D 2.1 – Specification of city & PT stakeholders strategies and needs

Deliverable n°	D 2.1
Version Date	13/04/2018
Type of Deliverable	Report
Dissemination Level	Public
Issued by	Giacomo Lozzi (POLIS)
Status	Issued

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement Nr. 769850

SUMMARY SHEET

Programme	Horizon 2020
Contract N.	769850
Project Title	Fast and Smart Charging Solutions for Full Size Urban Heavy Duty Applications
Acronym	ASSURED
Coordinator	VUB
Project Director	Prof. Noshin Omar
Website	www.assured-project.eu
Starting date	1 October 2017
Number of months	48 months

Deliverable Nr	2.1
Title	Specification of city & PT stakeholders strategies and needs
Date of issue	13/04/18
Distribution (internal/External)	External
Dissemination level (confidential / public)	Public
Key words	Cities, PTAs, PTOs, e-Deployment strategies, electrification roadmaps, SUMP, 'electromobility profiles'
Abstract	*Assessing the needs and strategies of local administrations, and public transport authorities and operators regarding the integration of fully battery-electric buses, freight trucks and vans.* *Facilitating the best possible identification and understanding of cities' and Public Transport needs, a three-step analysis takes place including: categorisation of cities, collection of cities' and Public Transport stakeholders' demands, survey of existing roadmaps for transport electrification.*

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Entity	Short name	Country	Contact person
European Commission	INEA	Belgium	Mr. Michal Klima

DOCUMENT CHANGE LOG

Version number	Date	Organisation name	Description
V01	23/02/2018	Polis	Structure
V02	27/03/2018	Polis	Development
V03	9/04/2018	Polis	Corrections
V04	10/04/2018	FEV, TNO, UITP	Review
V05	11/04/2018	RINA-C BE	Quality Check
V06	13/04/2018	Polis	Corrections
Final version	13/04/2018	VUB	Version ready for submission

ACRONYMS

AF: Alternative Fuels
AFI: Alternative Fuels Infrastructure
AMB: Àrea Metropolitana de Barcelona
BEV: Battery Electric Vehicle
CCS: Combined Charging System
CEVs: Conventional freight vehicles
DNO: Distribution Network Operators
EAFO: European Alternative Fuels Observatory
EC: European Commission
EEA: European Economic Area
EFV: Electric Freight Vehicle
EPBD: Energy Performance of Buildings Directive
EU: European Union
EV: Electric Vehicle
GHG: Greenhouse Gas
GVVP: Gemeentelijk Verkeer en Vervoerplan
HD: Heavy Duty Vehicles
ICE: Internal Combustion Engine
ITS: Intelligent Transport Systems
Las: Local authorities
LIVE: Logistics for the Implementation of Electric Vehicles
MD: Medium Duty
MRP: Maximum Resale Price Provisions
NGO: Non-Profit Organisation
NPF: National policy frameworks
OEM: Original equipment manufacturer
OfGEM: Office of Gas and Electricity Markets
OPG: Osnabrücker Parkstätten-Betriebsgesellschaft
PT: Public Transport
PPP: Public Private Partnership
PTA: Public Transport Authority
PTO: Public Transport Operator
RACC: Reial Automòbil Club de Catalunya
SUMP: Sustainable Urban Mobility Plans
SWO: Stadtwerke Osnabrück
TCO: Total cost of Ownership
TEN-T: Trans-European Transport Networks
TMB: Transports Metropolitans de Barcelona
UFUG: Freight Operators User Group
WHO: World Health Organisation
ZeEUS: Zero Emission Urban Bus System

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Executive Summary

ASSURED is looking at innovative and fast interoperable charging infrastructure concepts and solutions, mainly addressing commercial electric vehicles such as buses, trucks and vans, to be tested in different cities across Europe.

ASSURED aims to enable the industrial partners to improve their total cost of ownership and to reduce the operational cost of the vehicles. It also assumes that the views and needs of cities, public transport authorities and operators and other urban actors, such as freight operators, are essential to define a shared vision on how to make cities cleaner through the electrification of all types of vehicles, and solve challenges about the deployment of the related charging infrastructure.

Supporting a scenario that envisages a large deployment of electric vehicles, it is important that cities set effective and coherent Electrification Deployment Strategies[1] to define their implementation plans for fast charging infrastructures and to follow their roadmaps towards sustainable mobility. Concerning that, this work preliminarily investigates the needs of the cities and the public transport authorities and operators of Gothenburg, Osnabrück, Barcelona and Eindhoven. They are the ones involved in the project's pilots, supporting the definition of the requirements for next-generation fleets of electric Heavy-Duty commercial vehicles and related charging infrastructure. Cities and public transport authorities and operators need to evaluate the impact of these fleets of vehicles in their urban environment, also considering the high-power charging equipment on the electricity grid in the city.

Attainment of the objectives and explanation of deviations

Regarding the submission of Deliverable 2.1, due on March 31, 2018 (month 6 of the project), the submission was postponed for two weeks, i.e. to April 13, 2018. The reasons for this request are due to the methodology used to prepare the deliverable itself, envisaging the involvement of subjects external to the consortium.

First, a City and Operators Strategies and Needs Workshop was organised by UITP, with the support of POLIS. Cities and operators provided their feedback on the ASSURED survey template elaborated to collect cities information, needs and strategies. The template has been considerably adapted accordingly, to satisfy the requests of the task:

1) Categorise cities: key indicators set to define several cities' profiles with possibly different needs and expectations
2) Identify cities' and public transport stakeholders' needs
3) Map existing roadmaps for transport electrification: collect existing document and assess them, including the integration of electrification strategies in SUMPs

To obtain reliable results, ASSURED interacts with interested European cities, Public Transport Operators and Public Transport Authorities to collect their needs and support them in defining their implementation plans for fast charging infrastructures. Several European cities active in the electrification of transport have been consulted, in particular those that are currently engaged in the implementation of strategies towards e-mobility. However, the consortium does not include local authorities, therefore POLIS, UITP and RC invited external organisations to contribute to the deliverable, on two levels:

1) City level data and information to build a city electromobility profile: collection of city information and vision, strategies and policies, infrastructure data, vehicles data, e-buses data (desk research, filling of dedicated template)
2) Cities needs investigation: qualitative assessment of specific needs, demands, constraints and expectations of local authorities about development and integration of

[1] http://www3.weforum.org/docs/WEF_2018_%20Electric_For_Smarter_Cities.pdf

electric buses, trucks and VANs, as well as the related charging infrastructure and methods (filling of dedicated template and bilateral interview).

In particular, the direct consultation of the local authorities of the cities hosting the ASSURED pilots, i.e. Gothenburg, Osnabruck, Barcelona and Eindhoven provided first-hand results. These are necessary for the project to effectively implement the pilots, thanks to a greater awareness of the needs of the cities and transport operators.

Getting such detailed information and organising interviews with organizations that are not project partners, and therefore have no immediate benefit or obligations towards ASSURED, has generated a slight delay. Nevertheless, the information is available, and the needs of the cities have been acquired. We received valuable, first-hand information and contribution from the cities, improving the success of the deliverable.

Partners' Contribution

Company	Sections	Description of the partner contribution
POLIS	All	Development report structure Development section 1 Development section 3 (except for 3.5.1.5, 3.5.3.2, 3.5.4) Development section 4 (except for 4.2) Development section 5.1.2 Section 4: interviews of following cities/authorities: Barcelona, Eindhoven, Gothenburg, London, Madrid, Manchester
UITP	3, 4, 5	Development sections 3.5.1.5, 3.5.3.3 Development section 4.2 Development section 5 (except for 5.1.2)
	All	Review report
RC	2, 3, 4	Development section 2 Development section 3.5.4 Section 4: interviews of following cities/ authorities: Osnabrück, Bremen, Gdynia, Aachen
RINA-C	3	Quality check
VUB	All	Review report, quality check
TNO	All	Review report
FEV	All	Review report

1. Introduction

This deliverable collects the needs of cities, Public Transport Operators (PTOs) and Authorities (PTAs) and end users for battery electric buses, trucks and vans. The identification of the boundary conditions and constraints for super-fast charging infrastructure implementation are considered, to provide ASSURED project partners with useful information to develop case studies and pilots. This analysis is carried out by investigating three main areas:

1. **Survey of existing roadmaps for transport electrification**: Cities play a key role in supporting vehicle electrification policies. Through their planning schemes, local authorities (LAs) can define long-term visions and roadmaps, adopt strategies and implement measures that are essential to influence the uptake of Electric Vehicles (EVs) in urban environments. Electromobility strategies can contribute to reaching local goals that reflect EU objectives. For being effective, those interventions must be included in existing plans, such as Sustainable Urban Mobility Plans (SUMP). Therefore, ASSURED wants to collect existing roadmaps for transport electrification adopted at the local level, and assess the integration of electrification strategies in SUMPs.
2. **Create cities' 'electromobility profiles'**: ASSURED aims to identify elements that characterize European cities that decide to adopt an urban transport electrification strategy. Starting from a survey carried out within the European Alternative Fuels Observatory (EAFO) project, the survey elements have been adapted to ASSURED to build a city electromobility profile, considering city information and vision, strategies and policies, infrastructure data, vehicles data, e-buses data. Subsequently, ten local authorities[2] filled the ASSURED template and were interviewed to identify the key aspects characterising their e-mobility situation. In particular, the profiles of the four cities in which ASSURED pilots will take place have been compiled.
3. **Identify cities' and public transport stakeholders' needs**: interviews and questionnaires, together with the ASSURED workshop (21st February 2018, Eindhoven), the ASSURED-ELIPTIC[3] workshop (19th March 2018, Brussels) and desk research were carried out. They served to gather the opinion and to identify the needs of cities, PTO and PTA to properly manage and efficiently accommodate the upscale of e-fleets in cities, and in particular for the Heavy-Duty (HD) EVs, such as buses, trucks and vans, requiring special conditions including fast charging infrastructure implementation.

[2] Aachen, Barcelona, Bremen, Eindhoven, Gdynia, Gothenburg, London, Madrid (EMT), Manchester (TfGM), Osnabrück
[3] http://www.eliptic-project.eu/

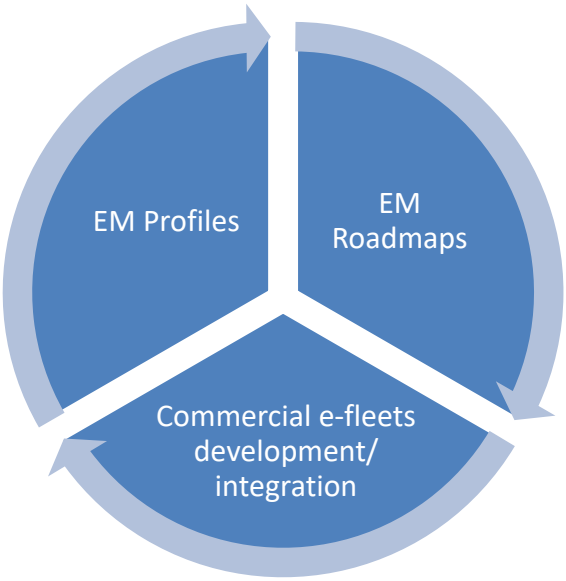


Figure 1 - The planning cycle for the electrification of urban mobility

Chapter 2 defines the state of the art of existing roadmaps for transport electrification, identifying EU and national legal frameworks and analysing electrification strategies, that can be assessed with regard to their different dimensions of integration into the respective planning areas.

Chapter 3 “builds” the cities’ ‘electromobility profiles’ as described above. In the beginning, it reports the results of the EAFO survey on the deployment of alternative fuelled vehicles and infrastructure in Europe, then it introduces the methodology adopted in ASSURED for building the cities profiles and finally describes the situation in the four ASSURED cities: Barcelona, Eindhoven, Gothenburg and Osnabrück.

Chapter 4 identifies the needs of cities, PTO and PTA respectively, also taking into account the urban freight dimensions, around three main areas: 1) discussion on limitations for e-fleets and charging infrastructure roll-out; 2) electrification promotion; 3) user needs.

Chapter 5 suggests some measures for facilitating the uptake of HD EVs at local level, and defines the next steps for an ‘e-Deployment Strategy’. Although specific recommendations to ultra-fast charging and interoperability will come only at the end of the ASSURED project, and interoperability is more ‘tactical’ in nature, the ones here refer to the strategic objective of ASSURED, which is the upscale of the fleets.

2. State of the art: existing roadmaps for transport electrification

2.1 EU AND NATIONAL LEGAL FRAMEWORKS

On both levels, EU and national, there are legal frameworks that support the electrification of transport in Europe. As a key guiding strategy, the EU Transport 2050 Roadmap[4] sets clear targets and initiatives for reducing transport emissions by 60% and phasing out of conventionally fuelled vehicles by 2050. The most relevant legislation for transport electrification in Europe is the EU Directive for deployment of alternative fuels infrastructure (AFI - Directive 2014/94/EU)[5], which sets technical specifications on charging and requires member states to develop national policy frameworks (NPF) for the market development of alternative fuels and their infrastructure. Member states are obliged to set targets for providing publicly accessible recharging points to be built by 2020.

Many member states do not entirely meet the requirements of the Directive in their national policy frameworks; the main challenge for many member states, including Austria, Belgium, Germany, Ireland and the UK, is to reach the ratio for charging points per EVs on the road in the respective countries. Estimates for the number of EVs on public roads are low in most member states, with targets of under 1% for shares of EVs on the roads. Yet, each member state sets different emphases in the NPF in order to meet the requirements of the Directive. The Polish NPF, for instance, focuses on the development of the market for electric cars and aims for 1 million EVs on the road by 2025, and Luxembourg has developed a detailed action plan for the development of nationwide public recharging infrastructure for EVs.[6]

The deployment of EVs in EU member states is also shaped by independent national incentives. Most countries adopted a variety of initiatives, including purchase subsidies for EVs, registration tax benefits, ownership tax benefits, company tax benefits, infrastructure incentives and other local incentives. VAT benefits are a rarer incentive in the EU and only adopted by Iceland.

Further legislation in support of transport electrification on EU level is the Clean Vehicles Directive (2009/33)[7], which requires public procurers to take into account energy consumption, CO_2 and pollutant emissions from vehicles. The Renewable Energy Directive (2009/28)[8] requires a share of 10% of Renewable Energy Sources in motor fuels by 2020. The EU Clean Air Policy Package of 2013[9], which targets a reduction of air pollutants by 2030, and the EU target as part of the Paris Agreement (2015)[10] to reduce greenhouse gas emission in the EU territory by 40% by 2030, also foster the deployment of electromobility across Europe. The 2013 Urban Mobility Package[11] outlines and details next steps towards the further rollout of SUMPs. It also offers a range of guidelines on clean city logistics, access regulations, ITS for smart cities, urban safety and SUMP development.

[4] https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en
[5] https://publications.europa.eu/en/publication-detail/-/publication/d414289b-5e6b-11e4-9cbe-01aa75ed71a1/language-en
[6] EC 2017. Commission Staff Working Document. Detailed Assessment of the National Policy Frameworks.
[7] https://ec.europa.eu/transport/themes/urban/vehicles/directive_en
[8] https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
[9] http://www.consilium.europa.eu/en/policies/clean-air/
[10] https://ec.europa.eu/clima/policies/international/negotiations/paris_en
[11] https://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en

2.2 INTEGRATION OF ELECTRIFICATION STRATEGIES

Across Europe, cities increasingly integrate targets and strategies for the electrification of transport into local planning processes. The existing strategies can be assessed with regard to their different dimensions of integration into the respective planning areas[12].

2.2.1 Horizontal Integration

The approaches to integrating strategies for the electrification of transport differs from city to city. Electrification of transport is often defined as a target in cities' sectoral strategies like air quality plans (e.g. the Air Quality and Action Plan for Bremen[13] and the Air Quality Action Plan for Manchester[14]), or noise reduction plans (e.g. the Noise Reduction Plan for Aachen[15]). The impelling problems behind these plans are high noise levels and low air quality, which the cities intend to improve, amongst others, by promoting electromobility and thus reducing traffic-induced noise and particulate matter. Electromobility plays a supporting role in the pursuit of objectives in those plans but is rarely reflected in specific targets or actions. For instance, Manchester's Air Quality Action Plan commits local transport authorities to review the future role and needs of electric vehicles and encourage their uptake. However, these intentions are not further defined as strategic measures in the plan's list of actions.

Transport-focused local strategies, such as the Alternative Fuels Strategy for the Liverpool City Region and the SUMPs of Aachen, Barcelona, Madrid and Manchester ascribe a larger role to electromobility. The SUMP of Barcelona, for example, sets several targets and measures to promote the use of EVs (see section 3.5.1). Further targets aim to electrify specific bus fleets, promote electric delivery as well as increased use of private EVs. In the transport-focused strategies, electromobility is generally integrated as a provision for the reduction of noise, pollution and traffic congestion.

Several cities and city regions have developed or are currently developing stand-alone strategies and action plans for the electrification of transport, such as the E-Mobility Strategy for Vienna[16], the Electromobility Concept for Osnabrück, the Electric Vehicle Strategy in Oslo[17], Liverpool[18] and Eindhoven, the Electric Vehicle Action Plan for Edinburgh[19], and the Action Plans for Electromobility for Berlin[20] and for Berlin-Brandenburg[21], respectively. Furthermore, the city of Aachen is currently developing a strategy for the expansion of charging infrastructure in the city. The targets within these specific electrification strategies tend to be quantified and more clearly defined than in strategies with other foci and are often linked to specific measures for implementation. For instance, the targets within the E-Mobility Strategy for Vienna[22] include an increase of the share of electric travel from 33% to 38% by 2025, as well as the implementation of at least 22,000 private and public charging points. Specific actions to achieve these targets are for example the development of guidelines for office charging stations, and the expansion and support of urban fleets. The policy lever for strategies and action plans focused on the local expansion of electromobility is, similar to the strategies listed above, increasing concerns over climate change and ongoing air quality

[12] Appelhans, Nadine; Hanke, Stefanie; Klein-Hitpaß, Anne: Elektromobilität – Ansätze für kommunale Planungsverfahren. Handbuch der kommunalen Verkehrsplanung: 2017-10
[13] https://www.bauumwelt.bremen.de/sixcms/media.php/13/LRP_Bericht_VERS.1.0_14.pdf
[14] http://www.greatermanchester-ca.gov.uk/downloads/file/228/greater_manchester_air_quality_action_plan_2016-21
[15] http://www.aachen.de/DE/stadt_buerger/umwelt/laermschutz/laermaktionsplan_ac/laermaktionsplan-ac.pdf
[16] https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008435.pdf
[17] http://www.c40.org/blog_posts/driving-action-oslos-electric-vehicle-strategy-leading-the-way
[18] https://www.merseytravel.gov.uk/about-us/local-transport-delivery/Documents/E-Mobility-Strategy.pdf
19 http://www.edinburgh.gov.uk/download/meetings/id/55565/item_74_-_electric_vehicle_action_plan.
[20] https://www.berlin-partner.de/fileadmin/user_upload/01_chefredaktion/02_pdf/publikationen/eMO%20Aktionsprogramm%20%28english%29.pdf
[21] http://www.emo-berlin.de/fileadmin/user_upload/Downloads/Praesentationen_Hauptstadtkonferenz_2014/Vortrag_Thomas_Meissner.pdf
[22] https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008465.pdf

impacts, while the broader objective of these strategies is to encourage the uptake of EVs in general and to unlock wider economic benefits.

In the development of e-mobility strategies, single cities have started to work cross-departmentally. The city of Aachen, for instance, has established an integrated planning culture specifically around the topic electromobility, but still is facing problems in comparison to other cities[23]. The municipal e-mobility strategy as part of the SUMP has been developed in close cooperation with all relevant departments (transport management, building administration, environment, economic development). Both, the cities of Aachen and Gdynia, have created a position for an e-mobility officer who works across the different city departments.

2.2.2 Modal Integration

In the majority of analysed strategies, electromobility is considered as a complementary element to existing public transport, with high potential to reduce emissions and traffic congestion if it is integrated strategically. The future of electromobility is commonly understood as multimodal, with public transport as a backbone. Most electromobility strategies plan for the step-wise electrification of several transport modes and aim for interconnection of these modes. The electrification objectives in the Electric Mobility Strategy of the Hanseatic City of Rostock[24] include the strengthening of inter- and multimodal mobility chains and cross-linking of different transport modes; In addition to the long-term conversion of diesel fleets to e-buses, the city plans to expand supplementary e-mobility services such as pedelec rental systems and introduce eCar-sharing systems, in order to provide door-to-door mobility options. Targets for electric travel shares in a city's modal split are not usually included in electrification strategies. As mentioned above, Vienna's E-Mobility Strategy is an exception with its aim to increase the share of electric travel by 2025. Where charging infrastructure is addressed, strategies usually focus on the charging of private or shared electric cars and pedelecs. At this point, neither fast charging infrastructure nor multipurpose/interoperable charging solutions are an issue for European cities. Developments in these charging solutions are not yet addressed in the existing e-mobility strategies.

