Leipzig Use Case set-up Report

Pillar A+C

Deliverable	D2.11
Authors	Thoralf Knote (Fraunhofer) Eberhard Nickel (LVB) Christiane Wagner (LVB) Andreas Böttcher (LVB)
Status (D: draft; F: final)	F
Document's privacy (Public: PU; Private: PR)	PU
Reviewed by	Yannick Bousse (UITP) VDV (Schmitz, Berends) Wolfgang Backhaus (Rupprecht Consult)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 636012.

SUMMARY SHEET

Programme	Horizon 2020
Contract N.	636012
Project Title	Electrification of public transport in cities
Acronym	ELIPTIC
Coordinator	Free Hanseatic City Of Bremen
Web-site	http://www.eliptic-project.eu/
Starting date	1 June 2015
Number of months	36 months
Deliverable N.	2.11
Deliverable Title	Leipzig Use Case set-up Report
Milestones	Pillar A: M1 Bus operation schedules completely provided Month 8 M2 Transfer of bus operation schedules into *IVi*sion completed Month 14 M3 Energy balancing calculations finished Month 26 Pillar C: M1 Task for tendering/ procurement procedure Month 13 M2 Adjustment during the Partner Meeting in Gdynia Month 13 M3 Contract with external expert Month 15 M4 Final report/ study (German version) Month 25 M5 Final report/ study (English version) Month 26 M6 Lobbying Month 28
Version	1
Date of issue	11/2015
Distribution [Internal/External]	External
Dissemination level [Public/ Confidential]	Public
Abstract	Pillar A: Pillar A describes the set-up of Pillar A of the Leipzig use case. The objective of this use case is the evaluation of all LVB bus lines that are predominantly served by 12 m buses regarding the feasibility of battery bus operation. The use case is subdivided into 12 work steps, which will partly be carried out in parallel, and some of them as iterative steps. The core activities are so-called energy balance calculations, which check on whether enough electric energy is stored in the vehicle energy storage at any time throughout a day of operation. The work will be based on both measured data on LVB bus line 89 and information from a Fraunhofer data base. Pillar C: This deliverable describes the set- up of Pillar C of the Leipzig use case. The objective of this use case is a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of

	the existing tram infrastructure, i.e. selling energy from the tram network to third parties. The use case is subdivided into 11 work steps.

Keywords	battery buses, feasibility study
Critical risks	none

DOCUMENT CHANGE LOG

Pillar A:

Version	Date	Main area of changes	Organisation	Comments
V0.1	12 Nov. 2015	first draft	Fraunhofer	
V0.2	17 Nov. 2015	first draft	LVB GmbH	
V0.3	30 Nov. 2015	language check	Fraunhofer	
V0.4	22 Feb. 2016	Review of document	UITP	

Pillar C:

Version	Date	Main area of changes	Organization	Comments
V5	10/02/2016	2nd draft	Leipziger Verkehrsbetriebe	
V5	13/02/2016	Commented draft	VDV/Berends	
V6	16/02/2016	3rd draft	Leipziger Verkehrsbetriebe	
V7	18/03/2016	4th draft	Leipziger Verkehrsbetriebe	
V8	01/04/2016	Final review	Rupprecht Consult	

CONTRIBUTING PARTNERS

Company	Names	Company Info
Fraunhofer	Thoralf Knote	Research partner of the Leipzig use case
LVB	Eberhard Nickel	Public transport operator
LVB	Christiane Wagner	Public transport operator
LVB	Andreas Böttcher	Public transport operator

Table of Contents

Overview Tables

Overview Figures

1. Executive Summary Pillar A

D2.6.1 – Pillar A describes the set-up of Pillar A of the Leipzig Use Case. The objective of this use case is the evaluation of all LVB bus lines that are predominantly served by 12 m buses regarding the feasibility of battery bus operation.

The overall methodology used in this use case has been developed by Fraunhofer IVI and has been applied in many projects in which the feasibility of battery bus operation has been evaluated. The use case is subdivided into 12 work steps, which will partly be carried out in parallel and partly as iterative steps. The core activities are so-called energy balance calculations, which check on whether enough electric energy is stored in the vehicle energy storage at any time throughout a day of operation.

The base for the energy balance calculations are formed by both so-called bus operation schedules and adapted energy consumption parameters. The bus operation schedules describe all tasks that a specific bus has to fulfill throughout a day of operation. Especially, driven distances as well as driving and turn-around times are used. One important prerequisite is the necessity not to allow any changes to the existing bus operation schedules, as additional personnel efforts or vehicles are to be avoided.

The work will be based on both measured data on LVB bus line 89 and information on typical energy consumption figures coming from a Fraunhofer IVI data base. The advantage of bus line 89 is that it is subdivided into three sections with substantially different distance-speed-patterns. With that, additional energy consumption data can be used for energy balance calculations.

2. Partner Contribution Pillar A

Company	Sections	Description of the partner contribution
LVB	3	Information on context and LVB public transport operation
Fraunhofer	all	Everything except for the input provided by LVB
UITP	All	Review of document

3. Context conditions Pillar A

3.1. Economic, geographical and urban context of the Use Case

In 2015, the city of Leipzig has approx. 545,000 inhabitants living in 10 town districts on a total area of about 297 square kilometers. With that, Leipzig is the city with the highest population in the Free State of Saxony and its population is still growing. Together with the city of Halle / Saale it forms the urban agglomeration of Halle-Leipzig with a population of approx. 1.1 million.

As all East German cities Leipzig has been undergoing a major economic transformation during the past 25 years. Currently, about 38,000 companies and 5,100 crafts enterprises are registered in Leipzig. In October 2015, the official unemployment rate was 8.9 %. Furthermore, Leipzig is also an important place for higher education with Leipzig University and its 28,000 students being the biggest educational institution.

