Tender Structure for Urban Electric Bus Procurement

Deliverable n°	**D 51.8**
Version Date	**04/10/2018**
Nature of Deliverable	**External**
Dissemination Level	**Public**
Status	**Issued**

Issued by	Project Director
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PROJECT ACRONYM: ZeEUS

PROJECT FULL TITLE: ZERO EMISSION URBAN BUS SYSTEM

GRANT AGREEMENT NUMBER: 605485

Project funded by the European Commission
under the Seventh Framework Programme for Directorate General Mobility & Transport

Coordinator: *UITP – International Association of Public Transport*

SUMMARY SHEET

Programme	Seventh Framework Programme
Contract N.	605485
Project Title	Zero Emission Urban Bus System
Acronym	ZeEUS
Coordinator	UITP – International Association of Public Transport
Project Director	Umberto Guida, *umberto.guida@uitp.org*
Website	*www.zeeus.eu*
Starting date	1 November 2013
Number of months	42 months

Deliverable n°	D51.8
Deliverable Title	Tender Structure for Urban Electric Bus Procurement
Project Title	Zero Emission Urban Bus System
Version	v1
Date of issue	04/10/2018
Distribution	External
Dissemination level	Public
Book captain	Aida Abdulah, Umberto Guida, Arno Kerkhof (UITP)
Abstract	Tendering out electric buses differs from the process of tendering conventional buses in one central element: the new e-bus system shall be considered as a whole, including the three elements vehicle, infrastructure and operation. The present report is aimed at providing useful guidance and recommendations for tendering urban electric bus systems to any stakeholder interested in the deployment of electric buses.
Key words	Electric bus, tender, procurement, specifications, system approach, operators, authority

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DOCUMENT CHANGE LOG

Version number	Date	Main area of changes	Organisation name	Comments
d.0.1	24/04/2018	First draft	UITP	
d.0.2	13/08/2018	Elaboration	UITP	
d.0.3	16/08/2018	Redefinition & further elaboration	UITP	
V.1	04/10/2018	Finalisation	UITP	

CONTRIBUTING PARTNERS

#	Participant Partner Name	Short Name	Country
1	INTERNATIONAL ASSOCIATION OF PUBLIC TRANSPORT	UITP	Belgium

ACRONYMS

ITS: Information and Telecommunication System

KPI: Key Performance indicators

LCC: Life Cycle Cost

PT: Public Transport

PTA: Public Transport Authority

PTO: Public Transport Operator

SOC: State of Charge (of the battery)

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1. EXECUTIVE SUMMARY

Cities and Public Transport Authorities are becoming increasingly aware of the benefits of the electric technology to address the transport and health challenges in cities, e.g. emissions and noise reduction, as well as improved image of bus services. However, many of them struggle to launch a tender process for (cleaner) zero-emission systems: which technology is the most appropriate; what changes compared to diesel tenders; what are the basic specifications to take into account; who are the players involved and to what extent, etc.

The present deliverable “ZeEUS Tender Structure for Urban Electric Bus Procurement” will guide the reader through the steps for a successful tender process for electric buses. The first part of the report provides an overview of the main issues to take into account when procuring electric buses and it’s complemented with the findings of the Expert Group on Clean Bus Deployment in which UITP takes part. The second part is dedicated to the specifications and requirements that differ to the tender process for conventional buses under the question “What changes when procuring electric buses?”

The recommendations and tips provided in this report are based on long experience and good practice in the urban (electric) bus business, but can’t supersede any local roles or regulations. It also is worth noting that this report is based on some European specificities, though the principles may also apply wider.

We wish you a pleasant read!

2. INTRODUCTION

Procuring electric buses imply a paradigm shift from vehicle to system procurement, i.e. vehicle – infrastructure – service and operation. This new context requires to build alliances and cooperation between the several actors in the PT system (local administration, PTA, PTO, energy supplier, charging solution suppliers, bus manufacturers, etc.) to ensure the success of the tendering process and the subsequent implementation of the system.

In terms of upscaling e-bus deployment and the transition to cleaner bus fleets, UITP's strategy is based on the practical approach developed within the ZeEUS Project and consisting in 4 phases "IF, WHEN, WHAT, HOW" that will provide stakeholders with tools and guidelines for the successful deployment of electric bus systems. The present deliverable "ZeEUS Tender Structure for Urban Electric Bus Procurement" is part of the phase 3 aimed at answering the question "What to select and procure".