2.2.3 Sectorial Integration

Cooperation of cities with local industry and energy providers for local electrification plans is common practice and usually regarded as a catalyst for the achievement of targets. The model of municipal utilities in Germany is particularly beneficial in this regard. Municipal utilities are municipal companies in the majority ownership of one or more municipalities. They provide technical services and utilities or provide municipal infrastructure on a public service basis. As municipal utilities often include local energy providers, cities that own municipal utilities tend to have a stronger influence on the development of local charging infrastructures. For instance, the city of Osnabrück focuses on off-street charging concepts in public parking garages. In the implementation of their charging infrastructure plans, the city of Osnabrück works directly through their subsidiary company that manages the city's parking garages. Likewise, the relationship between the city of Aachen and the city's municipal utilities STAWAG facilitates cooperation on joined activities for electromobility in Aachen[25]. Besides the cooperation with municipal utilities, the city of Aachen works closely with local EV manufacturers as well as the local PT operator and local research institutes. The city of Vienna has committed to cooperating with the logistics industry to optimize the flow of goods and traffic, by integrating electromobility. On the basis of a roadmap within their "Smart City Vienna framework

[23] http://www.aachener-nachrichten.de/lokales/aachen/elektromobilitaet-aachen-will-von-erfahrungen-der-anderen-lernen-1.1841435
[24] http://rathaus.rostock.de/sixcms/media.php/1246/HRO_Elektromobilit%C3%A4ts-Aktionsplan_2015.pdf
[25] https://www.stawag.de/ueber-uns/elektromobilitaet/

strategy"[26], Vienna plans to develop new instruments or adapt existing instruments in order to support logistics companies in implementing e-mobility strategies.

Cooperation with the local industry, such as logistics operators using EVs is beneficial particularly for charging infrastructure planning. Generally, cities have little influence on the construction of private or semi-public urban charging infrastructure. Local logistics operators usually use their own charging infrastructure at the private depots, as is the case in Aachen with the electric utility vehicles by the company "StreetScooter". However, the city of Aachen intends to intensify cooperation and exchange with private actors to reach an overview for charging infrastructure planning in the city[27].

2.2.4 Temporal Integration

The time horizons set in e-mobility strategies range from short-term goals (targets by +/-2020) to medium-term goals (by 2025-2030), to long-term goals (targets for up to 2050), whereby the latter are mostly visions, or future scenarios rather than clearly defined targets, and usually include strategic step-by-step implementation plans. In their SUMP, "Vision Mobility 2050", Aachen plans for all local vehicles to be independent from fossil fuels in the year 2050. Electrification targets are often in line with estimations for future demographic and technological trends.

2.2.5 Financial Integration

Electrification strategies rarely include detailed information on required funding or funding sources for implementation measures. As an exception, the intended Charging Infrastructure Strategy for Aachen will include a detailed list of costs and required resources for purchase, construction and installation of charging points. The E-Mobility Strategy of Vienna lists various support programs through which the local e-Mobility projects are funded. The city of Gdynia is challenged by a lack of sufficient financing for the implementation of e-mobility projects, due to budget cuts, high implementation costs and regulatory limitations in the city. Currently, e-mobility is not a high enough priority in the city of Gdynia to overcome these financial barriers.

2.2.6 Societal Integration

In the vast majority of electrification strategies, the motivations for electrification measures are local air and noise pollution. Thus, the local public is addressed through aspects of public health and well-being in the cities. Despite this emphasis on improving urban liveability for citizens, only few cities plan to involve the public directly into planning processes for e-mobility. However, more and more cities (e.g. Gdynia, Madrid, Manchester) are starting to integrate e-mobility and charging infrastructure concepts into their local SUMPs. As citizen involvement is an integral part of the SUMP process cycle, cities are expected to include public participation into their planning activities for the deployment of e-mobility as well. Good examples are provided by the city of Arnhem, where the tool "SparkCity" is used to enable citizen to submit requests for charging points at specific locations[28]. Moreover, the city of Aachen has conducted an online survey to investigate public acceptance of electromobility in the city. The results showed positive feedback and high acceptance of e-mobility among Aachen's citizens. The efforts of the city of Aachen for citizen involvement in e-mobility are further reflected in the e-mobility event "Aachen goes Electro"[29], that is organized annually to draw attention to e-mobility activities and projects.

[26] https://smartcity.wien.gv.at/site/wp-content/blogs.dir/3/files/2014/08/Langversion_SmartCityWienRahmenstrategie_deutsch_doppelseitig.pdf
[27] Interview with the city of Aachen, 22.03.2018
[28] http://sparkcity.org/wp-content/uploads/2018/02/4AT98_Report_Anand_Vijayashankar.pdf
[29] https://aachengoeselectro.de/

3. Building cities' 'electromobility profiles'

This chapter illustrates the methodology and results of the analysis to define the ASSURED cities' 'electromobility profiles'. Starting from the activity of the EAFO observatory, and with the contribution of ten European LAs[30], a template has been defined to capture key aspects of e-mobility in the urban context. This has already been filled by nine of the cities involved. Nevertheless, it must be considered a *living tool*, to monitor the situation in the different European local contexts and inform ASSURED about the needs and progress of cities. The promotion of this activity is supported by the Urban Freight Operators User Group (UFUG)[31]. On the basis of the data collected, the profiles of the four cities in which ASSURED pilots will take place have been compiled (Barcelona, Eindhoven, Gothenburg and Osnabrück).

3.1 THE STARTING POINT: EAFO CITIES PROFILES

3.1.1 Description of EAFO

To help Member States meet the AFI Directive goals[32] and support the market development of alternative fuels in the EU, the EC established the EAFO observatory[33].

The EAFO features a web portal that presents data and information on alternative fuels and clean vehicles in Europe, mapping their actual introduction and use, their infrastructure and the existing incentives across the EU. It supports national and EU legislation, programmes and incentives for alternative fuels. The observatory includes information from EU and European Economic Area (EEA) Member States, and Turkey. The EAFO targets EU policy-makers, manufacturers of related technology and infrastructure, Non-Profit Organisations (NGOs) and other stakeholders concerned by the topic. The vision for the EAFO is that it is 'the' reference point for information about alternative fuels in Europe, where all interested parties go to find data, information and best practice.

The EAFO's primary focus is on electric battery and hybrid vehicles, and those running on fuel cells, and then on natural gas and other alternative fuels. The website currently presents data on the five countries that sell the most EVs: Norway, Sweden, Iceland, the Netherlands, and Switzerland, as well as on 11 EU cities (Aachen, Amsterdam, Barcelona, Copenhagen Region, Dundee, London, Madrid, Manchester, Oslo, Stockholm, Stuttgart).

The Observatory also involved these cities in the preparation of a city-specific template for the deployment of alternative transport fuels, to ensure their needs and priorities are being taken into account. This template has been adapted to the specific area of investigation of ASSURED, in the way explained in 3.4.

3.1.2 Methodology of EAFO

To assess the current development of the alternative-fuel market at city-level, and to understand local drivers and barriers, the EAFO circulated a questionnaire among a selected group of cities to find out[34]:

[30] Aachen, Barcelona, Bremen, Eindhoven, Gdynia, Gothenburg, London, Madrid (EMT), Manchester (TfGM), Osnabrück
[31] Relevant experts, including local authorities, are invited to attend key ASSURED events and to exchange on and validate the project's innovations
[32] "The Directive, as adopted by the European Parliament and the Council on 29 September 2014 following the inter-institutional negotiations: 1) requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure; 2) foresees the use of common technical specifications for recharging and refuelling stations; 3) paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology" (from https://ec.europa.eu/transport/themes/urban/cpt_en)
[33] http://www.eafo.eu/
[34] CIVITAS INSIGHT: Cities' role in introducing clean vehicles and using alternative fuels: http://civitas.eu/sites/default/files/civitas_insight_20_cities_role_in_introducing_clean_vehicles_and_using_alternative_fuels.pdf

- General information on the city, its political strategy and vision to develop and introduce alternative fuels and infrastructure, energy and air quality targets, and links with the local/regional SUMP and building regulations;
- Information on mobility services, clean procurement, fiscal incentives and how the city manages local electric infrastructure;
- Current state-of-play and data related to alternatively fuelled vehicles in public fleets (for example, buses, shared cars, e-bikes, ferries and delivery/service vehicles) and privately-owned cars (including taxis and L category vehicles such as powered two- and three-wheelers);
- Data related to existing electric and biogas charging infrastructure, either publicly accessible or privately owned;
- Information concerning the city's involvement in EU/national projects to develop and introduce alternatively fuelled buses.

The template was developed in cooperation with cities through meetings and consultations, for the most appropriate selection of indicators. Cities involved were Aachen, Amsterdam, Barcelona, Copenhagen Region, Dundee, London, Madrid, Manchester, Oslo, Stockholm, and Stuttgart.

3.1.3 EVs Charging Infrastructure statistics

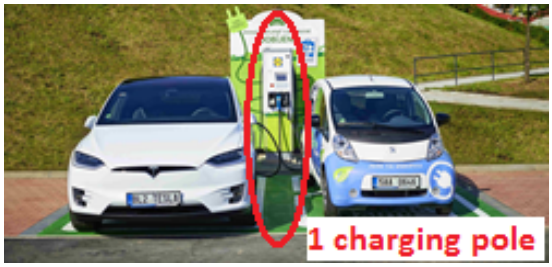
Based on the analysis of the city templates filled by the above-mentioned cities, it has been possible to aggregate some data on the EV Charging Infrastructure in those cities and to derive some interesting preliminary results.

The EAFO template aimed to map the EV charging infrastructure at three different levels:

Table 1 - Three levels of EV charging infrastructure

EV Charging point, defined as an "interface capable of charging one electric vehicle at a time", and including the power supply, plug and the space to park the car.

EV Charging pole, defined as an EV charger which may include more than one charging point/position.



EV Charging station, which may include more than one charging pole/charger.

In terms of distinction between normal and fast charging, EAFO decided to follow the AFI Directive definition of "normal" and "high power" charging infrastructure. Nevertheless, different interpretations and understandings exist on the definition of high power / fast / super-fast charging points, depending on the type of vehicle and the size of the batteries.

The AFI Directive makes the following distinction in terms of power provided by the charging infrastructure[35]:

- "normal power recharging point' means a recharging point that allows for a transfer of electricity to an electric vehicle with a power less than or equal to 22 kW, excluding devices with a power less than or equal to 3,7 kW, which are installed in private households or the primary purpose of which is not recharging electric vehicles, and which are not accessible to the public;
- 'high power recharging point' means a recharging point that allows for a transfer of electricity to an electric vehicle with a power of more than 22 kW".

According to the classification above, and limited to the cities filling the template, we could count a total of 131,763 charging points in 11 cities, of which 17,794 (14%) are H-power (>22 kW).

[35] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0094

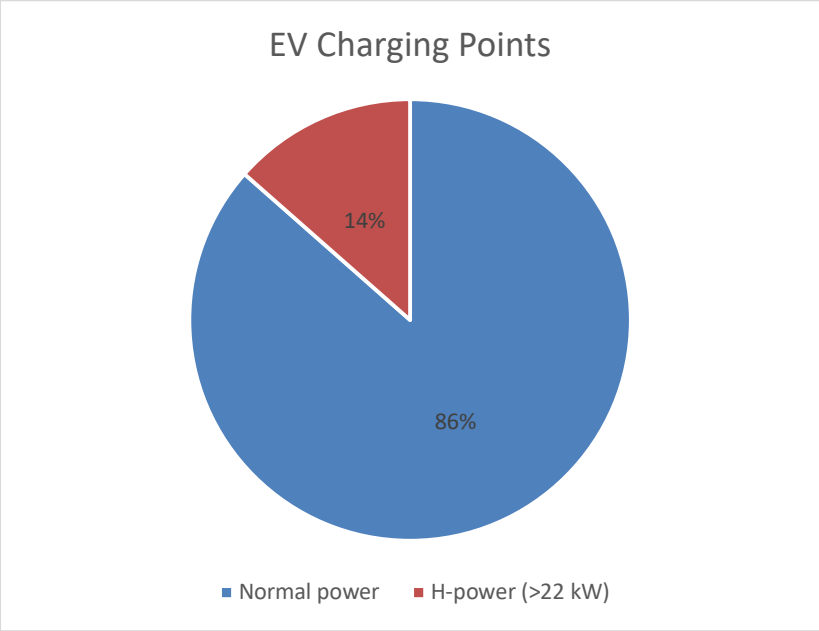


Figure 2 - Share of Normal / High power charging points in EAFO cities[36]

3.1.4 Vehicles data: electric full-size commercial fleets

THE EAFO template also mapped the amount of alternatively fuelled vehicles in the city. Total number of vehicles were accounted by fuel (electricity, hydrogen, natural gas - LNG and CNG) and by type, including both publicly owned or managed captive fleet, such as municipal fleet, public transport, service vehicles (waste, water, delivery), and privately-owned vehicles, such as car sharing schemes, taxis, 2/3 wheelers, pedelecs. However, data provided by cities are fragmented and incomplete. Therefore, data from the latest ZeEUS eBus Report #2[37] are reported in the table below:

Table 2 – Vehicle data : e-buses technologies in Europe in 2017

Type of vehicles	Category	BEV	PHEV	FCEV	Total
Buses (Public Transport)	M2+M3 City Fleet	235	59	686	980

Source: ZeEUS eBus Report #2

Data on other types of commercial vehicles, belonging to the city fleet or to private freight operators, have been aggregated in the scope of this research, to provide for an overview of the current trends of commercial e-fleet deployment.

[36] Source: elaboration based on EAFO city templates (available on http://www.eafo.eu)
[37] 24.10.2017: http://zeeus.eu/uploads/publications/documents/zeeus-report2017-2018-final.pdf

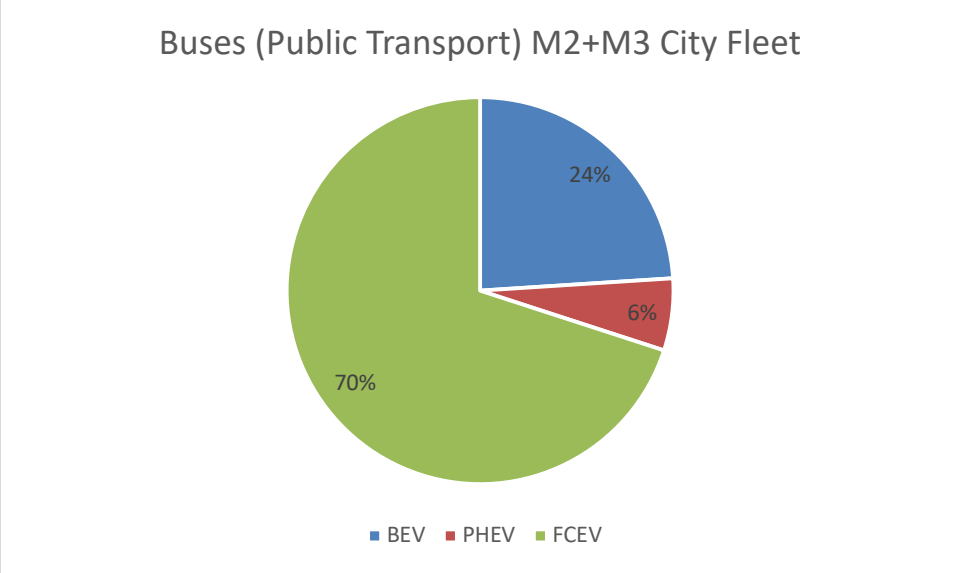


Figure 3 – percentage of e-buses technologies in Europe in 2017[38]

Table 3 - Vehicles data: electric full-size freight commercial fleets in EAFO cities

Type of vehicles	Category	Total
Light Commercial Vehicles	N1 Total *(N1 City Fleet)*	954 *(158)*
Heavy Duty Vehicles	N2/N3 City Fleet	12
Total		**966**

Source: elaboration based on EAFO city templates (available on **http://www.eafo.eu**)

3.2 ASSURED: FOCUS ON (SUPER) FAST CHARGING OF URBAN COMMERCIAL VEHICLES

The World Health Organization (WHO) links many transport-related emissions (i.e. nitrogen oxides, particle matter, etc.) to diseases reducing life expectancy and quality of living, including lung and bladder cancer, chronic bronchitis, asthma and cardiovascular diseases[39].

Compared to conventional vehicles powered by an Internal Combustion Engine (ICE), the electrification of vehicles in urban areas has direct benefits on the quality of air, and consequently generates positive impacts from a social, economic and environmental point of view for the community. The emissions of vehicles are significantly reduced, generating a reduction in the external costs of transport for public health: having fewer sick citizens, means having a healthier society, but also lower costs regarding public spending on health. Furthermore, when combined with the use of renewable energies, vehicle electrification brings benefits to the urban and non-urban environment, which could reduce global emissions and greenhouse gases from the production of fuel for traditional-powered vehicles.

Electrification of vehicles is emerging as a leading technology to achieve the urban-related objectives defined by the EC in the 2011 White Paper on Transport[40]: reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050; halve the

[38] Source: ZeEUS eBus Report #2
[39] http://www.euro.who.int/__data/assets/pdf_file/0006/74715/E86650.pdf
[40] https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en

use of 'conventionally fuelled' cars in urban transport by 2030; phase them out in cities by 2050; and achieve essentially CO_2-free city logistics in major urban centres by 2030.

However, production numbers still remain low primarily because of the high additional cost of the electrified powertrain and storage system. In general, battery size, efficiency and fuel consumption, Greenhouse Gas (GHG) regulations and zero emission zones are the main parameters for the optimization of the Total Cost of Ownership (TCO) and driving the demand and supply of the HD and Medium Duty (MD) vehicles. Hence, the HD vehicle manufacturers have a strong incentive to reduce the TCO in order to improve the business case for electrified powertrains/vehicles, complying not only with the EU objectives, but also with the cities' and end users' needs towards clean transport.

3.3 BUILD THE ASSURED CITY PROFILE: INDICATORS AND METHODS

ASSURED aims at boosting the electrification of urban commercial vehicles and their integration with high power fast charging infrastructure. Pilots will be implemented in Gothenburg, Osnabrück, Barcelona and Eindhoven. The goal is to charge different vehicles using the same infrastructure, which is what makes ASSURED so innovative. As a first step, D 2.1 is focusing on three main aspects:

1. Survey of existing roadmaps for transport electrification
2. Create cities' 'electromobility profiles'
3. Needs, constraints and expectations

For this purpose, a template developed with different cities for EAFO has been adapted with the support of different local and PT authorities (see ANNEX II). Cities hosting the ASSURED pilots and external cities, PTOs, PTAs and freight operators were consulted with different methods:

- by participating in the ASSURED workshop (21st February 2018, Eindhoven) and the ASSURED-ELIPTIC workshop[41] (19th March 2018, Brussels), to discuss best practices for moving from a pilot and demo service towards a large scale electric fleet
- by filling the updated ASSURED template
- by an interview about needs, demands, constraints and expectations for the development and integration of electric buses, trucks and vans, as well as the relating charging infrastructure and methods and on the existing roadmaps for electrification.

3.4 FROM EAFO TO ASSURED: UPDATE AND UPGRADE OF CITIES PROFILES

As illustrated in the section on preliminary findings of the EAFO survey (section 4.1), cities stressed the need to exchange at the EU level on e-bus depots, maintenance and storage facilities related to e-fleets, as well as on interoperability of charging plugs and opportunity charging systems' standards. These needs are addressed by ASSURED. In order to take advantage of the remarkable findings of EAFO, but at the same time to make a step further, ASSURED has taken over the EAFO survey structure, adapting it to focus on electric commercial vehicles, and to consider freight-related strategies and plans, further aspects of procurement and fast charging infrastructure.

In the phase of the conception of a new survey, ASSURED took into account the various feedback provided by the 11 cities that had previously participated in the EAFO questionnaire. In particular, cities had emphasized the following challenges, many of them related to the difficulties of collecting data (for more details, see section 4.1):

- Problems differentiating between locations, chargers and positions in the infrastructure table prepared by EAFO

[41] https://www.polisnetwork.eu/publicevents/515/61/ELIPTIC-Workshop---Charging-Infrastructure-amp-Policy-recommendations

- Lack of available vehicles data in EU vehicle categories
- Lack of available statistics for vehicle and infrastructure data, as well as for the number and types of contracted vehicles
- Impossibility to keep track of the charging points in use
- Not all data are immediately available
- Exact statistics for charger coverage are unavailable, as well as vehicle statistics
- Inability to share data and information developed in the context of EU projects and protected by confidentiality clauses.

As far as possible, ASSURED, in addition to adapting the template to its research scope, has tried to overcome these issues in the new version of the template.

Table 4 gives a quick overview of the aspects addressed in the ASSURED survey template. In the following sections, the new ASSURED-related elements are explained.