3.2. PT service context

The Leipziger Verkehrsbetriebe (LVB) GmbH transports about 161 million passengers per year. Public transport in Leipzig is dominated by 314 trams, which annually transport approx. 137 million passengers on 13 tram lines with a total network length of 218 km. Except for line 89 which connects the very city center with the Connewitz quarter, all buses are operated on feeder lines or tangential lines. In total, 88 buses are operated on 36 LVB bus lines transporting approx. 26 million passengers per year on a bus network of 1,272 km. The bus fleet is composed of

- 64 articulated buses
- 86 standard buses
- 8 mini/midi buses

with an average age of 5.5 years.

3.3. Information about the Use Case

The overall objective of the use case is the technical and economic analysis of all bus lines regarding the possibilities of operating battery buses on these lines. In total, 42 bus lines that are predominantly served with standard buses will be analyzed.

The basis for this analysis is the operation of two battery buses on bus line 89 between Kreuz Connewitz and Leipzig Main Station / Goethestraße. The operation will start in early 2016. The 5.4 km long bus line is subdivided into three sections. The first section is situated in the very city center of Leipzig where the buses partly drive through a pedestrian area and where their average commercial speed is very low. The second section leads through an area with speed limits of 30 kmph. After that, the buses run on major roads with a speed limit of 50 kmph.

The buses are recharged at the bus depot and at the terminal stop Kreuz Connewitz. The charging power at the terminal stop will be 250 kW. The charging station will be connected to the DC grid of the local tram system.

One of the battery buses, which both belong to Fraunhofer IVI, is equipped with measuring devices that allow the measurement of energy consumption on different sections.

The operation of the battery buses is part of a R&D project called “eBus Batterfly”, which is co-funded by the German government. However, results of the operation will be used for Pillar A of the Leipzig Use Case. The operation of battery buses on bus line 89 provides important information on energy consumption that will be used for the analysis of all other bus lines mentioned above.

The analysis will be carried out using the so-called energy balance calculation method implemented in the Fraunhofer software tool *IVI*sion. The method has been used for the evaluation of many bus lines and entire bus networks in the past. It uses the existing or planned bus operation schedules and duty rosters as the operation of battery buses shall not lead to any changes in the bus schedules or especially the labor requirements.

The so-called energy balance calculation method compares the available energy in the vehicle energy storage with the consumed energy and the necessary energy reserve at any time throughout a day of operation. The operation of battery buses on a certain line is deemed to be possible if

$$E_{bat} + \sum E_{ch} > \sum E_{con} + E_{res} \qquad (3\text{-}1)$$

with

E_{bat} energy content of the battery after leaving the bus depot [kWh]

E_{ch} energy charged during operation [kWh]

E_{con} consumed energy [kWh]

E_{res} energy reserve [kWh]

is given at any time throughout a day of operation.

4. Objectives Pillar A

4.1. Objectives of the Use Case

The main objective of the Leipzig Use Case is a comprehensive survey on the possibilities for operating battery buses on all bus lines that are predominantly served with standard buses. At the end of this feasibility study there will be a list of bus lines for which the necessary vehicle design in terms of energy storage and the necessary charging infrastructure in terms of charging power and location are listed. It will also describe the possibilities to connect the charging infrastructure to the local electricity grids. Furthermore, an important objective is the definition of a standard vehicle and a standard charging infrastructure in order to give the local operator a high flexibility in its bus allocation to different schedules and bus lines. However, at present, it is not yet clear whether this objective can be met.

4.2. Expected impacts

The Leipzig Use Case will provide a comprehensive survey on the possibilities to operate electric battery standard buses. It will show a possible migration path towards the conversion of the entire LVB standard diesel bus fleet to electric buses. Within this migration path several steps for the procurement of buses and the implementation of the charging infrastructure will be defined. They will mirror expected development steps of key technologies for battery buses, most importantly the energy storage and the heating system.

The survey will provide the local operator and the authorities of Leipzig with a blue print for the conversion of diesel buses into electric battery buses, and therefore with a sound basis for necessary decisions and fund raising.

It will also show the environmental impact of the operation of battery buses in comparison to conventional diesel buses, namely savings in CO_2, NO_2, NO_x and PM_{10}. However, savings in greenhouse gases and air pollutants will not be included into the financial evaluation.

4.3. Use Case KPIs

The KPIs described are subdivided into KPIs that are only connected to the ELIPTIC project (KPI-A) and KPIs that originate from the electric bus operation within eBus Batterfly (KPI-B) and that will be used for the activities in Pillar A.

Table A 1: KPIs for the Leipzig Use Case – Pillar A

KPI definition	KPI-A	KPI-B
Ose10 – Charging time		X
Eco1 – Operating cost	X	
Eco2 – Investment for the network	X	
Eco3 – Training cost	X	
Eco6 – Vehicle capital cost (assumption for calculations)	X	
Eco7 – Vehicle capital cost without batteries (assumption for calculations)	X	
Eco8 – Vehicle capital cost without batteries (assumption for calculations)	X	
Eco19 – Residual value of the buses (assumption for calculations)	X	
Eco21 – Cost for depot facilities	X	
Eco22 – Cost for charging infrastructure	X	
Eco23 – Electricity cost	X	X
Eco24 – Electricity cost for traction	X	X
Eco25 – Electricity cost for non-traction	X	X
Eco27 – Fuel cost (assumption for calculations)	X	
Eco28 – Cost for grid connection	X	
Eco29 – Interest rate (assumption for calculation)	X	
Ecn4 – Fuel consumption on line 89		X
Ecn4 – Average fuel consumption	X	
Ecn9 – Electric energy consumption	X	X
Eem1 – CO_2 emissions (calculated from fuel and electric energy consumption)	X	X
Eem2 – CO emissions (calculated using HBEFA factors)	X	X
Eem3 – NO_x emissions (calculated using HBEFA factors)	X	X
Eem4 – PM_{10} emissions (calculated using HBEFA factors)	X	X

5. Risks Pillar A

Although Pillar A of the Leipzig Use Case is closely connected to the eBus Batterfly project, it does not necessarily depend on it. Fraunhofer IVI owns a comprehensive data base on electric buses from which necessary input data for the evaluation using *IVI*sion can be taken if the eBus Batterfly project fails, does not run as planned or does not provide sufficient data for further evaluation steps.

