Szeged Use case set up report

Pillar A+C

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SUMMARY SHEET

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Abstract	This document describes the implementation of the Use Case Szeged in the framework of Pillar A+C. Present document identifies the contribution of partners, describes the context conditions, determines the objectives, identifies the risks, constraints and monitoring criteria and describes the Use Case Szeged regarding Pillar A.
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Critical risks	

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Pillar C:

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0.0	06/11/15	Entering information	SZKT (Náday Attila)	
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Pillar A:

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USZ (P18)	Dr. István Tibor Tóth	University of Szeged
UITP	Yannick Bousse	International Association of Public Transport

Pillar C:

Company	Names	Company Info
SZKT	Szegedi Közlekedési Kft.	Public transport operator in Szeged
USZ (P18)	Szegedi Tudományegyetem	University of Szeged
BKK	Budapesti Közlekedési Központ	Main public transport operator in Budapest
BKV	Budapesti Közlekedési Zrt.	Public transport sub-operator in Budapest

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1. Executive Summary Pillar A

This report contains a brief information about the city of Szeged, public transport in the city, detailed information about the use case (objectives, expected impacts, KPI's, risks, monitoring, etc.) and a short summary about the expected results of the use case. To create this report SZKT was cooperating with USZ (University of Szeged).

The present deliverable relates to Pillar A and provides comprehensive information about the use case. The description and objectives below will form the frame of the next 2,5 years of the Use Case.

2. Partner Contribution Pillar A

University of Szeged and SZKT are the document leaders. UITP has reviewed the document.

Company	Sections	Description of the partner contribution
USZ	3.,4.,5.,6.,7.,8.,	Cooperation, consultation, establishing KPIs
UITP	Entire document	Review of document

3. Context conditions Pillar A

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

Szeged is the third largest city in Hungary near the southern border of the country. The city has about 170 000 inhabitants. More than 100 years ago Szeged was building the first tram line and for 35 years Szeged also has a trolleybus network. The trolley and tramlines are operated by the Szegedi Közlekedési Kft. (SZKT). SZKT is 100% owned by the Municipality of Szeged.

A 1 Figure - Location of Szeged in map of Hungary (Source: Wikipedia)

Another PT company also operates in Szeged (DAKK Zrt.), who is responsible for operating the bus lines in the city. The table below shows the trends of the number of passengers from 1993 until 2015 in Szeged. It contains the number of passengers during one specific day in the year, grouped by PT operator.

Year	1993	1999	2005	2008	2012	2015
% of SZKT in the total	47	43	47	49	54	59
SZKT	143 099	108 325	111 436	108 394	107 000	99 413
Tisza Volán Zrt. / DAKK Zrt.	161 370	143 730	126 153	112 275	91 068	67 784
PT total	**304 469**	**252 055**	**237 589**	**220 534**	**198 068**	**167 197**

A 1. Table - Passengers using PT in Szeged (day)

3.2. PT service context

PT network organization

The SZKT (Szeged Transport Ltd.) has a public service contract with the Municipality of Szeged to run the electric PT operations in the city. SZKT operates the City-owned PT-infrastructure and the car-parking system.

In the contract, the tasks of the SZKT are well defined. The SZKT has to run the trolley and tramlines in the City, keep the timetable, sell, validate and check tickets, inform the passengers, service the vehicle fleet and control/manage the daily operation of the lines.

The bus lines are operated by a different company (DAKK Zrt.). This is not a private company, but DAKK Zrt. is owned by the state, not the Municipality of Szeged (such as SZKT). The public service contract specifies the share of revenues and subsidies (based on ticket sales) between the two PT companies.

Electric PT network capacity

SZKT's electric PT network consists of 6 trolley (total: 34,3 km) and 5 tramlines (total: 31,3 km) in interconnected structure.

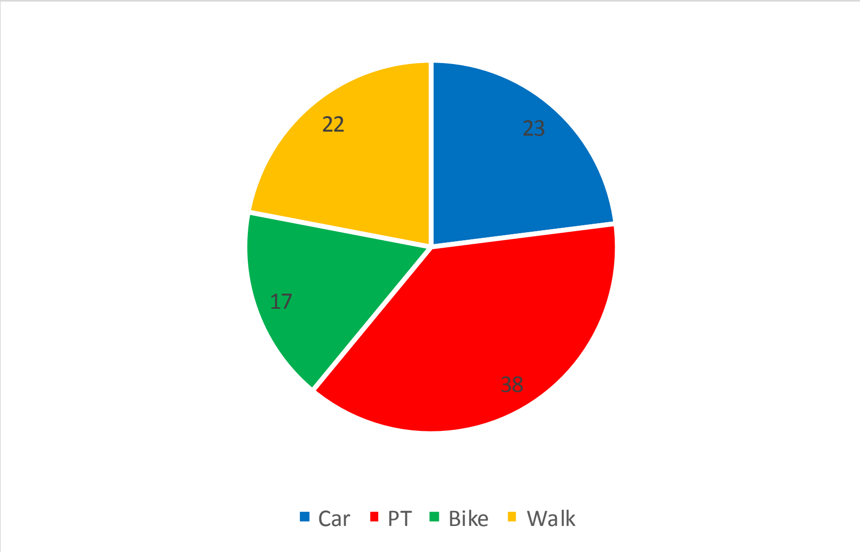
The working-day peak vehicle expenditure is 23 trams + 42 trolleybuses. Annual mileage performance: 3,9 Million km.

The operation key figures of SZKT are: (basis year 2014/2015):

Total number of lines (day/night)	11 / 0
Total line length (tram/trolley)	65,6 km (31,3 km /34,3 km)
Total number of stations	170
Total number of trams (articulated/standard)	46 (27/19)
Total number of trolleybuses (articulated/standard)	63 (42 / 23)
Total number of staff (driver, technical, administration)	578 (270 / 131 / 77)
Total number of transported passengers (based on 2015 passenger counting)	34 Million/annum

A 2. Table - Key figures of SZKT

Modal split of transportation in Szeged (2015)



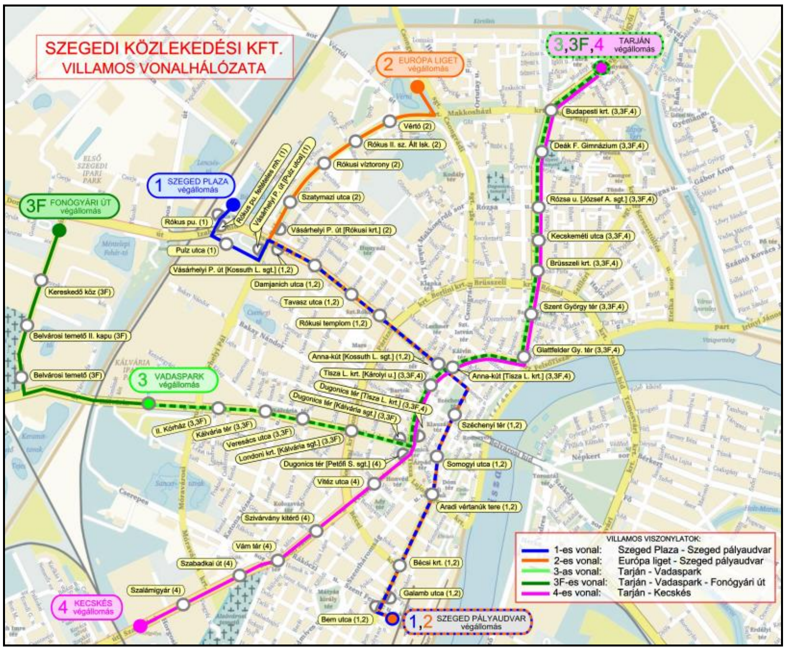
Source:
KSH (Central Statistical Institute) Hungary

