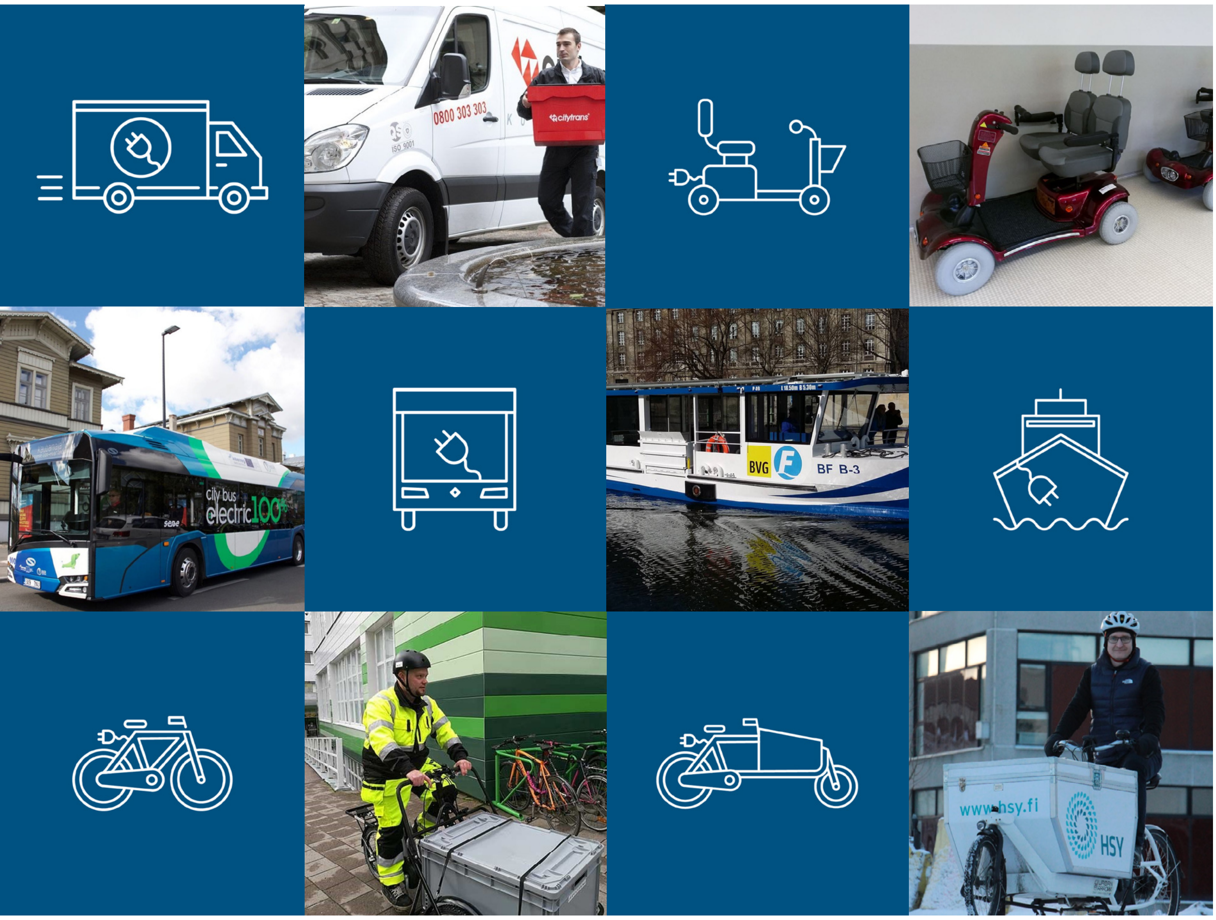
The BSR electric Roadmap

Fostering E-mobility Solutions in Urban Areas in the Baltic Sea Region



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Foreword

Over the last three years (2017-2020) the BSR electric project has been a productive platform to exchange on and develop ideas for implementing sustainable e-mobility solutions across urban areas in the Baltic Sea Region. The common challenges all partner countries are facing these days are linked to the EU's ambitious targets for the reduction of transport sector emissions and the overall aim to phase out conventionally fuelled vehicles in urban transport by 2050. E-vehicles produce significantly less CO_2 and noise emissions and can therefore be considered a valuable means of sustainable transport in an urban context. While national promotion strategies for e-mobility have primarily focused on individual car use, other promising applications, such as electrification of city logistics, e-bikes, e-buses, e-scooters and e-ferries have received less attention. Experience with practical implementation of these multiple applications of e-mobility solutions in BSR cities was still limited at the start of the project and moving out of a project mindset into full electric operations in transport system is an ongoing challenge.

Accordingly, we were honoured and privileged to have received funding by the EU's INTERREG VB BSR Region Programme and, with this publication, invite you to explore the outcomes of the BSR electric project. This roadmap document synthesizes BSR electric project's results which are put into a larger context: The BSR roadmap is one of the key outputs and provides a compact information directory for urban e-mobility stakeholders, especially decision-makers. It includes a brief presentation of the BSR electric project and an overview of the state-of-the-art of e-mobility applications in the Baltic Sea Region. Short profiles of the project's various use cases give detailed insights into the transnational value, key results and lessons learned from real-life implementation. In the end, an overview of existing challenges and promising approaches as well as a depiction of perspectives and potentials for e-mobility solutions serve as a basis for developing conclusions and recommendations for fostering e-mobility solutions in urban areas in the Baltic Sea Region and beyond.

Thanks to the stimulating Interreg Baltic Sea Region programme, whose financial support is herewith gratefully acknowledged and the gainful expertise provided by the multi-disciplinary BSR electric consortium, the utilisation of e-mobility in urban transport systems is taking a step forward.

Enjoy the read!

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About the BSR electric project

BSR electric (10/2017-9/2020) aimed to enhance the utilisation of e-mobility in urban transport systems around the Baltic Sea Region. The focus was explicitly laid on demonstrating potential applications of various types of to date less utilised urban e-mobility solutions, i.e. excluding e-cars. Its results provide guidance to public authorities, companies, transport planners and operators who want to integrate e-mobility into their urban transport strategies. The project outputs serve to help these stakeholders making informed decisions on how and where to plan for and invest in e-mobility. In the long term, BSR electric thereby contributes to support the reduction of CO_2 emissions as well as to the improvement of living conditions in urban areas that increasingly suffer from traffic-related air and noise pollution.

The BSR electric project was initiated at the right time, as real-life experiences with actual implementation and integration of the featured e-mobility solutions into existing BSR cities and their urban transport systems were still limited. Starting from an empirically grounded baseline, the project partners explored the technical state-of-the-art, status quo and potentials of selected e-mobility solutions in the partner countries.

This preparatory phase was followed by demonstration actions (seven use cases) in the involved cities, each of which resulted in recommendations for planning and implementation that may lead to further replication and upscaling. BSR electric focuses specifically on the following solutions:

- Urban logistics: Electric delivery vans and trucks that could greatly reduce the CO_2 and noise emissions of the urban logistics sector;
- E-logistics: e-mobility solutions that could replace cars in inner-city logistics in a city-owned company with the aim to optimize maintenance and logistic routes;
- E-bikes (rented/owned) that can be used by commuters traveling the last mile to their workplace or for business trips in inner cities, or as a replacement for families´ cars;
- E-buses to make public transport even more environmentally friendly if routes, charging infrastructure and operational routines are planned and designed effectively;
- E-scooters to increase the accessibility of public places such as cemeteries and hospitals for people with impaired mobility, thereby strengthening social inclusion;
- E-ferries and water taxis to complement public transport systems in the many coastal cities of the Baltic Sea Region.

Through building mutual learning partnerships and organising joint webinars, study visits and international capacity building seminars, the consortium ensured a continuous flow of experiences and know-how between the involved partners as well as with experts beyond the partnership.

Ultimately, the key learnings of all these activities fed into theme-specific recommendations, an online learning module for urban transport stakeholders as well as this "Baltic Sea Region Roadmap for Urban E-mobility".

CAPACITY BUILDING

Publicly available webinars by experts to educate and update the audience on the latest developments in implementation of e-mobility.

webinars | publicly accessible | public events

E-LEARNING

A course to learn policy implementation along with latest research in e-mobility for decision makers and researchers alike.

interactive | podcasts | networking group | open source

POTENTIAL ANALYSIS

Stakeholder survey and Baltic Sea regional analysis for understanding the scope and relevance of existing e-mobility solutions, public data base of current e-mobility implementations.

8 baltic sea countries | open database of existing products and solutions

THEME SPECIFIC RECOMMENDATIONS

Checklists of important activities and potential pitfalls to consider for successfully implementing an e-mobility solution, gathered from real world experiences from the BSR electric use cases.

implementation | theme specific recommendations related to planning | best practice checklists

Executive summary

Urban areas are vital to the economic development of the Baltic Sea Region (BSR). At the same time, cities are also responsible for much of Europe's greenhouse gas emissions. The EU's targets for the reduction of transport emissions and the aim to phase out conventionally fuelled vehicles in urban transport by 2050 constitute a common challenge for BSR countries. E-vehicles produce significantly less emissions, so they are an ideal means of transport in an urban context, i.e. due to the relatively short distances. While national e-mobility strategies primarily focus on individual car use, other potential applications have received less attention. Concurrently among many decision-makers, the know-how of e-mobility and its potential in the urban context is still fragmented, indicating weak institutional capacities to address matters related to the electrification of urban transport. To generate the know-how and precedence needed for sustainable investment decisions, BSR electric offers assessments of user acceptance, economic viability and technical implementation barriers. These assessments are based on real-life testing and allowed for mutual learning between cities, both within and beyond the partnership. With its use cases on themes such as urban freight logistics, e-vehicles in public transport or e-bicycles and electric ferries in urban transport systems, the project developed a set of good practices demonstrating the potential of e-mobility in urban areas.

The objective of this roadmap is to introduce the reader to the key factors shaping the decision-making on investments into e-mobility solutions and the development of sustainable and cost-effective operation concepts. Against this background this roadmap is divided into four parts:

1) Introduction to the thematic of e-mobility solutions in urban areas and sustainable mobility concepts in times of climate change;

2) Presentation and analysis of potential e-mobility applications tested within the BSR electric project;

3) Showcase further inspiring sustainable mobility projects;

4) Conclusions on e-mobility solutions in urban areas in the Baltic Sea Region.

During the BSR electric project, it becomes clear that there is still great potential for the expansion of the current usage of e-mobility solutions in the BSR and the EU. The implementation of e-mobility solutions is a complex process calling for the need to include all relevant as well as diverse stakeholders, dimensions and sectors. It is not only about individual car usage but - as BSR electric shows - other modes of transportation should be considered too. Overall, this roadmap seeks to inspire the reader with proven examples of sustainable mobility solutions and allows to enter into a dialogue with the project partners who have implemented use cases.