The so-called energy balance calculation method has been used in many projects before. Both the methodology and the software tool to be used are ripe and tested. Fraunhofer IVI employs several engineers who can carry out the analysis.

Overall, there is no major risk of not reaching the set objectives.

6. Detailed description of the Use Case Pillar A

6.1. Description of expected use case features, establishing the link among use case conditions, objectives and background

As already mentioned in section 3 the very content of Pillar A of the Leipzig use case is a feasibility study on the operation of electric battery buses on LVB bus lines predominantly served with standard buses (12 m).

It will be based on the results of a nationally co-funded project called »eBus Batterfly« in which the LVB bus line 89 will be served with two battery buses provided by Fraunhofer IVI. Together with data from a Fraunhofer IVI data base, the results will be used to evaluate further LVB bus lines regarding the operation of standard electric battery buses. However, it is important to stress again that Pillar A of the Leipzig Use Case does not depend on the execution and the outcomes of the eBus Batterfly project.

6.2. Use Case constraints

Although based on operational data and a comprehensive data base, the feasibility study will remain a simulation-based analysis. By their very nature this kind of analyses are characterized by a remaining error.

6.3. Use Case monitoring criteria

The use case monitoring will be carried out using the completion of work steps and the fulfilment of milestones as described in chapter 7.

7. Use case work plan Pillar A

7.1. Use Case development logic

Figure 1 shows the use case development logic using a flow chart that describes the individual work steps, their sequential arrangement and their interdependencies.

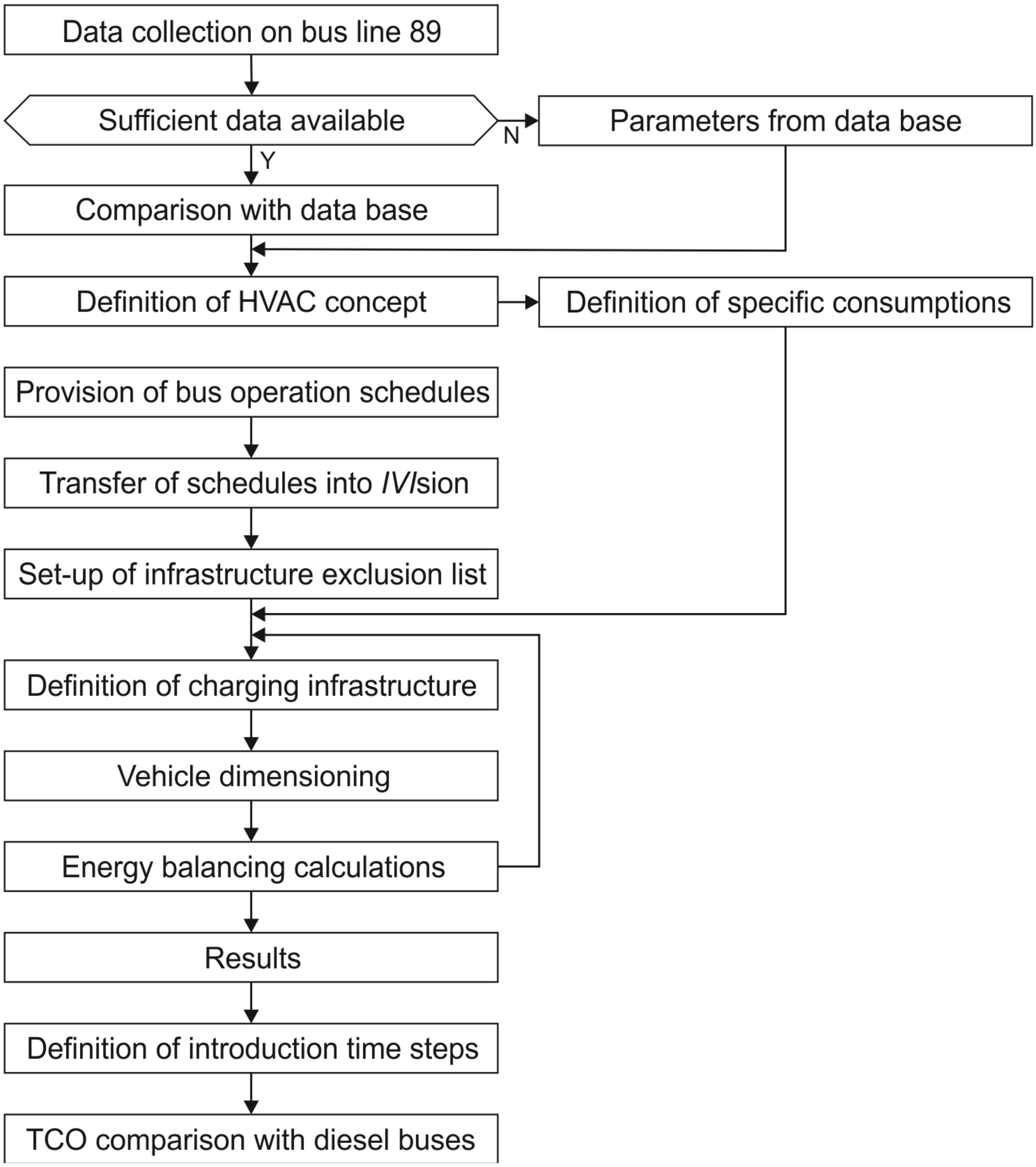


Figure A 1: Development logic of the Leipzig use case – Pillar A

Figure 1: Development logic of the Leipzig use case – Pillar A

WS 1 – Data collection on bus line 89

As already mentioned above data originating from the battery bus operation on LVB bus line 89 will be used to evaluate other LVB bus lines. However, the use case does not depend on sufficient data as usable parameters are available in a Fraunhofer IVI data base.