The UITP Bus Committee (together with the UITP VEI Committee and PTA Committee) was tasked with the development of the updated version of the existing Tender Structure document[1] reflecting the ongoing transition from internal combustion engine buses to electric buses and alternative fuel technologies. The ZeEUS Project has played a key role, contributing with crucial insights to the development of the final guidelines for the electric mobility chapter.

The European Bus market is changing rapidly with regards to upcoming regulations for clean air, local pollutants, but also for the need of including urban noise as an important factor when planning for public transport. The next development level in the electric mobility field is to consolidate the further penetration of the Plug-In and Battery Electric buses that have entered the market place, and are delivered gradually to more and more cities across Europe, America and China.

Supporting this goal, the European Commission recently launched a number of declarations in favour of "clean buses" to support the fulfilment of national targets set by different Member States by 2025 and 2030 targets. For example, the Netherlands has approved a national plan (Green Deal) to electrify its entire public transport bus fleet (over 5,000 buses) by 2030, with some regions like Zuid-Oost Brabant aiming even for 2025. Also, in Sweden, clean buses must be purchased to minimum 30% year by 2025 and minimum 50% year by 2030 of the total purchase in the country. There is also an upcoming CO_2 legislation, targeting in the first place the declaration of CO_2 emissions beginning of 2021, followed by monitoring of the same one year after. Buses with low CO_2 values will be prioritised when purchasing new vehicles in the future. All these actions depict a promising future for the electric (and alternatively-fuelled) bus market.

This report is aimed at providing stakeholders with recommendations and tips when tendering for electric buses, based on long experience and good practice in the (electric) bus business, but can't supersede any local roles or regulations. It also is worth noting that this report is based on some European specificities, though the principles may also apply wider. For a proper and beneficial implementation, we encourage the revision and adaptation of this guidance to the local context.

2.1 The urge to act: Cities getting into action

More than 50% of the world's population live in cities and it is predicted that by 2050 this percentage will become 70%, according to the forecasts of the United Nations[2]. Increasing

[1] UITP Tender Structure – for the tendering of buses and related services, (2009), UITP.
[2] http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html

numbers of people in cities come hand in hand with greater needs for mobility and transport, challenging pre-existing conditions and in many cases impacting people and the environment. Several of these challenges are the consequence of transport related emissions, which contribute to climate change and generate noise and air pollution.

While climate change is expected to rise sea level and increase frequencies of extreme weather events at global level, noise and air pollution generate relevant health impacts at local level. According to the World Health Organization, air pollution has become the world's single biggest environmental health risk and it is the fourth highest cause of death among all health risks, exceeded only by high blood pressure, poor diet, and smoking[3]. Moreover, European transport is responsible for more than half of all NOx emissions and contributes significantly (around 13% or more) to the total emissions of the other pollutants[4].

The relevance of the challenges posed by transport emissions has caused increasing social environmental awareness and led to more restrictive regulations at both global and local levels. Accordingly, local authorities have started reviewing priorities and strategies to make cities healthier and greener. To achieve this, cities are developing plans and programs with an overall long term city strategy. In the field of transport, most of these plans (sustainable mobility plans, e-mobility plans integrated in SUMPs, etc.) include pollution reduction targets and strategies oriented towards cleaner technologies for transport provision. Some of the measures that can be included in these plans to control and reduce transport related emissions are:

- The introduction of low emissions zones
- Congestion charges
- Protocol of actions in case of high levels of NO_2 and PM_{10} such as the reinforcement of public transport services
- Incentives to reduce car ownership, e.g. free public transport travel cards when scrapping environmental unfriendly vehicles, etc.
- Renew the urban bus and taxi fleet with sustainable options such as electric vehicles
- Car parking outside cities to access expanded public transport such as a ‘park and ride’ system
- Platform for the coordination of services such as the Last Mile Delivery, coordination of regulated parking, etc.
- Incentives (tax reductions, subsidies, etc.) to promote cycling and walking
- Awareness-raising and environmental education measures

Such a policy framework shall support the progressive introduction of clean vehicle technologies in public transport fleets, with a multiplier effect on the environmental, social and economic liveability of cities and citizens.