Table 4 - Overview of ASSURED survey template's main topics and indicators

Topic	Indicators
City info and vision	**City** basic information **Alternative Fuels** considered in local strategy **Projects** EU/National, case studies **Targets**, e.g. long-term electrification, zero emission vehicles, renewable energy…
Strategies and policies	**Planning**: SUMPS/electrification strategy including freight **Procurement** promoting fleet electrification **Incentives**: purchase, parking, access, infrastructure… **Charging infrastructure**, including fast charging
Infrastructure data	**Statistics** charging points and stations Normal/High Power
Vehicles data	**Statistics** according to EU vehicle categories or could be completed with data as registered by local authority
E-buses data	Manufacturer, technology, charging method…

3.4.1 Strategies and policies

3.4.1.1 PLANNING

The survey investigates whether the city has a SUMP integrating Alternative Fuels' promotion provisions - in particular for electrification - or other relevant strategy/roadmap for transport electrification, and if this strategy/plan considers the integration of electric urban (commercial) vehicles in multimodal transport.

In addition, ASSURED also considers the urban freight and logistics component, since it looks at e-vans and e-trucks, besides e-buses. Therefore, it investigates whether the city has an

urban freight transport plan and/or supports the implementation of specific measures, including the deployment of freight electric vehicles and charging infrastructure.

3.4.1.1 PROCUREMENT

Procurement is considered an effective method to influence and increase the demand for EVs, as well as to give a good example to citizens and business. Therefore, the survey investigates whether the city has specific procurement protocols in place promoting GHG, Air Quality or other specific goals and replacement policy for city fleet vehicles (own or contracted) with EVs. Compared to EAFO, which considers all types of alternative fuels, the scope has been narrowed to EVs only.

3.4.1.2 INCENTIVES AND SUPPORT

During the Eindhoven workshop, cities representatives asked to make clear the difference, in the survey, between the presence of incentives directly provided at city level (therefore depending on them), and the ones already existing at the national and regional level to incentivise the use of EVs, namely the following ones:

- Incentives for parking an EV
- Incentives for access to restricted areas or roads, e.g. Bus lane use
- Incentives for fleets, e.g. delivery vehicle schemes, zero emission taxi schemes, car sharing schemes
- Incentives to invest in charging infrastructure (public or private infrastructure)
- Other measures (such as 'Mobility as a service' city-apps type) promoting the use of EVs

3.4.1.3 CHARGING EVS

The EAFO survey already foresaw a dedicated section on charging EVs. In this update, we included more detailed questions specifically referring to ASSURED, i.e.:

- Does the city provide public charging infrastructure solutions?
- What are the main protocols for procuring public charging infrastructure? Private investors involved/ownership and maintenance of infrastructure?
- Does the city provide public super-fast charging infrastructure solutions? If not, are there plans to do so?
- What are the main protocols for procuring public super-fast charging infrastructure? Private investors involved/ownership and maintenance of infrastructure?
- Is the city tracking the use of publicly accessible (super-fast) charging points and analysing data?
- Is the city requiring payment for the use of public chargers?
- Payment method used (e.g. per kWh, time via parking fees etc.)?
- Are the charge infrastructure managers entitled to sell electricity? Who regulates this sector? (national / regional / local government)
- Does the city assure interoperability between involved operators or service providers?
- Is there a policy to use renewable energy for publicly accessible chargers?
- Does the city stimulate innovative solutions for charging, e.g. inductive charging, use of lamp poles for charging?
- Is there a city-wide coverage of EV charging infrastructure or is this foreseen?
- Which solutions are foreseen for off-street charging/charging in residential areas? How are private investors involved?

3.4.2 Infrastructure data

ASSURED looks at the Charging & Refilling Infrastructure statistics of the cities. In terms of distinction between normal and fast charging, EAFO decided to follow the AFI Directive definition of "normal "and "high power" charging infrastructure (see 3.1.3), although different interpretations and understandings exist on the definition of high power/fast/super-fast charging points, especially for what concerns commercial vehicles.

Consequently, despite the same approach was adopted by ASSURED to ensure continuity and consistency in data collection, it is asked to cities to specify whether they have defined a clear criterion for their classification. According to that, they are asked to describe the current deployment situation for high power/fast/super-fast charging points. Tables 5 and 6 report the type of data cities are asked to provide on charging points and charging stations, intended as:

- **EV Charging point**: interface capable of charging one electric vehicle at a time, this includes the power supply, plug and the space to park the car.
- **EV Charging station**: EV charging station may include more than one charging charger.

The EAFO template also considered charging poles, intended as “EV charger which may include more than one charging point/position”. However, this category was disregarded because it constantly generated confusion. Moreover, the template was simplified in terms of details required, and pictures were included to clarify to cities the differences between the types of infrastructures.

Table 5 - Number of charging Points (= positions)

			Normal Power			High Power* > 22 kW (charging systems)			
Infrastructure	Place	Accessibility	3.5 kW	7 kW	11-22 kW	Combo	ChaDeMo	Type 2 AC	Tesla SC
EV Charging points	Street	All							
	Public Parkings	All							
	Other	All							
	Any	City fleet or contracted							
	Any	Taxi or Car sharing							
	Any	Restricted (other)							

Table 6 - Number of charging Stations (= locations)

Infrastructure	Place	Accessibility	Locations
EV Charging points	Street	All	
	Public Parkings	All	
	Other	All	
	Any	City fleet or contracted	
	Any	Taxi or Car sharing	
	Any	Restricted (other)	

3.4.1 Vehicle data

This section investigates the number of e-fleet circulating in cities. 'City fleet' refers to those vehicles directly procured by the public authority. 'Contracted' refers to vehicles providing a public service on behalf of the city.

Table 7 - Number of EVs circulating in the city

Type of vehicles / use	Category		Number				
			Total vehicles*	BEV	PHEV	FCEV	Total EV
Passenger cars	M1	*total if available*					
Passenger cars	M1	City fleet or contracted					
Buses (Public Transport)	M2+M3	City fleet or contracted					
Light Commercial Vehicles	N1	City fleet or contracted					
Light Commercial Vehicles	N1	*total if available*					
Heavy Duty Vehicles	N2/N3	City fleet or contracted					
Light vehicles (quadricycles)	L6/L7						
Light vehicles (two-wheelers)	L1-L5						
Taxis							
Car-sharing *(through "rental" or "subscription")*	M1+M2						
e-bike or e-motor sharing	L1-L5						
Ferries							
			: ALL fuels!				

3.4.1 E-buses data

Finally, a separate section is dedicated to electric buses, to investigate in detail which models are in circulation, types, modes and locations of charging, how and if the energy is stored and which types of batteries are used:

1. Bus
    a. Manufacturer/Model
    b. Length
    c. Technology**
2. Power (kW) MAX
    a. Opportunity changing
    b. Overnight Charging
3. Energy Storage
    a. Storage**
    b. Battery type (e.g. Li-Ion) & Capacity (kWh)
4. Charging

a. Method**
b. Location**

5. "e-Range (km)"
6. Number of buses

As for e-buses data collection, the Eindhoven workshop proved to be fundamental to align the type of questions to be asked to the cities with the needs expressed by the technical partners of ASSURED. In particular, it was decided to insert pre-defined categories regarding some features of the electric buses:

Table 8 - pre-defined categories to define e-buses

Options for technology, storage, method and charging location columns.	
Technology	BEV
	PHEV Diesel
	PHEV Gas
	FCEV
	Trolley
Storage	Battery
	Supercapacitator
	Battery + Supercapacitator
	Other
Charging Method	Conductive (Cable & Pantograph)
	Conductive (Cable)
	Conductive (Pantograph)
	Inductive
	Hydrogen
Charging location	Depot
	At Stops
	Depot & Stops

Moreover, two strategic questions have been included:

- Are the e-buses deployed/to be roll-out part of the e-mobility strategy/SUMP/or other specific plan?
- What are the specific policy goals/objectives in the short and medium term?

3.5 CATEGORISATION OF ASSURED CITIES

In this section, the profiles of the 4 cities involved in the ASSURED pilots are presented. The profiles have been built on the basis of the data provided by local city officers in the survey (by filling the ASSURED template) and during telephone interviews, and complemented by desk research. The names of the respondents are available in ANNEX I.

3.5.1 Barcelona

3.5.1.1 VISION AND STRATEGY

Barcelona is the capital and the most populous city of the community Catalonia, and the second most-populated municipality in Spain, with a population of 1,620,809[42] (3,239,337 including the metropolitan area)[43]. The main transport challenges faced by Barcelona include protection of the historical city centre; a high proportion of powered two wheelers (motorcycles & mopeds) which may reduce demand for road space but cause pollution (especially noise); and high levels of commuter traffic between the city centre and suburban towns.

Since the Urban Mobility Plan of 2006, the promotion of AF vehicles has been a major line of work in the Mobility and Environment strategies of the Barcelona City Council. Especially since 2008, the City Council of Barcelona began to develop important Strategic Plans (Mobility, Air Quality, Energy, Industrial Promotion) where EVs had very relevant consideration.

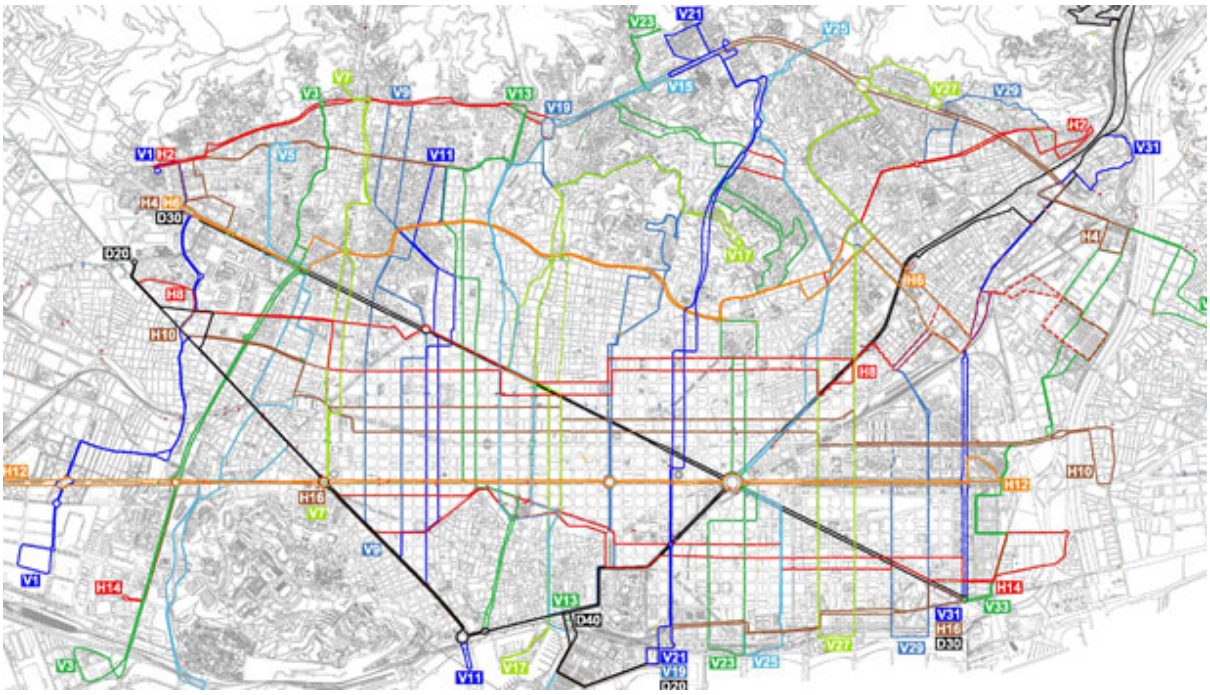


Figure 4 - Plan of Barcelona[44]

Barcelona has adopted a SUMP referring to the period 2013-2019, which aims at a safer, more sustainable, equitable and efficient mobility in Barcelona. As for urban freight, Action 4.1.4. of the SUMP states that Barcelona has to "promote the delivery of goods through the use of low impact means". The objective is to promote the use of electric bicycles, small vans,

[42] Statistical Institute of Catalonia. Retrieved from: http://www.idescat.cat/emex/?lang=en&id=080193
[43] http://www.amb.cat/en/web/area-metropolitana/coneixer-l-area-metropolitana/poblacio
[44] Source: SUMP Barcelona: http://www.bcnecologia.net/sites/default/files/proyectos/pmu_angles.pdf

etc. for the deliveries in pacified areas such as the interior of the superblocks to reduce the impacts of urban freight distribution, such as noise, pollution, congestion, etc.

In March 2018, Barcelona adopted the Electromobility Strategy 2018-2024[45]. The strategy aims[46]:

- As for city fleet, to increase the number of electric vehicles in the municipal fleet to 80% in 2024.
- As for public transport, to increase the current total of four electric buses[47] to 100 vehicles in 2024, and for the entire fleet to use zero-emissions buses by 2040.
- As for private electric vehicles, to rise from 1,057 to 24,000 electric cars in 2024, as well as incentivising the use of electric motorbikes.

The strategy considers electrification of vehicles as a necessary measure to improve air quality but not enough to improve the quality of life of the citizens: non-motorized mobility remains the main priority, however the promotion of electromobility is essential to achieve the objectives of the SUMP of Barcelona in those transport services that must necessarily be motorized (e.g. PT, freight, taxis, etc.). As a strategy of public interest, it is necessary to promote it, and even finance and manage the necessary refuelling infrastructures.

In 2009, the Barcelona City Council set up the Logistics for the Implementation of Electric Vehicles (LIVE) platform[48]: a public-private platform promoting e-mobility and encouraging the use of EVs in the city. LIVE coordinates e-mobility plans of various levels of government and disseminates information, raising awareness among companies. It promotes the creation of new business models related to EVs, associated services and the infrastructure needed to make this possible.

3.5.1.2 MEASURES

Some actions in the municipal policies are:

- Free parking in toll parking areas for EVs users
- Free charge at the public charging stations
- 75% discount on the Vehicle Tax
- Subsidies to buy new electrics cars
- Assistance from the Housing Department for the energy grid upgrade of buildings
- Facilities for installing e-chargers in municipal car parks
- 2,5% of all new street parking construction must be equipped with EVs charging posts
- Companies working with the City Council need to have at least one EV.

These local measures are supported by national and regional policies such as:

- Use of reserved lanes
- National Registration Tax at 0%
- State aid for the purchase of electric vehicles

[45] http://mobilitat.ajuntament.barcelona.cat/en/noticia/electric-vehicles-to-drive-sustainable-mobility
http://ajuntament.barcelona.cat/premsa/2018/03/14/lestrategia-per-la-mobilitat-electrica-2018-2024-a-la-ciutat-de-barcelona/
[46] http://mobilitat.ajuntament.barcelona.cat/en/noticia/electric-vehicles-to-drive-sustainable-mobility
[47] Two opportunity-charged 18m articulated buses and two overnight-charged 12m buses, tested in the ZeEUS project: http://zeeus.eu/uploads/publications/documents/zeeus-city-sheet-barcelona-en-final.pdf
[48] http://www.electraproject.eu/attachments/article/120/BCNecologia%202nd%20e-article.pdf

3.5.1.3 LOCAL CHARGING INFRASTRUCTURE POLICIES

The 'Public Network of Fast Charging Points' and the 'Network of Charging Points for Motorcycles' count 16 and 150 charging points respectively, managed by the municipal management centre.

The Fast Charging Points have more than 150 monthly utilisations on average, exceeding 300 monthly charges in some strategic stations. Considering these 16 Fast Charging Points, it is estimated that 95% of users have a free charging point at less than 2 km and / or 6 minutes distance. In general, there are currently 249 public charging points, making Barcelona the city with most charging stations in the Spanish territory, though most of them are slow charging points. As for EVs, 15% and 40% of the overall Spanish fleet are registered in Barcelona and Catalonia, respectively.

The city is tracking the use of publicly accessible charging points (all free of charge) and analysing data, by monitoring the recharges of users and vehicles. In terms of usage of renewable energy for publicly accessible chargers, there is currently a pilot test in place, with a fast charger charged via a second life battery. The city stimulates innovative solutions for charging, by installing charging stations for public services like taxis.

Charging infrastructure is considered the main barrier for the deployment of e-mobility. It is important to couple the parking strategy with the charging strategy, assuming that 'EVs must charge where they park, not park where they charge'. In Barcelona four types of recharge are considered:

- Residential Charge:
  - Charging at home, overnight, private sphere
- Opportunity Charge:
  - "Meanwhile" charging, associated to another main activity, at work, leisure, shopping, restaurant, hospital, Park&Ride… private/public activity
- Emergency Charge:
  - Battery exceptionally exhausted, needed to get back home or just to enlarge autonomy once (one of the main fears of a novice EV driver). Public Service. Also Reial Automòbil Club de Catalunya (RACC) Road Assistance.
- On Route Charge (250/300 kwH):
  - Long planned trip, charging in route to enlarge autonomy

Figure 5 - Pantograph located at the top of the e-bus Solaris Urbino E18[49]

EVs should quick charge only when needed. There are two criteria considered: 1) land coverage, to ensure the presence of 1 fast charging station at maximum 6-min distance, meaning every 2 km where average speed is 20Km/h and every 6 km where average speed is 60Km/h; 2) demand, i.e. number of stands per station depending on users demand.

3.5.1.4 ELECTRIC VEHICLES DATA

The Transports Metropolitans de Barcelona (TMB) bus fleet has 2 standard buses (12m) and 2 articulated buses (18m) which serve the H16 line, as well as a charging pantograph in Plaça del Nou. In July 2018, TMB will receive seven 18m articulated e-buses from Irizar and Solaris with opportunity charging. In 2019, line H16 will be fully electric (with 22 buses) and TMB will begin electrifying another line. The public transport company has already one of the cleanest bus fleets in Europe, as a result of the strong investment in hybrid and compressed natural gas vehicles and the retrofitting of diesel vehicles with particulate filters. LIVE additionally works to install new public and private charging points in Barcelona.

[49] Source: ZeEUS website

Figure 6 - Solaris Urbino E18 e-bus in Barcelona[50]

Electrification of the municipal vehicle fleet: the city has a municipal fleet of 270 cars, ten motorcycles and 37 electric hybrid vehicles for services. The introduction of EVs in waste collection and street cleaning decreased the average noise pollution by 30-40% and there is potential to reduce energy use by 60%.

26 taxi drivers have opted for an EV. The main distribution and courier companies are committed to developing the electrification of their fleets in Barcelona (Calidad Pascual, SEUR, AraVinc, etc.).

3.5.1.5 The Public Transport Authority – TMB

TMB is the PTA of the City of Barcelona, working closely with Àrea Metropolitana de Barcelona (Metropolitan Area of Barcelona or AMB), the local administration, for the organisation of the public transport. The requirements related to the charging infrastructure in Barcelona can be summarised as follows:

- All charging procedures must be automatized, and per pantograph (no cables, no manual interaction).
- Indicators for battery state of charge, charging failures, alarms, etc. are all monitored. The monitoring protocols bus-charging point undergo very accurate tests.
- Bus lines with a high level of service must have two charging points.
- Opportunity charging is done at 500 kW. Charging at the depot is done both during the day and overnight (to balance the batteries) at charging power of 50-80 kW.
- Communication bus-charger is completely monitored and automatized. Chargers must be data connected with the rest of the infrastructure in a standard procedure because of smart charging, infrastructures control, cost assignation of every vehicle, etc. is a requirement for a proper operation.
- On-street chargers have the same requirements. In this case, it is very important for operation to foresee failures of the charger (installation) and to apply contingency

[50] Source: ZeEUS website

measures as well as to carry out remote and emergency actions (e.g. reset, reconnect protections, etc.)

- Fast charging is essential. When needed, 50 kW chargers are combined by adding small power units up to required power.

TMB has a highly automatized process for operation of the bus system. The charging strategy followed applies both opportunity and in depot charging (day and overnight). Smart charging is applied in order to optimise power availability (depending of the rest of the requirements of the depot), the electricity price (hourly tariff), and the availability of the vehicles (each bus must be charged at time is required).

The charging is completely automatized via pantograph (no plugs, no manual interactions). All charging points are remotely controlled to change charging power and to delay start (e.g. the bus can be plugged to the pantograph but the charging procedure starts later).

Others action possible thanks to smart charging is preparing the vehicle for the service (air conditioning, heating, air compressor, etc.) some minutes before departing, when the bus is connected to the charger, aimed at reducing the battery consumption.

The chargers in depot have a low power capacity (range 50-80 kW) and can be installed as islands. TMB has installed islands of 4 chargers of 50 kW. It is convenient to have the possibility to combine chargers to automatically have the followings options, e.g.: a) to charge 4 buses at 50 kW; b) charge 2 buses at 100 kW; c) charge 1 bus at 200 kW.