Find out more: https://www.bsr-electric.eu/results

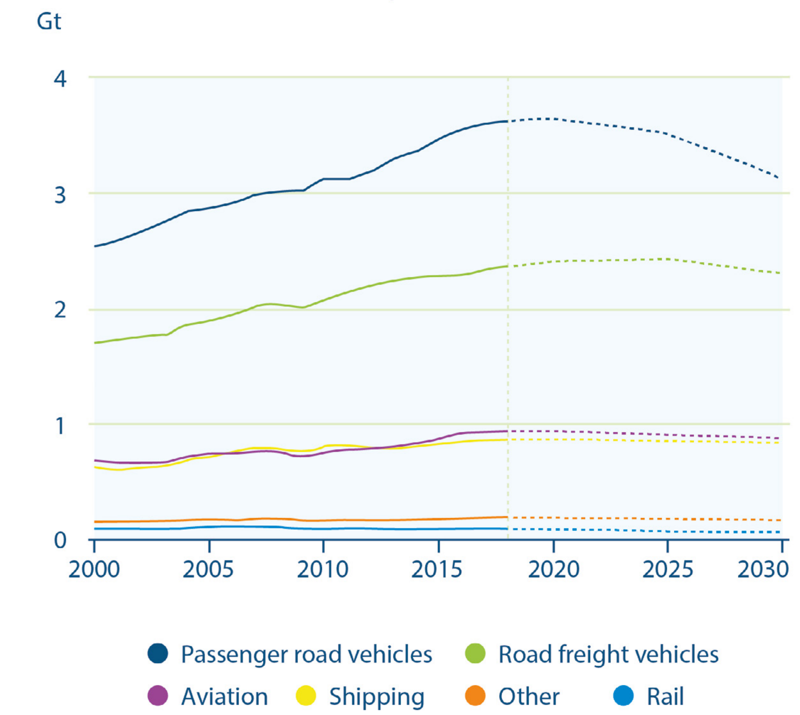
1 | Fostering e-mobility solutions in urban areas in the Baltic Sea Region

1.1 | Sustainable mobility in times of climate change

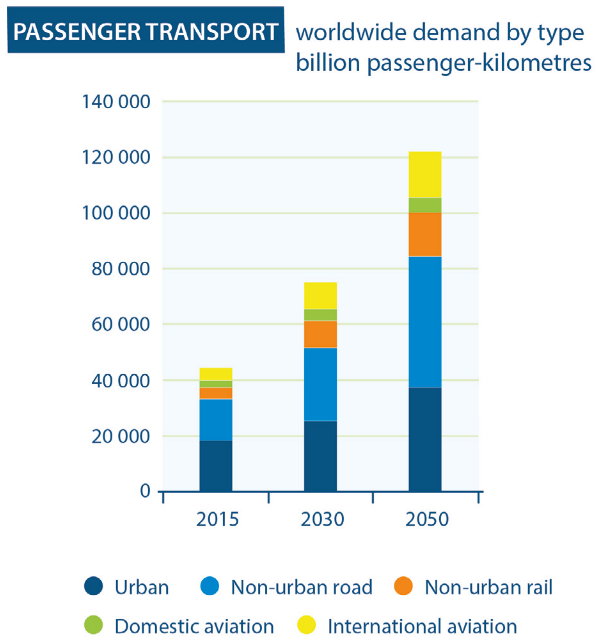
Climate change is one of the most pressing transformational challenges of the twenty-first century and accordingly picked up by main policy strategies throughout the world and the EU. With the settlement of the Paris Agreement in 2015 in total 195 countries worldwide agreed for the first time on a general but legally binding global action plan to limit global warming to well below 2°C (preferably 1.5°C) above pre-industrial levels. To achieve this long-term goal each country committed to draw up ambitious nationally determined contributions with stricter targets every five years if scientific evidence indicates needed adjustments.

The level or rather the reduction of greenhouse gas (GHG) emissions is the benchmark against which the nation-states must evaluate their contributions and mitigation actions. Limiting global warming requires limiting the total cumulative global anthropogenic emissions of CO_2 since the pre-industrial period, that is, staying within a total carbon budget. While looking at current statistics on a global level, it becomes clear that little time is left for decision-makers to take action. The annual ZERO IN report by the CONSTRAIN project (2019), EU-funded by Horizon 2020, states that from the start of 2020, the atmosphere can absorb no more than 985 gigatonnes (Gt) of CO_2 if we are to keep the 2°C threshold with a 66% likelihood. To limit warming to 1.5°C with a 66% probability, it is reduced to 235 Gt CO_2. However, since around 42 Gt of CO_2 is emitted globally every year (IPCC, 2018), this remaining carbon budget is expected to be used up in the next couple of years. But some trends offer reasons for hope. For

TRANSPORT SECTOR CO_2 emissions by mode in the Sustainable Development Scenario, 2000-2030



Source: IEA 2020, adapted



Source: ITF 2019, adapted

example, the global energy-related CO_2 emissions flattened in 2019 at around 33 Gt, following two years of increases (IEA, 2020b). This is attributable to a sharp decline in CO_2 emissions from the power sector in advanced economies thanks also to the expanding role of sustainable energy production and the use of renewable resources.

The transition to renewables in the power sector and its approved positive impact on greenhouse gas emissions could trigger other sectors to follow. In particular, the transport sector has great potential to continue or even accelerate this positive trend. On a global level, transportation accounts for a quarter of the carbon dioxide emissions (IEA, 2020c). While emissions from shipping and aviation continue to rise, the biggest impact derives from road transport - cars, trucks, buses and two- and three-wheelers - accounting for nearly three-quarters of transport CO_2 emissions (see figure p. 9 „Transport sector CO_2 emissions by mode in the Sustainable Development Scenario, 2000-2030").

Furthermore, the demand for transport is expected to rise. As the global population continues to expand from currently 7.8 billion people (as of January 2020) to 8.5 billion by 2030 and 9.7 billion by 2050 (UN, 2019a), freight and passenger mobility demand will grow respectively. This counts in particular for urban areas as the global population residing in city regions is expected to rise to 68% (UN, 2019b). Increasing sub-urbanisation in the wake of expanding urban populations will further boost the demand for private, public and commercial transportation modes and related infrastructures.

1.2 | Urban transport sector - key to zero-emission

It is clear that the transportation sector and in particular urban transport systems will play an important role in reaching the goals set out by the Paris Agreement. The implementation of sustainable mobility concepts including e-mobility are key to reduce GHG emissions and to phase out conventionally fuelled modes of transportation. This is also recognised by current EU policies such as the European Green Deal defining "cleaner, cheaper and healthier forms of private and public transport" as one of the main action fields to reach zero GHG emissions in Europe by 2050 (EC, 2019). Although cities and regions and respective authorities are seen as the main actors to bring the European Green Deal off the ground (CoR, 2020), and although the EU strongly recommends its concept of Sustainable Urban Mobility Plans (SUMPs) as a guidance for cities to initiate planning towards sustainable mobility, regional policies such as the EU Strategy for the Baltic Sea region still focus on a rather macro-regional level emphasizing transnational connectivity and long-distance transport corridors to foster trade and international exchange of knowledge and services (Eltis, 2019; EC, 2017).

However, these policies do not directly address urban sustainable mobility. The BSR electric project suggests practical solutions to fill this perceived gap in the strategy by providing a set of real-life examples that can enhance the role of e-mobility in urban transport systems; concrete results and lessons learned may be replicable and transferrable throughout the BSR, thereby contributing to upscaling sustainable mobility solutions on urban roads and waterways, i.e. helping to meet the ambitious CO_2 emission targets of the countries within the region and, in the end, improving quality of life on local (city) level.

"In Gothenburg, ElectriCity is an arena for developing, testing, demonstrating and evaluating solutions for sustainable mobility."

Peter Lindgren, Gothenburg Urban Transport Administration, Sweden

When looking at different future trends, it is obvious to perceive urban transport as the key sector for decision-makers to act (see figure p. 10 „Passenger transport worldwide demand by type billion passenger-kilometres"). The ITF Transport Outlook 2019 predicts that urban transport demand will continue to grow worldwide from around 18 trillion passenger kilometreers (p-km) in 2015 to 37 trillion p-km in 2050 (ITF, 2019). While private cars, two- and three-wheelers and taxis still dominate the mode of travel worldwide, currently making up nearly 75% of urban passenger transport in OECD countries and over 60% in non-OECD countries, a considerable shift towards shared mobility (shared bikes, scooters, cars, taxis and buses) and public transport is expected: Shared mobility was only responsible for 1.5% of worldwide urban p-km in 2015, but by 2050 it is likely to cover more than one fifth of urban trips. Public transport will account for 35% of worldwide urban passenger transport by 2050, that is 2.4 times more than in 2015.

"Shared mobility could halve the number of vehicle-kilometres travelled in urban areas if widely adopted. This could lead to a 30% decrease in CO_2 emissions from urban transport by 2050 relative to projections based on current ambitions."

ITF Transport Outlook, 2019

Mobility as a Service

Urban mobility is often provided by a number of different and disconnected service providers which often operate with little coordination. Modern technology developments provide an opportunity for a revolution in how processes can be optimised.

Digitalisation offers to combine separately regulated services in the transport sector and deliver mobility instead of separate single operators or modes, but rather as a continuum of services, or in other words Mobility as a Service (MaaS). At its core, MaaS supports the digital integration of transport, information and payment services thus ensuring a smooth and reliable experience for customers.

The potential impacts of MaaS depend on the respective business offers as well as the policies that public authorities put in place (or not) to influence the way people modify their behaviour (or not) in response to the new offer. Additionally, potential impacts could also be seen on traffic congestion, the environment, safety/health as well as effects related to land use or real-estate market.

Insofar as MaaS systems facilitate the adoption of shared mobility services, they have had significant impacts on urban transport systems. Studies show that early uptake of ride-sourcing services leads to modest substitution effects for car travel with more riders coming from public transport, walking and cycling. However, this is variable between areas and likely linked to the quality and frequency of existing public transport services as well as cycling infrastructure. These findings may evolve, especially as many of these services are actively linked to provide low-latency, affordable, convenient and highly reliable trips. They may also be influenced by public policies in support of public transport use and active mobility.