2.2 The view of Public Transport Authorities and Operators

Building on the overall strategies defined at city level, PTAs devise transport policies to help cities achieve their objectives. In the case of bus systems, the need for cities to reduce pollution and noise levels has been often translated into requirements for introducing hybrid and electric vehicles in public transport fleets.

However, the shift to those alternative technologies generally results in an increase in complexity with new infrastructure and vehicle requirements, new actors involved and

[3] http://www.who.int/airpollution/ambient/health-impacts/en/
[4] https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-air-pollutants-8/transport-emissions-of-air-pollutants-5

greater needs for coordination through the definition and procurement processes. A systemic perspective becomes increasingly needed to approach bus provision. For instance, the introduction of electric buses requires considering not only the vehicle but also the charging infrastructure, because they become inter-linked elements that have to be planned in parallel. Moreover, each case study, location and service is different and we have to analyse it individually. Consequently, a comprehensive feasibility study is recommended to identify the best solutions for the specific local context. Additionally, it is necessary to think and plan in an iterative way, since it is always essential to rethink the system depending on the different existing technologies.

Figure 1. The electric bus system approach

Based on this, several business models can be defined with different allocation of risks, roles & responsibilities to the parties involved, now including new or additional actors as is the case of electricity suppliers.

Vehicle and charging equipment provision becomes then the final step of a definition process rooted in the overall city strategy through the policies, operational targets and specific requirements defined for a particular context. As a result, vehicle and charging equipment provision should:

- Be aligned with the overall city strategy, mobility plans and PTA policies and operational targets
- Be based on detailed studies that examine from a system perspective all relevant context elements and requirements. In this respect the definition of the following elements is critical, particularly when introducing electric vehicles in the fleet:
  - General context regarding operational and administrative characteristics of the area to be served and their public transport system.
  - Local operational conditions: climate, topography, traffic, power supply capacity
  - Public transport system: number of lines, contracting period, existing business model, ownership & maintenance, types of buses or vehicle age structure

- Strategy for infrastructure: long term plan, charging/refuelling responsibilities, time plans (short/medium/long), land availability and consents for the installation of charging stations and other facilities required.

In summary, different business models can be structured in order to meet the previous points. As indicated before, they should clearly state how risks and tasks are allocated to actors in order to guarantee a correct system definition and operation that ensure effective project governance. Potentially available financial instruments and subsidies should be identified as well.

The context analysis and the business model are the framework in which the vehicle procurement will be defined. Depending on the role and tasks assigned to PTA, operators, manufacturers and other actors, particular scopes and requirements should be clearly set out in the tender specifications.

As a final consideration, and in order to achieve a successful outcome, enough time should be allowed to planning and defining the system, conciliating apparently contradictory aspects as the long term perspective and the speed at which organisational models and cleaner technologies for transport are evolving.

3. PROCURING ELECTRIC BUS SYSTEMS

The transition to electric (and cleaner) fleets implies a change in the procurement process, which for the first time involves the vehicle, the infrastructure required to charge the vehicles and run the service, and the operation and service changes that derive from the introduction of electric buses.

This has been mentioned several times but it is worth mentioning it as much as needed: it is a change in the way we procure that affects substantially the timeline and the planning of the whole tender process, as well as the actors involved in the process.

From the city and/or PTA point of view, there are important considerations that shall be addressed to support the bidders (mostly PTO, bus manufacturers) to present economically feasible, solid offers.

From the point of view of the bidders, the offers shall meet the tender requirement in terms of environmental targets and technical specifications, putting special care in the definition of a fair risk-sharing framework among the suppliers of the different offer elements (e.g. charging infrastructure) in order to present offers that are not only viable but cost-efficient.

Currently, there is no single way to tender out electric bus systems. There are several models highly dependent on the local context (e.g. city targets, operational context, energy requirements, construction constraints, etc.) and the financial framework, which make the harmonisation of the procedure quite complex. Still, some recommendations can be derived to ensure that the tender process is on the right way.

