bus in seconds.</p> <p>This design allows an extreme compact and lightweight arrangement of the charging system with very short charging cycles.</p>	<p>The SLS 201 inverted solution from Schunk Smart Charging is designed as a half-scissor pantograph with an insulated 4-pole contact head.</p> <p>The flexible contact head allows compensation of the parking tolerance of the vehicle as well as kneeling or other movements of the vehicle at charging stops due to the spring loaded connection.</p> <p>The contacts (positive, negative, PE, control pilot) set up the contact to a counterpart on the vehicle roof. A variety of contact counterparts are available for different applications. The control pilot guarantees a permanent safe current transmission during the whole charging process. This design allows the use of different sizes of vehicles (single deck and double deck bus) using the same pantograph and charging station.</p>
<b>Suitable charging place</b>	Depot charging, opportunity charging (at terminal or selected bus stops)	Depot charging, opportunity charging (at terminal or selected bus stops)
<b>System</b>	Conductive via bus-mounted pantograph	Conductive via pole-mounted pantograph
<b>Max. output power range</b>	Up to 350kW	Up to 450kW
<b>Charging Standard</b>	-	OppCharge and CCS
<b>Indoor and/or Outdoor use</b>	Indoor and Outdoor	Indoor and Outdoor
<b>Operating temperature range</b>	-30°C to +65°C	-30°C to +65°C
<b>Compatible bus brands</b>	Any	Any
<b>Number of charges installed/planned</b>	1	10
<b>Examples of implementation</b>	Prague (1 x Bus)	Differdange (4xBus and 3 x Pantographs) Gothenberg (6x Bus and 2 x Pantographs) Hamburg (6 x Bus and 2 x Pantographs) Paris (10 x Bus and 1 x Pantograph) Turku (6 x Bus and 2 x Pantograph)

Product name	Schunk Smart Charging SLS102	Schunk Smart Charging SLS102 high power Version
<b>Product short description</b>	<p>The Schunk Smart Charging SLS102 is a roof mounted pantograph that is designed for charging battery-driven vehicles with an insulated 4-pole contact head as per CCS-4 mode communication (IEC 61851-23).</p> <p>The flexible contact head mounted on a linear bearing allows compensation of parking tolerance and different angles of the bus as well as kneeling during the charging process.</p> <p>The contacts (positive, negative, PE, control pilot) set up the contact to the charging station allowing the current transmission from charging station to the energy storage on the bus in seconds. The control pilot guarantees a permanent safe current transmission during the whole charging process.</p> <p>This design allows an extreme compact and light-weight arrangement of the charging system with very short charging cycles.</p>	<p>The Schunk Smart Charging SLS 102.1 is a roof mounted pantograph that is designed for charging battery-driven Vehicles with an insulated 4-pole contact head as per CCS-4 mode communication (IEC 61851-23).</p> <p>The flexible contact head mounted on a linear bearing allows compensation of parking tolerance and different angles of the bus as well as kneeling during the charging process.</p> <p>The contacts (positive, negative, PE, control pilot) set up the contact to the charging station allowing the current transmission from charging station to the energy storage on the bus in seconds. The control pilot guarantees a permanent safe current transmission during the whole charging process.</p> <p>This design allows an extreme compact and light-weight arrangement of the charging system with very short charging cycles.</p>
<b>Suitable charging place</b>	Depot charging, opportunity charging (at terminal or selected bus stops)	Depot charging, opportunity charging (at terminal or selected bus stops)
<b>System</b>	Conductive via bus-mounted pantograph	Conductive via bus-mounted pantograph
<b>Max. output power range</b>	Up to 500kW DC	Up to 1MW DC
<b>Charging Standard</b>	OppCharge and CCS	OppCharge and CCS
<b>Indoor and/or Outdoor use</b>	Indoor and Outdoor	Indoor and Outdoor
<b>Operating temperature range</b>	-30°C to +65°C	-30°C to +65°C
<b>Compatible bus brands</b>	Any	Any
<b>Number of charges installed/planned</b>	179	100
<b>Examples of implementation</b>	Barcelona (2 x Bus) Copenhagen (2 x Bus) Den Bosch (10 x Bus) Dresden (1 x Bus) Eindhoven (43 x Bus) Espoo (2 x Bus) Graz (2 x Bus) Groningen (10 x Bus) Hannover (3 x Bus) Helsinki (6 x Bus) Jaworzno (16 x Bus) Köln (8 x Bus) Krakau (4 x Bus) + Krakau (20 x Bus) Leipzig (1 x Bus) Maastricht (4 x Bus) Münster (4 x Bus) Oberhausen (2 x Bus) Tampere (4 x Bus) Venlo (12x Bus) Waddeneilanden (10x Bus) Warsaw (11 x Bus)	Amsterdam (100x Bus)

## COMPANY PROFILE

Siemens is a worldwide leaders in electric products and solutions.