Find out more:

- White Paper on Mobility as a Service (MaaS): https://jpi-urbaneurope.eu/white-paper-on-mobility-as-a-service-maas/
- Mobility as a Service for European Union project: http://www.maas4eu.eu/
- MAAS-Alliance: https://maas-alliance.eu/

1.3 | From global to regional perspectives - e-mobility as a solution

The shift towards shared mobility concepts and public transport in urban regions will lower GHG emissions to a great extent but even more, if this transition will be accompanied by electrification of the urban transport system. Thereby, e-vehicles will play an important role to reach sustainable development goals. The International Energy Agency (IEA, 2017) estimates that the electrification of the global vehicle fleet will comprise about 30% of projected emissions reductions by 2050 - CO_2 emissions savings by e-vehicles are significantly higher in countries where the power generation mix is dominated by low-carbon sources. Although e-vehicles constitute only less than 1% of the current global vehicle stock, the market is gaining momentum. In 2015, sales of new electric cars worldwide comprised 450,000 but jumped to 2.1 million in 2019 (BloombergNEF, 2020). Sales of electric two-wheelers have also increased, reaching already some 30% of global two-wheeler sales today. In 2030, the BNEF Electric Vehicle outlook 2020 predicts 1.4 billion passenger vehicles on the road and e-vehicles account for 8% - China and Europe combined represent 72% of all passenger e-vehicle sales in 2030 (BloombergNEF, 2020). As battery prices continuously fall, energy density improves and more charging infrastructure is built, the share of e-vehicles on car sales worldwide will rise to 31% by 2040 - some regions even go higher with China and parts of Europe at over 50% (BloombergNEF, 2020).

While technology progress on battery performance and battery storage as well as growing investments in and expansion of manufacturing capacities are delivering substantial cost cuts on market prices both for batteries and charging hardware, main drivers for the electrification of the global vehicle fleet are political commitments made by cities, regions and countries.

In the European region, key policy developments and incentives to roll-out e-vehicles and charging infrastructure in the European Union are:

- Regulation (EU) 2019/631 - setting CO_2 emission performance standards for both newly registered passenger cars and vans (light commercial vehicles) from 1 January 2020 on. The regulation also includes a mechanism for manufacturers to incentivise the uptake of zero- and low-emission vehicles, in a technology-neutral way.

Types of e-vehicles

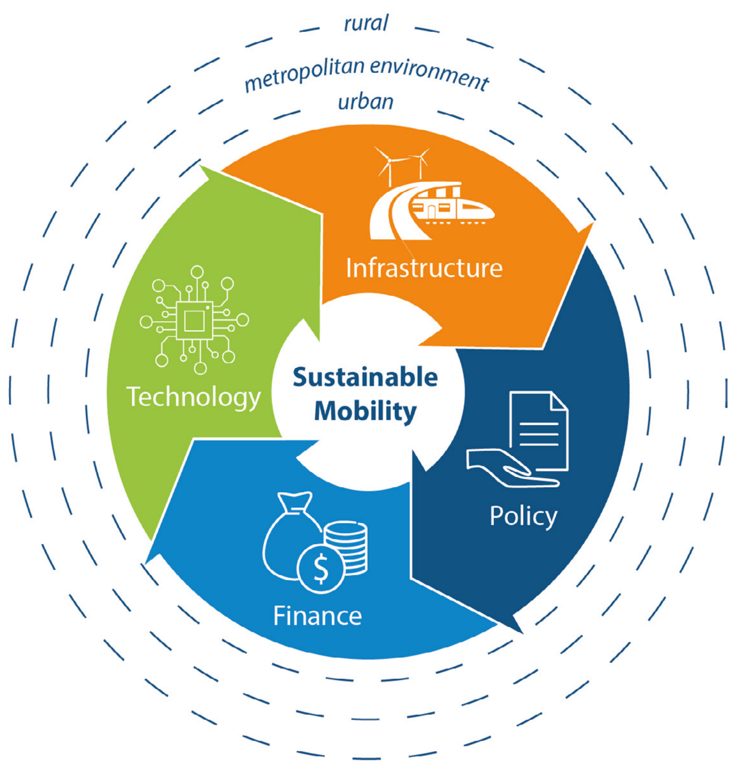
By definition, electric vehicles are battery electric vehicles (BEV), electric vehicles with extended range (REEV) or hybrid/plug-in hybrid vehicles (PHEV).

- Battery electric vehicles (BEV) operate on battery power only
- Range extender electric vehicles (REEV) operate with a small internal combustion engine and a generator that could provide assistance if the battery is too weak. The combustion engine therefore supplies power for the battery but cannot drive the vehicle itself;
- Hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) also have a combustion engine and an electric motor, whereby both engines can act together to drive the vehicle independently of each other. HEVs are only charged via regenerative braking or the combustion engine, while the enlarged traction battery of the PHEV can also be charged via a socket or chagrin station;
- In contrast to other electric vehicles, fuel cell electric vehicles (FCEVs) produce electricity using a fuel cell powered by hydrogen, rather than drawing electricity from only a battery.

Several types of e-vehicles are already in use: cars, buses, ferries, trucks, bikes and scooters. In addition, there are grid connected electric vehicles such as trams, metro systems or trolleybuses, which are a familiar sight in urban transport all around the world.

- Directive (EU) 2019/1161 - promotion of clean and energy-efficient road transport vehicles in public procurement tenders of cars, vans, trucks and buses. The directive will apply to contracts whose awarding procedure starts after 2 August 2021.
- Energy Performance of Buildings (EPBD) Directive 2018/844/EU - introduces several new elements to modernise the building sector towards a highly energy efficient and decarbonised building stock by 2050. This includes also minimum requirements for charging infrastructures in new and renovated buildings - at least one charging station per building has to be installed. EU-countries have to transpose the new elements into national legislation from 10 March 2020 on.

FOUR KEY PILLARS of sustainable mobility



Source: own illustration

- Directive 2014/94/EU - sets out minimum requirements for the development of alternative fuels infrastructure, including recharging points for e-vehicles and refuelling points for natural gas (LNG and CNG) and hydrogen. Besides the trans-European transport network (TEN-T) core network corridors, the directive focuses also on urban and suburban areas, where vehicles are being used most of the time. Among other targets for electricity supply for ports and stationary airplanes, the directive requires EU Member States to set up an appropriate number of publicly accessible charging points to ensure that e-vehicles can circulate in urban/suburban and other densely populated areas by the end of 2020 as well as on the TENT-T core network by 2025.

On national and city level, the incentives and status of transposing the diverse EU-directives into policy programmes and legislation varies from country to country. But gradually, national targets have been set or legislation adopted in the BSR whereas cities and regions turn out as frontrunners in the transition to low and zero-emission mobility.

Accordingly, the introduction of e-mobility solutions in urban transport systems takes place in different action fields. Ideally, all four key pillars of sustainable mobility are considered (see figure above „Four key pillars of sustainable mobility") and key actors, decision makers and approaches from all dimensions, namely policy, infrastructure, technology and finance are involved. While this chapter closes with an overview of main developments on e-mobility in the BSR electric partner countries, chapter 2 will introduce specific use cases and lessons learned of implemented e-mobility solutions in the BSR electric project.

Falling battery prices

From 2010-2019, Lithium-ion battery pack prices fell by 87%, with the volume-weighted average hitting $156/kWh. Main drivers are the introduction of new chemistries, new manufacturing techniques, simplified and innovative pack designs, the application of big data to right size batteries and the expansion of production capacity in manufacturing plants. In the future, material prices will be crucial to keep the trend.

1.4 | State-of-the-art of e-mobility in the Baltic Sea Region

Besides "classical" instruments such as the further development of cycle paths, emission-free public transport or higher vehicle taxes, more efforts are put into the promotion of e-vehicles and the development of slow and fast charging infrastructures. The most common actions in BSR cities in the last couple of years are:

- The authorization of access to city centres only for e-cars;
- Free parking for e-vehicles;
- Benefits for road transport such as the use of bus lanes for e-cars;
- The development of a public charging network and awareness campaigns;
- Public procurement programs;
- Reduced taxes such as VAT, registration tax and annual road tax;
- Fiscal incentives for the purchase of e-vehicles;
- Free recharging at some charging points.

The following key facts provide an overview of main developments on e-mobility in the BSR electric project's partner countries.

Denmark

The majority of 24,743 passenger e-vehicles (BEV/PHEV) currently registered (EAFO, 2020) are sold to public customers. At the same time **a great number of charging spots** have been established and deployed within urban regions and alongside highways, thus making the Danish electric grid network very stable - about 2,500 charge spots throughout Denmark equalling 4 cars per charge spot. The majority of charging infrastructure is installed and financed by private operators. Furthermore, Denmark was the first country to introduce **a large-scale free flow carsharing** programme for e-vehicles, with more than 800 e-cars currently running in the area of Greater Copenhagen (OECD/IEA, 2018).

The initiatives on green mobility include that all new public procurements of busses in the Capital Region of Denmark must be electric (100 new registrations of BEV-busses in 2019 - EAFO, 2020). At the same time, test and small-scale operations on **autonomous e-busses** in certain areas have started and will be implemented in the following years.

Regarding e-delivery, the Danish Government co-finances from April 2020 onwards needed infrastructure and also the **procurement of e-vans**. This is a result of a Green Transport Paper published in 2018 with a total pool of app. € 75.mio. for **green investments** in Denmark. For 2020 it has now been approved by all political parties, that the first part of the pool approximately € 10.mio should be dedicated the infrastructure to support electric cars, and procurement of e-vans.

Currently, only **3 e-ferries** are in operation. However, it's estimated that approx. 90% of all ferries in operation in Denmark could be substituted and replaced by matching e-ferries.

A central contact point for e-mobility Copenhagen Electric managed by the Capital Region of Denmark and consulting both private and public entities on planning and implementing e-mobility solutions has been established already in 2013. It also comprises information on funding, public tendering, EU-project coordination and engagement, local pilot tests, information campaigns and conferences on e-mobility (Copenhagen Electric, 2020).

Estonia

The largest asset supporting the use of e-cars in Estonia is **a country-wide fast-charging network** introduced by the government through the ELMO project from 2011. In 2018 about 100 e-cars were sold out of the total 25,000 (less than 1% from overall sales). The fleet of e-cars consists of 1,500 vehicles in total.

There are two large electrical taxi companies Välk and Elektritakso in Estonia, which have operated e-cars daily for several years now competing with gasoline-powered taxis.

In June 2019, **a bike-share system** was launched in Tartu, which consists of 750 bikes (510 e-bikes and 240 regular bikes) and 69 bike share stations across the city (SmartEnCity, 2020).

In Tallinn, e-bus tests are planned together with local energy producer Eesti Energia AS and from 2035 **full application of 650 e-buses** is envisioned in Tallinn.