The most important is to ensure an open dialog among the tender entity (city/PTA) and the potential bidders in order to define a proper tender framework that supports the best operational and technical solution in terms of:

- Daily operational requirements of the line (e.g. passenger capacity, mileage, energy consumption, charging time, etc.).
- Infrastructure needed regarding charging and operation of the service, considering also route constraints.
- Ensuring a proper tender timeline that allows the bidders to obtain and confirm all permits and authorisations for the construction works and installation of charging infrastructure and related equipment. This is crucial to safeguard the economic feasibility of the project as delays in starting the operation highly jeopardize the success of the whole process.
- Provision of all specific requirements for the integration of the bus system infrastructure elements (charging stations but also stops, dedicated lanes, etc.) into the city design and the grid network.
- New operation tasks, which include trainings for drivers and maintenance staff, and also for first responders (police, fire fighters), as well as adaptation of the depot in terms of technical preparations of the workshops, counting on the technical support of the manufacturers (delivery of crucial spare parts, flying doctors, etc.).

The technological risk associated with the introduction of new technologies can be mitigated by seeking close cooperation with the vehicle manufacturers to ensure the technical and operational coordination. It is recommendable to adopt negotiated procedures to properly address crucial issues impacting the economic feasibility of the offer, e.g. energy consumption, vehicle availability, headways, etc. For instance, it is possible to specify service parameters as tender requirements rather than vehicle requirements (e.g. headway vs passenger capacity). This way the bidder can address the service specification flexibly and offer more solid solutions, which do not depend on a concrete technology or vehicle.

4. NEW ALLIANCES: COOPERATION AMONG TENDER ACTORS

The successful implementation of a new e-bus project starts with the implementation of a system approach that considers the design of the new system at two levels:

- Actor level: based on a customer-centric approach including PTA, PTO, bus manufacturers, industry and electricity suppliers, grid owners and research centres (and all other stakeholders potentially related to the new system) from the very beginning to set up a proper project governance.
- Operational level: considering the operational context (network design, information to passengers, traffic management, etc. as well as the required infrastructure (number of bus stops, dedicated lanes, charging strategy, etc.) in order to define the operational requirements.

Figure 2. The ZeEUS phases for the deployment of e-bus systems

Consequently, business models should clearly define the responsibilities and roles of each party, allocating risk where handled best and reinforcing cooperation amongst the parties. Early involvement of different parties when possible is strongly recommended.

Moreover, agreements have to be made between different actors, and the relationship with the traditional actors has to be reviewed, with the purpose to:

- Make it possible that the best possible electric buses solution can be studied and implemented for each operation.
- Create the best possible conditions for the transfer of used electric buses to the next PTO.
- Promote interoperability of the system in order to improve usability of infrastructure investments (e.g. charging systems).

These relationships are very important to ensure the success of the new e-bus project. The following section describes the main issues that shall be taken into account when developing a tender and presenting offers for electric bus systems from the perspective of a) the relationship PTA-PTO and b) the relationship PTO-bus manufacturer.

5. WHAT CHANGES WHEN PROCURING ELECTRIC BUS SYSTEMS?

There are several models for the procurement and contracting of e-bus systems. In some models when there is interaction between PTA and PTO during the development of an e-bus operation, close cooperation among PTA and PTO for the definition and implementation of a new e-bus system is essential to ensure a successful project.

The system must be developed in a way that allows the PTO (sometimes in cooperation with the bus manufacturer) to determine performances according to the technology available and the system needs. Imposing operational parameters without involving the PTO in their definition can lead to unsuccessful systems.

The areas of competence of the PTO in partnership with bus manufacturers are:

- Developing the time tables related to electric bus operation, taking into account the provision of the daily services in km and in hours.
- Specifying the number of buses needed to be able to run these services and specifying the size of the battery pack regarding this.
- Developing a battery charging strategy which includes the number of chargers, the capacity of the chargers, the locations where the chargers should be installed and the charging planning.
- Defining the energy capacity needed on each location where we plan to charge the batteries.
- Discussing with energy suppliers to see if the needed energy can be supplied and what should happen to make this possible.

Independently from the model chosen, a study regarding the possibilities for implementing electric buses, including associated infrastructure, should be carried out. This can happen in three different ways:

a) Before the tender for an electric bus operation is launched. The PTA may write out a tender for the development of a “study and advice” on the infrastructure options for operating e-buses.

b) As part of the tender for an electric bus operation. With the tender for an e-bus operation, the operator is also expected to offer a solution for the infrastructure that suits the way he wants to carry out the operation.

c) Where appropriate, studying the possibilities regarding the infrastructure during the on-going operation (running contract). During the existing operation with traditional vehicles, together with the current operator and the other stakeholders (the city, the energy supplier, battery charger suppliers, etc.), they will examine how a charging infrastructure for electric buses can be built up. In this case, the authorities will ensure that the same information is provided to all bus operators participating in the final tender for the bus operation.