Siemens HPC



Siemens RAVE  
Plug-in charger

## CONTACT

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## CHARGING SYSTEM - GENERAL INFORMATION

Product name	Siemens HPC (High Power Charger) with top-down pantograph	Siemens RAVE Plug-in charger
<b>Product short description</b>	The Siemens HPC is a high power charging system for buses in highly-frequented city applications. For charging, the bus stops below a charging mast or other possible location (e.g. roof) where the pantograph is mounted. Once a connection between bus and charging station is established, the charging procedure starts. The bus only has contact rails mounted at the roof.	Plug-in charger, with 30-150kW charging power. Supported charging standards: CCS and GB/T
<b>Suitable charging place</b>	Opportunity charging (at terminal or selected bus stops), depot charging is possible (conditions regarding possible charging time, space and grid load have to be considered)	Depot charging, opportunity charging (at terminal or selected bus stops) are possible (depending on operational conditions)
<b>System</b>	Conductive via pole-mounted pantograph	Conductive via cable (CCS Type 2 or GB/T plug possible)
<b>Max. output power range</b>	300kW DC per HPC station in Hamburg (450kW realised in other projects; 600kW in planning)	150kW DC
<b>Charging Standard</b>	OppCharge	CCS, GB/T
<b>Indoor and/or Outdoor use</b>	Indoor and Outdoor	Indoor and Outdoor
<b>Operating temperature range</b>	-35°C to +45°C	-25°C to +50°C
<b>Compatible bus brands</b>	In operation Volvo and Solaris others are coming soon	All buses with CCS and/or GB/T support
<b>Number of charges installed/planned</b>	15	Approx. 20
<b>Examples of implementation</b>	In Hamburg, four charging stations are implemented on the so-called 'Innovation route 109' between central station and Alsterdorf. At both terminal stations, two charging points with 300kW each are installed. The charging time there is approx. 6 minutes.	Siemens plug-in chargers are in operation in different applications. They started with initial projects at Stuttgart airport; there are now increasing numbers of depot applications in project execution.

# ZeEUS AT A GLANCE

Coordinated by UITP, ZeEUS is the most important EU-funded project, testing almost hundred series and pre-series high capacity battery e-buses across Europe. The project has proved that high capacity electric buses are a viable technology that can effectively contribute to reducing air and noise pollution in our cities.

During ZeEUS, several electric powertrain technologies are being tested under different operational conditions and evaluated with a common methodology, not with the purpose of comparing them, but to learn about their operational aspects.

The project focuses on the policy, economical, operational and technological aspects that solve the challenges faced during wider electric bus deployment. The ultimate objective of the project is to create a comprehensive set of tools to support decision-making through all the various steps for the deployment of electric bus systems, from vehicle choice to procurement and successful operation.



**1,458,161**  
km

The distance travelled by ZeEUS buses running in pure electric mode<sup>1</sup>



**523,998**  
litres<sup>2</sup>

The amount of diesel fuel saved by the ZeEUS bus project<sup>1</sup>



**751,6**  
tons<sup>3</sup>

The amount of carbon dioxide emissions prevented by the ZeEUS bus project<sup>1</sup>

<sup>1</sup> Figures coming from 7 cities for the period September 2014 - August 2017

<sup>2</sup> Assuming 38l/100 km

<sup>3</sup> ISO 16258 factor for Diesel and GaBi factor for EU electricity grid mix (2014)