WS 2 – Comparison with data base

The collected data will be validated using information from the Fraunhofer IVI data base. This work step will only be carried out if the collected data as such is sufficient enough for the evaluation of other LVB bus lines. Otherwise, parameters from the Fraunhofer IVI data base will be used.

WS 3 – Definition of the HVAC concept

The HVAC concept significantly influences the energy consumption of battery buses and their operational range between recharging.

Heating: A decision will be made regarding the heating concept. Most likely, the heating concept will consist of one of the following technologies:

- auxiliary diesel heater
- auxiliary diesel / electric heater
- fully electric heater.

AC: Currently, LVB buses are only equipped with an AC unit for the drivers workplace. However, a decision has to be made on whether this policy will also be followed in the future.

WS 4 – Definition of specific consumption parameters

The energy balancing method is based on specific consumption parameters (kWh/km). Based on the parameters from work step 2 and the HVAC, different specific consumption parameters will be defined. They will depend on the speed profile of the bus lines and will be provided for different bus weights as the energy storage size will be varied in a later work step.

WS 5 – Provision of bus operation schedules

Bus operation schedules define

- the time of bus departure from the bus depot
- all time frames, routes and turn-around times of the bus throughout an operational day
- the time when the bus returns to the bus depot.

The bus operation schedules will be provided by LVB using the schedules for the year 2016.

WS 6 – Transfer of bus operation schedules into *IVI*sion

All necessary information of the bus operation schedules will be transferred into a data format that can be processed by the *IVI*sion software. Depending on the raw data format, this can be a time consuming work. However, once the raw data is converted, energy balancing calculations are very quick, which allows the evaluation of a multitude of variations regarding the vehicle energy storage and the charging infrastructure. Work step 6 also includes the test of the data using default values for vehicle and consumption parameters.

WS 7 – Set-up of infrastructure exclusion list

Charging infrastructure will most likely be installed inside the bus depot and at selected terminal stops. However, experiences from similar evaluations in other cities show that terminal stops may not be suitable for the installation of charging stations, especially due to

- insufficient space
- missing or extremely costly grid connection
- environmental or architectural considerations.

The infrastructure exclusion list will list all terminal stops that are not suitable for the installation of charging stations as this is important input information for the definition of the charging infrastructure as basis for the energy balancing calculations.

WS 8 – Definition of charging infrastructure

The definition of the charging infrastructure, the vehicle dimensioning and the energy balancing calculations are iterative work steps that will lead to an optimum under the assumption that no changes in the bus operation schedules will be allowed. The iteration work steps will start with a minimum of charging stations. This initial step will be based on experiences mostly, but will be supported by an analysis of daily arrivals and available turn-around times at terminal stops. Furthermore, terminal stops in the proximity of electric tram infrastructure will have a higher priority, assuming that the cost for connecting the charging infrastructure will be lower. The objective is to use as many similar charging stations as possible.

WS 9 – Vehicle dimensioning

The vehicle dimensioning in work step 9 is limited to the variation of the energy storage. The resulting different vehicle weights will be considered by different specific energy consumption parameters provided in work step 4. The objective is to define as few as possible different vehicle parameters. In general, the energy storage should be rather large, as higher available energy contents provide a higher flexibility and make the system proofed against disturbances etc.

WS 10 – Energy balancing calculations

The energy balancing calculations form the core of the feasibility study. Detailed information on the methodology can be found in chapter 3.3. The results are not the absolute optimum as no changes in the bus operation schedules are allowed. However, such changes might be more cost effective than the installation of additional charging stations. During the project, it will be decided whether changes of the bus operation schedules will be possible and if so to which extent.

WS 11 – Definition of introduction time steps

The introduction of battery buses is influenced by a number of factors. The most important ones are the planned renewal of rolling stock, the increase of electric autonomy, available funding and political directives.

Planned renewal of rolling stock

Every bus operator has a more or less detailed plan for the renewal of its rolling stock and most companies will not afford any renewal ahead of time. Therefore, any definition of introduction time steps must consider planned renewals.

Increase of electric autonomy

Each increase of electric autonomy or operational range between recharging reduces the necessity of charging infrastructure outside the bus depots. Already today, many bus operation schedules can be covered without recharging at bus stops or terminal stops. Assuming an increase in energy density and with that in electric autonomy, more and more bus operation schedules can be covered without recharging. Whether the recharging at terminal stops is more cost effective than solely recharging at bus depots depends on the number of vehicles operated on a specific bus line. However, implementing charging infrastructure can be extremely difficult. Therefore, the substitution of diesel buses should also consider the number of bus operation schedules that are suitable for battery buses without recharging at stops.

Political directives

Many European cities have issued political directives that sooner or later will ban non-emission-free urban buses. However, such directives do not exist in the city of Leipzig.

WS 12 – TCO comparison with diesel buses

TCO or total cost of ownership describes the total costs that sum up during the whole life time of a bus as a result of its purchase, operation, maintenance and repair as well as its resale or disposal. However, in this use case only cost differences between battery and diesel buses will be considered, also taking into account the necessary infrastructure.

7.2. Work plan

The expected action plan with the respective involved partner’s staff effort and time-line is presented in the table below. The work plan is subdivided into 12 work steps. It leaves out the low possibility that only parameters from the Fraunhofer data base are available.