The EBSF_2 project (*www.ebsf2.eu*) led by UITP developed an E-Bus Design Charter[5] aimed to benefit from the technological transformation and trigger a radical transformation of the urban bus in terms of image, comfort and usage, offering a better customer experience and thus generating a status upgrade of the bus mode. It is important to

[5] *http://www.ebsf2.eu/sites/default/files/180410_EBSF_2%20Design%20Charter%20LR.pdf*

underline that the Charter is not intended to provide any specification for vehicle production, but to be considered as an inspirational blueprint supporting the research and design phases of the vehicle for bus manufacturers, as well as in the definition of tender specifications for PTAs and/or PTOs.

5.1 PTA in relation with the PTO

In some models, the selection of the PTO is part of the tender process for an electric bus operation. The PTA should take full benefit of the competence that is available at the PTOs in partnership with the electric bus manufacturer they have chosen.

In this case it is recommended that the PTA avoids setting too many technical parameters regarding electric buses (number of buses, time tables, range on one charge, charging strategy, energy consumption, etc.).

5.1.1 TENDERING PERIOD

The tendering period (the period between launching the tender and receiving bids from PTOs) should be sufficient. Where the tendering period is not sufficient, the risk to achieve a suboptimal solution is greatly increased.

Where the PTOs are required to identify the best possible solution and are required to investigate the feasibility of that solution (e.g. does the city allow installations on public domain, can permits be obtained for civil works etc.). In this situation a period of 1 year is likely to be necessary.

The tender document should also include the date that the electric bus operation is planned to commence. PTA’s should be aware that the implementation of electric buses, the needed charging equipment and the connection to the grid, with in many cases upgrading the grid capacity, takes time. For this reason the starting date of the new electric bus operation should normally not be earlier than 1 year after the contract has been awarded.

5.1.2 COSTS

Replacing traditional bus operation with electric bus operation requires significantly higher upfront investments, mainly related to a higher price of the vehicles and the charging infrastructure linked to the new e-fleet. A way to laminate the upfront costs, in those cases where the operator is taking both the investment in vehicles and charging infrastructure, is that the PTA establishes measures to support the operators to spread the costs over a longer period in order to balance the LCC. The following measures could be taken:

- Apply longer contract periods.
- Allow a gradual inflow of e-buses within the operation rather than imposing a fixed number of vehicles from the beginning.
- Don’t specify in the tender requirements a maximum average age of e-buses; instead, specify the quality criteria that the vehicles have to be meet (without changing the basic specifications). This enables the operator to make better decisions based on the economic feasibility of a possible refurbishment of the vehicles, or to put new buses in service.
- Allow the depreciation of the e-buses and the charging infrastructure over a period even longer than the contract period. Typically a 15 year period.
- Implement mandatory procedures within your tender documents to assure the transfer of e-buses and charging infrastructure towards the next operator (next contract).

- Set the financial conditions for transferring buses that have not been completely depreciated, including the depreciation for the refurbishment if applicable e.g. depreciated over a 5 years period.
- Set the conditions for depreciating the grid connection cost when paid for by the operator, and transfer the part of these costs which are not depreciated towards the next operator if he will use this connection.
- Maximizing the investment, taking into account ways to increase the operational mileage and ridership on electric buses. To be able to achieve this, measures should be considered to benefit the use of public transport (PT only zones, bus lanes etc.).

Where applicable, it is recommendable to include “green loans” or grants within the tender. Where national and/or international subsidies are available, coordinate the tender demands with the demands for such subsidies, with the aim to assure that the bidders can also include this in their offers (guaranteed access towards these subsidies if winning the bid).

5.1.3 Feasibility study

In order to perform and to properly facilitate the analysis of the electric bus solution, including the feasibility of the system, a detailed study is recommended. With the study, characteristics and requirements are identified in order to ensure the administrative, local and operational constraints are fulfilled.

The main challenges which will need to be addressed under a feasibility study are:

- Time table requirements
- Number of buses
- Bus specifications
- Charging strategy and consents
- Energy supply
- System lifetime

In order to address these challenges a detailed analysis of the following aspects will be necessary.