# ZeEUS CITIES MAP

## CORE CITY

Cities operating electric buses within the ZeEUS project

## OBSERVED CITY

Cities operating electric buses outside the ZeEUS project

## COMING SOON

Cities with upcoming plans for the deployment of electric buses



### Austria

- Graz
- Klagenfurt

### Belarus

- Mogilev

### Belgium

- Antwerp
- Bruges
- Brussels
- Charlerloi
- Ghent
- Leuven
- Namur
- Tienen

### Bulgaria

- Sofia

### Czech Republic

- České Budějovice
- Frýdek-Místek
- Haviřov
- Hradec Králové
- Hranice
- Karviná
- Krnov
- Olomouc
- Ostrava
- Plzen
- Prague
- Trinec

### Denmark

- Copenhagen

### Estonia

- Tallinn

### Finland

- Espoo
- Helsinki
- Tampere
- Turku

### France

- Aix-en-Provence
- Amiens
- Argenteuil
- Athis-Mons
- Aubervilliers

- Bayonne
- Buc
- Castres-Mazamet
- Frontignan
- Gaillac
- Grenoble
- Le Havre
- Marseille
- Nantes
- Nice Airport
- Paris
- Périgueux
- Rennes
- Rouen
- Sète
- Strasbourg
- Versailles

### Germany

- Aachen
- Aalen
- Bad Neustadt an der Saale
- Bad Langensalza
- Berlin
- Bingen am Rhein
- Bonn
- Borkum
- Bottrop
- Braunschweig
- Bremen
- Cologne
- Darmstadt
- Dresden
- Eberswalde
- Essen
- Frankfurt am Main
- Fulda
- Fürth
- Göttingen
- Hamburg
- Hanover
- Lahr
- Leipzig
- Lübeck
- Mannheim
- Munich
- Münster
- Neuss
- Nuremberg
- Oberhausen
- Öhringen
- Osnabrück

- Solingen
- Stuttgart Airport
- Trier
- Wiesbaden
- Wolfsburg

### Hungary

- Budapest
- Pecs
- Szeged

### Iceland

- Reykjavík

### Israel

- Afula
- Modi'in-Maccabim-Re'ut
- Netanya
- Tel Aviv

### Italy

- Cagliari
- Bergamo
- Bolzano
- Campobasso
- Milan
- Novara
- Turin

### Latvia

- Rēzekne
- Riga

### Luxembourg

- Echternach
- Luxembourg

### Macedonia

- Skopje

### Moldova

- Chişinău

### Netherlands

- Almere
- Amsterdam
- Arnhem
- Assen
- Groningen
- Haarlem
- Rotterdam

- Schiemonnikoog
- Schiphol Airport
- 's-Hertogenbosch
- Utrecht
- Zuid-Oost-Brabant

### Norway

- Drammen
- Kristiansand
- Lillehammer
- Oslo
- Stavanger
- Tromsø
- Trondheim

### Poland

- Chodzież
- Gdynia
- Inowroclaw
- Jaworzno
- Katowice
- Kraków
- Lodz
- Lublin
- Ostróda
- Ostrów Wielkopolski
- Polkowice
- Rzeszów
- Sosnowiec
- Szczecinek
- Warsaw
- Września
- Zielona Góra

### Portugal

- Braga
- Lisbon
- Porto

### Romania

- Bucharest
- Cluj-Napoca

### Serbia

- Belgrade

### Slovakia

- Bratislava
- Košice
- Nove Zamky
- Šafa
- Žilina

### Spain

- Azuqueca de Henares
- Barcelona
- Bilbao
- Donostia / San Sebastian
- Madrid
- Valladolid
- Valencia