Year:
2015

Population:
171.952

A 2. Figure - Transportation modes in Szeged (2015)

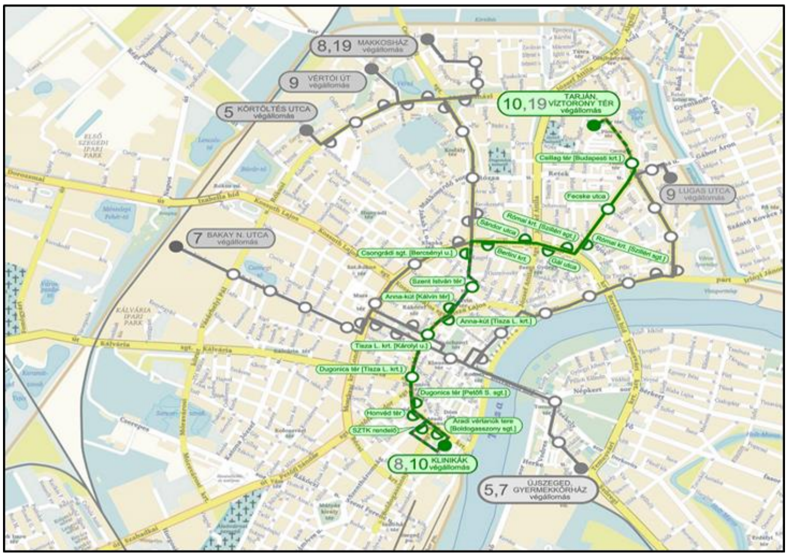
The above diagram is based on research by KSH (Central Statistical Institute) Hungary considering the total number of inhabitants in Szeged. These numbers were processed and published in 2015.



A 3. Figure - Tram network of Szeged

The 3rd figure shows the tram lines in Szeged. Szeged currently has the most recent tram fleet in Hungary (source: Wikipedia). There are five tramlines in Szeged: 1, 2, 3, 3F and 4. SZKTs tram fleet consists from the following tram types (the nr. of a vehicle type):

- KT4D (18)
- Tatra T6A2 (13)
- Tatra TB6A2D- M (4)
- PESA 120Nb (9)
- Vintage trams (6)



A 4. Figure - Trolleybus network of Szeged

The 4th figure shows the trolleybus network. SZKT operates the following trolleybus lines: 5, 7, 8, 9, 10, 19. SZKTs trolleybus fleet consists from:

- Skoda 14 Tr (9)
- Skoda 15 Tr (27)
- Skoda 21 Tr (5)
- M-Benz Citaro O-530 TR12/TV.EU (6, redone from diesel bus)
- Volvo B7 TR12/TV.PR (1, redone from diesel bus)
- Skoda 22TrAC (1)
- ARC Tr187/TV.EU (1, SZKTs prototype)
- Ikarus-Skoda Tr 187.2 (13, hybrid trolleys)
- IKARUS 280-GANZ (1)
- Vintage trolleybuses ZiU-9, IK-280 (2)

In addition, SZKT has a smaller bus fleet (8 diesel buses) to replace trams/trolleys if necessary (in case of damages to the infrastructure due to weather conditions or accidents, vehicle breakdowns).

3.3. Information about the Use Case

The trolleybus extension is only possible from an existing trolleybus end station. We plan to realize the demonstration in the PT system of Szeged. With the examination of the current trolley lines, we defined the possible battery line-extensions.

We have chosen the line-extension from trolley line ‘5’, which could be extended to an existing bus line (‘72’) end station. This extension reaches a residential area of the city. We negotiated the possible line extensions with the Municipality of Szeged and therefore we had to re-plan the demonstration line. We made alternative proposal for a new trolley line, this line not yet an existing trolley line but runs mostly under the existing trolley overhead system so it would be a good example of demonstrating the bus line replacement with partially self-moving trolley trolleys.

As the total length of section in battery mode would be 3,2 km in one way (6,4 in total), this makes possible to organize the first demonstration if the Municipality will accept SZKTs proposal.

During the first test (‘TEST 0’) in January 2016 we have checked the capability of running in battery mode of our hybrid trolley Ikarus-Skoda Tr 187.2. The test run have proved the good self-moving capabilities of this type of trolleybus and this is very promising for the future tests and demonstrations.

4. Objectives Pillar A

4.1. Objectives of the Use Case

The short-term objective during the project is to demonstrate the technological feasibility of this development for SZKT, for the City-politicians (Municipality) and for the citizens (not only for the passengers) also. The demonstrations of the Use Case will give the possibility to measure many Key parameters and Context parameters. These parameters will give a base for wide comparison of the different Use Cases in the ELIPTIC project (and other projects). The technical-experiences of the Use Case will be used by SZKT in the near future for planning trolleybus line extensions. In Szeged it will be a first time battery powered trolleybuses are examined in a scientific project. There are different areas like traction battery technology, overhead wire technology, transport organisation, finances which are included in this Use Case and experiments in these areas are necessary to spread the technology.

The long-term objectives in the Use Case are that this project will prove the financial and legal feasibility of this development. If the demonstration is successful then SZKT will lobby at local level (at the Municipality of the City of Szeged) to extend the electric PT grid with this technology and this will lead to a decrease in the local environmental impact of conventionally fuelled buses. If we could increase the electric transport at the expense of combustion engine transport this would cause a direct reduction of the local pollution.

In the long term we also expect this Use Case to support the development of good practice for this technology through the actual feasibility study, guidelines, policy recommendations and business models and thus would help to reach some goals of the EU in the PT-transport like decreasing the use of conventionally-fuelled cars in cities by 2030 (and phasing them out by 2050) as well as the emissions reduction target of 60% by 2050, as laid down in the Transport White Paper, Roadmap to a Single European Transport Area.

4.2. Expected impacts

We expect an economic impact by extending the service area with a trolleybus line. This could increase the income of SZKT according to the public service contract. We expect environment impacts by also decreasing the local and global environmental impacts. The Use Case will have a direct effect on local emissions with lower air pollution in the scope of CO_2, NO_x, particle matter emissions, and maybe noise reduction by replacing the diesel bus service. The global emission-reduction will be calculated from the basis of the National electric-energy mix. The line extension could improve the usage rate of electric PT in Szeged which could increase the general corporate efficiency of the company. Under the demonstration the longer trolley service line with battery-powered line section could increase the amount of the recycled and recuperated energy by using traction batteries. This is due to the trolleys being connected to the overhead wires all the time and the batteries are kept full so could not absorb recuperated energy. This could lead to an increase in the average energy efficiency of the trolleys per km. We expect that the satisfaction level of the passengers and drivers will increase on the tested line, and the electric PT mode will be more likely accepted by the public, because the comfort level of the demo-trolleys are fairly high. The electric (and mainly the battery-powered) transport technologies has got an extra allurement due to their novelty (just like other newly implemented technologies).

SZKT has to consider not only the contract with the bus operator company but the possible reaction of the passengers, citizens and politics also. In case of any change in the city's PT system it is expected that some part of the passengers will be affected negatively. For example if during the demonstration the move of an existing station or the changes in timetable will cause inconvenience for the passengers. It is expected that there will be many passengers who would not be reached by the information campaign and for them it could cause inconvenience.