Table A 2: Work plan of the Leipzig use case – Pillar A

#	Action	PM	Staff Fraunh.	Staff LVB	Start-month	End-month
WS 1	Data collection on bus line 89[1)]	-	SE	-	8	16
WS 2	Comparison with data base	0.1	SE	-	16	16
WS 3	Definition of the HVAC concept	0.3	SE	SE	13	13
WS 4	Definition of specific consumption parameters	0.1	SE	-	16	16
WS 5	Provision of bus operation schedules	0.3	-	SE	6	8
WS 6	Transfer of bus operation schedules into *IVI*sion	3.5	JE	-	8	14
WS 7	Set-up of infrastructure exclusion list	2.6	SE	SE	10	16
WS 8	Definition of charging infrastructure	0.2	SE	-	13	26
WS 9	Vehicle dimensioning	0.1	SE	-	13	26
WS 10	Energy balancing calculations	2.5	SE	-	13	26
WS 11	Definition of introduction time steps	0.9	SE	SE	28	28
WS 12	TCO comparison with diesel buses	0.9	SE	SE	28	28
JE junior engineer SE senior engineer [1)] not part of the ELIPTIC project						

7.3. Detailed timeline

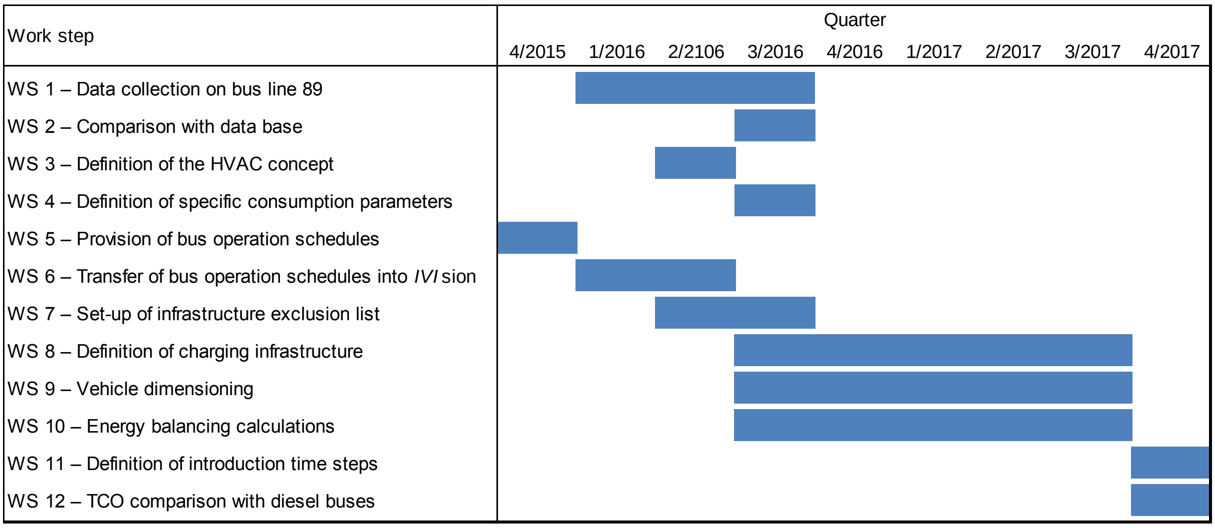


Figure A 2: Detailed time line of the Leipzig Use Case – Pillar A

The following milestones have been defined:

M1	Bus operation schedules completely provided	Month 8
M2	Transfer of bus operation schedules into *IVI*sion completed	Month 14
M3	Energy balancing calculations finished	Month 26

8. Expected results Pillar A

The main objective of the Leipzig Use Case is a comprehensive survey on the possibilities for operating battery buses on all bus lines that are predominantly served with standard buses. At the end of this feasibility study, there will be a list of bus lines for which the necessary vehicle design in terms of energy storage and the necessary charging infrastructure in terms of charging power and location are listed. It will also describe the possibilities to connect the charging infrastructure to the local electricity grids. Furthermore, an important objective is the definition of a standard vehicle and a standard charging infrastructure in order to give the local operator a high flexibility in its bus allocation to different schedules and bus lines. However, at present, it is not yet clear whether this objective can be met.

Beyond a technical and financial evaluation, the feasibility study will also identify the climate and environmental impacts of the battery bus operation. Although the savings in CO_2, NO_x, NO_2 and PM_{10} will not be included into the financial evaluation, they make a substantial contribution to the air quality improvement plan of the city of Leipzig.

9. Executive Summary Pillar C

The content of Pillar C of the Leipzig use case is a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties. This study will describe the KPIs as well as recommendations and possibilities how to support e-mobility in case of multi-purpose use of infrastructure.

It will be based on the verification of contemporary legal regulations with the focus on recharging of electrice / ebuses by using the tram energy, existing tram infrastructure. Therefore recommendations for political decision making processes and public transport companies shall be compiled.

Within this study external experts shall consider the German/ European law towards the support or restrictions for using the tram power network to recharge electric vehicles, also the verification of legal effects for the use of the power supply for vehicles within the transport company or for third parties has to be looked at on the German and European level.

Recommendations shall be compiled out of the results of Pillar C, to point out present conflicts in German government aid (subsidies, development funds), tax law and energy law. In addition to that, it also shall be examined to what extent European partner countries face similar conflicts that need to be solved.

10. Partner Contribution Pillar C

Company	Sections	Description of the partner contribution
Leipziger Verkehrsbetriebe		Leader of the document

11. Context conditions Pillar C

11.1. Economic, geographical and urban context of the Use Case

Figure C 3: Leipzig location within Germany (source: Wikipedia)

Area size	297,37 sqkm
Population	544.479 (31.12.2014)
More information	www.leipzig.de

As of 2015 the city of Leipzig has approx. 545,000 inhabitants who live in 10 town districts on a total area of about 297 square kilometers. With that Leipzig is the city with the highest population in the Free State of Saxony and its population is still growing. Together with the city of Halle / Saale it forms the urban agglomeration of Halle-Leipzig with a population of approx. 1.1 Mio.