Operational data	• Planning data influencing the limitation of the range on one charge • Route characteristics
E-bus specifications	• Number of buses regarding limitation of the range on one charge • Passenger capacity • Battery capacity • Battery life • Energy consumption
Charging point data	• Overnight or opportunity charging • Location of charging equipment • Capacity of each charger • Permits for the installation of charging infrastructure in public domain

Table 1. Feasibility study elements

5.1.4 ROUTE CHARACTERISTICS

Listed below is a summary of the key aspects to consider, albeit non exhaustive:

City constraints

- Climate
- Topography
- Noise requirements
- Zero emission zones
- Traffic and congestion
- Others

Main characteristics of the current and/or a new route(s)

- Length
- Timetable
- Speed
- Number of stops
- available charging time
- Number of buses and drivers
- Others

5.1.5 CHARGING STRATEGY AND GRID CAPACITY

Feasibility analysis are key within the development of an electric bus operation. In addition to the route analysis it is necessary to perform feasibility analysis of the entire electric charging infrastructure (grid, chargers, monitoring etc.) to establish a charging strategy. A study should determine the most economic operation including the related charging infrastructure, and lead to the following definitions:

- Charging capacity for the complete infrastructure.
- Charging locations with individual charging capacity and energy supply from the grid.
- The capacity and installation of substations (transformer capacities).
- Charging speed to be applied with each charging location (with regard to route characteristics and time tables).
- Charging management (timing and charging profile).
- Charging technology (overnight or opportunity charging only or a combination of both)
- Electric bus specifications regarding the battery technology to be used (authorized charging speed) the size of the pack and the way to charge (pantograph, cable and plug, etc.).

Are the local authorities open for placing charging equipment on public roads? If so, include in the tender documents what it is acceptable on the public space /their territories regarding charging equipment and under which conditions, e.g.:

- Location of charging stations.
- Facilitation of the space for the installation available for the operator and under which conditions; period, renting fee, is this transferable to the next operator, etc.

In cases where the most economical e-bus operation cannot be implemented because of one or more constraints, consideration should be given to changing parameters within the study to adapt the solution.

5.2 PTO in relation with the Bus Manufacturer

When initially procuring buses for a new e-bus operation it is procuring a complete new bus operation system. Quotations could be requested regarding:

- Bus purchase price: with and without batteries.
- Battery renting proposal.
- Charging infrastructure offer: as applicable, slow charger and fast charger proposal with equipment to allow connection to the vehicles.
- Maintenance and repair offer quotation.

Bus manufacturers can be requested to deliver a turnkey solution, in which they supply together with the buses:

- The charging infrastructure.
- The maintenance and repair activities as part of a Maintenance and Repair agreement.
- The monitoring of the charging equipment.

Where a turnkey solution is proposed detailed consideration should be given to ensure that bus manufacturers are not being required to take on responsibility for risks that could be better managed or controlled by the PTO or PTA. Examples: civil engineering work related to power supply, grid connection.

Within this configuration the bus manufacturer will be able to agree on a “Bus availability warranty”.

5.2.1 Vehicle specifications

In addition to the specifications usually applicable for conventional buses, the manufacturer will supply information regarding:

5.2.1.1 Functional specifications

- Passenger capacity, taking into account the battery pack size offered and the number of seating capacity requested.
- Driving autonomy on one battery charge and regarding the battery pack size offered and within the operational conditions.
- Energy consumption, with at least the energy consumption in kWh/km according to the e-SORT protocol (third party certificates) (traction energy)

The power consumption in kW for the worst case situation defined by each PTO (coldest and/or hottest day of operation) according to the “Thermal comfort protocol” (third party certificates). Note that this value aims at estimating influence of thermal comfort on electric autonomy. It differs then from the annual energy consumption used for TCO calculation.

- Life on board/comfort: HVAC and thermal comfort

To ensure technological neutrality, needs for thermal comfort should be expressed, as much as possible, in terms of functional requirements. Annex V (“UITP Thermal comfort measurement") proposes a standardized list of parameters that should be used by any operator to describe its specific requirements.