4.3. Use Case KPIs

The list of KPI-s could be extended in the future if in this Use Case it would be necessary or other Project Partner would ask this for higher level comparison of the Use Cases in the Project or for general studies like business cases, etc.

KPI #	KPI Name	KPI Definition	Collection methods/sources	Unit of measurement	Reference period
Osu1	Passenger capacity (line)	Passengers volume that can be carried past a single point on a fixed route, in a given period of time	Product of the frequency and the maximum number of persons per vehicle	pass/h	peak time
Osu5	Peak vehicles requirement	The maximum number of vehicles required to operate a transport service at peak periods	Total amount of vehicle required to operate in the morning/afternoon peak hours	vehicles/route km	peak time
Eco1*	Operating cost (general)	Monthly expenditures due to staff, energy, maintenance management, to purchase external goods and services, ~~to~~ financial costs, depreciation, and taxes	Sum of all expenditures for operations recorded in a month	*: EURO/vkm	month
Eco6	Vehicle capital costs (for all different vehicles: E-bus / diesel bus, 12m / 18m version etc.)	Capital costs of owned vehicle	Sum of expenditure for each vehicle owned	kEURO/vehicle	
Eco10	Additonal components capital costs	Capital costs of the assortment of stored additional components	Sum of expenditure for assortment	kEURO/vehicle	
Eco15	Disposal costs	Costs of disposal of used items (solid and/or fluid)	Sum of expenditure to dispose of used items	kEURO/vehicle	month
Eco22	Recharging infrastructure	Costs of the use of the recharging infrastructure	Sum of all the costs due to operate the recharging activities	kEURO/per charging operation	Eliptic demo timeframe

Ein 2	Incentives for vehicle procurement	Reduced price for vehicle procurement granted by external bodies	regulatory reference	Euro/vehicle	
Ecn 1	Vehicle fuel efficiency	Fuel used per vehicle km, per vehicle type.	Data should be derived from the city fleet characteristics (number and type of vehicles). A splitting of vehicle types is recommended. For each class, the amount of the monthly total vkm multiplied by the average consumption provides the consumption per type of fuel and per vkm. The result obtained should be converted in MJ.	MJ/vkm	month
Ecn 9*	Electricty consumption	Total amount of electricty consumed	as reported per vehicle	* : MJ/vkm	* day and month
Eno1	Noise exposure	Amount of population exposed to traffic noise (day/night)	Population exposed, broken down into 5 different perception bands of L_{day} and L_{night}: the perception is classified by five answer options, two negative, two positive and one neutral (absolutely dissatisfied, partly dissatisfied, absolutely satisfied, partly satisfied and neither satisfied nor dissatisfied.	%	Eliptic demo timeframe
Eem1	CO_2 emissions	Average emissions due to the Eliptic demos, distinguishing vehicle categories	Modelling	g/vkm	Eliptic demo timeframe

Eem2	CO average emission	Average emissions due to the Eliptic demos, distinguishing vehicle categories	Modelling	g/vkm	Eliptic demo timeframe
Eem3	NOx average emission	Average emissions due to the Eliptic demos, distinguishing vehicle categories	Modelling	g/vkm	Eliptic demo timeframe
Eem4	PM_{10} average emission	Average emissions due to the Eliptic demos, distinguishing vehicle categories	Modelling	g/vkm	Eliptic demo timeframe
Ppa1	Awareness	Assessment of the passengers' awareness of the need to implement a given Eliptic measure	A specific questionnaire to be submitted to passengers provides a qualitative assessment on the awareness of passengers of the need to implement the tested measure according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups
Ppa2	Acceptance	Assessment of the passengers' acceptance of a given Eliptic measure	A specific questionnaire to be submitted to passengers provides a qualitative assessment on the acceptance of a given Eliptic measure according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups

Ppa3	Attractiveness	Passengers' perception of attractiveness of a given Eliptic measure	A specific questionnaire to be submitted to passengers provides a qualitative assessment for selected attractiveness issues (for instance, pleasure to travel by a greener mode ecc.) according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups
Ppa4	Travel comfort	Passengers' perception of travel comfort related to a given Eliptic meaasure	A specific questionnaire to be submitted to passengers provides a qualitative assessment for selected travel comfort issues (for instance , waiting time at bus stops, travel experience, travel time, ecc.) according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups
Ppa5	Noise perception	Passengers' perception of noise nuisance related to a given Eliptic meaasure	A specific questionnaire to be submitted to passengers provides a qualitative assessment of the perceived noise (for instance , on board and at bus stops) according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups

Pdr1	Driving comfort	Drivers' perception of travel comfort related to a given Eliptic meaasure	A specific questionnaire to be submitted to drivers provides a qualitative assessment for selected travel comfort issues (for instance, braking operations, stopping at bus stops, ecc.) according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups
Pdr2	Acceptance	Assessment of the drivers' acceptance of a given Eliptic measure	A specific questionnaire to be submitted to drivers provides a qualitative assessment on the acceptance of a given Eliptic measure according to options measurable by a 10-point scale. The sum of each option is divided by the total amount of assessment and multiplied by 100	%	Eliptic demo focus groups
Ecn11 * /made by SZKT	Recuperated energy usage	Ratio between realised and possible recuperated energy.	Based on the data of the on-board data register, the charging of traction battery increase the usage of recuperated energy. The recuperated energy what couldn't be used by battery charging or other trolleybus on the grid have to be dissipated by the braking resistors.	%	Test periods / weekly

5. Risks Pillar A

The Public service contract changes between the Municipality of Szeged and PT operators could complicate the test. From 2017 a new service contract will be agreed (the existing contract will expire). A new contract could regulate differently the modifications in the network compared to the existing contract.

Legal environment and regulations could be changed (National Regulation changes for PT operators) or test routes could complicate or change the authorisation of tests. However nowadays the National transport strategy is moving to support electric mobility, we are observing the legislative changes.

Capacity shortage from the requested source (e.g: operational trolleybuses, technical background,) could appear if some unexpected events happen during a demonstration and we need the hybrid fleet for other activities than the demonstration. The demonstrations could relocate in time that could help to manage such situations.

The final infrastructure development – if necessary - could complicate the realization of tests. During the demonstration we plan only temporary infrastructure.

There is a technical risk because of the continuously developed battery-technology. We don't have real information about the battery lifecycle. We only have calculations, which are based on theoretical models and some laboratory measurements from the manufacturer of the trolleys. The real lifetime of the batteries could be different from expectations and if this will happen we have to check the situation and re-plan the demonstration if necessary.

Low interest or negative feedback from citizens and passengers could make it more difficult to continue the demonstrations. This mainly could happen if the demonstration will cause noticeable setback of trolleybus service for other trolleybus lines.

Table A 3: Risks and mitigation-measures

Description	Proposed risk-mitigation measures
Legal environment and regulations changes	SZKT and USZ are continuously observing the legislative changes and keeping touch with the Legal authorities and the Municipality of Szeged.
Capacity shortage from the requested source	SZKT is planning the demonstrations considering the existing capacities and traffic demand.
Necessity of high value infrastructure development	SZKT is planning the demonstrations according to the current infrastructure (catenary system,…).
Technical risk regarding to hybrid technology	SZKT and USZ are planning many technical test step to check the capability of hybrid technology. We plan a

	multistage development logic for the Use case.
Social interest and support	For social support the SZKT and USZ will publish the project steps in the local media promoting the social benefits of the project.