As with all East German cities Leipzig has been undergoing a major economic transformation during the last 25 years. Currently about 38,000 companies and 5,100 crafts enterprises are registered in Leipzig. As of October 2015 the official unemployment rate was 8.9 %. Furthermore Leipzig is also an important place for higher education with Leipzig University and its 28,000 students being the biggest educational institution.

11.2. PT service context

The Leipziger Verkehrsbetriebe (LVB) GmbH transports about 139 Mio. passengers per year. The public transport in Leipzig is dominated by 314 trams, which annually transport approx. 137 passengers on 13 tram lines with a total network length of 218 km. Except for line 89, which connects the very city center with the Connewitz quarter all buses are operated on feeder lines or tangential lines. In total 88 buses are operated on 36 LVB bus lines transporting approx. 26 passengers per year on a bus network of 1,272 km. The bus fleet is composed of

- 64 articulated buses
- 86 standard buses
- 8 mini/midi buses

with an average age of 5.5 years.

The operation key figures of Leipziger Verkehrsbetriebe are (basis year 2014):

Total number of trams	314
Total number of tram lines	13
Total line length	218 km
Total number of buses	88
Total number of bus lines	36
Total line length	1.272 km
Total number of transported passengers	139 Mio

11.3. Information about the Use Case

Pillar C describes the set- up of Pillar C of the Leipzig use case. The objective of this use case is a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties. In particular for Germany, with its Renewable Energy Sources Act, this study will produce important legal findings on the potential drawbacks such a use case may have. The study will consider German and European energy (market) regulations, the impact on relevant tax issues (tax benefits) and the future of current subsidy agreements for public transport services. The study will produce policy recommendations to be taken up by the (German/ European) political decision making process.

12. Objectives Pillar C

12.1. Objectives of the Use Case

The main objective of the Leipzig use case is a comprehensive study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure of public transport companies. The Leipzig use case will provide a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties. This will include recommendations for decision makers as well as public transport companies, stakeholders regarding the KPIs and possibilities how to support e-mobility in case of multi-purpose use of infrastructure and how to support e-mobility in case of multi-purpose use of infrastructure. Common rules for e-mobility for the adjustment of regulatory obstacles shall be generated.

12.2. Expected impacts

The Leipzig use case will provide a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties.

This study will give the local operator Leipziger Verkehrsbetriebe and other public transport companies as well as decision makers recommendations, principles and outcomes for this specific use case regarding the surveyed KPIs and possibilities how to support e-mobility in case of multi-purpose use of infrastructure.

12.3. Use Case KPIs

The KPIs described are subdivided into national and European KPIs regarding the multi-purpose use of infrastructure.

National KPIs

German energy regulations (OLei1)
Verification of legal regulations for recharging of electric vehicles using the existing tram infrastructure in Germany (verification of national law towards support or restrictions for using the tram power network to recharge electric vehicles)

Legal effects (OLei2)
Verification of legal effects for the use of tram energy for e-buses or e-vehicles (verification of legal effects for the use of the power supply for vehicles within the transport company or for third parties)

Recommendations (Olei3)
Recommendations for the national political decision making process (exchange of experience with other public transport companies/ project partners)

European KPIs

European energy regulations (OLei 4)
Verification of legal impacts for recharging of electric vehicles using the existing tram infrastructure in Europe (verification of European law towards support or restrictions for using the tram power network to recharge electric vehicles)

Legal effects (OLei 5)
Verification of legal effects for the use of tram energy for ebuses (verification of legal effects for the use of the power supply for vehicles within the transport company or for third parties)

Recommendations (OLei 6)
Recommendations for the European political decision making process (exchange of experience with other public transport companies/ project partners)

13. Risks Pillar C

Within the project duration the progress or success of this use case may be affected by these conditions:

- political changes which may affect/ lead to changes in the legal regulations (e.g. in Germany)
- Check/ verification of legal basis for the use case
- technological evolutions
- determination of appropriate legal experts for the verification of legal aspects on the national German and European level
- Legal aspects in becoming operator of energy network: we will verify this, to avoid that Leipziger Verkehrsbetriebe is getting in such a situation

Due to the fact that the Pillar C activity of Leipziger Verkehrsbetriebe solely examines the theoretical analysis aiming to point out proposed solutions for current competing legislations, there is only the risk that the expected success will not be achieved and that the present existing legal and tax principles will still remain valid. This represents no risk for the task in Pillar C to further strengthen the electromobility with interoperable charging of all in electrical operation participating vehicles and companies.

Therefore it is important to mention that the elaborated recommendations for decision makers depend on the outcome of the study. However, as of today it is not clear whether this objective can be met.

14. Detailed description of the Use Case Pillar C

14.1. Description of expected use case features, establishing the link among use case conditions, objectives and background

As already mentioned in chapter 3 the content of Pillar C of the Leipzig use case is a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties. This study will describe the KPIs as well as recommendations and possibilities how to support e-mobility in case of multi-purpose use of infrastructure.

It will be based on the verification of contemporary legal regulations with the focus on recharging of electric/ ebuses by using the tram energy, existing tram infrastructure. Recommendations for political decision making processes shall be compiled.
However, as of today it is not clear whether this objective can be met. It also depends on whether appropriate bidders for the required external support can be found.

Therefore it is important to mention that the elaborated recommendations for decision makers and public transport companies depend on the outcome of the study.