3.5.2 Eindhoven

3.5.2.1 VISION AND STRATEGY

Eindhoven is in the province of North Brabant, in the south of the Netherlands. The population was 229,319 inhabitants in February 2018[51], making it the fifth-largest city in the Netherlands.

Eindhoven is a well-known centre for research and industry. Philips started this tradition in 1891, and nowadays there are several cooperation platforms in place for research and innovation. The University of Technology of Eindhoven hosts an incubator for technology start-ups. Brainport is a cooperative initiative by local government, industry and Eindhoven University of Technology to develop local knowledge economy in the Eindhoven region[52].

The city of Eindhoven has endorsed the climate goals of COP21 in Paris. In order to achieve the challenging objectives set in the agreement, the city of Eindhoven has adopted the 'Vision and Roadmap Eindhoven Energy-Neutral' in 2013, aiming to reach energy neutrality in the period between 2035 and 2045. The municipality has set the goal of achieving this ambition excluding mobility before 2035, and to achieve the ambition including mobility before 2045[53]. The Roadmap considers the storage of energy in electric vehicles as a relevant point in this regard. Air Quality and Noise targets are set at national level.

[51] "Bevolkingsontwikkeling; regio per maand" *[Population growth; regions per month]. CBS Statline (in Dutch). Retrieved 27 March 2018.*
[52] http://brainporteindhoven.com/work/success-stories/
[53] Eindhoven Energieneutraal. Gemeente Eindhoven. 2013. More info: www.eindhoven.nl/energieneutraal : http://www.tue-lighthouse.nl/EhvEnergyneutral2045.html

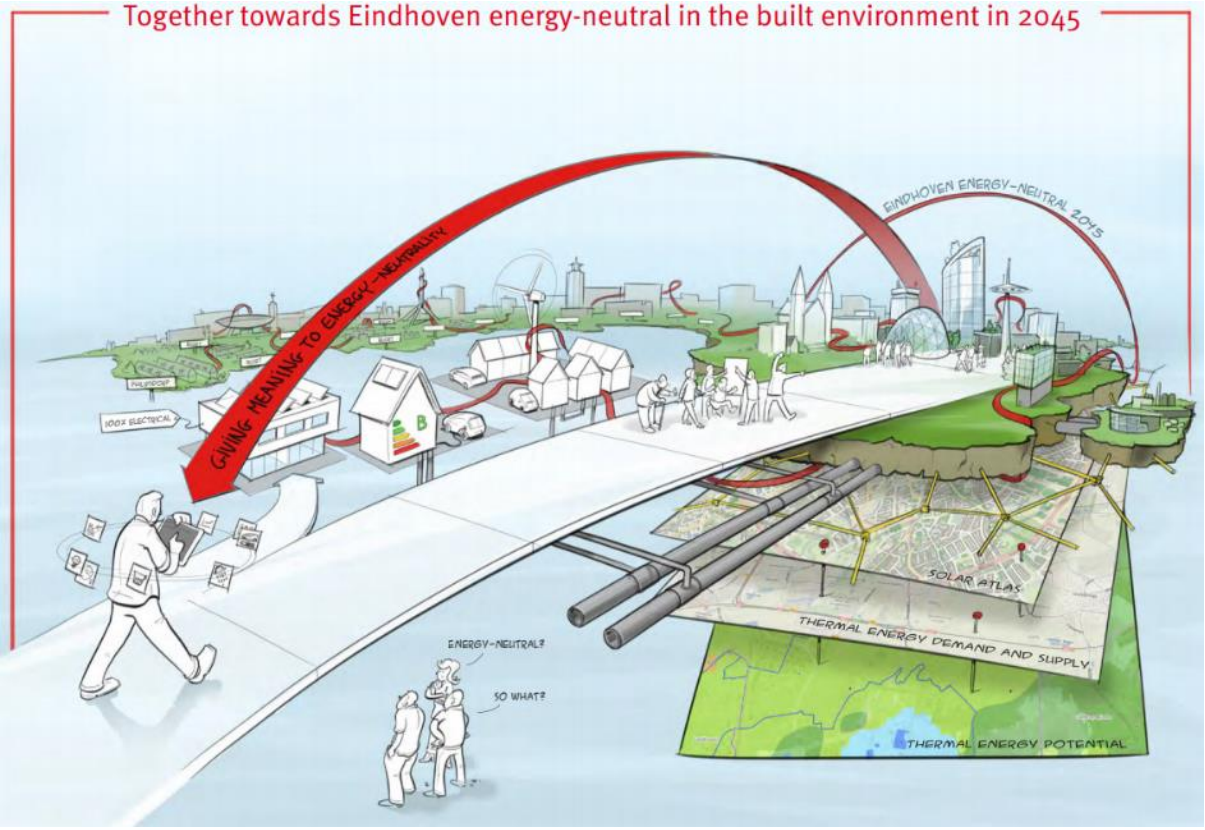


Figure 7 – Illustration of the Roadmap towards Eindhoven energy neutral in 2045[54]

The Eindhoven SUMP (GVVP, *Gemeentelijk Verkeer en Vervoerplan* in Dutch), 'Eindhoven on the road' (*Eindhoven op Weg*)[55] links to the Energy Roadmap, therefore it does not endorse any specific alternative fuels in the local strategy, it only sets ambitions in terms of emissions reduction and energy-neutrality. In this regard, the city sets the ambition of local public transport being emission free in 2025, and zero Emission taxis in 2026. A Zero Emission zone for all transport types within the inner city is planned for 2030. This zone will have an impact on freight transport as well. However, there are no specific targets on the deployment of electrification of urban commercial vehicles. As captured in the ASSURED survey template, the city is working to define a replacement policy for city fleet vehicles, according to the Eindhoven emission-free transport strategy.

[54] Source: Eindhoven Energieneutraal. Gemeente Eindhoven. 2013
[55] https://www.eindhoven.nl/sites/default/files/2017-12/Eindhoven%20op%20weg%2013052013.pdf

Table 9 - Modal split in Eindhoven: current and ambition

	% 2012	% 2025	total numbers '12 – '25
Pedestrians	13	14	+35%
Bicycles	40	44	+35%
Public Transport	5	7	+55%
Car	42	35	+ 5%
Totaal	**100%**	**100%**	

Source: SUMP Eindhoven

The SUMP encourages pilots in Eindhoven, considered as a 'living lab' involving knowledge partners and private companies on the practical implementation and improvement of new technologies, including e-mobility solutions. More sustainable practices should be promoted, such as electric charging infrastructure, agreements with shared car providers, zero-emission buses. The city can use its procurement power as a leverage.

There are some incentives in place for emission-free taxis, which have their own fast charging points at the train station, their own stops and they will be allowed on bus lanes. The city is also trying to use public procurement to promote an e-taxi fleet, including the objective of emission-free service within two years in its tendering procedure. However, no offer was received for the call for tender for the taxi service contract, meaning that the market is not ready yet to provide such a service under the conditions requested by the municipality.

In ASSURED, Eindhoven has the objective is to ensure that future operation of e-buses and charging can be scaled up in a smart and cost-effective way, ensuring that energy demand balancing is guaranteed without supersizing the electrical connection of the local grid. This will be done by implementing energy storage capabilities and intelligent and advanced monitoring capabilities of the charging infrastructure and the electric bus fleet up to 100 vehicles.

3.5.2.2 LOCAL CHARGING INFRASTRUCTURE POLICIES

The city provides public charging infrastructure solutions by facilitating the investments of charging infrastructure operators in the city. Permits are granted for the installation of charging stations to companies that install and operate the charging stations. The operator, Allego[56], places the charging infrastructure on request of EV users, while the municipality provides for the license.

At the moment, there are around 180 normal charging points in Eindhoven, and two fast-charging locations, corresponding to 6 charging points. Users can request the charging station from the operator via internet. Allego determines a place and looks at the technical feasibility and other charging station and proposes the optimal location to the municipality, which has to take a decision. If residents agree, the grid manager starts working and connects the grid to the charging station within 18 weeks. Allego places the charging point as soon as the connection is available.

The application and placement of a charging station are free of charge for the users. The total procedure for placing a charging station usually takes 3 to 6 months. However, a charging station is not installed if users have the possibility to place a charging point on their own site If there is a private car park in the building, it has to purchase the charging station. If there is

[56] https://www.allego.eu/companies/?sl=eu

a public charging station within a radius of 300 meters, an extra charging station can only be installed if the existing charging stations are often occupied. The operator collects data on the charging stations every 6 months, to assess whether new stations or points are needed.

Regarding parking policies, the parking space at a charging station is reserved for charging an electric car. This means that users can only park there if they need to recharge. If the charging station is located in a toll parking area, users have to pay for parking, on top of the payment for recharging, that is per kWh. In the Netherlands, EV users have an interoperable card to pay at all charging stations of the country. The sector is regulated at national level, which assures interoperability between operators and service providers. The municipality makes use of the standards selected at the national level. According to the energy-neutral Roadmap, the municipality encourages the use of green energy for publicly accessible chargers.

Figure 8 - Fast charging infrastructure in Eindhoven[57]

In terms of charging infrastructure for PT, the 43 e-buses introduced during the Zero Emission Urban Bus System (ZeEUS) project utilise a combination of fast opportunity charging and overnight charging at the bus depot. Opportunity charging is through roof-mounted pantographs and fast chargers within the bus depot during the day. There are 22 slow chargers of 30kW and ten fast chargers of 300kW available at the bus depot in Eindhoven, situated only 1km from the bus transit station[58]. An upgrade of the chargers and the expansion of the charging facilities to further locations or other depots is also foreseen.

[57] Image credits: HELIOX
[58] http://zeeus.eu/uploads/publications/documents/zeeus-city-sheet-eindhoven-en-final.pdf

Figure 9 - Overnight charging infrastructure in Eindhoven[59]

3.5.2.1 ELECTRIC VEHICLES DATA

At the regional level, Zuid-Oost-Brabant has set up a concession strategy aiming at the electrification of the bus fleet. In the framework of the ZeEUS project, 43 full electric 18.15m buses were introduced in the bus fleet of Eindhoven by the Public Transport Authority, serving the city centre and suburban areas. As next step, 65 e-buses will be added to the existing fleet during the period 2019-2021 (phase 2), and 65 more during the period 2022-2024 (phase 3).

Based on data from 2016, the municipality estimates the existence of around 1,500 EVs (all types) out of a total of 100,000 private passenger cars circulating in the city (1,5%).

In Eindhoven there are 245 taxis, of which only six are electric, as well as ten e-cars in the framework of the local car-sharing system.

3.5.3 Gothenburg

3.5.3.1 VISION AND STRATEGY

Gothenborg will grow rapidly in the next 15 years: at the beginning of 2018, there are around 533,000 residents in the city, and about 1,100,000 residents in the Gothenburg region[60]. By 2020, a growth corresponding to 5,600 new homes and 12,000 new jobs is expected in Gothenburg. The Gothenburg City Council has adopted a vision for the expansion of the inner city by transforming the adjacent former port, industrial and logistics areas, located along the river Göta älv (the River City Gothenburg area). By 2035, there will be 680,000 residents, 70–80,000 new homes, including 50,000 in the existing city, of which 25,000 in the River City Gothenburg area, and 80,000 more jobs of which 50,000 in the River City Gothenburg area[61].

Over the coming years, due to the expected expansion of the city, major construction projects in the city will challenge people to find new ways to get around, and vehicles will have to use space more efficiently. The city has a traffic strategy, outlining a development plan for dense built and populated areas of the city, in order to create safe, attractive, lively and overall sustainable city environments. Important elements are the priority of pedestrians and cyclists, as well as the consolidation of freight deliveries and clean vehicles. In the inner city, the following measures are in place:

- Length restriction

[59] ? Image credits: HELIOX
[60] http://international.goteborg.se/facts-figures
[61] http://alvstaden.goteborg.se/wp-content/uploads/2015/05/rivercity_vision_eng_web-2.pdf

- Time windows (when allowed to stop in the area)
- Walking speed areas
- Pedestrian zones
- Street closed for traffic

The City strategies 2035 (Transport strategy, Development Planning strategy, Green strategy) are built around three main objectives, to make Gothenburg:

- An easily accessible regional centre
- A more attractive urban space
- The logistic centre of Scandinavia

From an attractive city perspective, the municipality aims to reduce the overall number of vehicles circulating in the city, whether electric or traditionally fuelled. Therefore, the city strategies do not promote e-mobility via free or heavily subsidized charging, discourage charging points installation on street side parking, do not give electric cars exemptions for the congestion tax, nor the possibility for electric cars to access public transport lanes or dedicated parking. However, at the national level there are a higher tax for dirty vehicles and a Government proposal of a new bonus-malus system[62] for buying EVs, with effect from 1 July 2018. This system addresses only new passenger cars, light buses and light trucks, and includes the following provisions:

- Petrol and diesel vehicles: an increased vehicle tax (malus) is charged in the first three years from the first tax liability of the vehicle.
- Cars with very low emissions receive a bonus. For cars with zero emissions, the highest bonus is SEK 60,000 (about 5,800 EUR).
- Vehicles powered by alternative fuels, such as E85 (ethanol) and vehicle gas (biogas and natural gas) are not affected by the bonus-malus system: they vehicle tax stay the same.

At the same time, the municipality has plans in place to renew its own fleet replacing old vehicles with EVs. The municipality is supported by a leasing company which is responsible for the procurement of the city's fleet. This is valid for all tenders and procurements for any type of transport services. The number of electric vehicles and electric hybrid vehicles in the municipal fleet (passenger cars and light trucks) grew from 5 units in 2011 to over 250 units in 2018. The aim is to have 400 EVs in the city fleet by the year 2021.

The city is also using public procurement to influence the demand of EVs and zero emission deliveries: an example is the taxi service for disabled persons.

Regarding freight, a fast charging infrastructure is considered desirable and heavy electric powered vehicles could be subsidized, for example getting an exemption from congestion charges.

3.5.3.2 LOCAL CHARGING INFRASTRUCTURE POLICIES AND ELECTRIC VEHICLES DATA

The procurement of the public charging infrastructure is demanded to *Göteborgs Energi*[63] (the city energy company) and the municipal parking company. Private investors are involved, and they own and maintain the infrastructure. The payment method used for recharging is per kWh, or by paying a fixed monthly subscription. The charging infrastructure operators are entitled to sell electricity, and the sector is regulated at national level.

The development of heavy electric vehicles in public transport, cleaning and cargo delivery is particularly important. The City of Gothenburg is very restrictive with charging on streets and

[62] https://www.iea.org/policiesandmeasures/pams/sweden/name-167633-en.php
[63] http://www.gesab.net/-about-us https://www.goteborgenergi.se/English

squares. Urban Transport Administration promote but doesn't invest in charging infrastructure, the city energy company and the city parking company do. The city adopted an approach of close collaboration with the industry, payment for charging, and off-street location of normal charging, that should happen as domestic charging at apartment buildings and charging in car parks. However, for fast charging, things may change: the need for opportunity charging will shift the view from *'charging=parking'* to *'charging=refuelling'*. In 2018, the city is expecting to have 22kW chargers in about 50 locations, corresponding to 520 charging points, installed by *Göteborg Energi*, *Göteborgs stads Parkering*[64] (the city parking agency), *Klimatklivet*[65] (the Götaland region agency supporting local climate investments).

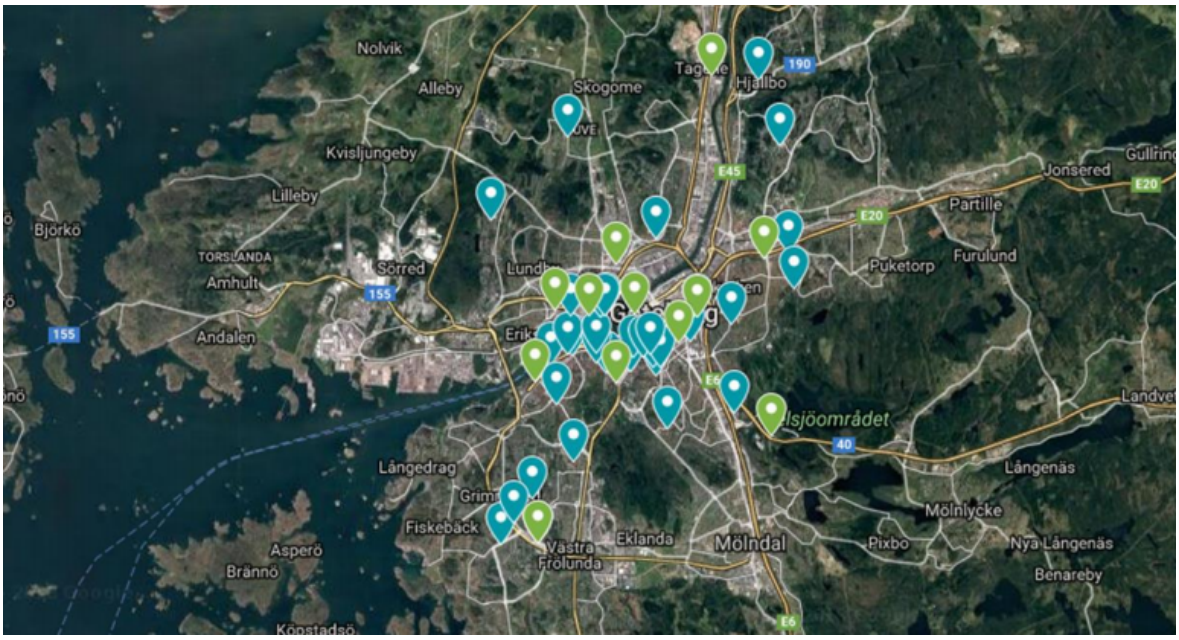


Figure 10 - Location of charging infrastructure in Gothenburg[66]

The region has new plans for public transport electrification with the objective to transfer all city buses to electric drive. In 2020-2023, all 700 Gothenburg buses will be renewed, and by 2025 all city buses will be electrified. Moreover, in 2019-2020 about ten more OppCharge chargers[67] and 2-5 high power Combined Charging System (CSS) chargers[68] for bus lines will be introduced within current traffic contracts. The charging system will probably be a mix of depot charging and end bus stop charging, based on OppCharge standard.

In order to reach this objective, the city is supporting other projects besides ASSURED: an example is the ElectriCity project[69], which is carrying out research and demonstration of 13 Electric buses (see Table 10). Five chargers with pantograph (OppCharge standard) and a couple of CSS high power fast chargers (150kW) have been implemented, one in a depot and one public.

As for other heavy vehicles, such as trucks and vans, three high power fast chargers (dual CSS/Chademo) have been installed by ElectriCity, two in a depot and one public. In the period

[64] https://www.p-bolaget.goteborg.se/
[65] http://www.lansstyrelsen.se/vastragotaland/Sv/miljo-och-klimat/klimat-och-energi/Pages/stod-for-lokala-klimatinvesteringar.aspx
[66] Source: ELIPTIC Workshop - Charging Infrastructure & Policy recommendations, 19 March 2018, Brussels – Gothenburg presentation
[67] https://www.oppcharge.org/
[68] The combo coupler is based on the Type 2 (VDE) AC charging connector, with full compatibility with the SAE specification or DC charging, with additional pins to accommodate fast DC charging at 200–450 Volts DC and up to 90 kW.
[69] https://www.electricitygoteborg.se/en

2019-2022, this will be followed by more chargers in other projects, including ASSURED, and finally by full development of both public and depot high power fast charging.

Regarding urban logistics, a consolidation service for the inner city, Stadsleveransen, has been running since 2012. The service has been developed within the EU-funded project SMARTSET, and serves at present approx. 500 businesses in the inner city with three electric distribution vehicles (one car and two trailers each) and two cargo bikes.

Table 10 - Gothenburg E-bus fleet

Gothenburg E-bus fleet												
Project	**Bus**			**Power (kW) MAX**		**Energy Storage**		**e-Range (km)**	**Charging**		**Remarks**	**Number of buses**
	Manufacturer/Model	Length	Technology***	Opportunity charging	Overnight Charging	Storage**	Battery type (e.g. Li-Ion) & Capacity (kWh)		Method**	Location**		
Electri-City	Volvo	12	BEV	Y		Battery	Li-Ion 60 kWh	60 km	Conductive (Pantograph)	At Stops	Concept vehicle	3
Electri-City	Volvo	12	BEV	Y		Battery	Li-Ion 150 kWh	150 km	Conductive (Pantograph)	At Stops		1
Electri-City	Volvo	12	PHEV Diesel	Y		Battery	Li-Ion 20 kWh	20 km	Conductive (Pantograph)	At Stops		7
Electri-City	Volvo	18	BEV	Y		Battery	Li-Ion 150 kWh	100 km	Conductive (Pantograph)	At Stops		2

3.5.3.3 THE PTA - VÄSTTRAFIK

Västtrafik is the PTA of Gothenburg. These are several reflections arising from the needs to upscale e-bus lines.

In the first place, the PTA does not own depots. To further electrify the bus system, Västtrafik depends on the availability of depots close to the traffic areas, which is especially challenging in the city centre.