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

In the preparation phase SZKT and USZ made needs-analysis for possible variations of demonstrations (routes, lines and durations) and clarify the possibilities considering the resources and legal constraints. We also scoped the financial sources of the demonstration because not all the costs are eligible in the project and therefore these costs could limit the dimension and extension of the demonstration. In the preparation phase (October 2015) we made some initial tests ('TEST 0') to define the basic capabilities and technical limits. The real range of electric vehicles highly depends on environmental parameters e.g. outside temperature. It is important to the passengers - and traction batteries also - to keep the temperature in the comfort-zone which requires high energy in winter or in summer and therefore reduce the possible range. That is why we plan the demonstrations in moderate-temperature periods but it also means that this circumstance has to be examined well but not in these demonstrations.

We made a basic passenger-questionnaire to explore the social awareness and support these technologies. The evaluations of the first test and the questionnaire were done by the USZ. After the evaluation we finalize the circumstances of the next test in the spring of 2016.

After the preparation phase we will make the first demonstration ('TEST 1') in real environment. In the spring of 2016 we plan a minimum one week long demonstration on the chosen trolley line. At the preparation of the test we will plan the data collection in the technical side. If necessary additional data measuring and collecting device will be used. We don't plan high value investment in infrastructure but for testing purpose it would be possible to install temporary wire connecting device to connect the trolleybuses current collectors onto the overhead wires under the demonstration. During the test we will make a detailed passenger questionnaire focusing on the general ELIPTIC project parameters (KPI) and our concrete project. We will examine the possibility to create a questionnaire which does not influence but develop and form the opinion of the passengers with reasonable and comprehensive questions and additional information.

This will prove basic data for analysing the similarities and differences between different Use cases and Project partners. After the test, the USZ and SZKT will evaluate the collected data and discuss the test experiences with the project partners. We will communicate with the WP3 and WP4 partners and WP leaders how we can modify the test for better comparison with the other Use Cases. It will be the first long term demonstration for the politicians and citizens as a battery-trolley line extension in Szeged.

In 2016 summer/autumn period we plan to use the hybrid trolley fleet during special events (open air theatre, country fairs, air-show...) without catenary system, to demonstrate ('**TEST 2**') the potential of this technology. During these events we will collect data for evaluation.

In the autumn of 2016 we plan another demonstration ('**TEST 3**') based on the **TEST 1**. If necessary we will organize a passenger questioning during the demonstration. Until this point we do not plan to do final infrastructure developments like overhead connecting elements for current collectors.

We will measure the acceptance of the trolley extension by asking the passengers in more steps (linked to the demonstrations: TEST 1 and TEST 3 to check the effects of the demonstrations and to form the opinion of the citizens about this technologies.

If the demonstrations will be successful we will examine the possibility of a long term trolley line-extension from 2017 ('TEST 4') because a new public service contract (between the City and PT companies) has to be made from that time and therefore it will be the next possible time to do this. For a permanent service it could be necessary to improve the infrastructure with final catenary connection devices. The Use Case will study all of the possible and necessary permissions, improvements and costs of a long term or final line extension. The long term demonstration could be a possibility for other ELIPTIC partners and outsiders to study the real service in Szeged.

For further development, in the ELIPTIC C6 Use Case (Multipurpose use of infrastructure for (re)charging trolley-hybrid-buses, e-bikes and e-cars, made by SZKT and USZ as the research partner of SZKT) we explore how it will be possible to extend the range of the hybrid trolleys with e-charger at new end-stations.

Using the results of the Use Case tests we will compose a Complex feasibility study of the trolley line extension in Szeged with battery powered trolley-hybrids.

Responsibilities of partners:

The University of Szeged (USZ) is the local research partner for SZKT by providing scientific background for feasibility studies, tests and simulations; determining measuring methods, validating measured data, organising and evaluating the passenger questioning, drawing conclusions from test results and writing feasibility studies.

The Municipality of Szeged is the owner of the SZKT. The SZKT needs permission from the Municipality to take part in the proposals. The Municipality is a customer of the SZKT and pay price-subsidies for the SZKT. The Municipality also can determine the minimal parameters of the public transport service in Szeged. The Municipality is responsible for the traffic development strategy of the city and therefore any developments and tests would be coordinated with them.

The Passengers/Citizens (Voters) cannot constrain conditions for the SZKT but they could force the politicians.

The SZKT purchased battery equipped trolleybuses that will be the basis of the demonstration. SZKT provides the technical background, experiences, experts, technical information, measuring possibilities for tests demonstrations and studies.

SZKT and USZ will organise information campaigns before every public demonstration step to inform the citizens and through the project a general media campaign will be kept about the ELIPTIC project.

6.2. Use Case constraints

The available data for collection will determine the evaluation procedure. To calculate parameters from the whole fleet we will use statistics of SZKT. We can collect technical data from the substations of the overhead wire system and also from the on-board data registers of the trolleys.

From the bus operation (external data) we will use public data from the market. The resolution of the measured parameters and the long-term data-storage allows for off-line data saving and analysing method. For passenger questioning the USZ will involve students from the University. For comparison and base line of the scenarios we will use official data of the Szeged public transports (modal split, passengers counting, official ticket sales data, etc.).

The duration of the tests is limited from financial side. Not all of the cost can be financed by the ELIPTIC project because some of the SZKT’s corporate costs can not be subsidized.

The trolleybus fleet is also an existing constraint for the demonstrations. Even though SZKT has got 13 battery powered IKARUS-SKODA type trolleybuses in service not all of them could be used in a demonstration at a trolley line extension because these are the most impressive and comfortable trolleys in the city. It is an expectation from SZKT to run these modern trolley fleet on every main trolley line. People are accustomed to these trolleys mainly in the city centre and it could hit back at the social support of the demonstration if we would relocate this fleet from the city centre.

For the demonstration it would be necessary to stop or change the bus service temporary on the demonstration-lines. A wide-range cooperation is necessary with the third parties (like bus service company) and partners (like Municipality, energy supplier companies) and Authorities.

6.3. Use Case monitoring criteria

In 2016 SZKT will realize its first public demonstration in relation with the use case. SZKT will cooperate with USZ to elaborate a solid plan for Use Case monitoring. USZ will collect passenger questionnaire (mainly) using its well educated human resources and questioning experience. SZKT will measure and collect technical data in relation with the rest of evaluation categories: operations, economy, energy and environment.

7. Use case work plan Pillar A

7.1. Use Case development logic

We plan a multistage test and demonstration with feedbacks from every test/level to the next one. We will make preparations before every test or demonstrations. In the beginning we will redesign the actual test step using the previous results.

For planning the **TEST 1** we will consider the results of **TEST 0** to calculate and plan the possible trolley line extensions. One of the main parameters for planning line extensions is the range of the trolleys in battery mode.

When we chose the trolley line for further demonstration we have to take into account the possible number of passengers because a technical demonstration without people could not reach the goal in regarding social acceptance but could be very expensive. The existing trolley network in Szeged is radial and the most crowded sections are in the city centre so it will be an important task to find the best line for extension -outside from the city centre- in the scope of the capacity utilization.

The experiences of the first passenger questionnaire will also be used to plan the next questionnaire. Not only the questions but the method will be reviewed.