14.2. Use Case constraints

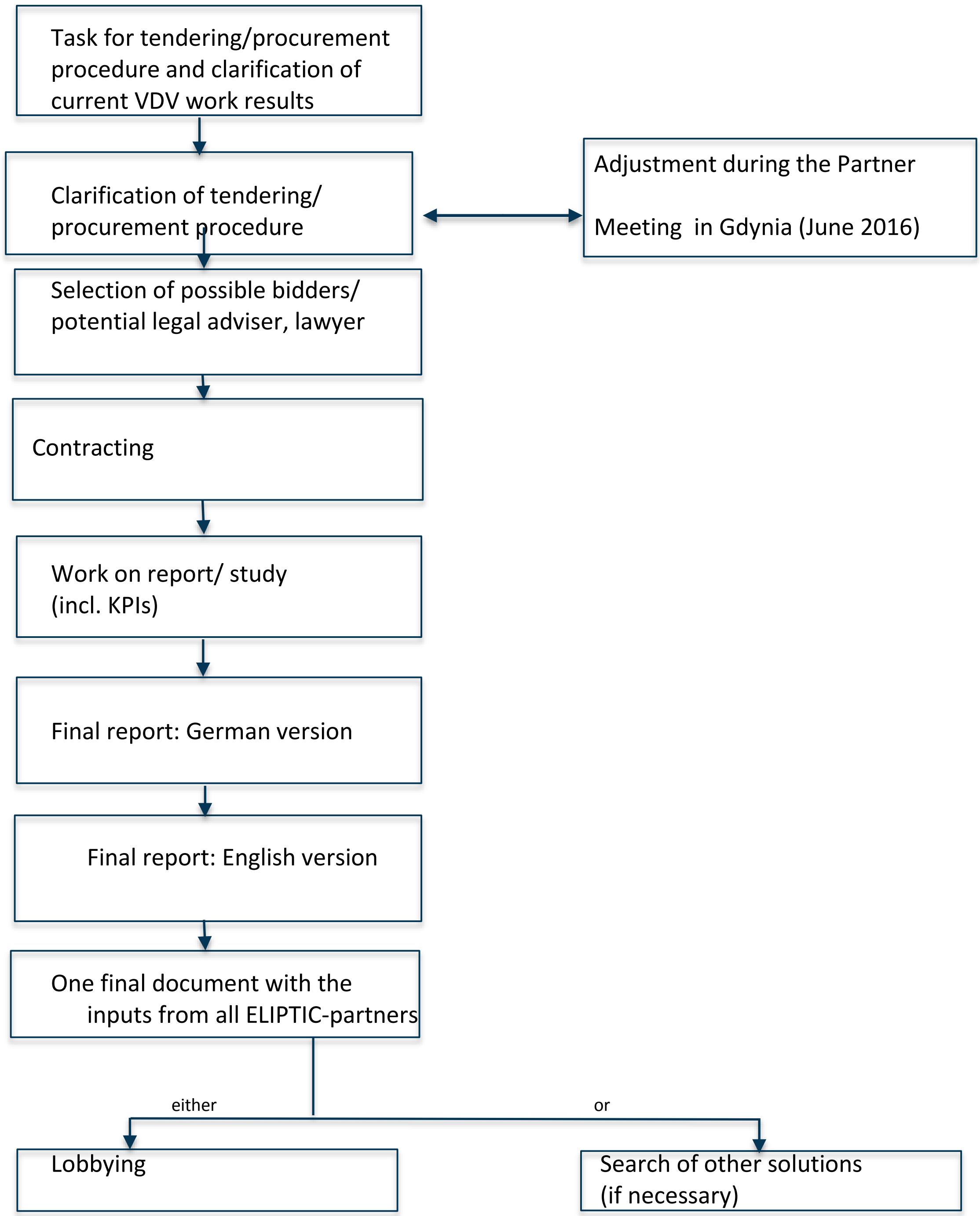
See section 13. Risks Pillar C.

14.3. Use Case monitoring criteria

The use case monitoring will be carried out using the completion of work steps and the fulfilment of milestones as described in chapter 15.

15. Use case work plan Pillar C

15.1. Use Case development logic



Development logic of the Leipzig use case- Pillar C

Work step 1- task for tendering/ procurement procedure and clarification of current VDV work results

The task for the tender/ procurement procedure will be defined until June 2016. This will contain the detailed work description (definition) of the expected aims/ objectives within this study as well as the required scope of work for the external support. E.g. besides the verification of German/ European law towards the support or restrictions for using the tram power network to recharge electric vehicles, planning of an implemented solution, also the verification of legal effects for the use of the power supply for vehicles within the transport company or for third parties has to be looked at on the German and European level.

Within this work step it is important to figure out the current status of VDV work on this topic. What are already achieved working results on the field of multi- purpose use of infrastructure or if it is possible to act jointly on different (sub-) questions. These results or recommendations shall be included in the work of the final report.

Work step 2- clarification of tendering/ procurement procedure

Depending on the work description and the required scope of work, the tendering procedure/ procurement procedure will be clarified for the required external support.
This is necessary due to the very specific aspects of the study.

Work step 3- Adjustment during the Partner Meeting in Gdynia

Presentation of the task for tendering/ procurement procedure at the partner meeting in Gdynia and confirmation respectively supplement of content. This includes also possible input from ELIPTIC-partners working on this topic.

Work step 4- selection of possible bidders/ potential legal advisers, lawyers

Identification of possible bidders/ potential legal advisers, lawyers who are able to meet the requirements the study will focus on. Therefore legal experts are required with the focus on the energy law, tax law e.g. as well as experts from economic ministry.

Work step 5- Contracting

The tendering will take place. After the successful tendering, the contract with will be signed and work on the report/ study starts.

Work step 6- work on report/ study incl. KPIs

The processing period for the report/ study covers approx. 9 months including the work on the KPIs on German and European level and the exchange of experience with other public transport companies/ project partners or organizations (e.g. VDV).
Consultations/ work meetings with Leipziger Verkehrsbetriebe and external support will take place every third months to monitor the work progress and the milestone plan.

Work step 7- final report: German version

Completion and reception of the final report in German language. This will include recommendations for decision makers as well as public transport companies, stakeholders regarding the KPIs and possibilities how to support e-mobility in case of multi-purpose use of infrastructure.