Regarding the charging strategy, as the authority procures the vehicles, it is not decided yet if the contracts with the operator shall include depot charged or opportunity charged buses. And this will affect the kind of equipment that will be needed at the depots.

Another important issue is the availability of standards both for depot charging as well as for opportunity charging, and even in a broader perspective to have the same opportunity solution (pantographs) in Sweden. The PTA strives to regulate this issue in order to be able to freely move buses from one fleet in a given city to another if needed, also across the country.

As a PTA, Västtrafik depends on the municipalities to obtain building permits for charging infrastructure in public space, thus the wish is to have a well-defined process for this purpose. It is expected that the busiest lines will most likely need more than one charging point at each end stop, meaning that the infrastructure will require more space in the street environment.

In summary, the essential question for Västtrafik is to have a well-organised and good functioning cooperation between all stakeholders involved: PTA and municipalities, energy companies and other actors (for example private owners) to avoid conflicts.

3.5.4 Osnabrück

3.5.4.1 VISION AND STRATEGY

With a growing population of currently[70] 164,070 inhabitants, Osnabrück is one of the four largest cities in the federal state Lower Saxony. The city is the centre of the Osnabrück Land region as well as the District of Osnabrück. Public transport exists in Osnabrück since 1906 and counts approximately 300 employees today. 35.5 million passengers use public transport each year. Out of the 150 buses in service, the city's routes are also operated by one e-bus and 7 trailer buses. The e-bus with a battery size of 170 kWh is in service since August 2013. It operates a route of 3.7 km (see Figure 11 below) and reaches a daily distance of 148 km.

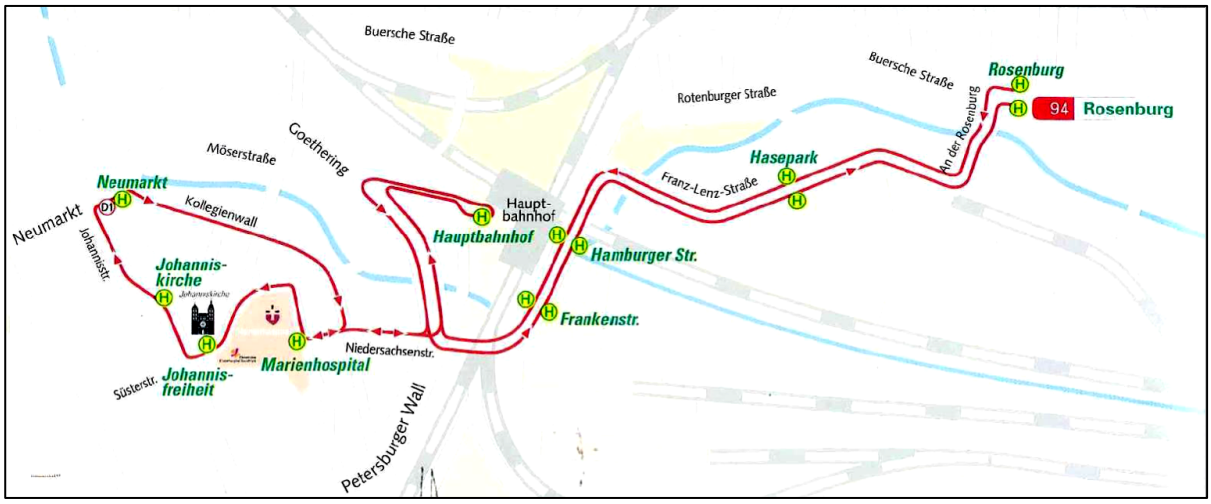


Figure 11 - E-bus line in Osnabrück

Having collected several valuable experiences with the e-bus, the city of Osnabrück set future plans for launching a new public transport system, which intends to expand electromobility as a component of expanding multimodality. Ultimately, Osnabrück aims to fully electrify public transport services within the 2020s. The city aims to focus on battery-electric buses, and plans to install opportunity charging at the terminal stops, as well as slow charging and balancing at a depot. By 2021, Osnabrück aims to deploy 40 e-buses, and plans to adjust the transport network, particularly also to stimulate multi-mobility. So far, the city completed the tendering process for the first 13 buses[71], 5 fast charging stations and the depot equipment, and expects the new buses to operate by mid/end of 2018. A following tender for another 13 buses was published in March 2018. Further electrification activities include:

- Development of an E-Mobility Platform
- Pedelec Renting System
- Integration of charging stations
- Intelligent charging infrastructure for bus fleet

3.5.4.2 LOCAL CHARGING INFRASTRUCTURE POLICIES

The Osnabrück University of Applied Sciences is currently in the process of developing an Electromobility Concept for the city, which is expected to be completed in mid-2018. The aim of the concept is to systematically develop the further expansion of the e-mobility system in the metropolitan area of Osnabrück. This includes the electrification of the car sharing offer, the development of a charging infrastructure tailored to the needs of customers, including

[70] 31.12.2016, http://www1.nls.niedersachsen.de/statistik/html/default.asp
[71] https://www.stadtwerke-osnabrueck.de/privatkunden/mobilitaet/startseite-mobilitaet/nachricht/artikel/15/01/2018/e-bus-partnerschaft-besiegelt.html

business model and services, as well as the combination with PV systems and demand-oriented control.

Osnabrück has set up a strategic board that is specifically looking at charging infrastructure in the city. The decision has been initially made to focus on providing charging infrastructure only in municipally-controlled parking garages. For this, the PTA Stadtwerke Osnabrück (SWO) will be working closely with the municipal subsidiary company Osnabrücker Parkstätten-Betriebsgesellschaft (OPG) that is responsible for the operation of the parking garages. The main advantage of providing several charging points concentrated within one building is that OPG can integrate these into an intelligent charging system that charges the electric vehicles when demand is low.

Due to the better controlling possibility as well as the fact that the city does not want to make on-street parking more attractive, Osnabrück will mainly focus in the next 2-3 years on providing charging opportunities in their parking garages. This will provide valuable lessons for the further electrification strategies of the city in order to also electrify SWO's own car fleet.

3.5.4.3 THE PTA - SWO

SWO - Stadtwerke Osnabrück AG - is the public service provider in Osnabrück in the fields of electricity, gas, water and public transport. As a mobility operator, SWO offers public transit in Osnabrück and the surrounding areas. Yearly more than 35 Mio. Passengers are transported on 24 routes and the surrounding catchment areas. The city buses mostly run every ten minutes. In 2010 the company launched a project called "mobility 2030". The project goal was to set the basis for the future development of public transportation in Osnabrück. The project was split up in the subprojects "innovative public-transport system", "technology", "sales", "communication" and "intermodal traffic". These topics were closely linked. The first two subprojects mentioned worked out a concept for future (electric) buses including the design and the system of operation. The company acquired two electric midi-buses (5.90m for field-testing. The project "e-connect" granted a subsidy on the investment costs. Stadtwerke Osnabrück gained many experiences about the usability for daily operation with electric vehicles. Particularly to explore (in) all business & techniques related matters & public perception. In addition, another approach was called "mobility hub". A "mobility hub" is a station which is used to transfer between different transport services (bus, car sharing, taxi, bike sharing) easily. The project team elaborated a concept for a 'smart station' which is a designed transfer station with smart access to a wide range of transport means.

4. View and needs of public authorities on (super) fast charging of urban commercial vehicles

4.1 VIEW AND NEEDS OF CITIES AND REGIONS

In addition to categorizing the cities that host the ASSURED pilots, this deliverable also sets the objective of qualitatively investigating the views and needs of public authorities on (super) fast charging of urban commercial vehicles. Following up on the EAFO survey insights, a new set of questions for cities have been identified, focusing on ASSURED, also taking into account freight operators:

- Discussion on limitations for e-fleets and charging infrastructure roll-out
- Electrification promotion
- User needs

4.1.1 Insights from the EAFO city survey

The survey conducted by EAFO investigates the potential contribution of the local level to the implementation of the AFI Directive, including policy measures to facilitate the roll-out of clean vehicles:

- **Direct incentives** for the purchase of EVs
- **Tax incentives** to promote EVs and the relevant infrastructure
- **Public procurement** including joint procurement
- **Demand-side non-financial incentives**: access to restricted areas, parking policy and dedicated lanes

Some examples are:

- **London**: the Go Ultra Low City Scheme investment (about 15 million Euro) in a residential charging network[72]
- **Madrid** funds up to 1.000 Euro for the purchase of an alternatively fuelled vehicle
- **Copenhagen Region**: financial support to companies and public institutions procuring electric vehicles (6-7,000 Euro per vehicle)

The survey highlighted a “clear political will”[73] of the cities interviewed for the deployment of alternative fuelled vehicles. However, significant differences across cities and their capacity to undertake substantial financial investments were identified. It has also been noted that there is a considerable difference between large cities, which have already begun to adopt policies favourable to the introduction of clean vehicles and infrastructures, and small-medium sized cities, which are still a step backwards. Also for this reason, cities have expressed the need to discuss and exchange with their counterparts, about policies, best practices and joint actions that can support the effective roll-out of alternative fuels. Moreover, it was found out a lack of governance at regional level: regional authorities often do not have targets or strategy that are mainly defined at national and local level.

Cities consulted expressed some concerns and barriers, especially regarding data linked to the full process of deploying clean vehicles.

As for **vehicle data collection**, it is hard for them to keep track of vehicles that are registered in another Member State: their systems are not able or allowed to recognise the type of vehicle based on the plate. This hinders the definition of a complete and reliable picture of the fleet

[72] https://www.goultralow.com/category/news/press-releases/
https://www.goultralow.com/how-do-you-charge-an-electric-car/charging-point-map/
[73] CIVITAS INSIGHT Cities’ role in introducing clean vehicles and using alternative fuels (page 11):
http://civitas.eu/sites/default/files/civitas_insight_20_cities_role_in_introducing_clean_vehicles_and_using_alternative_fuels.pd

circulating in their local context and as a consequence the possibility to elaborate effective counteractive strategies. Therefore, many cities stressed the need for a vehicles pan-European register log and the importance of strengthening data communication between national and local level.

As for **charging infrastructure data collection**, many cities are adopting a business model for the deployment of charging infrastructure based on the investments of the private sector under the supervision of the local authority. Compared to fully public facilities, privatization may reduce the amount of data available for the municipality, that is very useful for planning and land use management. Therefore, it is important that cities consider this aspect when they draft the corresponding tenders and agree with the operators on the most suitable procedures to access these data. In particular, tracking the use of charging points in cities is a challenging issue: some of the city fleets use rented parking lots, that are often private and therefore only few data are available. Moreover, most cities have not yet deployed a comprehensive, interoperable system that allows to collect all these data in a consistent way. Therefore, it was suggested that EU non-binding guidelines could be prepared to address this challenge.

Many cities have funded the research and preliminary implementation of their charging infrastructure in the framework of EU funded projects, implying the participation in consortia that often envisage some confidentiality clauses. This prevents cities to share data lined to these projects and therefore hindering a proper assessment of the national situation, that in turn affects the development of reliable and realistic National Frameworks for the fulfilment of the AFI Directive.

As for **e-buses and related infrastructure data**, it was pointed out the overall paradigm of the PT fleet management would change once electrification is massively deployed. Cities need to exchange even more at the EU level on e-bus depots, maintenance and storage facilities related to e-fleets, as well as interoperability of charging plugs and on-route recharging systems' standards.

4.1.2 Insights from the ASSURED city survey

4.1.2.1 Vision and strategies

Regarding vision and strategies, it is important to understand who is the interlocutor with whom one is dealing, and at what level of governance it plays and what competencies it has in the field of policies for the electrification of urban mobility. Depending on the country, but also on the region, it may be that strategies, funds, data, jurisdiction, etc. are attributed to different bodies, so for each aspect, it is important to understand who has the power to make decisions. See Chapter 2 for more details on visions and strategies.

4.1.2.2 Procurement

In all cities, procurement is considered an effective method to influence and increase the demand of EVs, as well as to give a good example to citizens and business, according to the principle 'practice what you preach'. In this sense, many cities are gradually renewing their own fleet by buying zero-emission vehicles. However, cities often tend to be technology-neutral, so in their strategies and tender procedures, they refer to emissions-free vehicle and infrastructure rather than e-mobility, leaving the market with the possibility to come up with the most suitable solution.

If the specifications in the tenders are too complex and difficult to be achieved, the risk is that they do not get any offer: the strategies of the city might not aligned with what the market is able to offer at the moment. There is a lack of market solutions especially for specific municipal services: heavy vehicles, adapted vehicles, etc. Madrid observes difficulties in the procurement processes which in most cases are monetary driven: e-vehicles are still more expensive than traditionally fuelled vehicles on average, and often purchases are made by the

procurement department that may have other, sometimes conflicting objectives, such as containment of the costs versus emissions reduction. In Bremen, each department has decision-making power and its own budget. However, there is a centralised procurement office, that deals with making purchases for all departments. Tendering cycles and contracts already in place can restrict the possibility to implement "green procurement schemes", therefore this transition period should be taken into account when planning to renew the city fleet or shift to more sustainable service providers. When tendering out, LAs must always guarantee that small suppliers can submit bids to the city's calls for tenders, avoiding setting too ambitious criteria that can only be met by large companies. The risk is that the market will be distorted, causing inefficiencies and worsening the economic conditions of local actors.

Another aspect to consider when commissioning EVs is the availability of charging infrastructure in public buildings and facilities, and the additional space required to recharge new purchased e-vehicles. However, in the opposite situation, if cities have the financial strength and the availability of land and facilities, they can convert them to e-fleet depots, installing a charging infrastructure that could serve a broader range of EVs, including public services like taxis and buses, but also private ones like commercial vans and trucks.

Joint procurement can be an effective way to increase the level of services and vehicles to procure and to reduce their price, by ordering large quantities and even sharing them among different buyers. However, in the case of vehicles and infrastructures, different buyers have different needs: when the specifications are not the same, and therefore an order envisages different types of products, it is more difficult to obtain advantages from the supplier. The BuyZET[74] and SPICE[75] projects, funded by DG MOVE under the Horizon 2020 research programme[76], are currently investigating innovative approaches to set up procurement buyers groups.

4.1.2.3 CHARGING INFRASTRUCTURE

Technical aspects related to the roll-out of the charging infrastructure should be considered by LAs: at present, being the e-fleet circulating in cities still limited, there are no major problems. However, when the deployment is systematic and on large-scale, there will be challenges with the energy grid, which will no longer be adequate to drive the amount of electricity needed. In Eindhoven, the municipality anticipates that the installation of new cables might require more space, currently not affordable in the city environment. The company that manages and maintains the electricity grid will have to discuss with the municipality and other stakeholders to find the most appropriate solutions that guarantee a smooth deployment of the EV charging infrastructure.

In some cities (Bremen, Gothenburg), the layout of the streets does not favour the rollout of EVs charging infrastructure: there is a lack of space, especially in dense neighbourhoods, where users with no possibility to install own charging devices require on-street charging. Adding space for EVs means subtracting it from other types of vehicles and operations, such as loading/unloading operations, and this type of intervention often causes strong opposition from local stakeholders (e.g. residents and couriers afraid of losing parking and loading/unloading areas). Therefore, in many cases, LAs tend to favour off-street solutions for normal charging points. There are limitations and challenges linked to the deployment of off-street charging infrastructure in public residential parking, as the costs may increase notably depending on the length of the wiring as well as on the legal requirements from the ownership point of view. Charging at the household level is one of the main constraints also from the users' perspective, as well as the purchasing price of EVs, especially in cities where incentives and subsidies are limited. A simplification of regulations and approval procedures can facilitate the deployment of individual charging points in existing apartment/office buildings. In the new

[74] http://www.buyzet.eu/
[75] http://spice-project.eu/2017/11/06/spice-supports-common-buyers-groups-trigger-innovative-procurement/
[76] https://ec.europa.eu/programmes/horizon2020/

Spanish apartment building regulation for example, EV owners only need to notify other co-owners to install a charging point at own costs. This eliminates the need for uncertain and long approval procedures. The 2016 passed French building code requires new apartment buildings to equip 50% and commercial/office buildings to equip 10% of parking spaces with conducts for minimum 7 kW charging. At EU level, similar measures should be included by the Energy Performance of Buildings Directive[77]. Some cities (see section on Gothenburg) have deliberately decided to reduce the urban space dedicated to vehicles, either traditional or clean, for improving the quality of life of citizens. As a result, switching to clean technologies must be coordinated with other priorities identified at the city level.

Energy grid constraints cause uncertainty for investors, including grid companies (Madrid), especially for fast charge points. However, although there will be a problem when investments have to be made on a larger scale, this could facilitate the identification of a business model for the operators interested in installing and managing the (fast) charging stations, which will necessarily have to invest in more expensive and efficient energy connections.

In the UK, most regions that have a tendered contract have usually secured competitive grant funding to so. Greater Manchester is reviewing the commercial case to package up EV infrastructure as a long-term investment. Some regions have divested themselves from their network and passed to private operators. However, it is important that cities work closely with service providers, guaranteeing that infrastructure is placed where it is most needed, and not only where it generates the highest revenue. For this kind of cooperation to happen, at the national and European level it is necessary to create an overall legislative framework that includes this principle. This is in line with the approach of the AFI Directive, aiming to accelerate the e-charging infrastructure deployment in Europe by mandating the build-up of sufficient numbers of publicly accessible charging stations, among other things. Cities also need to cooperate with Distribution Network Operators (DNOs), to encourage the exploitation of renewable energy (see Eindhoven moving towards energy-neutral activities).

A challenge related to the privatisation of the charging network, as already highlighted by the EAFO survey, is that it hinders data sharing, which is very useful for planning and land use management. However, in some cities (Aachen), even if the local utility provider is the owner of the majority of the charging infrastructure, it has to deliver the data to the respective city administration departments. However, in Spain and in the UK, there is no legal requirement to map charging infrastructure placed in private spaces, including utility companies; therefore, it is difficult to elaborate a clear picture on the infrastructure present in each city.

In general, the tendency is to encourage normal charging in off-street parking and residential areas, and to assign on-street infrastructure to fast chargers. This vision also influences the positioning of fast chargers, in particular those that must also be used by taxi drivers and freight operators. They need fast-charging infrastructure to be placed especially at points of interest and service centres, especially where stopovers will last 10-15 minutes, in order to have a high number of charging processes. Fast charging stations need to have several charging points, avoiding loss of time while waiting for a free column load. Focussing on people's needs/demands, fast-charging infrastructure has to be available in urban surroundings (e.g. see the masterplan fast charging of the Stuttgart Region[78]), additionally to the fast charging infrastructure across main routes or the Trans-European Transport Networks (TEN-T) corridor.

On the payment method used (e.g. per kWh, time via parking fees,..), there are various models in place. Many cities initially opted for a free system, or for an annual subscription at a very low fixed price, to encourage the purchase and use of EVs. Cities where the number of EVs has started to increase are trying to change the perception of users, since the electricity has

[77] The Energy Performance of Buildings Directive (EPBD) is oriented towards achieving EU targets in energy efficiency: https://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v10.pdf
[78] Presented at the EUSEW17 - Energy systems for smart mobility workshop, June 22, 2017. Presentation not available, agenda here: http://www.eusew.eu/sites/default/files/energy_days/agenda%20-%20EUSEW2017_2.pdf

a cost and recharging of EVs at charging points is often interpreted as a parking stop, implying an excessive occupancy of parking areas. For this reason, cities have begun to introduce a per-minute charge, to minimize the occupancy of the charging stations (Madrid), and to set time limits for the use of fast-chargers (London). However, the fact that provision of charge points and methods of access and payment are inconsistent between authorities can discourage people and in particular freight operators to shift to EVs.

In Aachen, the charging infrastructure is currently providing a sufficient network. As captured in the ASSURED survey, the ratio of all full electric vehicle/ Plug-in hybrid electric vehicle (PHEV) in Aachen and the charging points is 10:1. The city is now aiming to improve its fast charging infrastructure. However, not all cities are interested in the rollout of fast charging EVs infrastructure, in particular dedicated to heavy vehicles, since it is considered very expensive and represents a risk for investors (Bremen). Diversity of needs, diversity of plug-in and sockets, grid constraints, cost of vehicles (due to high capacity batteries), diversity of stakeholders and companies are considered the main barriers and challenges related to the fast charging infrastructure for heavy vehicles.

As for financing, being an open market system, operators must see the existence of a market that generates profits for them. Infrastructure needs to be packaged up as an attractive commercial long-term investment proposition with a strong return on investment. EV network usage is more guaranteed - in the UK it represents a significant vehicle market, since sales of petrol/diesel will be banned from 2040 - and the take-up of EVs will continue to grow exponentially. In the UK the Maximum Resale Price Provisions (MRP) have been specially altered by the Office of Gas and Electricity Markets (OfGEM) to support the commercial case of public EV infrastructure development: a public EV infrastructure network is the only network where electricity purchased for operation can be resold to customers at a profit. This fully supports commercialisation and creates room for profitability, therefore investors are interested to invest but would need a more long-term investment guarantee, possibly in the range of 15 to 25 years.