- Additional safety measures when cleaning, charging, driving and manipulating or maintaining the e-buses, e.g. type and way to connect the charger towards the bus.
- Battery monitoring: operational data, including battery state of charge and energy consumption in real time
- Diagnostic data adapted to electric bus: failure management.
- Smart charging, with charging session data monitoring and data needed for smart charging.

5.2.1.2 Technical specifications

- Vehicles: in addition to the specifications valid for conventional buses
  - Battery specifications: capacity.
  - Battery technology and authorized charging speed.
  - Minimum frequency of slow charging if applicable
- Charging equipment: as applicable
  - AC or DC charging
  - Charger on or off board the vehicle?
  - Slow and/or fast chargers: Charging capacity with type of connection towards the vehicle.
  - Charger efficiency rate (see also UITP E-SORT protocol, Annex V)
  - Charging communication protocol used (standardisation ongoing)
  - Impact on the grid (possible application of grid filters) especially with AC charging.

5.2.1.3 Warranties

In addition to the specifications also applicable for conventional buses, the manufacturer will supply information regarding:

- Battery warranty with the warranty conditions (max. SOC, min. SOC, max. C factor to be applied).
- Agreement on battery degradation, describing the tools that will be made available for the PTO to check on these.
- Vehicle availability: in case of turnkey agreement with bus manufacturer.

5.2.1.4 Tender evaluation criteria

In addition to the criteria also applicable for conventional buses, additional criteria should be set out to ensure that tenders are evaluated taking account:

- The most suitable electric bus solution with regard to the required electric bus operation.
- The most suitable technical solution is the best combination of the operational solution with the TCO proposal (investment in infrastructure and vehicles and operational costs).

- Energy consumption for thermal comfort has not always been taken into account in purchasing processes, but for extremely cold or hot climates, and for electric buses in any type of climates, this consumption is critical.
- If the body responsible for the bids appraisal intends to include in the evaluation criteria for energy consumption and in particular thermal comfort (heating, cooling and ventilation) it should be clearly expressed.
- In case a PTO intends to get comparable data, UITP recommends a specific measurement protocol (see annex V "UITP Thermal comfort measurement").
- To use this protocol in a comparison process, PTO should share with suppliers a typical curve of historical temperature, so that annual energy consumption shall be estimated by a numerical combination of some discrete measured values obtained from suppliers.

5.2.1.5 Implementation system test protocol – acceptance procedure

The purpose is to test the system (perform integrated tests), buses, loaders within the normal traffic situation with regard to the timetable the periphery, etc. before starting the operation.

Physical verifications (docking, crossing) and the compensation of the parking tolerances of the bus in resting position but also system performances (travel time, accessibility, comfort, safety) and the verification of the subsystems (fixed installations) to remove all uncertainties before starting the operation.

Validation steps:

- Validation of functionality: verification of the bus functionality and the charging infrastructure, on site is under the responsibility of the bus manufacturer when turnkey delivery of the system.
- Transfer towards clients test drivers: the transfer of the buses to the PTO's drivers who will be testing the vehicles in realistic circumstances regarding the operation wherefore the buses have been purchased is under the responsibility of the bus manufacturer when turnkey delivery of the system.
- Validation of the system: operating buses in operational circumstances and with regard to the timetables.
- Commissioning.

5.2.1.6 Training

Specific attention should be given regarding:

- Safety systems, especially high voltage systems.
- Economic driving electric buses: with regard to the trainer the trainer principles.
- Training in how connecting the buses for charging.
- Points of attention.
- How to verify that charging is activated.
- What to do when charging doesn't get activated.
- Precision docking: rely on the driver.
- Training in how manipulating the buses, e.g. towing e-buses.

- Training to familiarize with the product: acceleration and torque specificities.
- Training regarding daily checking the bus functionalities.
- Information for first and second responders on hazards and risks associated with-propulsion energy identification (“rescue sheets” with labels and pictograms see ISO 17840-4:2017).

6. CONCLUSIONS AND RECOMMENDATIONS

Cities and PTAs are becoming increasingly aware of the benefits of the electric technology to address the transport and health challenges, e.g. emissions and noise reduction, as well as to improve the image of bus services. However, when launching a tender, many of them struggle with a lack of knowledge and experience, which can create unbalanced relationships. PTOs and bus manufacturers, though, have a better overview of the e-bus market, which allows them to make the most appropriate technology choice based on the operational conditions. Also, they are used to work with energy and charging solutions suppliers in order to present the offer.