Work step 8- final report: English version

Translation of the final report into English version.

Work step 9- One final document with the inputs from all ELIPTIC-partners

Within the ELIPTIC- project, the inputs from all ELIPTIC- partners working on Pillar C will be summarized in one final-document. Support, collaboration and further discussion for this work step will be provided by Leipziger Verkehrsbetriebe.

Work step 10- Lobbying

Depending on the results of the final report/ study either work step 10 or work step 11 will be carried out. Within work step 10, it is intended that together with the VDV the lobbying together with decision- makers will start. This includes meetings regarding common rules for e-mobility (integration of climate change objectives?) for the adjustment of regulatory obstacles.

Work step 11- Search of other solutions (if necessary)

Depending on the results of the final report/ study either work step 10 or work step 11 will be carried out. Work step 11 (the search of other solutions will be carried out) will only be taken into account if work step 10 will not be carried out.

15.2. Work plan

The expected action plan with relative involved partner´s staff effort and time-line is described in the following table. The work plan is subdivided into 11 work steps.

Table C 3: Work plan of the Leipzig use case- Pillar C

Number	Action	PM	Staff LVB	External Staff	Start-month	End-month
Work step 1	task for tendering/ procurement procedure + clarification of current VDV work results	0,75	SE/JE	-	8 (Jan 2016)	13 (Jun 2016)
Work step 2	clarification of tendering/ procurement procedure	0,15	SE/JE	-	10 (Mar 2016)	13 (Jun 2016)
Work step 3	Adjustment during the Partner Meeting Gdynia	0,30	SE/JE	-	13 (Jun 2016)	13 (Jun 2016)
Work step 4	selection of possible bidders/ potential legal advisers, lawyer	0,20	SE/JE	-	11 (Apr 2016)	13 (Jun 2016)
Work step 5	Contracting	0,25	SE	-	14 (Jul 2016)	15 (Aug 2016)
Work step 6	work on report/ study incl. KPIs	1,50	SE/JE	SE/JE	16 (Sep 2016)	24 (May 2017)
Work step 7	final report: German version	0,20	SE/JE	SE/JE	25 (Jun 2017)	25 (Jun 2017)
Work step 8	final report: English version	0,25		SE/JE	26 (Jul 2017)	26 (Jul 2017)
Work step 9	One final document with the inputs from all ELIPTIC-partners	0,05	SE/JE	-	27 (Aug 2017)	28 (Sep 2017)
Work step 10	Lobbying	0,20	SE/JE	-	27 (Aug 2017)	28 (Sep 2017)
Work step 11	Search of other solutions	0,15	SE/JE	-	27 (Aug 2017)	28 (Sep 2107)

(SE = Senior Engineer / JE = Junior Engineer)

15.3. Detailed timeline

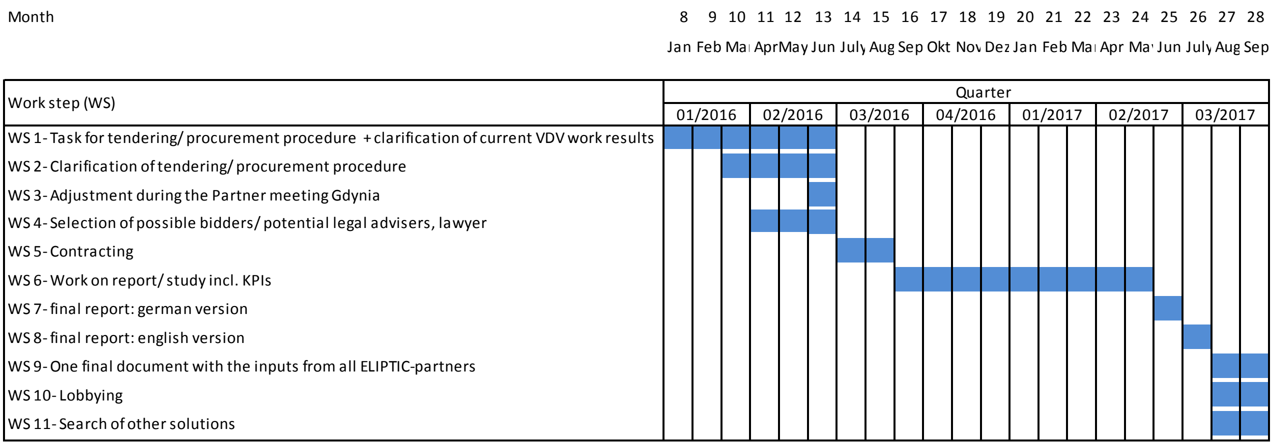


Figure C 4: Detailed timeline of the Leipzig use case- Pillar C

The following milestones have been defined:

M1	Task for tendering/ procurement procedure	Month 13 (Jan – Jun 2016)
M2	Adjustment during the Partner Meeting Gdynia	Month 13 (Jun 2016)
M3	Contract with external expert	Month 15 (Jul – Aug 2016)
M4	Final report/ study (German version)	Month 25 (Jun 2017)
M5	Final report/ study (English version)	Month 26 (Jul 2017)
M6	Lobbying	Month 28 (Aug – Sep 2017)

16. Expected results Pillar C

The main objective of the Leipzig use case is a study on legal barriers, juridical backgrounds in relation to multi-purpose use of infrastructure of the existing tram infrastructure, i.e. selling energy from the tram network to third parties. This study will describe the KPIs as well as recommendations and possibilities how to support e-mobility in case of multi-purpose use of infrastructure. Therefore recommendations for political decision making processes and public transport companies shall be compiled.
However, as of today it is not clear whether this objective can be met. It also depends on whether appropriate bidders for the required external support can be found. Therefore it is important to mention that the focused recommendations for decision makers and public transport companies depend on the outcome of the study.

17. References Pillar C

1. https://de.wikipedia.org/wiki/Leipzig