There are three models for developing a long-term proposition: 1) public sector owned and developed, 2) private sector owned and developed, or a 3) Public/Private Partnership (PPP).

Clarity and direction from public sector about the preferred model are needed to improve its attractiveness. In the UK (Manchester), the transport authority TfGM owns the infrastructure and installed the charging points, which are then given in concession for the operational aspects to a designated body. The initial approach of TfGM has been to select the most appropriate spots, and to support the installation with national funds. Next step is the commercialisation and the expansion of the network. In order to do that, for the long-term TfGM is considering setting up PPPs, to retain the control on the sites and some revenue from the charging. However, even in cases where charging infrastructures are operated by private actors, cities need to cooperate with them in identifying the best spots to install new stations - or at least they tend to reserve the right to approve them.

4.1.3 Understanding the urban freight sector

Electric Freight Vehicles (EFVs) can perform city logistics operations in daily life. TCO comparisons show that a positive business case is possible for small EFVs, under circumstances for medium EFVs[79]. At the moment, many changes are required when procuring an EFV in case no Original equipment manufacturer (OEM)-product is available. It is important to support a positive business case also for medium-heavy duty vehicles: commercial vehicles need to be the right size for their operations, and replacing one big truck with several smaller ones can increase rather than reduce congestion, CO_2 and air pollution.

[79] FREVUE Results and Guidance for Local Authorities: https://frevue.eu/wp-content/uploads/2017/09/FREVUE-Results-and-Recommendations-for-Local-Authorities-v_09.pdf

In FREVUE, demonstrations mainly replaced EFV-feasible roundtrips, however in the future logistics concepts need to be adapted for large scale usage of EVs.

A short-term market stagnation where transport companies are waiting for robust OEM products can be anticipated. National or more localized legislation and/or incentive programs could play a significant role in encouraging the uptake of EFVs in the next few years (see section 5.1.2 for more details about freight-tailored measures).

The current charging infrastructure system does not support the operations of logistics operators, which do not have fast charging points at the strategic points of the city. At the moment, operators who want to go electric must bear the costs related to the installation of a charging infrastructure in their depot, for the benefit of the subcontractors who work on their behalf, and who in turn have to bear the costs of buying a (still) expensive EFV, despite they do not have a stable contract with the logistics operator.

The urban freight operators owning their own fleet charge their EFVs in their own depots overnight at a low current. This process is generally slow and requires one charge point per vehicle. Furthermore, this charging method is best adapted to urban freight operations for which daily distances are limited. Although it has been demonstrated that about 80% of the daily distribution operations in the city fall within the charge range of a normal electric van[80], for some the battery range currently available can be an issue and might limit the wider uptake of full EVs.

[80] Ibid.

Figure 12 – An EFV charging at private depot[81]

Private infrastructure upgrades at depots require funding of other's assets, are non-incremental and expensive. Financial support is needed (e.g. FREVUE project), since not many operators are in the position to invest in third-party infrastructure. It is almost impossible to undertake such an action without public funding – until it would become compulsory. Such investment requires considerable pre-planning activities: to improve the grid, the previous infrastructure has to be dismantled and the new one installed from scratch. The smart grid can help to optimise the use of existing (limited) infrastructure.

To overcome the limited battery range issues and to allow additional charging during operational hours, cities need to install fast-charging stations in strategic points of the city, that can be used by freight operators for opportunity charging. The choice of location of the fast charging stations is important to attract high usage. Once available, drivers of commercial electric vehicles are more frequent users of fast chargers than citizens. A survey conducted by the municipality of Stockholm[82] shows that that fast charging stations in urban areas are a way of enabling electric kilometres for commercial traffic, rather than being an opportunity for individuals. However, the investment is still worth: while they only constitute a small

[81] Image credits: © FREVUE project
[82] 'Experiences from setting up public charging facilities for electric vehicles in Stockholm'. Retrieved from: https://frevue.eu/resources/experiences-setting-public-charging-facilities-electric-vehicles-stockholm/

percentage of the vehicle fleet in a local area, the high mileage driven makes freight operators a very present player on the streets and therefore a significant source of emissions.

Fast opportunity charging coupled with a pre-booking system allows efficient use of public infrastructure by commercial electric vehicle drivers and strongly reduce the issue of 'range anxiety' among drivers.

The majority of the cities interviewed do not have any freight-related initiative in place. The general approach is that charging infrastructure for EFVs should be installed at private depots. TfGM is currently conducting a study for a roadmap for heavy vehicles towards fuel electrification. The roadmap includes three scenarios, which consider the type of infrastructure that the freight vehicles would need. According to this study, the best model for the freight sector seems to be the overnight charging at the company depot, which nevertheless implies barriers in terms of network capacity. The municipality of Madrid also considers that freight operators need to have associated charging infrastructure at depot - or homes, in case of own-account and subcontractor drivers, who are the owners of their vehicles. However, it is also necessary to have a minimum fast charging network (opportunity charging) to overcome possible range limitations if needed. The new 'PLAN A: Air quality and Climate Change Strategy of Madrid' takes into account the deployment of charging infrastructure for professional users (taxi and freight). In Aachen, urban logistics is part of the mobility strategy 2030, to be approved in late 2018; in Gdynia, the SUMP envisages the introduction of AF vehicles for waste collection; nevertheless, specific strategies for recharging EFVs are absent.

4.2 VIEW AND NEEDS OF PUBLIC TRANSPORT AUTHORITIES AND OPERATORS

The following section introduces briefly the organisation of the PT market. It is followed by the description of the identified needs and requirements of PTAs and PTOs for the deployment of large e-bus fleets, including a brief description of the methodology and the validation of the identified needs and requirements. The results are consolidated for both PTAs and PTOs.

When it comes to the further deployment of e-bus systems, the main concern of PTAs and PTOs is how to upscale the fleet meeting the economical, operational and environmental requirements. It is thus important to underline that the identified needs and requirements are aligned with this need. The topic of charging infrastructure and charging strategies is considered then as a sub-topic of the main focus.

4.2.1 Introduction

The identification of needs of PTAs and PTOs related to the deployment of bus systems has been successfully approached in the past. The EBSF (2009) and ZeEUS (2018) projects explored this field and provided valuable insights to build on when extending the system to alternatively-fuelled buses, more concretely and in the case of ASSURED to electric powertrain buses.

The following section provides a brief overview of the main aspects of the public transport system and describes the approach followed within ASSURED to revisit the existing knowledge and to adapt it to electric bus systems.

4.2.2 The Public Transport market

Public Transport is provided for the benefit and general good of the citizens, having to meet certain requirements, e.g. reliability, convenience, accessibility, safety, security, and environmental protection criteria in order to provide excellence of service. The organisation of PT system is thus highly complex as it is highly dependent on the specific context and the diversity of solutions and arrangement prevails at the local level. Furthermore, it has to balance three main pillars: high investment costs of the PT network and infrastructure, the service provision to the largest amount of people, and ensuring accessibility by providing the service

at a low cost. For this reason, very often PT requires the intervention of public authorities to regulate and subsidise the market.

The relationships in the PT market can be illustrated as follows, where often enough and due to the variety of governance models for PT, the Authority level cannot be clearly identified. The different relationships determine the main interests of the different actors, being mainly regulated by direct influence exerted from Passenger-Authority and Authority-Operator.

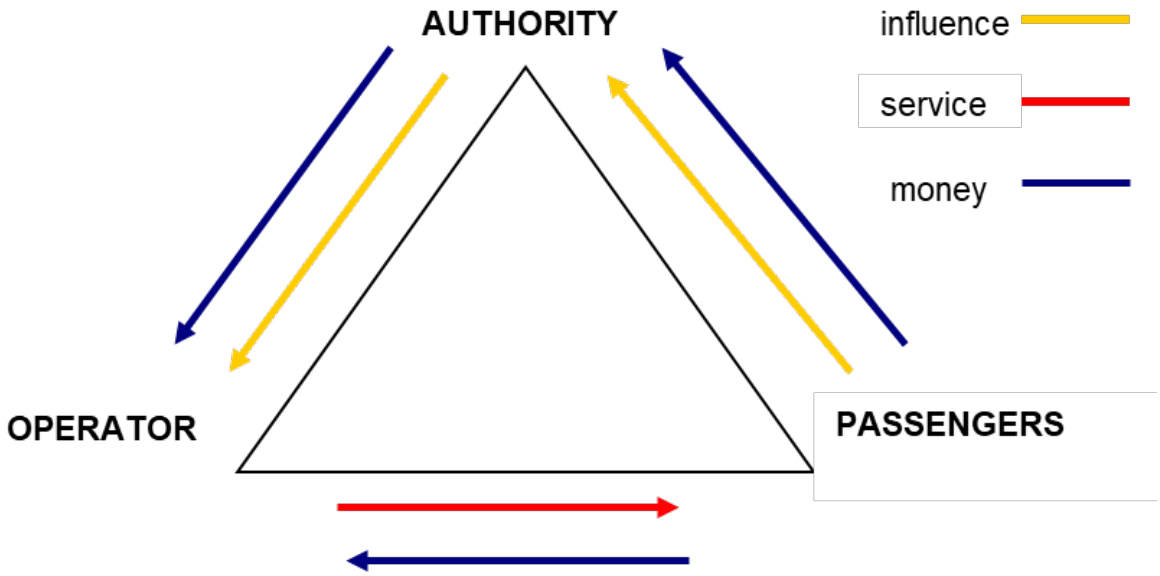


Figure 13 - Relationships among actors of the Public Transport Market[83]

In order to define the needs and requirements of the stakeholders involved in the PT system, it is necessary to extend this initial categorisation to a more complex picture, highlighting the need for a more detailed definition of the Operator aspects. The results arising from EBSF and ZeEUS provide a detailed breakdown of the stakeholders involved in any public transport system:

- Public Transport Users
  - The regular users
  - People with special needs (elderly, disabled, children, students)
  - Occasional users
- The Public Transport Operators
  - Management
  - Drivers
  - Maintenance personnel
- The Public and Transport Authorities
- The other road-users
- The industry

[83] Image credit: UITP

As indicated previously, ASSURED will focus on PTAs and PTOs.

The specific tasks and risks of PTAs and PTOS differ according to the different existing organisational models. In general, the PTA keeps strategic and tactical tasks[84] while the PTO is in charge of the operational functions.

In Europe, taking into account the current organisation of tasks and function in the public transport it is possible to identify two models of operation: one representing a direct relation between a public authority and the PTO, and other one in which this relationship is taken over by a PTA which mediate between the local authority and the PTO.

The two models represent different allocation of tasks, competences and responsibilities that determine the nature of the relations among the various players, the distributions of risks, the arrangement of the contracting out of service, the contract management and monitoring and the coordination of PT with other transport modes.

As for the assessment of the users' needs, these two organisational models were properly considered through the involvement of both public and transport authorities in the collection of inputs. For the sake of simplicity and with the aim of providing a tool, however, it was decided to combine the results achieved for public and transport authorities in a unique category of stakeholders.

4.2.3 Reviewing approach

The reviewing procedure was carried out in three steps: a) evaluation of the existing EBSF and ZeEUS technical reports and assessment of the extension of the relevant features to electric powertrains; b) validation of the extended features list through a dedicated workshop with cities, PTAs and PTOs held in Eindhoven in February 2018; and c) wrap-up and finalisation of the validation exercise for the purpose of the present deliverable.

Over 300 collected features were grouped according to their degree of sensitivity to the implementation of electric bus systems. The large majority were identified as features not being impacted by the introduction of a new technology as they are features belonging to bus systems in general, irrespective of the energy carrier. A total of 38 features were identified as affected or influenced by the introduction of electric powertrains.

These features were grouped into two categories as a) impact of the introduction of electric powertrains and b) generated by the use of electric buses, in both cases showing the need to take in account a number of facts, costs, kind of impact on the public space or operator's infrastructure, technicalities, in these two levels of influence.

A World Café organised in the above-mentioned workshop gave the opportunity to discuss these impacts with a selected group of PTAs and PTOs, particularly on the features that participants deemed more significant or critical.

4.2.4 Needs and requirements of Public Transport Authorities and Operators

The identified features, from now on called Needs, are distributed in two tables as indicated above following a pattern of 11 areas of investigation:

1. Safety and security
2. Service performance
3. Comfort, cleanness and quality feeling/perception
4. Accessibility to vehicles and infrastructures

[84]. The establishment of a PTA is often associated with a wider impact beyond the economics of transport: it is viewed as an efficient and effective way to organise mobility with measures such as fare and ticket integration, increasing the convenience of the service, and with it potentially the ridership. Also, it can provide the ideal arena to start creating a vision and strategy for public transport which also includes other relevant aspects like the impact of mobility measures on societal health.

5. Information to passengers, relational and behavioural issues
6. Modal integration and additional/flexible services
7. Environmental issues
8. Maintenance
9. Pricing and commercial policies
10. Economic and operation issues
11. Urban development and quality of life

Hereafter, and starting from the indicated areas, it is possible to assign every Need with the corresponding agent or body in charge (i.e. PTO management, drivers, maintenance staff and PTA) according to the local allocation of responsibilities. This allows flexibility in the implementation, as no specific pattern of competencies allocation is assumed beforehand.

Table 11 - Impact of the use of electric powertrains on PTO/PTA Needs

Nr	Area	Need	Impact generated by the use of electric powertrains	Stake-holder	Area of Competence
1	URBAN DEVELOPMENT AND QUALITY OF LIFE	Analysis of opportunity for exchange parking areas (P&R)	Deployment of e-buses: synergies between P&R areas with on-road charging stations for e-buses, e-bikes, e-truck, e-cars…Linked to 3	Authorities Operators	Authorities Management
			Park and Ride areas offer a good opportunity for synergies between e-bus and other electric vehicles both private and commercial; P&R areas are usually sited in proximity to rail stations that offers good opportunities for easy access to energy grid (assuming the regulatory frame allow rail operator to provide energy to third parties), and this would easily make available e-bikes or provide energy for bus opportunity charging. From an operational point of view, the long parking time of private vehicles in P&R would also allow slow charging, reducing costs and increasing charging efficiency		
2	URBAN DEVELOPMENT AND QUALITY OF LIFE	Analysis of opportunity for interchanges and other shared infrastructure	Deployment of e-buses: synergies between P&R areas with on-road charging stations for e-buses, e-bikes, e-truck, e-cars…Linked to 1	Authorities Operators	Authorities Management
			Interchanges offers a good opportunity for synergies between e-Bus and other electric vehicles both private and commercial; these areas are usually sited in proximity to rail and/or metro stations that offers good opportunities for easy access to energy grid (assuming the regulatory frame allow rail operator to provide energy to third parties), and easily make available e-bikes or provide energy for bus opportunity charging. The area dedicated could not be necessarily too large and therefore an accurate management of the charging infrastructure and the vehicle charging operations would be necessary.		
3	URBAN DEVELOPMENT AND QUALITY OF LIFE	Improved image of the city	Stress on real zero emissions because of e-powertrain. Provided no fossil fuels are used for heating!	Authorities	Authorities
			The clean propulsion can be used as vehicle to improve the image of the city as a place where environment is considered together with sustainable mobility. Giving priority to e-bus deployment and operation, even respect the development of private clean traffic, has the double advantage to contribute to renew the bus fleet towards clean solutions, and to make the city less congested and more liveable. Furthermore, the new on-board technology give the opportunity to re-think the urban bus as something new, different, designed around the message of “clean” he gives. The project EBSF_2 (www.ebsf2.eu) has developed a design charter about this argument.		
4	MAINTENANCE SAFETY AND SECURITY	Safety and security provisions in maintenance	New requirements due to new type of equipment in the garage, both on board and in depot and garage.	Operators	Maintenance Staff
			The use of electric buses bring changes in the maintenance environment and procedures. It has to be said that several operators already are used to work with HV DC systems, and a complete and exhaustive literature already exist and is adopted. But it needs to be ensured that such rules are strictly respected Garage set-up would require bridges for accessing electronic equipment roof-mounted, and tools for monitoring DC systems. New skills are necessary, and this require to put attention on training. From the point of view of security, modern systems are characterised by a heavy use of IT both in local that in remote. Cybersecurity would be a new aspect to be considered.		
5	MAINTENANCE	Continuous training of maintenance personnel also with support of multimedia	Staff of subcontracted suppliers to be duly trained in terms of HV DC components.	Operators	Maintenance Staff
			The use of electric buses bring changes in the maintenance environment and procedures: a new type of power-train, new elements on-board (batteries, BMS…) and infrastructure (chargers); but also, new tools for fleet management, smart charging, system diagnostic and maintenance. New skills, more relative to electro-techniques and IT than motorists become necessary. Training cover an essential role in this technologic change. Even if several operators already are used to working with DC systems and high voltage, and complete and exhaustive literature already exists and often adopted, the use of a new evolving technology also requires that training material and procedures are reviewed more frequently. Telematics-based training can help keeping the maintenance staff always updated about technologic changes. Training shall also consider cybersecurity.		

6	MAINTENANCE	Design limiting number of builder-specific parts/ admitting generic spares	Impact of new technology and supply chain	Operators	Management
			From a theoretical point of view, electric bus power train is simpler than an ICE (Internal Combustion Engine) one. But more parts (in percentage) would come from external suppliers (batteries, electric elements); as consequence, manufacturers need to rely more to third parties for the development of products. For electric buses, this phase of the technological development is characterised by several different solutions, some developed by main actors and supported by many companies, but some developed by a limited number of industries. For this reason, the number of builder-specific parts is quite high. In addition, electric bus systems are also quite "personalised" system, and this is also not contributing to the reduction of builder-specific parts. The increase of standardisation, and the "darwinian" consolidation of market will have a positive effect on this issue.		
7	MAINTENANCE	Optimization of vehicular flow and parking in depot	One of the elements of the Bus systems that need big changes when electricity is used for propulsion is the depot (re-filling became re-charging)	Operators	Maintenance staff
			In order to optimise such operation (for infrastructure dimensioning, energy costs…) it is required that vehicles are parked connected to the charging infrastructures (usually for several hours but can also be for only few minutes during operations) and that not all the vehicles are charged at the same time (parked or in movement). When dealing with slow charging, the alternation of vehicles plugged can be solved physically by moving vehicle to/from chargers, adding complexity to the depot operation. Or can be solved by plugging all the vehicles and then controlling the charging process by IT systems: this would allow smart charging. When the depot is used for opportunity charging, then the flow of the bus in the garage will be quite "fast" and for short time. Its optimisation is linked to the whole dynamic service management. It has then to be noted that automation can provide a great contribution to such type of movements in depot, increasing efficiency, safety and use of space (parking closer vehicles).		
8	SAFETY AND SECURITY	Contributing to the overall improvement of citizens safety perception	Safety to be taken into account as well, similarly to other alternative appliances (CNG, hydrogen, etc.)	Authorities	Authorities
			There are today already several mobility systems using high voltage and electricity, like metro, trams and trolley-buses. As such, several standards exist today that, if correctly applied, ensure the safety of the users. The "new" today main concern in terms of safety perception of Electric buses (and electric vehicles in general too) is linked to the presence of batteries on-board, based also on some very specific episode happened in which batteries exploded. On the other side, it should be reminded that also diesel, petrol, gas can be potentially dangerous. In any case, work is ongoing from several Country's fireguard corps in defining procedures and tools to be used for each different propulsion type of bus, also with contacts and involvement of ISO (the international standardisation body)		
9	ECONOMIC AND OPERATION ISSUES	Cost-effective infrastructures (build and exploitation)	Care must be taken to all the aspects, from the ownership to the business model for its exploitation	Authorities Operators	Authorities Management
			Factors like the use of different type of vehicles (ex; buses and urban trucks) or same type belonging to different concessionaries, require the development of innovative schemes and models for ownership and exploitation of system elements. For what concern the ownership, issues are the ownership of the land and the ownership of the on-road charging infrastructure. At level of exploitation, the use of it from different users has to be regulated by legal, operational or contractual rules. Furthermore, the use and/or transfer of ownership (for example in case of new concession) need to be carefully considered. Ex. in France SEM (Societé d'Electrité Mixte), PTA buys the infra so that can be used also for other PTOs; while in the Nederland the PTA usually asks the PTO to develop charging infrastructure		
10	ECONOMIC AND OPERATION ISSUES	Development of new procurement / tendering schemes	For what concern the e-buses, this is key issue, encompassing all aspects of the tendering process. In fact, it has to be considered that in case of e-buses the scenario moves from the procurement of a vehicle to the procurement of a whole system. For this reason, the so-called system-approach shall be adopted, looking to the whole system at first and then to how each element contributes	Authorities	Authorities