Finland

The Finnish government supports the purchase or leasing of new fully electric cars by a subsidy and there are further **incentives for e-vehicles**, e.g. 50% reduction of parking fees in the City of Helsinki. However, overall the market share of e-cars is presently low but increasing. The Helsinki greater area prefers e-mobility in the city's public procurement, which has recently led to the purchase of **30 e-buses**.

Helsinki energy company Helen is providing **a free charging station for e-bikes**. However, the number of e-bikes in general is not high. Similarly, while there is a small amount of piloting of e-vehicles in Vantaa Aviapolis and Helsinki Jätkäsaari areas, the number of e-vehicles is minor compared to the total number of vehicles in the logistic sector.

There are **e-ferries** operating in Turku and its surrounding archipelago. Turku's landmark river ferry Föri has been **newly modernised** from diesel to electric motor and it carries passengers free of charge.

Germany

According to the German Association of the Automotive Industry (VDA), the accumulated number of newly registered e-cars was at 222,525 by the end of March 2019 of which 54% were BEVs. The increase in new registrations from 2017 to 2018 was at 24%. Even though the market for e-cars is still considerably small, it is increasing. There are 60 different models available, from which 26 models are coming from German manufacturers and **the use of e-vehicles** is promoted by funding programs. Additionally, a total of 17,400 public and semi-public charging points are listed.

The sales of e-bikes are constantly increasing - in 2018 the total sale was at about 980,000, which corresponds roughly to 25% of all bike sales. However, no direct funding for e-bikes is available. Yet, e-bikes can be considered similarly to company cars, where the employee can use a car that is bought or leased by the company and obtain tax benefits.

Latvia

Several **benefits for e-vehicles** are available in Latvia, for instance, e-vehicles are exempt from vehicle operating tax, reduced taxes for company cars, free first-time registration and free special number plates for e-vehicles as well as free parking benefits and permission to use bus lanes. Subsidies for purchase of e-vehicles and charging points were available from climate change financial instruments in 2014 when 202 e-vehicles and 35 charging points were supplied. In 2018 **a network of 72 fast-charging stations** was installed on all major roads and by 2021 the number will be extended to 150 fast-charging stations.

Co-financed by the EU Cohesion Fund the first **4 e-buses** have been introduced in Rēzekne. Additionally, by 2020 15 e-buses and 3 charging stations are planned to be introduced in Ventspils, in Jelgava - 4 e-buses and 3 charging stations and in Jūrmala - 2 e-buses.

Norway

In 2018, 31% of the new cars sold in Norway, a fore-runner country in terms of e-mobility, were **e-cars**, and in March 2019, 77% of the new cars sold in Oslo were electric. In 2018, 7.2% of the total car fleet in Norway was electric, in Oslo 12.1% of the car fleet was electric.

GHG emissions from e-vehicles

The well-to-wheel (WTW) GHG emissions from the e-vehicle fleet considering the full lifecycle are determined by the combined evolution of the energy used by e-vehicles and the carbon intensity of electricity generation - as the grid becomes less carbon-intensive, so do e-vehicles. In the New Stated Policies Scenario, 2017-2030 (IEA, 2018), which considers the impact of announced policy ambitions including the Nationally Determined Contributions made for the Paris Agreement, WTW GHG emissions by the global e-vehicle fleet are projected at around 230 Mt CO_2 in 2030. The emissions by an equivalent vehicle fleet powered by internal combustion engines (ICE) would be almost double (450 Mt CO_2).

Sidenote: The carbon dioxide equivalent (Mt CO_2) is a metric measure used to compare the emissions from different greenhouse gases based upon their global warming potential (GWP) - the ability of one unit of a greenhouse gas to trap heat in the atmosphere as compared to one unit of carbon dioxide over a given time period. The Mt CO_2 for a gas is derived by multiplying the tons of the gas by its associated GWP. It is calculated by adding the metric tons of carbon dioxide emissions with the metric ton carbon dioxide equivalents for methane and nitrous oxide.

Oslo and Akershus county started operating e-buses from 2017, and they have set the goal that **all public transportation (bus, ferry, tram, metro) is going to be fossil-free** in 2020, and all electric by 2028. A number of other counties have also started electrifying the bus fleet.

The **first e-ferry** started operating in Norway from **2015**, currently, about 72 e-ferries are either in operation or already ordered and under construction.

Poland

In Poland, the benefits for e-vehicle owners are still small, introduced mainly at the local government level. For instance, some **cities individually reward the owners of such vehicles** by introducing, for example, public, free chargers or no fee policy in paid parking zones, or by allowing drivers to use bus lanes. One of the biggest barriers to the development of e-mobility in Poland is the relatively high price of e-vehicles and insufficient financial support from the state.

The **market for the production of e-buses is developing dynamically**, currently ahead of the domestic demand. Despite the fact that e-buses are more expensive than those powered by a combustion engine, they appear more frequently in the public transport of large cities.

Urban e-bikes can be found in Warsaw, consisting of 100 bikes, and in Gdańsk-Gdynia-Sopot metropolitan area an **electrically powered bike system** has been launched in March 2019 with 1,224 bikes and the number is planned to be increased to 4,080 which is one of the largest systems in EU (Modijefsky, 2019).

Seasonally two ships (capacity- 28 passengers) operate with an electric drive serve in Bydgoszcz. They are powered by energy obtained by photovoltaic panels mounted on the entire surface of the roof. Additionally, they are equipped with quick charge batteries.

Sweden

In Sweden, another forerunner country, there are around **79,000 plug-in cars** (both hybrid and battery e-cars) at the end of March 2019, and the market share of plug-in cars was about 10% in April 2019. New green vehicles with low emissions of carbon dioxide **qualify for a bonus at purchase**. Furthermore, the Swedish government mandates the adoption of **environment-friendly and electric cars in government fleets**, except for some classes of cars (e.g. emergency vehicles). The national support scheme Klimatklivet has funded several thousand recharging points. The government also has a support scheme for private charging. The support to home chargers is with up to 50% or SEK 10,000 (EUR 960) for hardware and installation costs.

There were **110 battery e-buses** in operation at the end of February 2019.

More than **100,000 e-bikes** are in use, the e-bike market share is around 15-20%. Also, e-kickbikes have recently been implemented in several Swedish cities. For instance, the Polish company Blinkee City has introduced its sharing system of e-scooters in Stockholm.

Sweden has several demonstration projects with **e-trucks in urban environments**. Moreover, **the first in the world smart road** is planned in Gotland, it will charge e-buses and trucks inductively while in full motion.

Sweden together with Denmark has two battery electric ferries. They are used between Helsingør (Denmark) and Helsingborg (Sweden), a distance of approximately 4 km carrying more than 7.4 million passengers and 1.9 million vehicles annually.

2 | In the spotlight: The BSR electric use cases

2.1 | Results and lessons learned

While national promotion strategies for e-mobility have primarily focused on individual car use, other potential applications have received less attention. That is the starting point for the practical implementation of multiple applications of e-mobility solutions in BSR cities within the seven use cases of BSR electric offering hands-on experiences from real world settings. The demonstration actions carried out in frame of BSR electric illustrate how environmentally friendly transport solutions can be implemented, while also generating opportunities for innovation for small and medium- sized enterprises from the region.

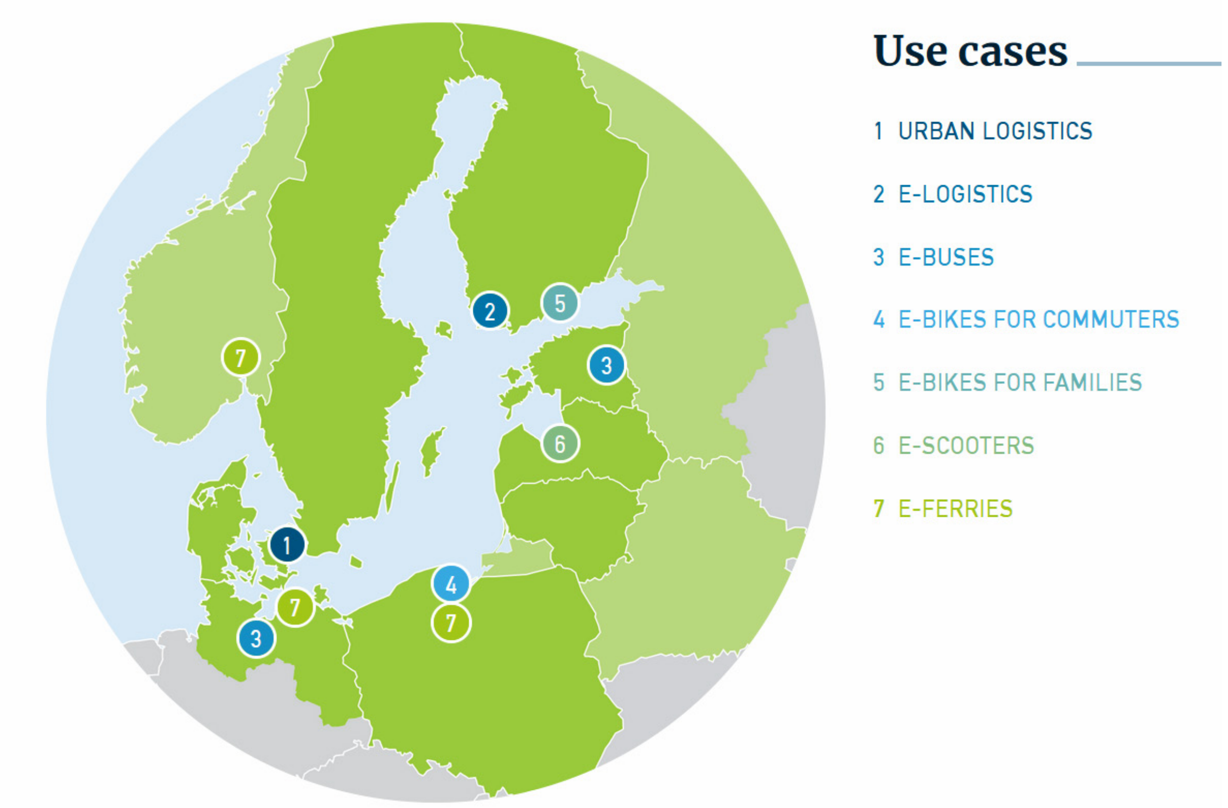
Based upon findings and results of piloting activities, project partners have developed a set of theme-specific checklists guiding the target group in decision-making.

Available for download here: https://www.bsr-electric.eu/results

Access Augmented Reality App

An augmented reality app provides additional information to the use case descriptions in this roadmap.