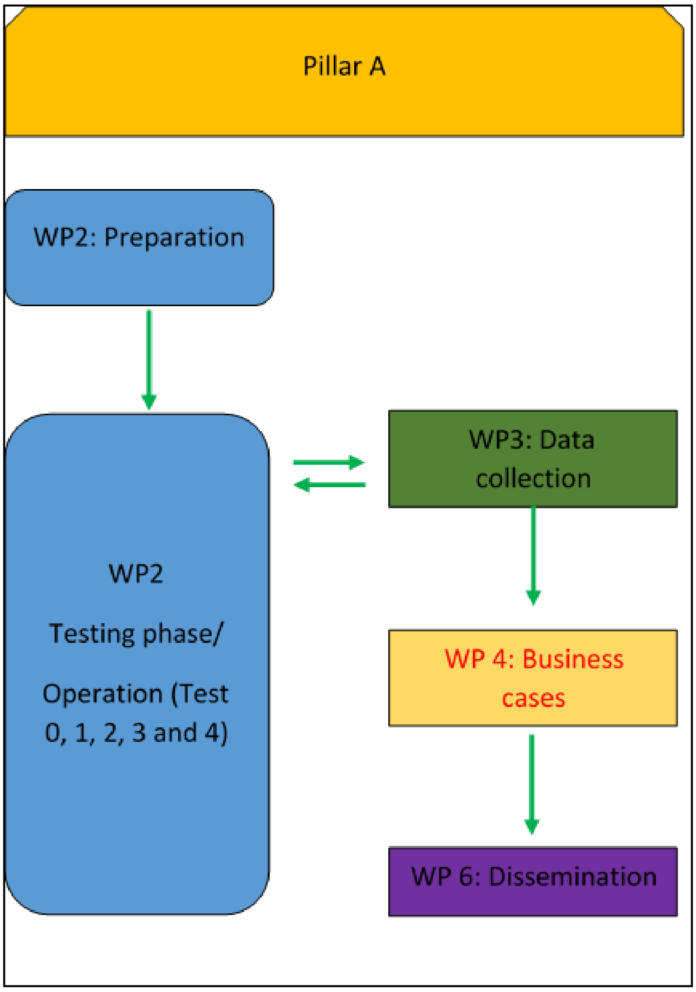
The test of the technology (vehicle and catenary system) will explore the elementary conditions for next demonstration/test steps. We also need experiences with the reliability of the battery powered trolley fleet in line extension what means real battery-moving on every cycle. We do not expect any extra maintenance activity on the fleet but we will look for that.

The preparation of TEST 2 and TEST 3 will be based on the above points and after the permissions, publication, preparation of measuring devices and the technical preparations of test (passenger information tables at bus-stops, etc.) will be done. After the TEST 2 we will evaluate the test data. The demonstration will provide a base for planning longer test periods. The preparation of TEST 4 will be similar to TEST 2 preparation but execution of this test step depends on many external conditions and not guaranteed to be kept in this project.

We will cooperate with other ELIPTIC partners for information/experience exchange. The list of the key parameters has an impact on the test preparation and execution because of the collected parameters. The demonstrations will run for a long period so there would be the possibility to change the measuring/collecting or data processing procedures if necessary.

If the demonstrations will be successful we plan to get a possible line-extension from 2017 (in the new public service contract) to extend trolley lines. For the permanent service it could be necessary to improve the infrastructure. The long term demonstration could be a possibility for other ELIPTIC partners and outsiders to study the real service in Szeged. The necessary developments for long term service will be examined and defined under the previous testing periods.

The final Complex feasibility study will be composed from the use case test results.



Use case development logic

7.2. Work plan

The Szeged use case will be modelling the case of replacing diesel bus lines with extension of the trolley bus network with trolley-hybrids without the need for additional infrastructure. In 2013 SZKT purchased battery equipped trolleybuses that will be used in the demonstration. The charging will come from the existing catenary network and the battery trolley buses will run in accumulator mode in between the existing and extended network. At first SZKT will conduct a feasibility study to explore possible/alternative route definitions, the effects of such a system on the traffic, external effects, the determination of external partners and the definition of important indicators. After the results of the feasibility study, the demonstration preparation will involve the following sub tasks:

Once the demonstration is in the execution phase, the following sub tasks will be completed: equipment preparation (vehicle, data measurement/collection), staff training (drivers, technical assistance, traffic assistance) and the test run.

Nr.	Action	Total PMs	Staff 1	Staff 2	External	Start-month	End-month
1.	Selection of the test route from the alternatives	2	Staff from Administrative Units (Marketing, Planning)	Staff from Technical and Operational Units (Maintenance, Supervision etc)	USZ (University of Szeged)	1	10
2.	Definition of the transport service based on the traffic and technical parameters	1,2	Staff from Administrative Units (Marketing, Planning)	Staff from Technical and Operational Units (Maintenance, Supervision etc)	USZ (University of Szeged)	2	6
3.	Definition of the demanded vehicle fleet	1,2	Staff from Technical and Operational Units (Maintenance, Supervision etc)			3	9
4.	Definition of test period and time	1,8		Staff from Administrative Units (Marketing, Planning)		1	9
5.	Authorization of the test.	0,2	Staff from Administrativ	Staff from Technical		9	10

	(Partner: Municipality, Authority)		e Units (Marketing, Planning)	and Operational Units (Maintenance, Supervision etc)			
6.	Temporary infrastructure installations (bus-stations, end stations, etc.)	5,6	Staff from Technical and Operational Units (Maintenance, Supervision etc)	Staff from Administrative Units (Marketing, Planning)		9	18
7.	Measuring device/system preparations (vehicle and catenary system)	7	Staff from Technical and Operational Units (Maintenance, Supervision etc)	Staff from Administrative Units (Marketing, Planning)		10	36
	In total	19					

A 3. Table - Main UC activities

7.3. Detailed timeline

no.	Activity	Year		2015							2016												2017												2018				
		Month		J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
		start	end	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	Legal feasibility	1	9																																				
2	Status of extraordinary maintenance actions, if required	5	19																																				
3	Unexpected trolleybus operational issues, if relevant	5	19																																				
4	Unexpected wiring/de-wiring technology operational issues, if relevant	5	19																																				
5	Unexpected infrastrcuture operational issues, if relevant	5	19																																				
6	Unexpected sub-station operational issues, if relevant	5	19																																				
7	Unexpected route issues, if relevant	5	19																																				
8	Unexpected other technical issues, if relevant	5	19																																				
9	Test 0: vehicle parameters test	5	8																																				
10	Close monitoring of daily operation of vehicles	5	20																																				
11	Temporary Infrastructure technical test	9	11																																				
12	Temporary Infrastructure installation	10	12																																				
13	Installation of data recording system	10	11																																				
14	Test 1: 2016 spring	10	12																																				
15	Regular operation of the data monitoring system	5	19																																				
16	Data collection according to the selected KPIs	10	19																																				
17	Test 2: 2016 summer/autumn extra routes	12	16																																				
18	Close monitoring of charging infrastructure	12	16																																				
19	Test 3: 2016 autumn	17	18																																				
20	Feasybility study for Test 4	10	17																																				
21	Charging infrastructure procurement	14	30																																				
22	Test 4: constant service of self moving trolleys in PT	20	36																																				
23	Local dissemination	4	36																																				
24	Status of Delivery: Final use case report	12	32																																				

A 6. Figure - Work plan and schedule for Pillar A

8. Expected results Pillar A

From the project we expect global implications of hybrid trolleybus technologies: To prove the technological and economic feasibility of this PT mode. Concrete implications for this bus lines: Acceptance of this technology in Szeged. Extension of electric PT mode in Szeged. The project will focus on the public attention to the electric PT, independently from the result of the demonstration. The general mind-set will be formed directly by the passenger questionnaires and the dissemination of ELIPTIC.