			Some of the most important aspects to be considered in the tender a) ownership of infrastructure and assets (see 6 above) b) the inclusion of new stakeholders like integrators and suppliers c) new evaluation criteria should be also considering, in particular the so-called “positive externalities”: in fact the environmental benefits of e-buses impact other “costs elements” of a city budget (for example the health and associated social costs) e) length of the contract, that could not be sufficient to amortise the investments sustained or could be not in line with the planned life of the battery f) responsibility in the replacement of batteries (without or with new investments), assuming that the technology evolution will not make it too obsolescent g) decommissioning of harmful components		
11	ECONOMIC AND OPERATION ISSUES	Efficient fleet management, also through collaboration bus manufacturers	Access to data in standardised way for dynamic fleet management of e-bus fleets	Operators	Management
			The present e-bBus technology does allow to perform operations in the same way as diesel bus. For this reason, operators needs also to have an efficient fleet management, based on continuous monitoring of the bus state of charge and charging system capacity. This allow the operator to intervene dynamically on the bus service and on the charging process during the service, by giving priority to some buses respect others in terms of charging station access. In fact it shall be considered that the state of charge of a vehicle is the result of several factors, some of them not always predictable (traffic, energy consumed by auxiliaries) bit that shall be accurately monitored, even by using efficient remote diagnostic systems and predictive models. Considering the normal operational scenario, with buses from different manufacturers working together, it becomes essential that bus manufacturers would collaborate in order to agree on the e-bus data to be accessible in a standardised way to an operator; Work started in the frame of the bus FMS working group and in ITxPT association		
12	ECONOMIC AND OPERATION ISSUES	System data access for remote diagnostic and predictive maintenance	Access to data of the system for the identification of the issues and their prediction in order to reduce to vehicle off-line time	Operators	Management
			The present e-bus technology does allow to perform operations in the same way as diesel bus. For this reason, operators needs to have direct or indirect (through industry) access to data from the e-bus system elements that would allow him to perform at best its operation. Which type of data would be available, depends on balancing the request from the operator that would try to access as much data as possible, and the availability of the data accessible that industry would to limit as linked to internal strategy. But the importance of the topic and its positive effect on the operation need to be considered and shall bring to collaboration between the partners, especially when the adopted technology, like electric propulsion, is still new and collaboration can bring great mutual advantage.		
13	ECONOMIC AND OPERATION ISSUES	Optimisation of the investment	Shift from high operational costs towards high investment costs. Linked to 6 and 9	Authorities	Authorities
			The introduction of innovation in cities (even beyond pure mobility) requires more and more the development of important and expensive infrastructures (dedicated structures, charging points, IT networks…). For this reason, all the stakeholders involved, cities, authorities, vehicle manufacturers, suppliers, energy suppliers, operators are developing new business models. The optimisation of the TCO practically act in showing a balance between the higher investment costs respect the (presumably) lower operational costs. An additional important point is the access to suitable financing mechanisms to support the high upfront investments for e-bus.		
14	ECONOMIC AND OPERATION ISSUES	Special provisions for energy supply tenders	Introducing specific requirements (reliability, availability), facilitated fares, and other contracting aspects	Operators	Management
			Use of e-buses require operator to open contracts with the energy company for the provision of energy for propulsion. Of course tenders and type of contract is ruled by the specific applicable rules. Some aspects, peculiar for e-bus systems, entering in the contract can be: amortisation/mortgage/use of the charging infrastructure, availability of the charging infrastructure, guaranteed power levels… Special fares could be envisaged at National level (as for tram and metro systems) and/or can derive by direct negotiation, especially when the operator already have a contract for its metro or tram network.		

15	ECONOMIC AND OPERATION ISSUES	Special contracts for energy generation, feeding and / or storage at PT facilities	In case of local PV or wind generation, and dealing with other business models such as grid regulation.	Operators	Management
			In most of the case, especially when there is no synergy with metro/tram energy network, the operator will not produce enough energy even for its internal use. But in case there is a good synergy and the operators use the metro/tram energy distribution also for e-bus charging points, then this can open new scenarios for energy distribution to other users (delivery, taxis, private cars, e-bikes). New business scenarios can appear, but the complexity of the European and local regulatory scenario for energy distribution should be carefully evaluated. Another aspect that could enter in this contractual discussion is the possibility for vehicle-to-grid that could provide advantages to the energy supplier in balancing the power network.		
16	SERVICE PERFORMANCE IMPROVED PT IMAGE ECONOMIC AND OPERATIONAL ISSUES URBAN DEVELOPMENT AND QUALITY OF LIFE	Improved commercial speed	Dwelling at stop / Charging	Operators	Management
			Impact of the use of electric buses on commercial speed can be quite limited. The improved acceleration help reaching the nominal speed faster, assuming of course that this does not impact on the passenger comfort. A particular case can be when the electric bus is charged at all/or selected bus stops, as the charging process could impact the dwell time and, consequently, the commercial speed (ex. TOSA system in Geneva, the SRS system by Alstom, or the use of supercapacitors like in Beograd) The increase of commercial speed has a positive effect on the Public Transport share, helping to reduce carbonisation of transport, pollution and congestion.		
17	SERVICE PERFORMANCE URBAN DEVELOPMENT AND QUALITY OF LIFE	Improved management of traffic lights and priorities for PT (green wave)	A priority factor for e-buses may be the current SOC, traffic lights to be controlled by the dispatchers-TCC	Authority Operators	Authority Management
			One of the issues for electric bus operation is the dynamic monitoring of the fleet as in n.9. Policies ensuring an effective management of traffic lights, with prioritisation for buses have also a positive effect on the charging. This need is also linked to n.13, and represent one of the main tools to support, with dedicated Public Transport infrastructure, local policy strategies that have positive effects in increasing the increase of commercial speed.		
18	ENVIRON-MENTAL ISSUES	Disposal and recyclability of the vehicle and of its parts	In e-buses, this is a big issue as batteries are done with material potentially dangerous for the environment. It is then important to find an environmental friendly solution that would prolong the operative life of the battery until a "clean" recycling process.	Operators	Management
			Today there is a variety of possible treatments for the use of batteries after the period they are used for traction, depending if the battery is owned by the operators or rented/leased. In case the battery is owned by the operators, then several possibilities appear: a) setting up of a secondary storage at the bus depot or elsewhere, thus enabling the management of cheap available charging power, then reducing power costs (ex: Amsterdam) b) when the available capacity of such secondary storages reach a sufficient size, some sort of grid management could be operational (e.g. matching solar and wind generation to real consumption) namely in the grid frequency adjustment procedures. This possibility enables new business models (acting the owner of these storages a service provider to the grid manager). Ex; Muenster. When the ownership of the batteries is kept by another party (vehicle or batteries manufacturer for example), at life end of the batteries, the party is responsible for the recyclability, re-use, disposal or whatever end solution feasible. This option encompasses all models displacing the recyclability issue upstream in the supply chain, up to even the manufacturer of the batteries.		

			From the point of view of sustainability, direct recovering of old batteries by its manufacturer could simplify some recycling processes apparently appropriate (ex. lithium recovery), including also some heavy metals.

Table 12 - PTA/PTO Needs arising from the use of electric powertrains

Nr	Area	Needs for the deployment of large fleets of electric buses	Justification	Stakeholders	Area of competence
1	MODAL INTEGRATION AND ADDITIONAL/FLEXIBLE SERVICES	Interoperability & adoption of standard protocols in the adopted charging technologies	Standardisation of charging systems and protocols is a key topic in the current phase of market up-take and variety of technical proposals. It concerns on the way to cope with the various charging technologies and their impact on tendering regularity, reselling value, cost optimisation	Operators	Management
2	MAINTENANCE	Control of recharging time	Crucial for charging time both at the depot and on-road. Monitoring systems and smart charging are right enablers for this. PTOs start looking to fully automatic depots as a natural next step with the automation of the vehicle itself: automatic charging without plugs and manpower.	Operators	Management
3	ECONOMIC AND OPERATION ISSUES	Flexibility for the introduction of alternative propulsion system (availability of fuel selection tools)	Prior to decision, to define the best approach to alternative energies implementation. Local factors to be considered. A feasibility study, involving all the actors, and considering risks, operational scenario and economical aspects is greatly encouraged	Authority Operators	Authority Management
4	ENVIRONMENTAL ISSUES	Reduction of greenhouse gas emissions and pollutants (SO_2, NOx, PM_x, etc.)	Related not only to local policies and decisions from all the stakeholders but also to state level commitments such as Climate international agreements	Authorities Operators	Authorities Management
5	ENVIRONMENTAL ISSUES	Renewal of the fleet with vehicles eco-sustainable	Even if often politically driven, financial requirements have to be strongly considered versus service contracts obligations and service operational requirements. Priority (supported by political decisions and adequate financial means) shall be the improvement of environmental performances, not just putting new technologies. And should never be forgotten that the main objective of bus is to bring passengers in an efficient way, so technology shift shall not impact the quality of the service (in number of buses on a line, for ex)	Authorities Operators	Authorities Management
6	MAINTENANCE	Storage of enough power to perform the entire daily service	This particular issue is linked to very harsh trade-offs between service quality, vehicle weight, operating range, heating/HVAC needs, on-road charging possibilities, investment, ownership schemes, etc. This issue requires the joint work of all the involved partners, industry, authorities, operators and energy suppliers, as it combines vehicle performances, grid capacity, depot and city infrastructure.	Authorities Operators	Authorities Management

7	SAFETY AND SECURITY	Safety and security provisions for charging operation	New requirements due to new type of equipment in the garage, both on board and in depot and garage. The use of electric buses bring changes in the operations, by adding the charging phase, in a depot or during the service. Standards exist on safety during HV operations and those standard are under update in order to be applicable also for charging operation. Of course it needs to be ensured that such rules are strictly respected. Charging points need to be equipped with all the features necessary for the safety of drivers, passengers and maintenance staff: training is necessary for operating staff. Automation can greatly increase the safety of the operation, especially when charging has to be completed under time-pressure due to the late arrival of the bus at the charging station. From the point of view of security, modern systems are characterised by a heavy use of IT both in local that in remote. Cybersecurity would be a new aspect to be considered	Operators	Maintenance Staff Driver
8	SERVICE PERFORMANCE	Monitoring on-road charging infra	On-road infrastructure availability is essential in order to ensure the correct operations of e-buses, when opportunity charging strategy is adopted. A part grid status, in case of energy storage (e.g. to get cheaper fares) also needs to be checked the SOC of a local storage system. This need is dependant on the charging station ownership. In case the authority own it, then the status needs to be communication to the operator and the consequences of unavailability on the service contract considered.	Authority Operators	Authority Management
9	SERVICE PERFORMANCE	Management of on-road charging access	This need refer to the best use of the charging station. It linked to the dynamic monitoring of the fleets by the operator, who is then optimising the access to the charging station based on the status of the fleet e-buses. In case the charging station is shared between different PT operators or road users, then the management of the access to the station will need to be carefully managed also in relation to its contractual implications	Authority Operators	Authority Management
10	MAINTENANCE	Maintenance of on-road charging access	It is linked not only to the technical maintenance of the charging point, but also to the contractual responsibility for such activity. Ownership of the charging access will have of course a big impact. Probably the most suitable scenario would see the operator taking care of the maintenance of on-road charging access, as it can keep control on the impact on the passenger service. Scenarios where the charging point is shared between operators or users would probably require the direct intervention of the authority as ideal owner of the charging station in this scenario.	Authority Operators	Authority Maintenance Staff
11	ECONOMIC AND OPERATION ISSUES	Financial trade-offs for e-buses and related infra procurement	One of the key barrier for the deployment of e-buses in service is the high investment required due to the increase cost of the vehicle and/or the infrastructure. For these reasons, the right financial means that can help the procurement should be identified and correctly applied by operators or authorities according to the organisational model.	Authorities Operators	Authorities Management

1 2	ECONOMIC AND OPERATION ISSUES URBAN DEVELOPMENT AND QUALITY OF LIFE	Planning of charging infrastructure	This is in relation to several different aspects beyond the technological ones linked to the operational needs of e-bus service to be planned. Factors that should not be underestimated are relative to the public works planning and execution, in terms of: choice of the place (linked to city image); permissions (that can a quite long process); existing regulation (that could require to modify the project); unforeseen events (unexpected pipelines). An important optimisation can come by having joint collaboration between all the involved actors, and comparing operator service planning with grid map. In fact, it could happen that it is possible to move the charging station of some meters in a place where high power is already available, and at the same time is still suitable for charging operation.	Authorities Operators	Authorities Management

5. What's next: consolidated vision and next steps for an "e-Deployment Strategy"

5.1 MEASURES FOR UPSCALING ELECTRIC FULL-SIZE COMMERCIAL FLEETS

5.1.1 Measures for Public Transport

Public Transport is provided for the benefit and general good of the citizens. With the aim of developing a culture of service excellence[85], public transport authorities and operators shall embrace a global and integrated mobility vision based on high-quality service to passengers and aimed at improving quality of life in cities.

To achieve this, the decarbonisation of transport will play a major role. Today there is a strong interest of operators and authorities in cleaner vehicles and more concretely in the future deployment of electric buses. This is reflected in the growing number of e-bus orders in Europe especially for the last years as shown in Figure 14 - Number of e-bus orders in Europe.

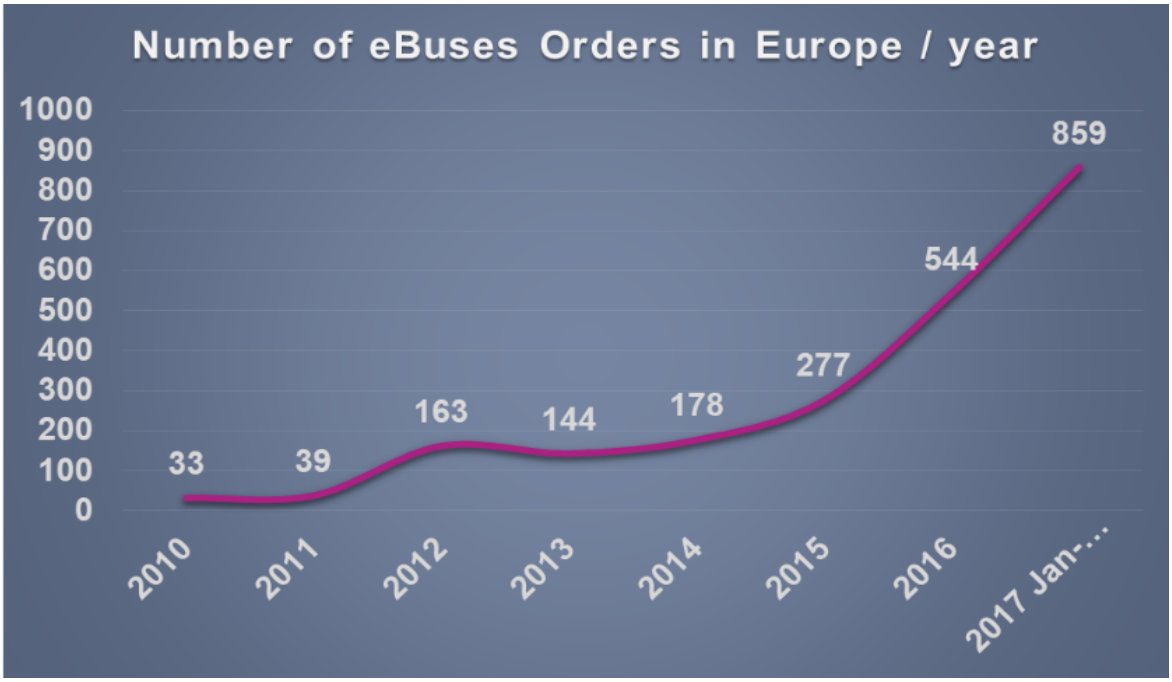


Figure 14 - Number of e-bus orders in Europe[86]

In summary, there are several measures that can be taken into account by authorities and operators in order to ensure a proper framework for the deployment of e-buses:

- Development of integrated policies and strategies promoting modal shift from motorised individual means to collective and soft modes.

[85] The UITP Action Points, "Building a culture of service excellence to develop a public transport business", aims to present the importance for public transport companies to redefine their corporate culture, vision and values, so that staff is properly motivated to provide excellent service. The paper present the multiple benefits of developing a culture of service excellence and provides recommendations for making the "human factor" the central concern within the organisation, management and communication of the company.

[86] Image credits: ZeEUS, ADL

- Provision of efficient combined & shared mobility, with intermodal transport points designed to reduce travel time and improve the riding experience.
- Fleet renewal, introducing cleaner vehicles with lower GHG and local emissions.
- Vehicles accessible to all. Reference can be the EBSF_2 project developed a Design Charter with recommendations on how the e-bus of the future can be part of the urban landscape.
- Improving the service through high commercial speed and efficient traffic & operations management.
- Fostering the smart use of energy in the public transport system.
- Giving priority to public transport through dedicated public transport infrastructure, e.g. lanes, charging, etc.

5.1.2 Measures for freight distribution and service trips

Promoting the introduction of electric vehicles in the van and truck private commercial fleet that every day circulates through the city streets has a proven positive impact in terms of CO_2-free emissions savings, as well as local pollutants such as NOx and PM. Although difficult to quantify, EFVs also address noise pollution. If, in London alone, 10% of the freight fleet would be electrified by 2021, over EUR 1billion per annum in public spending on reduced health impacts and abatement costs could be saved.[87]

A short-term market stagnation where freight operators are waiting for robust OEM products can occur, given that they are faced with uncertainties on the purchase of higher priced products from conversion companies. Public authorities play a key role in creating the best conditions for the uptake of EFVs in urban centres. These measures can assist their deployment in several ways[88]:

- Economic and fiscal measures: in some cases, a congestion charge and other road pricing exemptions for EFVs can be used to increase the TCO of conventional freight vehicles (CEVs) compared to EFVs.
- Legal and regulatory measures: local traffic regulations, such as access regulations, time limitations, reserved loading zones, dedicated lanes can give operators using EFVs a long-term competitive advantage.
- Communication and awareness measures: they address the lack of information about EFVs, disseminate experiences of EFV performance, and explain costs and benefits to transport operators.
- Providing charging infrastructure: adequate fast opportunity charging infrastructure allows for a more extensive use of these vehicles, in particular, coupled with a pre-booking system if loading/unloading areas. The electric grid upgrade should be considered, as well as standardization of the charging points
- Procurement: introducing green public procurement criteria in the tendering process for public contracts has significant potential to increase the uptake of EFVs. This includes procurement of vehicles, but also of services implying a transportation component[89].

[87] FREVUE Results and Guidance for Local Authorities: https://frevue.eu/wp-content/uploads/2017/09/FREVUE-Results-and-Recommendations-for-Local-Authorities-v_09.pdf
[88] ibid.
[89] The BuyZET project (www.buyzet.eu) is investigating the transportation footprint of cities, and will develop innovative procurement plans to reduce the impact public procurement has on transportation patterns in cities.

However, since each city has its specific characteristics, the right combination of measures can only be elaborated taking into account the local situation and involving the interested stakeholders as much as possible.

5.2 RECOMMENDATIONS AND NEXT STEPS

Specific recommendations about ultra-fast charging and interoperability will come only at the end of the ASSURED project[90]. However, while recommendations about ultra-fast charging and interoperability will be more 'tactical' in nature, the ones below are about the strategic objective of ASSURED, which is the upscale of the e-fleets.

5.2.1 Recommendations for Public Transport

The ZeEUS project introduced the 4-phased approach for urban electric bus deployment in the picture below, and develop recommendations relative to each phase.

Figure 15 - The ZeEUS Phased Approach for Urban Electric Bus Deployment[91]

The methodology adopted within ASSURED capitalises on ZeEUS results, by focusing on the upscaling of e-bus fleet that is the next challenge for authorities and operators. In this section the ZeEUS recommendations have been extended and reviewed accordingly.

The distribution of tasks and responsibilities between operators and authorities depends on specific local context as the number and ways to organise the governance of transport are diverse. For this reason, the following recommendations, dealing with the deployment of urban electric full-size commercial fleets, can be addressed to authorities and/or operators.

At the planning level, there are:

Phase 1: Know and decide

In this phase the city and the involved stakeholders should define the global strategy towards emission reduction and assess the best technology for achieving their results.

- Define a global and integrated **mobility vision** backed up by the city authorities and counting on the support of the top management (SUMP or similar).
- To **exchange** vision and experiences among authorities and operators dealing with clean bus systems in order to get the right level of knowledge: EAFO, ZeEUS e-bus

[90] Deliverable 10.5 ASSURED Deployment Strategies for Cities and Users
[91] Image credits: ZeEUS

reports, EV4SCC, clean (electric) training courses specific for decision makers' team, site visits….