Use the QR code above or https://apps.apple.com/de/app/bsr-electric/id1508215478

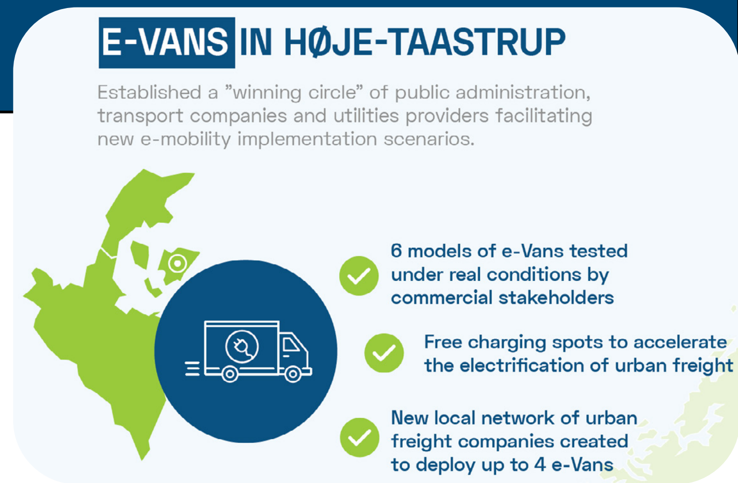


Use case 1 | Urban Logistics | Høje Taastrup, Denmark

Practical, financial, environmental and legal impacts of e-vehicles and trucks for last mile freight transport

A large part of air and noise pollution in cities can be linked to urban freight transport by diesel vans/trucks delivering goods from suburban transport hubs to the inner city. Substituting these with electric vans/trucks can effectively contribute to better air quality and less noise pollution.

This use case focuses on opportunities and barriers for sustainable e-mobility in urban logistics, including practical user aspects, economy, environment and legal framework. By cooperating closely with original equipment manufacturers (OEMs) and charging infrastructure operators, the use case helps pave the road for the creation of a new and sustainable business model for e-mobility in urban logistics.



DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

The Høje Taastrup Transport Center (HTTC) is located in the Municipality of Høje-Taastrup (HTK) and includes several larger Danish freight and logistic companies which commute daily in and out of Copenhagen.

HTK facilitated cooperation to create pilot cases in urban freight and logistics which involved testing zero-emission/low noise last mile freight transport using e-vehicles. Six established transport companies tested relevant e-van/truck models in the market, under real-life conditions. Furthermore, to carry out pilot testing, some fundamental ingredients had to be in place to facilitate the companies' decision making as to whether or not to take part in the tests. Namely, charging infrastructure and vehicles (e-vans) to operate. Consequently, the following actions were taken:

- HTK successfully engaged multiple business case scenarios, including regular express day-to-day delivery, specific goods delivery and exclusive products on special routes. As a response to the various existing technical and economic challenges, the project created new business cases with adapted routines, for example, a pilot with the French company L'Oréal focussing on pooled deliveries of generic commodities and high-end products that are optimized for the range and capacity of the e-vans.
- An overall strategy for charging infrastructure of e-vehicles in HTK has been developed, including lessons learnt from the pilots. Infrastructure partner E.ON provided decentralized AC chargers (for charging when out of operation) at the companies' parking lots and also granted access to its charging network in and around Copenhagen. A centrally located DC fast-charger (for charging during operation) was installed at HTTC to supply business and private e-vehicle owners. The project granted participating companies full access to daily charging free of charge.

LESSONS LEARNED

+ Cooperation between the municipality and logistics companies is crucial and leads to a positive experience.
+ For transport companies and OEMs to become involved, a project must be easily understandable, easily accessible, and require low upfront involvement.
+ Initial groundwork by municipalities is vital and municipalities can also be front-runners in the procurement of zero-emission delivery services.

! Access to quick charging is critical to secure as many hours of operational time on the road as possible.

! Financial savings only make a difference after several years and daily usage, since the cost of the e-vehicles is still high.

! Due to shorter range, a 1:1 exchange of diesel vehicles by e-vehicles is challenging, and a larger number of e-vans would be necessary compared to a diesel fleet.

Høje-Taastrup Kommune

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Use case 2 | Light Electric Vehicles (LEVs) | Turku, Finland

E-vehicles as an option for inner-city logistics with the aim to optimize maintenance and logistics routes

Inner-city logistics is often prone to a conservative mode of transport lock-in with mainly diesel-operated vans being used even if neither distance travelled nor cargo carried actually requires this type of vehicle. Replacing conventional vehicles with electric ones is an option cities can take to make the transport system more sustainable. In addition, via careful route planning and motivation of employees, many logistical functions in urban areas can be carried out with LEVs instead of cars of vans. This use case addresses the benefits and potential barriers of e-vehicle deployment in terms of e.g. charging infrastructure and route optimization, winter conditions, behaviour-related barriers to acceptance among city employees, and economic aspects of e-vehicle operations.

DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

The Turku use case, carried out in close cooperation with Arkea Ltd, a city-owned company in Turku, consisted of several actions. Two LEVs were leased and tested among the Arkea employees to explore their suitability for the company's operations and to assess their potential in replacing passenger car use on work-related trips.

- A regular e-bike was used by the office personnel for commuting and other work-related trips at the Arkea headquarters.

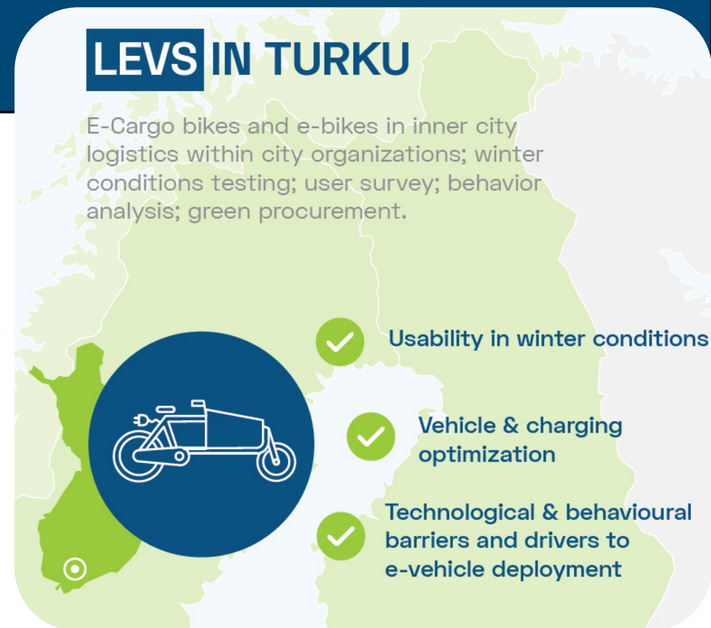
- An electric cargo bike was tested by maintenance workers at a suburb location.

The suitability of different LEVs for winter conditions was also further explored in a winter test session, arranged in cooperation with CIVITAS ECCENTRIC project. Here, eight different LEVs ranging from scooters to 4-wheelers and ribbers were tested on icy and snowy streets and minus degrees, mapping the LEVs' safety and winter-hardiness as well as battery lifetime.

In addition, a survey was conducted with the Arkea employees concerning the use, experiences and opinions regarding Arkea's existing e-fleet.

- Arkea's current fleet consists of 23 vans or other motorised vehicles, of which four are electric (Nissan e NV200).
- The e-vans were introduced in the summer of 2016 and are leased for Arkea.

Finally, a fleet track and route optimization tool was developed to assist city authorities or other relevant organizations in planning for the deployment of e-vehicles. The tool helps the companies to keep track and to evaluate the use of their fleets by analyzing the mileage covered by the vehicles with descriptive statistics. Furthermore, it helps with the planning of new routes for the e-vehicles. Based on the use case experiences and a comprehensive literature review, a report was devised that examines the feasibility of replacing (city)-organization fleets with e-vehicles or LEVs.



LESSONS LEARNED

+ Due to the high initial investment costs of e-vehicles, using energy efficiency as a procurement criterion for tenders for city functions and services can be beneficial.
+ When making procurement decisions, the lower total lifetime costs of e-vehicles should be emphasized over the upfront costs.
+ In addition to the financial aspect, many organizations these days recognize the value of environmental aspects of their procurements, as well as the image benefit they involve.
+ Introduction of LEVs is best to be coupled with incentives or an information campaign to guarantee a successful introduction.

! Usability of different LEVs is greatly dependent on the specific use context. Thus, careful mapping of user needs and market options should be done.

! Weather conditions in wintertime are a prohibiting factor for many potential users, especially those who don't cycle regularly. This should be considered when timing the introduction of LEVs.

! Practical issues such as storing requirements and safety related to LEVs are significant factors to their usability and can hinder initial eagerness towards the vehicles.

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Use case 3 | E-buses | Hamburg, Germany and Tartu, Estonia

Developing recommendations for the implementation of e-buses in public transport fleets by analysing implementation processes and operating data

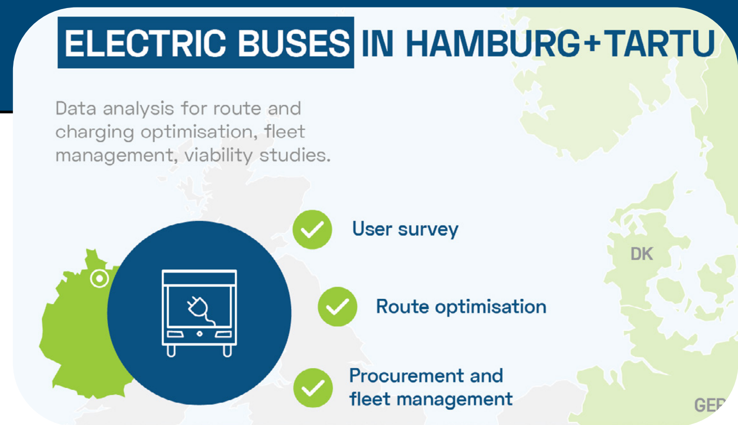
Cities around the BSR are facing both pressure and support to introduce e-buses into their public bus fleets. At the same time, comprehensive information is lacking regarding both procurement of e-buses and operation of electrified fleets. Public transport providers in Hamburg and Tartu, have tackled the challenges related to the integration of e-buses into urban bus fleets.

DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

The public transport company VHH in Hamburg aims to implement e-buses into their fleet. BSR electric is supporting this process by analysing data from the e-bus operation, with the aim to evaluate how different parameters influence the driving range of the e-buses, such as ambient temperature, route topography, driver behaviour and others. For this purpose, systems for the acquisition of the data were implemented and the data sets were analysed.