The project would give recommendations for further steps with stakeholders how to electrify the PT of Szeged.

9. Executive Summary Pillar C

This report gives a complete overview about the Use Case (objectives, expected impacts, selected Key performance indicators (KPI's) relating to the Use Case, risks monitoring criteria and expected results). The USZ (University of Szeged) supported the Use Case leader SZKT in completion of the Set-up report.

This deliverable relates to Pillar C and provides comprehensive information about the Szeged Use Case regarding fast-charging stations for electric cars powered from the tram energy network.

10. Partner Contribution Pillar C

Company	Sections	Description of the partner contribution
SZKT	Use Case leader	Public transport operator in the City of Szeged
USZ	KPI's, surveys	University of Szeged was identifying together with SZKT the list of KPIs and has done a passenger survey at the end of 2015. USZ and SZKT is also realizing the feasibility study of e-chargers in Szeged.
BKK	UC	Budapesti Közlekedés Központ is the PT organizer in the capital of Hungary and provided important information and a testing environment for the Use Case.
BKV	UC	Budapesti Közlekedési Zrt. is the main PT operator in the capital of Hungary and provided important information and a testing environment for the Use Case.

11. Context conditions Pillar C

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

Szeged is the third largest city in Hungary near the southern border of the country. The city has a population of about 170,000 inhabitants. More than 100 years ago Szeged opened the first tram line and since 35 years a trolleybus system is in operation. The trolley and tram lines are operated by the Szegedi Közlekedési Kft. (SZKT). SZKT is 100% owned by the municipality of Szeged.

Figure C 2 - Location of Szeged in map of Hungary [1]

In Szeged another public transport operation (DAKK Zrt.) is operating the urban bus lines in the city. The following table below shows the development of the passenger numbers from 1993 till 2015 separated by public transport operator and day.

Year	1993	1999	2005	2008	2012	2015
% of SZKT in the total	47	43	47	49	54	59
SZKT	143,099	108,325	111,436	108,394	107,000	99,413
Tisza Volán Zrt. / DAKK Zrt.	161,370	143,730	126,153	112,275	91,068	67,784
PT total	**304,469**	**252,055**	**237,589**	**220,534**	**198,068**	**167,197**

Table C 4 - Passengers using PT in Szeged (per day)

11.2. PT service context

[1] Source: Wikipedia

PT network organization

The SZKT (Szeged Transport Ltd.) has a public service contract with the municipality of Szeged to run the electric public transport services. Furthermore SZKT operates the city-owned public transport infrastructure and the car-parking system.

In the contract the tasks amongst those mentioned before are to keep the timetable, to sell, validate and check tickets, to inform the passengers, to maintain the vehicle fleet and to control/manage the daily operation of the trolley bus and tram lines.

The other public transport operator DAKK Zrt. is a public company as well and owned by the state. Their public service contract specifies the share of revenues and subsidies (based on ticket sales) between the two public transport companies.

Electric PT network capacity

SZKT's electric PT network consists of 6 trolley lines (total: 34,3 km) and 5 tram lines (total: 31,3 km). In total 42 trolleybuses and 23 trams are operating in the peak hour.

The operation key figures of SZKT are (basis year 2014/2015):

Total number of lines (day/night)	11 / 0
Total line length (tram/trolley)	65,6 km (31,3 km /34,3 km)
Total number of stations	170
Total number of trams (articulated/standard)	46 (27/19)
Total number of trolleybuses (articulated/ standard)	63 (42 / 23)
Total number of staff (driver, technical, administration)	578 (270 / 131 / 77)
Total number of transported passengers (based on 2015 passenger counting)	34 Million/annum

Table C 5 - SZKT operation key figures 2014/2015

The following table shows the modal split of transportation in Szeged in the year 2015:

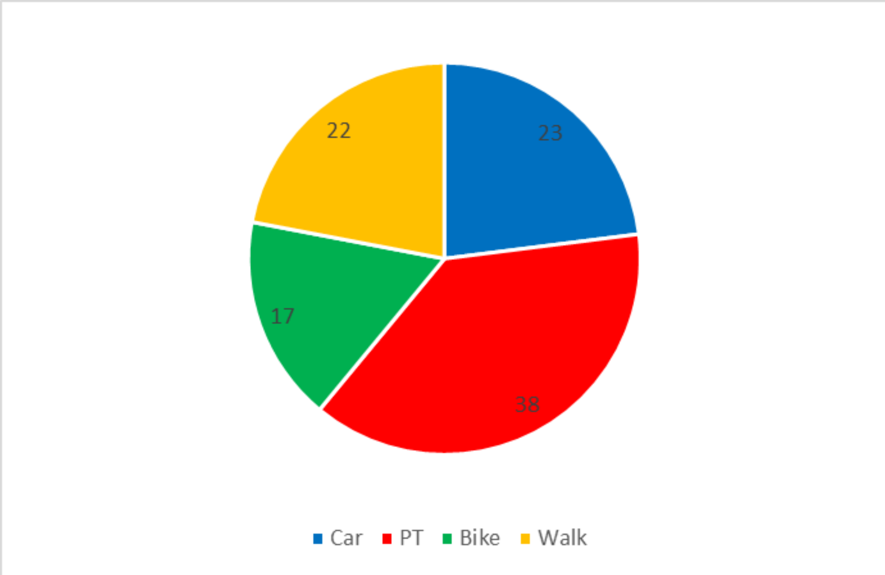


Figure C 3 - Transportation modes in Szeged (2015)[2]

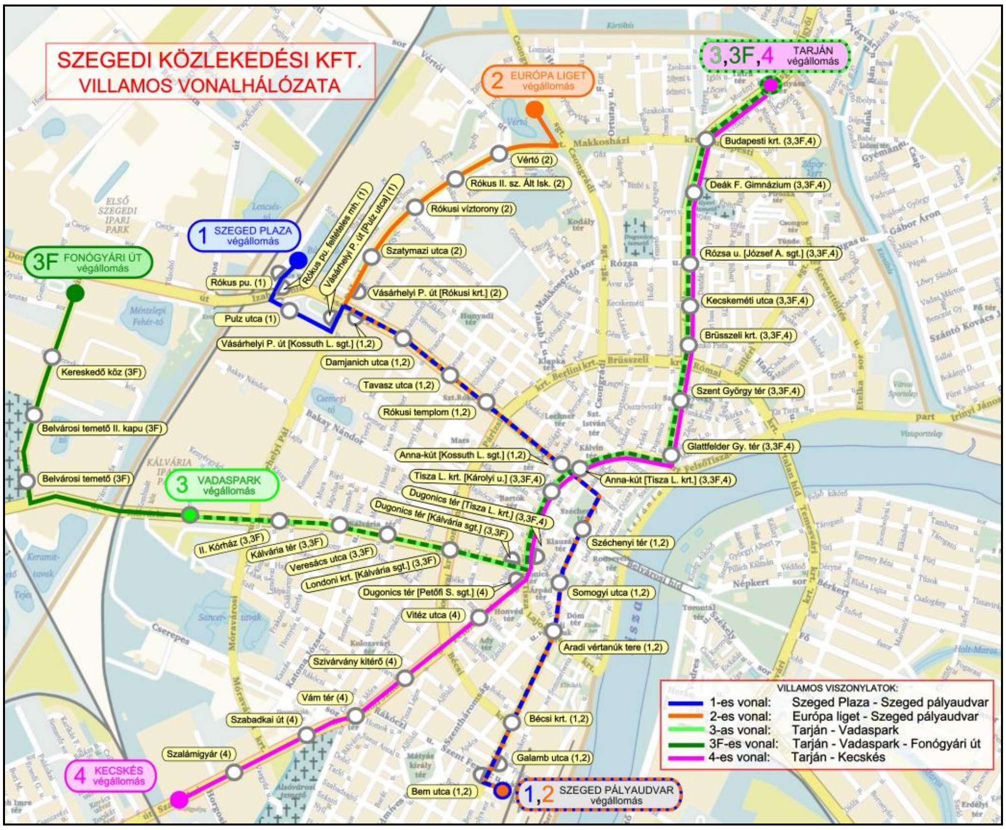


Figure C 4 - Tram network of Szeged

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[2] Source: KSH (Central Statistical Institute) Hungary, Total population: 171,952 people