- To **define own operational needs** from the characterisation of the involved lines and the service profiles, considering also the relative connections with other transport means.
- Perform an **in-depth feasibility study** involving all relevant stakeholders and including risk and cost analyses. Such study should also define the best strategy for the deployment of large number of buses and the installation of the associated infrastructure.
- In this sense, develop or use a **LCC / TCO model** suitable for the operational scenario and use it to evaluate the possible options.
- Then **assess**, also by use of simulation, if e-buses are the right clean vehicle solution for the identified needs
- Solve the **trade-offs** necessary to ensure the needed operational capability in own scenario, considering the different technologic options. For example (not exhaustive):
    - The possibility to keep the same timetable for the service vs the need to design a new one based on the operational capability of the possible technical solutions, for example by considering the time necessary for opportunity charging;
    - The passenger max capacity vs. autonomy of the bus, depending on the operations, and linked to the total battery weight;
    - The cost for opportunity charging station vs. bigger batteries and/or spare buses cost, in own operational conditions.

Design full-size commercial EVs systems starting with needs, rather than with technology

Phase 2: Plan, Regulate, Finance

A careful and detailed planning, developed based on system approach with a clear governance, in line with existing policies and supported by decision makers is essential to ensure a successful implementation

- In the planning phase the **system approach** should then be used for the detailed plan: operational context shall define the system requirements, while costs and technical solutions and performances set the characteristics of the e-bus system elements.
- Ensure the **support from the competent authorities** for each aspects of the following phases, from financial support to organisation of the road-works if necessary.
- Explore the possibility to **use an already existing Public Transport energy network** from metro and tram systems where existing, of course. Especially with increased number of e-bus operating, this would have a positive impact on the infrastructure installation costs (energy connection) and cost of energy (as linked to a bigger amount of energy)
- **Identify legislations and local policies** applicable to the operational scenario, like emissions regulations, zero emission zones… that rule (and hopefully support) the

deployment of urban clean vehicles for a more effective planning, implementation and potential funding.

- Finding the **most suitable funding & financing schemes** at European level or at national level, as many Countries has put in place interesting funding programmes (UK, Germany, the Netherlands). A high number of vehicles so as a complex infrastructure could maybe allow the access to financial mechanisms with better conditions (for example with the European Investment Bank)
- Set up a proper **project governance** in order to optimise the relations between the stakeholders dealing with public transport, energy and also ITS, in line with the smart city concept.
- To define **optimal contractual conditions for energy provision** by also considering the potential contribution of a high number of buses to the smart-grid implementation, and where existing the synergies with the tram and metro energy contract.

Do not rush, as it is all about planning!

Phase 3: Specify, Procure and Deploy

Procurement of urban electric bus systems should take into account all the aspects relative to the introduction of innovation, not only from the technical point of view, but also from the contractual.

- **Develop partnerships** with industry, procuring entity, regulators, financing actors, and energy suppliers to ensure coordinated and efficient actions towards the project goals.
- Define a fair and suitable **risk sharing schemes** between municipalities, authorities, operators and other involved stakeholders according to their roles and tasks.
- Stimulate and support procuring entities to **adapt tender process** to e-buses, e.g.
    - Reflect the system approach into “system procurement” (like *tram*). The tender structure document developed in ZeEUS can be a good starting point
    - Take into account the “innovation” aspects also in the tender (duration vs. investment, risk sharing, depreciation, reselling value…)
    - Take into account the amortization of investments vs the contract duration
    - Define un-ambiguous specifications with suitable indicators and acceptance procedures: use of E-SORT cycle is encouraged
    - Ensure the synchronisation between the vehicle delivery and the infrastructure readiness, by continuous monitoring of both procurement and provision processes
    - Check that the accounting rules match with the new type of procurement
    - ….
- **Facilitate infrastructure deployment processes** for getting building permits, depot upgrade, civil works for energy connections, roadworks, etc.

Be prepared and expect the unexpected!

Phase 4: Operate and Maintain

Implementation of urban electric bus systems requires several changes in different aspects of the whole operator organisation:

- Duly consider the necessary **changes in the organisation,** including bus depot design, company structure and roles, new equipment and tools for HV DC in the garage, bus movement (also for charging), cleaning, with all the relative safety aspects.
- **Coordination with other services** like firefighters and police are necessary in order to jointly develop emergency procedures linked to the new settings.
- **Continuously optimise the service** through dynamic fleet monitoring, predictive maintenance systems, and optimisation of auxiliaries' energy consumption.
- Consider the **potential reduction of costs** coming by a proper design of the charging strategy through smart charging.
- Give high importance to **trainings** for all categories of employees that are crucial in order to ensure a safe working environment and to engage the staff with the new technology, which will require new driving styles and new maintenance procedures.
- **Evaluate operations** including staff and passengers' satisfaction.

Don't forget the people!

5.2.2 Recommendations for freight distribution and service trips

Based on the analysis carried out so far, it is possible to provide also some preliminary recommendations to LAs to engage with freight and logistics stakeholders and take into account their needs and priorities. This can significantly accelerate the upscaling of the freight and logistics commercial e-fleet:

- Cooperation with the local industry, such as logistics operators using EVs, is beneficial particularly for charging infrastructure planning. LAs should involve the business sector in permanent platforms and stakeholder networks to gather their needs and views.
- Living Labs and PPPs can engage LAs, research partners and private companies on the practical implementation and improvement of new technologies, including e-mobility solutions. Testing new business models for the charging infrastructure including freight actors can improve its financial sustainability, since couriers typically make extensive use of fast chargers.
- Fast-charging infrastructure, as well as multi-purpose, interoperable charging solutions should be included in the planning processes and in the existing e-mobility strategies of EU cities. Understanding the optimal positioning and number of charging points per station is essential for maximizing their use.
- Provision of charging points and methods of access and payment should be as much consistent as possible throughout cities. This would encourage freight operators to shift to EFVs maintaining a satisfactory level of operational efficiency.
- National and local regulation and incentives schemes should be introduced in favour of transport companies purchasing EFVs, to overcome the risk of short-term market stagnation where companies are waiting for robust OEM products.

6. References

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31. Relevant experts, including local authorities, are invited to attend key ASSURED events and to exchange on and validate the project's innovations
32. "The Directive, as adopted by the European Parliament and the Council on 29 September 2014 following the inter- institutional negotiations: 1) requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure; 2) foresees the use of common technical specifications for recharging and refuelling stations; 3) paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology" (from https://ec.europa.eu/transport/themes/urban/cpt_en)
33. http://www.eafo.eu/
34. CIVITAS INSIGHT: Cities' role in introducing clean vehicles and using alternative fuels: http://civitas.eu/sites/default/files/civitas_insight_20_cities_role_in_introducing_clean_vehicles_and_using_alternative_fuels.pdf
35. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0094
36. Source: elaboration based on EAFO city templates (available on http://www.eafo.eu)
37. 24.10.2017: http://zeeus.eu/uploads/publications/documents/zeeus-report2017-2018-final.pdf
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39. http://www.euro.who.int/__data/assets/pdf_file/0006/74715/E86650.pdf
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http://ajuntament.barcelona.cat/premsa/2018/03/14/lestrategia-per-la-mobilitat-electrica-2018-2024-a-la-ciutat-de-barcelona/
46. http://mobilitat.ajuntament.barcelona.cat/en/noticia/electric-vehicles-to-drive-sustainable-mobility

47. Two opportunity-charged 18m articulated buses and two overnight-charged 12m buses, tested in the ZeEUS project: http://zeeus.eu/uploads/publications/documents/zeeus-city-sheet-barcelona-en-final.pdf
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49. Source: ZeEUS website
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51. "Bevolkingsontwikkeling; regio per maand" [Population growth; regions per month]. CBS Statline (in Dutch). Retrieved 27 March 2018.
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55. https://www.eindhoven.nl/sites/default/files/2017-12/Eindhoven%20op%20weg%2013052013.pdf
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66. Source: ELIPTIC Workshop - Charging Infrastructure & Policy recommendations, 19 March 2018, Brussels – Gothenburg presentation
67. https://www.oppcharge.org/
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http://civitas.eu/sites/default/files/civitas_insight_20_cities_role_in_introducing_clean_vehicles_and_using_alternative_fuels.pd

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79. Presented at the EUSEW17 - Energy systems for smart mobility workshop, June 22, 2017. Presentation not available, agenda here: http://www.eusew.eu/sites/default/files/energy_days/agenda%20-%20EUSEW2017_2.pdf
80. FREVUE Results and Guidance for Local Authorities: https://frevue.eu/wp-content/uploads/2017/09/FREVUE-Results-and-Recommendations-for-Local-Authorities-v_09.pdf
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82. Image credits: © FREVUE project
83. 'Experiences from setting up public charging facilities for electric vehicles in Stockholm'. Retrieved from: https://frevue.eu/resources/experiences-setting-public-charging-facilities-electric-vehicles-stockholm/
84. Image credit: UITP
85. . The establishment of a PTA is often associated with a wider impact beyond the economics of transport: it is viewed as an efficient and effective way to organise mobility with measures such as fare and ticket integration, increasing the convenience of the service, and with it potentially the ridership. Also, it can provide the ideal arena to start creating a vision and strategy for public transport which also includes other relevant aspects like the impact of mobility measures on societal health.
86. The UITP Action Points, "Building a culture of service excellence to develop a public transport business", aims to present the importance for public transport companies to redefine their corporate culture, vision and values, so that staff is properly motivated to provide excellent service. The paper present the multiple benefits of developing a culture of service excellence and provides recommendations for making the "human factor" the central concern within the organisation, management and communication of the company.
87. Image credits: ZeEUS, ADL
88. FREVUE Results and Guidance for Local Authorities: https://frevue.eu/wp-content/uploads/2017/09/FREVUE-Results-and-Recommendations-for-Local-Authorities-v_09.pdf
89. ibid.
90. The BuyZET project (www.buyzet.eu) is investigating the transportation footprint of cities, and will develop innovative procurement plans to reduce the impact public procurement has on transportation patterns in cities.
91. Deliverable 10.5 ASSURED Deployment Strategies for Cities and Users
92. Image credits: ZeEUS

Annexes

ANNEX I: LIST OF LOCAL AUTHORITIES INVOLVED IN THE ASSURED SURVEY

Organisation	Name	Country
Aachen	Kristine Hess-Akens	Germany
Barcelona	Angel Lopez	Spain
Bremen	Hendrik Koch	Germany
Eindhoven	Lot van der Giessen	The Netherlands
Gdynia	Alicja Pawlowska	Poland
Gothenburg	Michelle Coldrey	Sweden
London (TfL)	Mark Poulton	UK
Madrid (EMT)	Enrique Daniel Garcia Cuerdo; Sergio Fernández Balaguer	Spain
Manchester (TfGM)	Matthew Roberts	UK
Osnabrück	Joachim Kossow	Germany

ANNEX II: ASSURED SURVEY TEMPLATE FOR LOCAL AUTHORITIES

Topic	Question	Reply from city		
			Internet link	Description
City	Name of City or Metropolitan Area:			
	Scope concerns: city, metropolitan area, other (describe):			
	Area in km2			
	Number of inhabitants			
	Presence of Port (sea/inland), Airport			
	Scope concerns: city, metropolitan area, other (describe):			
	Modal split			
	Contact person to liaise with other cities (if city wants to share)			
		YES/NO		If yes, descri
Fuels	Which Alternative Fuels are considered within your local strategy? (electricity, hydrogen, natural gas, other)			
Projects	Projects at EU/National/Local level in which city is involved (demonstration/research projects on AF and in particular electric vehicles/(fast)charging infrastru			
	City internet links to information on electrification of urban (commercial) vehicles (general , case studies or projects)			
Targets	Targets (long term) on the deployment of electrification of urban commercial vehicles			
	Zero Emission targets for (specific) vehicle categories or uses (e.g. buses, taxis, deliveries,....), if so which and timing.			
	Zero/Low/Ultra Low emission zones currently or planned? If so: how large, which type / vehicle restrictions?			
	Buildings regulations e.g. mandatory EV chargers installed (in Parkings, new apartment buildings,...)			
	Climate Change GHG reductions / Climate Neutral objective			
	Renewable Energy targets			
	Air Quality and Noise			
	Publications or internet links around targets			

Question	Reply from city		
	YES/NO	Internet link	If yes, description / examples
Does the city has a Sustainable Urban Mobility Plan (SUMP) integrating Alternative Fuels - in particular electric - or other relevant strategy/roadmap for transport electrification?			
Does the city has an urban freight transport plan and/or supports the implementation of specific measures, including the deployment of freight electric vehicles and charging infrastructure?			
Any specific procurement protocols promoting GHG, Air Quality or other specific goals?			
Does the city has a replacement policy for city fleet vehicles (own or contracted) with Electric Vehicles?			
Other key actors involved in procurement of EV?			
Any examples of innovative procurement arrangements? (e.g. Joint procurement)			
Does the city directly provide any of the following incentives (not incentives from regional/national gov.):			
Incentives for commercial EV purchase			
Incentives for parking an EV			
Incentives for access to restricted areas or roads, e.g. Bus lane use			
Incentives for fleets, e.g. delivery vehicle schemes, zero emission taxi schemes, car sharing schemes			
Incentives to invest in charging infrastructure (public or private infrastructure)			
Are there other measures (such as 'Mobility as a service' city-apps type) promoting the use of EVs?			
Which incentives exist at national/local level to incentivise the use of EVs?			
Does the city provide public charging infrastructure solutions?			
What are the main protocols for procuring public charging infrastructure? Private investors involved/ownership & maintenance of infrastructure?			
Does the city provide public **super fast** charging infrastructure solutions? If not, are there plans to do so?			
What are the main protocols for procuring public super fast charging infrastructure? Private investors involved/ownership & maintenance of infrastructure?			
Is the city tracking the use of publicly accessible (super fast) charging points** and analysing data? How? open system, specific requirements to private actors in case of concession, etc.)			
Is the city requiring payment for use of public chargers? How?			
Payment method used (e.g. per kWh, time via parking fees,..)			
Are the charge infrastructure managers entitled to sell electricity? Who regulates this sector? (national / regional / local government)			
Does the city assure interoperability between involved operators or service providers?			
Is there a policy to use renewable energy for publicly accessible chargers?			
Does the city stimulate innovative solutions for charging, e.g. inductive charging, use of lamp poles for charging,...?			
Is there a city wide coverage of EV charging infrastructure or is this foreseen?			
Which solutions are foreseen for off-street charging/charging in residential areas? How are private investors involved?			

Please fill in points and add scroll to the right for stations if available or of interest

City Template: Charging & Refilling Infrastructure statistics

			Charging Points (= positions)							Charging Stations (= locations)
			Normal Power			High Power* > 22 kW (charging systems)				
Infrastructure	Place	Accessibility	3.5 kW	7 kW	11-22 kW	Combo	ChaDeMo	Type 2 AC	Tesla SC	Number of stations
EV Charging points	Street	All								
	Public Parkings	All								
	Other	All								
	Any	City fleet or contracted								
	Any	Taxi or Car sharing								
	Any	Restricted (other)								

*We follow the AFI Directive definition of "normal "and "high power" charging infrastructure (see below**). In general, different interpretations and understandings exist on the definition of high power/fast/super-fast charging points. Have your city defined a clear criterion for their classification? if other than above, could you please describe the current deployment situation for high power/fast/super-fast charging points?

Please fill in the numbers (of course as far as available, add an "e" for estimate)

Definition	EV Charging point	Recharging point « interface capable of charging one electric vehicle at a time », this includes the power supply, plug and the space to park the car.	
	EV Charging pole	EV charger which may include more than one charging point/position	
	EV Charging station	EV charging station may include more than one charging pole/charger	
		See also EAFO Glossary: http://www.eafo.eu/content/glossary	
Abbreviations	EV	Electric Vehicle	
	CCS (Combo)	Combined Charging System	The combo coupler is based on the Type 2 (VDE) AC charging connector, with full compatibility with the SAE specification for DC charging, with additional pins to accommodate fast DC charging at 200–450 Volts DC and up to 90 kW.
	ChaDeMo	Charge DE MOve	Trade name of a quick charging for battery electric vehicles delivering up to 62.5 kW of high-voltage direct current via a special electrical connector. It is proposed as a global industry standard by an association of the same name.
	Type 2 AC	Type 2 AC Connector	The IEC 62196 Type 2 connector (Also known as Mennekes) is used for charging
	Tesla SC	Tesla Supercharger	The Supercharger is a proprietary direct current (DC) fast-charging station that

City Template: Vehicles

For cities not able to respond to exact statistics, please feel free to define how the cities deals with (number of) vehicles
For fuels: please indicate if specifically renewable form are used or promoted (electricity, hydrogen, methane)
For e-buses: please further use the e-buses form if possible (for Trolley, FCEV, BEV, PHEV buses) -see 'e-buses data' tab

Type of vehicles / use	Category		Number				
			Total vehicles*	BEV	PHEV	FCEV	Total EV
Passenger cars	M1	*total if available*					
Passenger cars	M1	City fleet or contracted					
Buses (Public Transport)	M2+M3	City fleet or contracted					
Light Commercial Vehicles	N1	City fleet or contracted					
Light Commercial Vehicles	N1	*total if available*					
Heavy Duty Vehicles	N2/N3	City fleet or contracted					
Light vehicles (quadricycles)	L6/L7						
Light vehicles (two-wheelers)	L1-L5						
Taxis							
Car-sharing *(through "rental" or "subscription")*	M1+M2						
e-bike or e-motor sharing	L1-L5						
Ferries							

**: ALL fuels!*

Definition	City fleet or contracted	City fleet refers to those vehicles directly procured by the public authority. Subcontracted refers to vehicles providing a public service on behalf of the city

Abbreviations			
	BEV	Battery Electric Vehicle	electric vehicle,
	PHEV	Plug-in Hybrid Electric Vehicle	characteristics of
	FCEV	Fuel Cell Electric Vehicle	a fuel cell to power
	M1	Vehicle used for the carriage of passengers, with no more than eight seats in addition to the driver seat, also known as passenger cars.	
	M2	Vehicle used for the carriage of passengers, having a maximum mass not exceeding 5 tonnes	
	M3	Vehicle used for the carriage of passengers, having a maximum mass exceeding 5 tonnes	
	N1	Vehicle used for "light commercial vehicle less than 3.5 ton"	
	N2	Vehicle used for the carriage of goods, having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes	
	N3	Vehicle used for the carriage of goods, having a maximum mass exceeding 12 tonnes	
	L6	A vehicle with four wheels whose unladen mass is not more than 350 kg, not including the mass of the batteries in case of BEV's, whose maximum design speed is not more than 45 km/h, and whose power does not exceed 4 kW.	
	L7	Other than that classified for the category L6, whose unladen mass is not more than 450 kg (650 kg for those intended to carrying goods), not including the mass of batteries in the case of BEV's, whose power does not exceed	

See also EAFO Glossary: http://www.eafo.eu/content/glossary and the description of the different vehicles categories http://www.eafo.eu/content/european-vehicle-categories

E-bus fleet												
	Bus			Power (kW) MAX		Energy Storage			Charging			
Project (if it is the case)	Manufacturer/Model	Length	Technology**	Opportunity chaging	Overnight Charging	Storage**	Battery type (e.g. Li-Ion) & Capacity (kWh)	e-Range (km)	Method**	Location**	Remarks	Number of buses

E-buses deployment policies & strategies	
Are the e-buses deployed/to be roll-out part of the e-mobility strategy/SUMP/or other specific plan? please provide relevant links if available	
What are the specific policy goals/objectives in the short and medium term? please provide relevant links if available	

**NOTE: options for technology, storage, method and charging location columns. Please scroll down

Technology	BEV
	PHEV Diesel
	PHEV Gas
	FCEV
	Trolley
Storage	Battery
	Supercapacitator
	Battery + Supercapacitator
	Other
Charging Method	Conductive (Cable & Pantograph)
	Conductive (Cable)
	Conductive (Pantograph)
	Inductive
	Hydrogen
Charging location	Depot
	At Stops
	Depot & Stops

#	Cities/freight operators needs	Description
1	Limitations and challenges for the electrification of own fleet (municipality/FO): procurement, financing, operation & management, etc.	
2	Limitations and challenges for the rollout of the EVs charging infrastructure (general): off-street charging, smart energy management, energy grid constraints (capacity), procurement, financing, etc.	
3	Limitations and challenges for the rollout of EVs charging infrastructure (fast charging/heavy vehicles)	
4	Promotion of fleet electrification of 3rd parties (PTOs/PTAs, logistics operators, commercial own account)	
5	Users needs: main constraints for users, related to position/price/payment of charging infrastructure.	
6	For freight: what type of charging infrastructure operators need? At Depot (private) /Public (opportunity) (fast) charging? Are there initiative in place to promote freight EVs towards self-employed operators?	
7	Within ASSURED, main risks associated to the deployment of the solution.	

NOTE PTOs: Public transport Operators
PTAs: Public Transport Authorities

** This question should be answered by ASSURED pilot coordinators

Are there any questions or definitions used not clear?
Are there any questions or topics addressed not relevant?
Are there any relevant topics NOT addressed in this template?
Please comment on any of the questions where you feel you can not give a complete or correct answer (either here or in the form)
Any additional remarks?