### Sweden

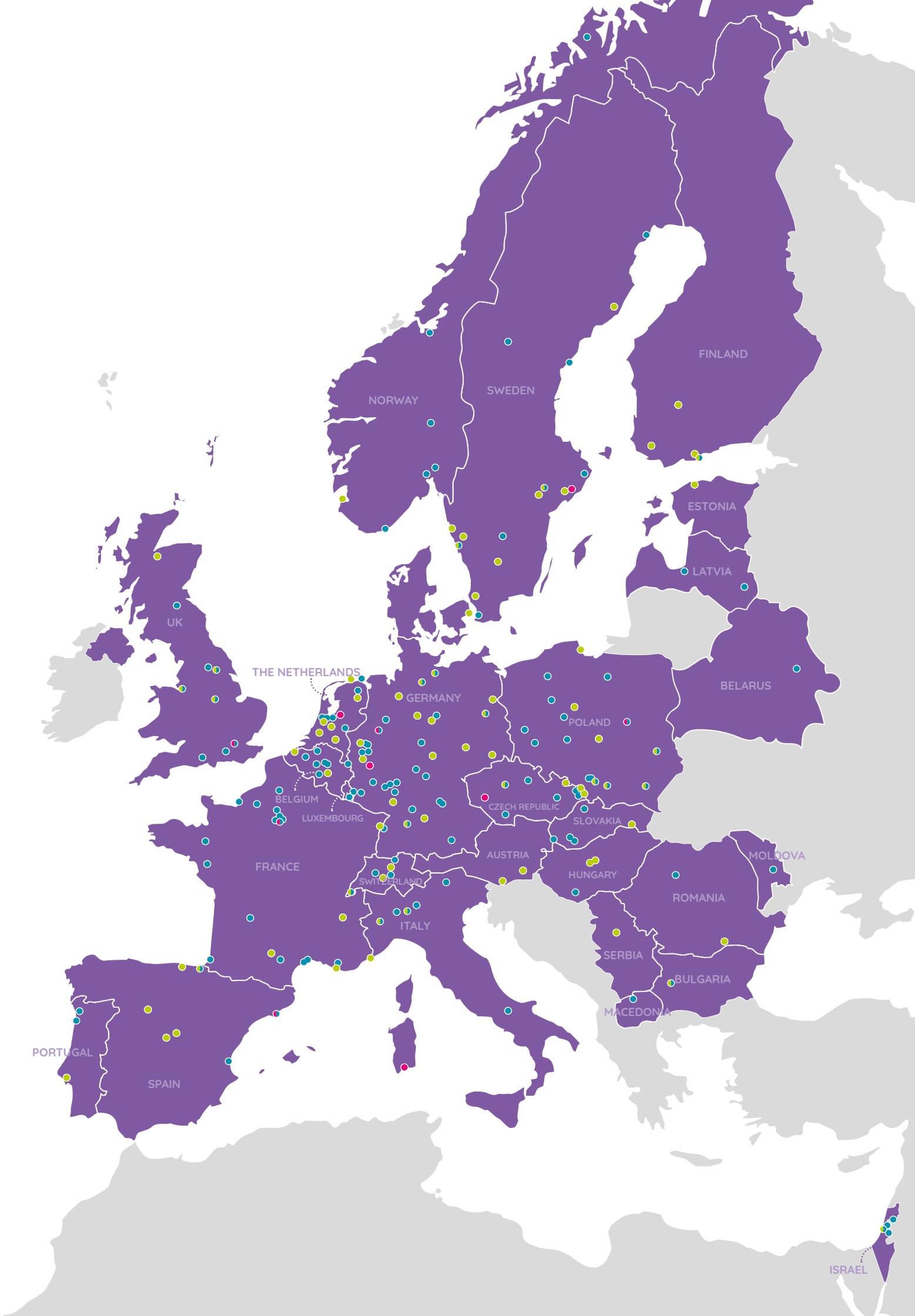
- Ale Municipality
- Ängelholm
- Eskilstuna
- Gothenburg
- Härnösand
- Luleå
- Malmö
- Norrköping
- Orust
- Östersund
- Södertälje
- Stockholm
- Umeå
- Värnamo
- Västerås
- Visingsö

### Switzerland

- Bern
- Geneva
- Interlaken
- Lucerne
- Obwalden
- Zürich

### United Kingdom

- Edinburgh
- Guildford
- Harrogate
- Inverness
- Liverpool
- London
- Manchester
- Nottingham
- Salisbury
- York





# ZeEUS *in brief*

- Scope** 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.
- Duration** Nov 2013 – April 2018 [ 54 Months ]
- Budget** 22.5m EUR [ 13.5 EU Funding ]
- Coordinator** UITP, the International Association of Public Transport

## ZeEUS

Zero Emission Urban Bus System

### Partners



[www.zeeus.eu](http://www.zeeus.eu)



The ZeEUS project is coordinated by UITP. ZeEUS is co-funded by the European Commission under the 7th Research & Innovation Framework Programme, Mobility & Transport Directorate General under grant agreement n° 605485. The ZeEUS project has been launched by the European Commission in the frame of the European Green Vehicle and Smart Cities & Communities.