Figure 3 shows the tram network in Szeged, which is with five lines the most developed tram fleet in Hungary. SZKTs tram fleet consists of the following tram types (vehicle type / year of manufacture):

- KT4D (18)
- Tatra T6A2 (13)
- Tatra TB6A2D- M (4)
- PESA 120Nb (9)
- Vintage trams (6)

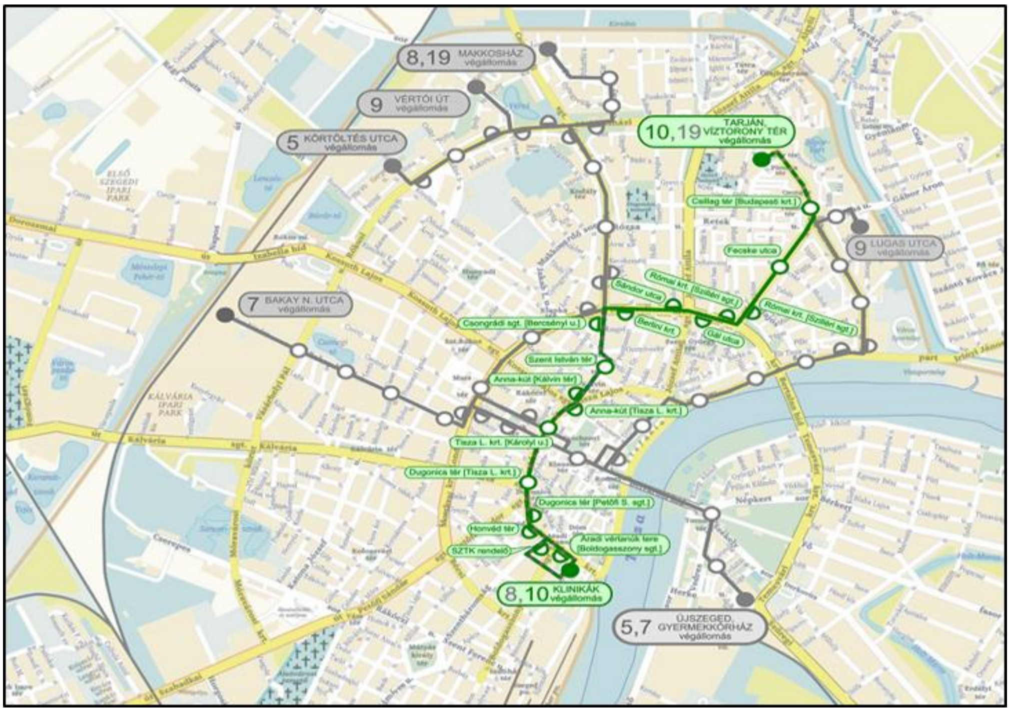

Figure C 5 - Trolleybus network of Szeged

Figure 4 shows the trolleybus network SZKTs trolleybus fleet consists of the following bus types:

- Skoda 14 Tr (9)
- Skoda 15 Tr (27)
- Skoda 21 Tr (5)
- M-Benz Citaro O-530 TR12/TV.EU (6, redone from diesel bus)
- Volvo B7 TR12/TV.PR (1, redone from diesel bus)
- Skoda 22TrAC (1)
- ARC Tr187/TV.EU (1, SZKTs prototype)
- Ikarus-Skoda Tr 187.2 (13, hybrid trolleys)
- IKARUS 280-GANZ (1)
- Vintage trolleybuses ZiU-9, IK-280 (2).

In addition SZKT runs a smaller bus fleet (8 diesel buses) to supplement trams/trolleys if necessary (in case of damages to the infrastructure due to weather conditions or accidents, vehicle breakdowns).

11.3. Information about the Use Case

SZKT will install, remodel and test the first public electrical multipurpose charging station for trolley-hybrid-buses, e-bikes and e-cars in the city of Szeged based on the results of a feasibility study. At first SZKT and USZ collect information about suitable locations to implement such stations and then install, test and demonstrate its use in combination with trolley-hybrid-buses and e-bikes.

The evaluation of this multipurpose use will lead to concepts for electric intermodal e-mobility concepts (interchange e-bike and trolleybus).

This first multipurpose charging station would support the existing long term transport strategy plan of the municipality. The ELIPTIC Use Case will promote e- traffic modes in the future mobility of Szeged and draw the attention of Szeged's municipality for these tested electro-mobility development possibilities.

In Hungary the network of multi-purpose electric chargers is not so sophisticated as in many other EU countries (Germany, UK, France, Italy), but at that time the Hungarian government drives this business development forward.

The latest trolleybus fleet developments moved to the autonomous movement technologies with batteries. SZKT has experiences with installation of new technologies and prototypes in trolleybus and battery-moving trolleybus technology.

The extension of the electric private car use in Hungary is in its initial phase. At the moment are about 50 public e-car charger in the whole country and only a part of them are fast charger. In Szeged there are no public e-vehicle charger available at present.

The main barrier of extending e-car technology in Hungary is the regulation of energy market: there is no legal way to sell electricity at a public e-car charger. Therefore only some of the electricity suppliers (major ones) can operate e-car chargers, at the moment mainly for advertising purposes.

The price of an private e-car is also a handicap for Hungary as regular car users aren't currently able to buy this kind of vehicle. The tax and other costs related to the electric vehicles were radically reduced by the government. For this reason it is expected that the e-car market is growing and progress in the infrastructure of multifunctional e-chargers will be evolved in the next few years.

12. Objectives Pillar C

12.1. Objectives of the Use Case

Short-term objectives: The feasibility study will prove the potential in this technology in connection with the existing hybrid trolleybus fleet. The study will define the technological, legal and other parameters of a multi-functional e-vehicle charger station. The study will give guidance to SZKT to define requirements for next developments (vehicle and infrastructure parameters). The SZKT will explore the potential partners in this business like power supply companies, technology companies, infrastructure developers. At the moment the City of Szeged doesn't have a clear strategy about the installation of public e-charging stations.

Long-term objectives: The ELIPTIC Use Case will promote e-traffic modes in the future mobility of Szeged and draw the attention of Szeged's municipality for these tested electro-mobility development possibilities. The evaluation of this multipurpose use will lead to concepts for electric intermodal e-mobility concepts (interchange e-bike and trolleybus). In long term these charging stations can improve the quality of life in Szeged.

12.2. Expected impacts

SZKT is expecting mostly positive impacts from realizing the Use Case. These impacts - reflected by the selected Key performance indicators (see chapter 4.3) – are as follows:.