In Tartu, the goal is to provide a reliable and environmentally friendly public transport service. In 2019 the Tartu City Government started a ten-year contract of public transport by gas-powered buses. For the next contract period starting in 2029, Tartu targets the implementation of electric buses running on renewable energy. In order to identify operational and logistic challenges of e-buses relevant for the transition of the transport system, Tartu procured and tested an e-bus. The key actions taken in Hamburg and Tartu are summarised as follows:

- The Hamburg Parliament decided in its meeting on May 10, 2017 that the chosen strategy for the implementation of the e-bus lines in Hamburg is based on purely electric buses (instead of hybrid buses) and overnight charging at the garage (instead of opportunity charging along the route). Parallel to commissioning the e-buses, VHH is developing and implementing IT systems for logging e-bus data during operations.
- In Tartu, one e-bus model by the manufacturer Solaris was tested, and the charging strategy chosen was overnight charging at the bus depot. Tartu tested the e-bus from September 2018 to August 2019.



LESSONS LEARNED

- + Involvement of external specialists to support the planning and implementation of e-mobility transition is advantageous.
- + Reliable data acquisition and analysis is an essential tool for the successful uptake of e-mobility in public transport and is necessary for reducing operational costs.
- + Opportunity charging combined with overnight depot charging were identified as the most effective charging method for the specific conditions in Tartu, whereas in Hamburg pure depot charging is economically more feasible.
- + Different driving styles have significant impact on the range thus suitable measures for monitoring and improving the driving efficiency are necessary, e.g. feedback systems or specific energy efficiency coaching, etc.
- ! Well-thought-out IT systems and real-time data exchange are crucial for the planning and performance of e-bus operations.
- ! It is important to ensure sufficient capacity and capability for e-bus maintenance and repair.
- ! The terms of the e-bus procurement should include sanctions if the quality of the delivered e-buses is deficient.

HAW HAMBURG

Tartu city of good thoughts

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https://www.bsr-electric.eu/use-cases/e-buses

Use case 4 | E-bikes | City of Gdansk, Poland

Promoting the use of e-bikes for commuters, by integrating e-bikes without central docking stations into the city's bike sharing system

E-mobility is a new concept in Poland, but awareness and curiosity are growing and people are willing to test new electric means of transport if they have the opportunity. Gdansk is one of the leading cycling cities in Poland, but general knowledge among its inhabitants about e-bikes is limited.

DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

The City of Gdansk focuses on the adoption of e-bikes in the city bike sharing system and their use for multimodal trips in a metropolis. In doing so, the City of Gdanskcarried out several activities:

- A conceptual study has been conducted, assessing the possibilities of integrating electric bikes into a 4th generation public bike system.
- The City of Gdansk carried out a campaign to promote the use of e-bikes in everyday travel, for commuters and for business trips.
- A user survey of commuters analysed the perception of e-bikes. Participants also registered their trips and distances covered with a smartphone app and took part in a competition, in which teams from different companies could participate as well.

Results of the survey indicated that only one in five people had used an e-bike before. For the vast majority, it was the first time testing such a vehicle. Almost all of the respondents stated that the e-bike could be used as a basic means for daily city travels. Additionally, research has shown that commuters are more likely to switch from car/public transport to bike if it is electric.

The main advantages of using e-bikes mentioned by respondents were the ease of climbing the hills, the possibility of riding without sweating or while wearing formal clothing and the ability to cover longer distances. The disadvantages include the heavy weight of the bike and the high purchase costs that may prevent e-bikes to become a common mode of transport in the city.

LESSONS LEARNED

+ The introduction of both electric and traditional bikes increases the functionality of the system and it should be profitable for the operator.
+ Building strong public-private partnership arrangements enable the launch and operation of the public bike rental system.
+ Providing incentives for employees participating in cycling campaigns increase public awareness and motivation to cycle to work.

! The user subscription fee was too low compared to the maintenance costs, resulting in unprofitable system management.

! Appropriate legislation on e-bikes is needed to increase the ease and safety to use them in urban spaces (e.g. different e-bike classes, speed limits).

! Solutions to improve the safety and comfort of active forms of mobility should be implemented (e.g. infrastructure).

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Use case 5 | Family bikes | Helsinki, Finland

Reduction of ownership and use of second cars in family households

Helsinki Region Environmental Services Authority's (HSY) piloted an e-bike promotion campaign. The original aim of the campaign is to reduce ownership and use of second cars in family households in the Helsinki metropolitan area. The tested and validated promotion campaign has the potential to be implemented in other cities.

DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

Between 2018 and 2020 several activities were carried out:

- A testing campaign, in which families substitute their second car with an e-bike (provided by the implementing partner, HSY) for a month. Four families were selected to record their testing experiences and share them via social media.

Subsequently, another similar campaign was organised to test how e-bikes would perform during wintertime.

- A testing campaign for housing companies, in which apartment houses received electric cargo bikes for shared use for 2-3 months.
- Two-week long e-bike testing campaign at Korkeasaari Zoo, in which families had a chance to use an e-bike to reach the zoo entrance from the parking lot or vice versa: parents tried e-biking whereas children travelled by an e-bike taxi. This testing opportunity was used by 90 families.
- In the campaign's framework, 15 e-bike testing events for residents and 13 events for workplaces were organized. Smaller-scale events took place in the suburbs whereas larger events were carried out in the Helsinki city centre as part of, for example, the Helsinki Day or EU-Presidency opening celebrations.

Overall, 1,810 people tested e-bikes in the project's events. The project has gained a lot of media attention and positive feedback. The sales of e-bikes doubled in Finland in 2018 and the same trend has been detected also in 2019.

LESSONS LEARNED

+ Most of the cars that families have replaced with e-bikes in the last year, have been their only cars.
+ Analysis of the routes, the "urban structure" of the area and the accessibility of services are valuable because those are the key elements affecting residents' daily mobility.
+ Working with large housing companies can be challenging, but nevertheless worth a try because of promising scalability.

! Starting an experiment in the winter or Nordic conditions is even more challenging than expected.

! It is important to do thorough initial testing of new digital technologies (smart locks, apps) to ensure that it is functional and well adapted to the users' needs and skills.

! Experiments with housing associations can take a long time as residents need time to realise the potential of changing their mobility habits.

! Campaigning should not be underestimated: online forms should be planned in a way that allows handling a larger number of responses in case expectations are exceeded.

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Use case 6 | E-scooters | Riga, Latvia

Examining the possibilities of using e-scooters in public spaces to decrease social exclusion of senior and disabled residents and to allow increased access to various restricted environments

Cities around the BSR and elsewhere are commonly facing challenges to preserve the mobility of elderly people or people with particular mobility requirements. In this regard, access to areas such as hospitals and cemeteries for people with impaired mobility – for whom longer walks are often impossible – is often limited.. Therefore, solutions need to be designed to allow citizens with special needs to access these areas.

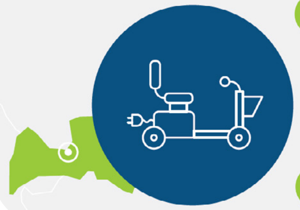
DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

This use case facilitated the testing of e-scooters in a large hospital complex in Riga for transporting patients and staff as well as e-scooters in a cemetery in Riga for transporting not only the workers and their equipment but also seniors and visitors with physical disabilities:

- Since October 2018, two e-scooter tests have taken place at the Riga 1st hospital. The hospital complex consists of 23 hospital buildings. After a more detailed assessment of the technical requirements of the site and consultation with technical experts, it was indicated that the selected vehicles needed to fit the hospital corridors and elevator, they should have a speed limit within the hospital complex (10 km/h) and for safety reasons make a special sound while in use.
- Since April 2019, an e-scooter demonstration has been taking place in a cemetery territory in Riga. The e-scooter was selected based on criteria specific to the conditions of the cemetery. Daily, it is used on average by more than 60 visitors. Cemetery staff received practical training of e-vehicle usage and maintenance. A specific garage was built for e-scooter storage where they are cleaned every evening from dust and dirt.

E-SCOOTERS IN RIGA

Use of e-scooters on a public graveyard and the city's hospital, viability and operational testing, improved social inclusion of the people with limited mobility possibilities.



- Accessibility of public spaces for disadvantaged groups
- Experiments with different workloads in a variety of terrains.
- Under ownership of the City Council

LESSONS LEARNED

+ Practical aspects have to be considered, e.g. that e-vehicles can be charged in all the different facility areas, in order to maximize usability.
+ E-scooters significantly improve the mobility of not only the patients but also the hospital staff.
+ E-scooters increase employee capacity, as well as social inclusion of patients and cemetery visitors.
+ A cargo compartment proved to be useful and the e-vehicle was able to transport visitors as well as freight and visitors' belongings (such as wheelchairs).

! When selecting an e-vehicle model, it is important to considder the characteristics and measurements of the site and buildings where they will be used.

! Appropriate training should be provided to staff of all generations.

! Considering the weather conditions in different seasons as well as specific road conditions (surface, weather impact, road width) is important.

! There is a need to increase awareness for all visitors of the possibility of using an e-vehicle in the area (e.g. by means of visitor information campaigns).

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Use case 7 | E-ferries | Germany, Norway and Poland

Exploring the possibilities for integrating electric water-bound passenger transport into public transport systems

More than a meaningful mode of transport in coastal and river cities, water-bound transport can also make cities more attractive to tourists. While conventional, diesel-powered, ferries are responsible for high emissions, e-ferries could prove to be an environmentally friendly alternative. However, even though electric ferries are becoming more common, there are only a few larger e-ferries in operation worldwide.

DEMONSTRATION ACTION AT A GLANCE - KEY ACTIVITIES AND RESULTS

This use case focuses on analysing the planning and investment phases for the electrification of ferry services, particularly with regard to technical solutions and procurement processes, in the BSR harbour cities of Rostock, Gdansk and Oslo. Due to large planning cycles and high investments, demonstration actions as such were not possible within the BSR electric framework. Instead, the project gathered best practice examples, giving insights from current implementation processes and ongoing operations. Currently, the ferry connection linking Gehlsdorf to Rostock-Kabutzenhof (operated by Antaris, AO 10) is due for an overhaul in the next years, and an e-ferry may present itself as a feasible alternative. Likewise, other ferry connections in the BSR could be electrified in the coming years. The City of Oslo is a frontrunner in this respect with introducing five smaller passenger e-ferries between Oslo Harbour and the small islands in the inner Oslo Fjord from November 2021 and high-speed passenger e-boats for a bigger part of the Oslo Fjord from 2024.

To further explore the possibilities of electrifying ferry connections, during the project, the following actions took place during the project:

- Project partner ATI Küste organised a workshop entitled „Electromobility on Waters - Contribution to Clean Shipping“ in June 2019, focusing on alternative energy sources as well as autonomous driving in electric water mobility. In March 2020, a workshop on "E-ferries and urban electromobility - benefits from the automotive sector" was implemented at the Porsche Center in Leipzig, with stakeholders from different industries, such as aviation, road transport and water transport.
- Work on a white paper, that features experiences and recommendations on technical as well as administrative issues. The white paper explicitly highlights the transferability of experiences across the BSR and beyond.