The challenge is then to safeguard bus operation with the same level of flexibility as before. This requires a careful and comprehensive analysis of the operational context, the energy needs and the costs related to the whole system implementation, which includes the charging infrastructure and the required adaptations along the route and at the depot (workshops, charging facilities and related equipment). All these points must be carefully considered by the tender entity and the bidders with the final goal of maximising the chances for an effective tender process that will lead to a successful e-bus project.

Based on the experience gathered along the ZeEUS Project, we recommend taking into consideration the following issues when preparing a tender document.

6.1 Paradigm shift: from vehicle to system procurement

Procuring electric buses implies a paradigm shift to consider the procurement of a whole system, i.e. vehicle – infrastructure – service and operation, rather than the vehicle in isolation.

This requires a new approach to define the procurement of electric bus(es) (systems). In this sense, it is recommendable to stimulate and support procuring entities to adapt tender process to e-buses peculiarities, ensuring that the process embeds the system approach (involving stakeholders from early project stage) in the definition of the tender structure in terms of vehicle specifications, indicators, evaluation methodology, the use of supporting tools such as the E-SORT[6], accounting rules, contract duration vs. amortisation of investments, depreciation, reselling, and other aspects.

6.2 Building alliances among different actors

This new context of a system procurement requires to build alliances and cooperation between the several actors in the PT system, e.g. the local administration, PTA, PTO, energy supplier, charging solution suppliers, bus manufacturers, etc. to ensure the success of the tendering process and the subsequent implementation of the system.

Setting up an open dialog with the industry, procuring entity, regulators and financing actors will help define risk sharing schemes between municipalities, authorities and operators according to their role, and address properly issues such as energy consumption, capacity, availability, and environmental impacts through negotiated procedures with the bidders.

[6] "E-SORT– Standardised On Road Test Cycles for electric buses" is a methodology developed by UITP with the aim to measure, in an accurate and reproducible way, the traction energy consumption and to obtain information on the Zero Emissions range of a bus. This can be very helpful in order to compare bids from different manufacturers. Further information can be found here:
https://www.uitp.org/news/E-SORT-addendum

6.3 Analysis of the supporting policy framework

The understanding of supporting regulations and policies at EU and national level on the different topics related to electric buses, e.g. emission standards (Low Emissions Zone), noise levels (Zone Acoustic Saturated), Bus Directive, Green Deals, etc. is crucial and shall be carefully analysed as this will help set up the appropriate framework conditions for the deployment of electric buses. Moreover, it is highly recommendable to integrate the deployment of the new electric bus system into the overall mobility strategy of the city in order to ensure the medium and long-term feasibility of the project.[7]

6.4 Each context has its own solution

There is no one-size-fits all solution, but standards elements that shall guarantee the best operational and financial results. For this reason, it is recommended starting from the operational requirements of the line in order to define the specifications for vehicle, infrastructure and operation.

6.5 Collecting permits and approvals for civil works

The processes for charging infrastructure deployment as well as building permits, depot upgrade, grid connections, roadworks needed to set the system infrastructure in place can be long and demanding, and need to be followed up carefully.

It is recommendable to set up a timeline provision of all necessary permits, authorisations for the installation of the charging infrastructure, as well as the requirements for urban design (bus stops and charging stations along route) in order to provide a proper tender period that allows the completion of the required steps to obtain all necessary permits.

Additionally, special attention shall be paid to the considerations of the infrastructure required to run the system (charging, bus stops, etc.) and the related restrictions in terms of urban design, power supply, among others. Examples of local regulations to be taken into account are safety elements in snow clearance regulations, specific design of urban elements to be aligned with bus stops and related furniture, etc.

6.6 Setting up the system: depot adaptations and new skills

In parallel, trainings and communication for first responders (fire fighters, police), but also for staff (drivers, maintenance staff) shall be planned and carried out in order to ensure a quick reaction in case

Adaptations in bus depot both in terms of technical preparation of the workshop and in the provision of the technical support to the staff shall be considered and if suitable agreed within the services provided by the bidders.

[7] The ZeEUS report "Analysis of existing legislation and funding sources applicable to urban electric buses" provides an overview of the policy framework for e-buses as of September 2017: *http://zeeus.eu/deliverables/instruments-for-procurement*

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