LESSONS LEARNED

+ Solar energy systems can increase the range of battery-operated e-ferries also in northern latitudes, such as Berlin, not only in southern areas and reduce operational costs by supplying the battery with solar energy.
+ In addition to their primary role as a means of urban transport, e-ferries can be used for touristic purposes and thus convey a more positive image of the city.
+ E-ferries are a sensible solution for urban public transport on short distances and on environmentally protected waters, the vessels are relatively small and infrastructure costs can thus be kept to a minimum.

! The costs for the energy supply systems for e-ferries (batteries, fuel cells) are still very high.

! Infrastructure is still lacking when using hydrogen and fuel cells, also the prices for hydrogen are still too high, thus, battery electric (and solar supported) ferries seem to be the most economical solution to date, for urban applications.

! For larger vessels with longer journeys, hydrogen-fuel cell hybrid technology will be a sensible alternative if an adequate supply infrastructure is available.

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2.2 | Challenges and success factors to foster e-mobility in the Baltic Sea Region

The process from the first step to a successful implementation of e-mobility solutions is complex and multifaceted, however, in the long-term - rewarding. As determined in expert discussions (IEA, 2019) and as illustrated in the BSR electric use cases, emerging challenges and success factors are clearly linked to the four key pillars (see p. 13) of sustainable mobility that need to be considered to foster e-mobility solutions, particularly in urban settings. This chapter summarises the challenges and success factors by assigning them to the four key pillars and pointing out to critical issues and possible improvements.

INFRASTRUCTURE

- The lack of adequate **charging infrastructure** is considered as a main obstacle to the widespread use of electric vehicles. In addition to the expansion of the charging infrastructure network, it should be made as user-friendly and demand-oriented as possible, thus, lifting the potential barrier for users to take up the new mode of transportation.
- A lack of a centralised information ("one stop") on all existing **recharging stations** and an insufficient visibility of existing recharging points in the urban environment prevent users to switch to e-mobility. Providing real-time data in a smartphone app could facilitate the use of e-vehicles.
- The lack of **visual instructions**, e.g. signs on cycling paths, as well as the poor quality of paths with potholes or curbs are obstacles in particular for e-bikes with increased speed compared to conventional bikes. Therefore, cycle paths must be improved and designed to ensure the cyclers' safety.

TECHNOLOGY

- Still, the **limited range of electric batteries** is one of the biggest obstacles for e-vehicles and long-distance freight transport. However, larger range batteries are heavier and more expensive and as a result, the vehicles are altogether heavier which may prevent the switch to e-mobility in particular e-bikes. Technological improvements can increase the range, although to a limited extent. Larger batteries, more efficient use of energy, charging opportunities along routes or battery swapping can alleviate such a constraint. In city centres, the problem of the range of e-vehicles can be reduced by combining parking spaces and charging stations. Additionally, recharging opportunities in close vicinity to apartment buildings should be made available to the best possible extent, e.g. in cooperation with housing associations.
- A larger e-vehicle fleet increases **electricity demand**. A solution could be to adjust the demand-side response by e.g. using low-demand periods for charging needs.
- Further, for transport providers, just replacing the conventional vehicles in operation with electric alternatives may not be enough, experts suggest including a '**volatility buffer**', for example increasing e-bus fleet size by 20-25% more e-vehicles to ensure reliable service. The electricity used by these vehicles needs to have a **low carbon intensity**. It is also essential that the components of e-vehicles, especially the batteries, are **recyclable**.

- The **variety of e-vehicles models on the market** is limited, e.g. currently there is still a gap for e-logistic vehicles.
- Due to the limited experience with e-mobility, a number of **technical issues** (repairs) cannot be solved by the e-vehicle dealers and require specialised maintenance.
- Some of the e-vehicle models on offer are not entirely suitable for the **demands of public road traffic**. In the case of e-bikes, the heavier weight specific maintenance requirements may occur as obstacles. Further, the purchase is hampered by the lack of opportunities for **testing e-vehicles** prior to purchase. Offering testing possibilities to potential customers would showcase as well as raise awareness of this mode of transportation.
- E-vehicles are subject to changing **weather conditions**. Among other factors, this can result in higher energy consumption requirements in winter, e.g. as additional energy is needed to heat up the vehicle. This affects energy consumption and thus the range of the vehicle, which is particularly the case with e-cars and e-buses. Although this can be mitigated by pre-conditioning: The vehicle is heated up and prepared for the drive while still plugged in to the charging station.

FINANCES

- In most cases, **prices of e-vehicles** are still not competitive. But the cost of producing batteries has been decreasing and is expected to continue to do so. Further, a full redesign of e-vehicle manufacturing platforms can offer savings due to the simpler design of e-vehicles compared to internal combustion engine vehicles. Vehicles with differing battery sizes according to the customers' needs avoid costly oversized batteries.
- The lack of charging infrastructure has been identified as an obstacle to the widespread use of e-vehicles. However, further enhancement of the charging infrastructure requires **additional financial resources** for improvements as well.
- There is still space for more promotion of e-vehicles, especially in cooperation with various companies, e.g. taxi companies or e-logistics, as **cost efficiency** increases with intensive daily use.

POLICY

- Many people are not yet aware of the advantages of e-vehicles and government incentives. Potential customers of e-vehicles should be provided with the relevant information on total Many people are not yet aware of the advantages of e-vehicles and government incentives. Potential customers of e-vehicles should be provided with the relevant information on total cost of ownership,, for example, by illustrating that e-vehicles are cheaper in the long term when used on a daily basis and if lower maintenance costs and fuel savings compared to conventional vehicles are taken into account.
- A potential rise in **fuel prices** and **lower price of electricity** could be supportive to long-term benefits to switching to an e-vehicle.
- To increase the diversity of available e-vehicles, **a study** of existing models, including those sold in other countries, could improve the situation and provide a better insight into the market possibilities.

Additionally, there are also **obstacles of belief**, e.g.: *The disposal of used batteries is very harmful to the environment! I don't believe in e-technology! Electric vehicles are so expensive!*, which affects the development of e-mobility solutions. Organising more awareness-raising events, sharing information as well as more widespread use of e-vehicles can be believed to help remedy such obstacles.

Challenges and success factors are (partly) interconnected and can be defined over several spatial, sectoral or organisational levels which makes the implementation of e-mobility solutions even more complex. To name a few examples: the electrification of urban logistics fleets requires efforts and expertise not only in the field of procurement, but also e.g. in terms of infrastructure and city planning; promoting the use of e-bikes is strongly connected to advancing cycling in general, and municipalities in the Baltic Sea Region are at very different stages in regards to bicycle-friendly infrastructure or attitude; during the transition towards public transport with e-buses several different stakeholders and operators are involved, from public transport providers to municipalities and transport companies.

Overall, spending sufficient time in the planning phase, researching the market, creating strategic (public-private) partnerships, putting e-mobility and its promotion on the political agenda as well as using incentives for different target groups and users play a crucial role for fostering e-mobility solutions in urban areas. But keeping the expected positive effects on air and noise pollution in mind, it's worth the effort.

3 | Towards sustainable mobility - further inspiring projects

The previous chapters including the BSR electric use cases illustrated the possibilities and lessons learned of e-mobility solutions for various applications and transport modes. This chapter shall broaden the horizon and potential for smart, shared, integrated and sustainable mobility solutions by a number of ongoing and already finalised good-practice projects across Europe.

The project **North Sea Electric Mobility Network (E-Mobility NSR)** funded by the INTERREG IVB North Sea Region Programme, project duration 2011-2014, helped to create favourable conditions to promote the common development of e-mobility in the North Sea Region.

Transnational support structures in the shape of a network and virtual routes were envisaged as part of the project, striving towards improving accessibility and the wider use of e-mobility in the North Sea Region (NSR) countries. Project actions included, amongst others, the development of a transnational e-mobility plan, smart grid solutions, setting up transnational electric mobility centres as well as the promotion of efficient and effective urban freight logistics solutions to enhance regional accessibility.

With its 11 partners (Belgium, Denmark, Germany, the Netherlands, United Kingdom, Norway and Sweden), the international consortium has established networks and collaborations with local authorities, government offices, universities, NGOs, SMEs and further stakeholders, and has, through its work, contributed to a better awareness of e-mobility in the NSR.

Find out more about the project:

http://e-mobility-nsr.eu/

Increasingly more people choose to live in suburban areas while continuing to work in cities, which results in a high number of daily commuters. Commuter traffic is still dominated by private cars causing congestion, air pollution, high demand for parking spaces and higher costs of public transport. The project **Sustainable Urban Mobility and Commuting in Baltic Cities (SUMBA)**, funded by Interreg Baltic Sea Region Programme 2014-2020, project duration 2017-2021, aims to address commuter transport and help to mitigate the previously mentioned challenges. SUMBA has developed and tested tools (e.g. commuting master plan template) that help urban and transport planners to assess, plan and integrate intermodal mobility solutions into transport plans and policies of their cities and municipalities.

SUMBA demonstrates how to effectively change suburban-city commuting towards more sustainable and inter-modal patterns in 10 pilot regions (in Germany, Estonia, Latvia, Sweden, Lithuania, Finland and Poland). The pilot regions have analysed their situation with a benchmarking tool and SWOT analysis, collected data and chosen suitable tools to plan or model their transport system. Based on the finding of these activities, commuting master plans and accompanying action plans have been developed in the pilot regions in a participatory way.

Find out more about the project:

http://sumba.eu/

Drive Sweden is a cross-functional collaboration platform that drives development towards sustainable mobility solutions for people and goods. Drive Sweden is working for a vision where Sweden takes a leading role in creating future mobility systems that are sustainable, safe and accessible for all. Via the platform, efficient, connected, shared and automated transport system solutions are created and demonstrated to help the vision become a reality. The purpose is to create a more sustainable society and thus contributing to goals within the field of transport policy.

The expected total duration of Drive Sweden is 12 years, and it is funded by the Swedish Energy Agency, the Swedish Research Council Formas and Sweden's innovation agency VINNOVA. Lindholmen Science Park is the host of the platform.

Find out more about the platform:

https://www.drivesweden.net/en

Lindholmen Integrated Mobility Arena (LIMA) is a mobility project for people who work at or in the vicinity of Lindholmen, Sweden. The purpose of LIMA is to simplify local and regional trips, decrease congestion on Lindholmen and contribute to a more sustainable city. LIMA aims to achieve an efficient and flexible mobility service, provide an economically sustainable mobility service that can be scaled up after the project, as well as positive environmental effects, such as reduced emissions and reduced congestion in traffic.

The project included a pilot test with a smart app that combines various modes of transport and parking. With the app, it's possible to use public transport and taxis, it also provides access to a fleet of electric cars via shared private or company cars and a public carpool.

The project is part of the Swedish Government's innovation partnership program, "The next generation's travel and transport" and is funded in part by Vinnova, Sweden's innovation agency, through Drive Sweden. The project develops and tests a smart, shared mobility service at a selected pilot group of 1,000 people who work at Lindholmen.

Find out more about the project:

https://drivesweden.net/en/lima

The **cities.multimodal** project promotes and facilitates multimodal mobility options in pilot areas, which are urban districts with walking- and cycling-friendly infrastructure. The focus is on dense inner-city areas already offering good opportunities for sustainable mobility and attracting inhabitants and commuters due to employers, schools, shops and services. The project is funded by Interreg Baltic Sea Region Programme 2014-2020, it includes 16 partners (8 EU countries + Russia), project duration 2017-2020.

The project defines multimodal mobility as a combination or the availability of different sustainable modes of transportation for one travel purpose. The aim is to provide sustainable options to citizens and visitors in the city that are as comfortable, easy and smooth to use.

Some of the project activities include implementing multimodal mobility points which combine at least two different sustainable modes of transport in order to improve accessibility, visibility and connectivity, testing IT solutions to support the multimodal mobility points as well as peer and study visits for exchanging practices and experiences amongst the project partners. The activities are complemented by campaigns for sustainable mobility options, highlighting the benefits of using public transport, shared mobility, walking or cycling or when combining car use with other modes of transportation.

Find out more about the project:

https://www.cities-multimodal.eu/

The **Green Regions with Alternative Fuels for Transport (GREAT)** project, , funded by the Connecting Europe Facility Programme, duration 2015-2019, has made the TEN-T Scandinavian-Mediterranean Corridor between Hamburg and Oslo/Stockholm one of the first to meet the EU's directive for alternative fuels. The project contributes to the decarbonisation of the transport sector and therefore has the potential to make the corridor an EU best-practice example on how to meet environmental and climate challenges.

The project has taken a holistic approach to promote various alternative fuels for road transport. It targets end users in a unique collaboration between the public sector, private providers of alternative fuels and vehicle manufacturers.

Installations are finished as of October 2019 with the result of 50 fast chargers and one LNG/LBG station in Sweden, 17 fast chargers in Denmark and 2 fast chargers in Germany.

Find out more about the project:

https://great-region.org/

Funded by the Interreg North-West Europe Programme, the **eHUBS** project, project duration 2019-2022, aims at kickstarting mobility transition by implementing smart, shared green mobility hubs which are dedicated on-street locations, where citizens can choose from different sustainable electric transport options, thus presenting an alternative for the use of private cars.

Six partner cities from five different countries realise and promote eHUBS and pave the way for others to do the same. The eHUBS implementation approach differs according to the size and needs of the respective cities. Overall 92 shared mobility eHUBS, with almost 2,400 light electric vehicles are to be provided for citizens.

The project is set to provide knowledge, best practices and a blueprint that would lead to replication of the experiences in other cities and regions, as well as a consistent reduction of air pollution, congestion and CO_2 emissions in the cities as well as a growing market for commercial shared e-mobility providers aligned with local policy goals.

Find out more about the project:

https://www.nweurope.eu/projects/project-search/ehubs-smart-shared-green-mobility-hubs/

CIVITAS **ECCENTRIC**, funded under the European Union's Horizon 2020 research and innovation programme, project duration 2016-2020, focuses on sustainable mobility in suburban districts and innovative urban freight logistics - two important areas that have previously received less attention in urban mobility policies.

The project aims to (1) demonstrate and test innovative sustainable mobility in peri-central areas, combining new policies, technologies and soft measures, (2) demonstrate and test innovative urban freight in urban centres, based on close cooperation with the research and private sectors, (3) contribute to the knowledge base and capacity building on effective mobility solutions with the goal to replicate solutions in other cities and (4) increase the impact of ECCENTRIC through communication, networking and promoting the successful commercial concepts developed.

In the project, five European cities (Turku, Stockholm, Munich, Ruse, Madrid) demonstrate a variety of innovative solutions for suburban mobility and emission-free freight in urban areas. One of the thematic areas is electric mobility and specifically the electrification of municipal fleets.

Find out more about the project:

https://civitas.eu/eccentric

mySMARTLife is a project funded under the European Union's Horizon 2020 research and innovation programme, project duration 2016-2021. The project aims at making the three Lighthouse Cities of Nantes, Hamburg and Helsinki more environmentally friendly by reducing the CO_2 emissions of the cities and increasing the use of renewable energy sources.

Project activities focus on three core elements: „Inclusive Cities", offering a high quality of life to residents, „Smart People" are playing a vital role in their city's development and „Smart Economy" - an innovative and dynamic economic concept aiming at guaranteed employment and an adequate income, attracting talents and providing goods and services according to the actual requirements.

The interventions planned and carried out in the three Lighthouse Cities include innovative technological solutions in connection with refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions. An integrated planning process, where citizens are actively involved in the decision making, links the actions in different fields (e.g. mobility, sustainable energy, ICT). Following a structured city business model leads to an integrated urban transformation strategy, which can be easily transferred to other cities also beyond the scope of mySMARTLife.

Find out more about the project:

https://www.mysmartlife.eu/

"The time is now to implement e-mobility since technologies are advanced, materials such as batteries are cheaper than couple of years ago and a lot of experiences and good practices to refer to are existing."

Magnus Karlstroem,
Lindholmen Science Park, Sweden

4 | Perspectives and potentials for e-mobility solutions in urban areas in the Baltic Sea Region

The possibilities of e-mobility are extensive. E-mobility can contribute to more climate-friendly traffic, reduce noise pollution and enable logistics to be as environmentally friendly as possible. BSR electric use cases as well as other mobility projects highlighted key aspects, challenges and opportunities to be considered for lifting transforming mobility systems onto a more sustainable level. The necessary transformation of the mobility sector is still not progressed enough even though upscaling of some means of transport can be observed throughout Europe, e.g. in terms of e-cars, e-buses and e-bikes. To ensure success and longevity of the shift towards e-mobility, the main actors of the four key pillars of sustainable mobility (policy, infrastructure, finances and technology), have to cooperate in their strategies. A broader set of new ideas need elaboration, for instance, developing MaaS solutions. Thus, obstacles to e-mobility can be removed - among other things by working on the image of e-vehicles, the improvement and development of battery technology, charging infrastructure, procurement procedures and the price of electricity. Aspects such as political targets, spatial planning and city development plans, the transport system, strategic partnerships and networks are of importance as well. Overall, this is a complex process, in which the use of e-vehicles affects the energy transition process and the energy chain, which in turn affect business, policymaking and technology development. In practice, e-vehicles will transform transport and electricity infrastructure systems which are embedded in the economy and daily practices and can also be resistant to change due to the complex interdependencies amongst the many actors of the systems. Therefore, government intervention is needed not only to promote the shift towards e-vehicles but also to define the industry and operational standards, which would support a reliable electricity supply as well as safeguard public interests. To further ensure successful implementation of e-mobility, enough time should be spent in the planning phase, including participatory approaches. The market should be further researched, mobility should be advertised, and good infrastructure should be provided. Furthermore, subsidies should be used to support e-mobility.

Through its comprehensive activities, BSR electric's approach addresses all pillars that are needed to successfully foster successful implementation of sustainable e-mobility solutions, particularly in urban settings: all of the project's activities contribute to increasing the awareness and understanding of how different e-mobility applications can be implemented in practice and guide public authorities, companies, planners and transport providers within the region in the process of integrating these into their urban transport strategies.

- Urban Logistics: Creating a winning circle in urban freight - Through municipal coordination and networking, the Municipality of Høje Taastrup (DK) tackled the chicken and egg problem and incentivized urban transport actors to feed-in e-mobility solutions into existing businesses.
- E-logistics: Optimizing inner-city logistics - Testing of various Light Electric Vehicles in a city-owned company in Turku (FI) allowed to identify the most feasible and most efficient solutions for inner-city maintenance and logistics.
- E-buses: Re-inventing the wheel in public transport - Public transport providers in Hamburg (DE) and Tartu (EE) tackled the challenges related to the integration of electric buses into urban bus fleets and derived valuable recommendations for e-bus operations and implementation.
- E-bikes for commuters: Transforming everyday urban travelling - Gdansk, one of the leading cycling cities in Poland, integrated e-bikes into its bike-sharing system and through large-scale campaigns boosted the use of e-bikes for multimodal trips in the metropolitan area.
- E-bikes for families: Promoting sustainable transport through trending experiments - In the Helsinki Metropolitan Area (FI), a series of e-bike promotion and testing events for families and workplaces received major media attention and resulted in a transferable campaign concept that can be implemented in other cities.
- E-scooters: Enabling social inclusion in public spaces - In Riga (LV), e-scooter implementation facilitated access and thus increased social inclusion of senior and disabled residents in a large hospital complex and a cemetery.
- E-ferries: An electrified water bound alternative for urban transport - Cities, operators and further transport stakeholders from Rostock (DE), Gdansk (PL) and Oslo (NO) compiled experiences and recommendations regarding suitable technologies, charging infrastructure, policy, and procurement regulations for electric ferries.

Based upon the findings and results of the aforementioned piloting activities, BSR electric also developed a hands-on recommendations guide, i.e. **five theme-specific Action Checklists** (see box below) guiding decision-makers to integrate and upscale electric mobility solutions in their own transport systems.

Action checklists

- E-vans and E-logistics - Action Checklist for Municipalities, Local and National Politicians
- E-buses - Action Checklist for Municipalities and Public Transport Providers
- E-bikes - Action Checklist for Municipalities and Companies
- E-scooters - Action Checklist for Municipalities and Organizations
- E-ferries - Action Checklist for Municipalities

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The BSR electric project has been implemented from October 2017 to September 2020 as part of the INTERREG Baltic Sea Region Programme 2014-2020. The project covered eight BSR countries and involved 14 partners and 28 associated organisations, including public authorities, business, academia and NGOs. This roadmap synthesizes the project's results. It is one of the key outputs and provides a compact information directory for e-mobility stakeholders and further decision makers within the project community and beyond.

Want to learn more?

You will find more results and outputs at our website!
We invite you to enroll for our online learning module on e-mobility solutions in urban areas in the Baltic Sea Region at https://dl4sd.org/!

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