- If the demonstration will be realized based on the feasibility study it would prove a real basis to extend the existing electric service network.
- Increase the social acceptance and awareness of e-mobility in the city.
- E-charging stations can increase the electric transport rate in Szeged; this increase has an direct effect on the local environmental impacts resulting from the local transport in the city.
- Positive marketing appearance for SZKT by supporting the private personal e-traffic possibilities as a modern and environmentally friendly company.
- Increase the number of services provided by SZKT and the e-traffic possibilities in the city of Szeged.
- By using e-charging stations at the trolley line terminus of the new extended trolley lines, SZKT will be able to reach far areas of Szeged and provide direct connection to the electric PT.
- SZKT expects a positive change in society regarding the use of multipurpose charging stations. Everybody likes the quieter yet powerful technologies, cheap and conventional energy sources, a so called “energy on the go”.
- These charging stations would support the whole line of e-vehicle users and SZKT's expectation is that more chargers we deploy, more e-vehicle buyer we get (of course there are limits also). Energy suppliers will invest more in this business and develop green technologies as well to satisfy the energy need of inhabitants.

12.3. Use Case KPIs

A total amount of 22 Key Performance Indicators (KPIs), required to evaluate the success of this Use Case, have been selected by SZKT and USZ. These KPIs are classified in six (6) main groups and listed in the table below: Operations (4), Economy (5), Energy (2), Environment (4), Passengers (6) and Other (1). In the table it is also indicated whether the KPI is available before or during the demonstration.

The data collection of these KPIs will be carried out in the period between April 2016 and May 2018. SZKT and USZ are collecting all relevant data and are supported by the public transport operators BKK and BKV.

Evaluation Category	KPI #	Name	Definition	Unit of measurement	Availability of KPI before the demonstration	Availability of KPI during the demonstration
Operations	Ost3	Maintenance staff	Amount of personnel with maintenance duties divided by the amount of chargers composing the network	man/chargerstation		X
	Ost5	Maintenance workload	Workload required to maintenance activity per chargerstation	man-month/chargerstation		X
	Osu5*	Peak charger coupling requirement	The maximum number of vehicles using the charger service at peak periods	vehicles/hour	X	X
	Ose10*	Charging time	Amount of time due to fuel/recharging operations	h/vehicle (min/max/average)		X
Economy	Eco1*	Operating cost (general)	Monthly expenditure due to staff, energy, maintenance management, to purchase external goods and services, to financial costs, depreciation, and taxes	kEURO/chargerstation	X	X
	Eco2*	Investment for the network	Annual expenditure due to investments in infrastructures, vehicles and other items	kEURO/chargerstation		X
	Ere1*	Economic surplus	Monthly benefit due to operations	kEURO/chargerstation		X
	Ein1	Incentives for fuel/energy	Reduced price for fuel or electricty granted by external bodies	Euro/MJ		X
	Ecn9**	Electricity consumption	Total amount of electricty consumed	MJ/chargerstation		X
Energy	Esu5	Recharging capacity	Amount of e-vehicles recharged per charging facility	vehicles/day		X
	Eno1	Noise Exposure	Amount of population exposed to traffic noise (day/night)	%	X	X
Environment	Eem1	CO2 emissions	Amount of population exposed to traffic noise (day/night)	g/vkm	X	X
	Eem2	CO average emission	Average emissions due to the Eliptic demos, distinguishing per vehicle category	g/vkm	X	X
	Eem3	NOx average emission	Average emissions due to the Eliptic demos, distinguishing per vehicle category	g/vkm	X	X
	Eem4	PM10 average emission	Average emissions due to the Eliptic demos, distinguishing per vehicle category	g/vkm	X	X
Passengers	Ppa1	Awareness	Assessment of the passengers' awareness of the need to implement a given Eliptic measure	%		X
	Ppa2	Acceptance	Assessment of the passengers' acceptance of a given Eliptic measure	%		X
	Ppa3	Attractiveness	Passengers' perception of attractiveness of a given Eliptic measure	%		X
	Ppa4	Travel comfort	Passengers' perception of travel comfort related to a given Eliptic meaasure	%		X
	Ppa5	Noise perception	Passengers' perception of noise nuisance related to a given Eliptic meaasure	%		X
	Pdr2	Acceptance	Assessment of the drivers' acceptance of a given Eliptic measure	%	X	X
Other	OSze1	Incentives for charger procurement	Reduced price for charger procuremet granted by external bodies	Euro/chargerstation		X

Figure C 6 – Overview of selected KPIs

13. Risks Pillar C

SZKT identified the risks regarding fast-charging stations for e-cars powered from the tram network, as follows:

- The multi-purpose electric charging stations (supplied from existing tram/trolleybus catenary system) are under development or at least in Hungary doesn't any comparable example exist, the maintenance and reliability of these facilities are a clear risk.
- Technical risks: the existing electric wire system might be insufficient to operate a multi-purpose e-charger with high energy demand or this will lead to develop the existing network in a lopsided manner. This could make impossible to build/realize the e-charging stations.
- We need a supporting attitude from behalf of the municipality, what isn't guaranteed (regarding that there is no current strategy in the area of e-charging stations).
- Legislative changes - Building regulations, energy trading, vehicle regulations could have impact on the demonstration. Significant legislative changes on the way (actually called: "Jedlik Ányos Project") which may redefine the legal environment in this business in the next 6-12 months.

The following table shows the identified risks and in the proposed risk mitigation-measures:

Description	Proposed risk-mitigation measures
Legal aspects in becoming providers of energy - No unique standards regarding chargers in public areas	In Hungary the respective market is in the process of being set up which means that it is not well developed and finalized from legal point of view. New legislative changes may affect badly the whole project. At this moment SZKT is not allowed to supply energy for charge.
Attitude of Municipality and stakeholders	Because there is no current strategy from behalf of Szeged's leadership regarding e-chargers, it is questionable how they will support the efforts done by SZKT. SZKT is trying to communicate and co-operate with the municipality to achieve the most supportive attitude from the leadership.
Technical risks regarding the existing electric wire system	The existing wire system might be insufficient to empower an electric charging station and/or the electricity demand of this facility would force SZKT to invest big amounts of money in new/extended infrastructure. SZKT will analyze its infrastructure and will identify the best possible point to install an e-charging station.
Low number of e-vehicles in Szeged	Recent national researches have shown that in whole Csongrád county the number of e-vehicles is low, especially the number of e-cars and hybrid buses/trolleybuses. SZKT will do it's best to popularize e-moving technologies.

Table C 6 – Risks and mitigation measures

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

At first SZKT and USZ will examine the technical, legal and economical possibilities of e-vehicle chargers in Szeged and USZ will write about this a feasibility study in 2017. This will be the basis of our development logic and this will mark the paths to SZKT.
SZKT will promote these developments to the municipality of Szeged and other possible business partners (energy supplier, parking companies).

The feasibility study will examine the technical possibility of multi-functional use of the existing electric infrastructure to charge other e-vehicles. The critical tasks will be the voltage and current transformation for the individual e-vehicles and communication with the technologies of third parties (different type of battery management systems).

The feasibility study will also explore the possibilities of multi-purpose charging stations in case of further development in the local trolleybus public transport service: Is it a possible way to use the hybrid fleet with new charger stations at new line end stations? Is it possible to charge the trolley by short overhead wires with their own current collectors (this way faster than charging by wire)?

In the framework of the Use Case - after the feasibility study - SZKT would like to involve third parties into the realization of the main task like energy suppliers, technology developers and parking companies. The following table shows the number of vehicle charging points per vehicle type in Hungary.

Vehicle type	E-car	E-bike	E-motorbike
Number	54	23	23

Table C 7 - Number of e-vehicle charging stations in Hungary3

[3] Source: www.holtoltsek.hu

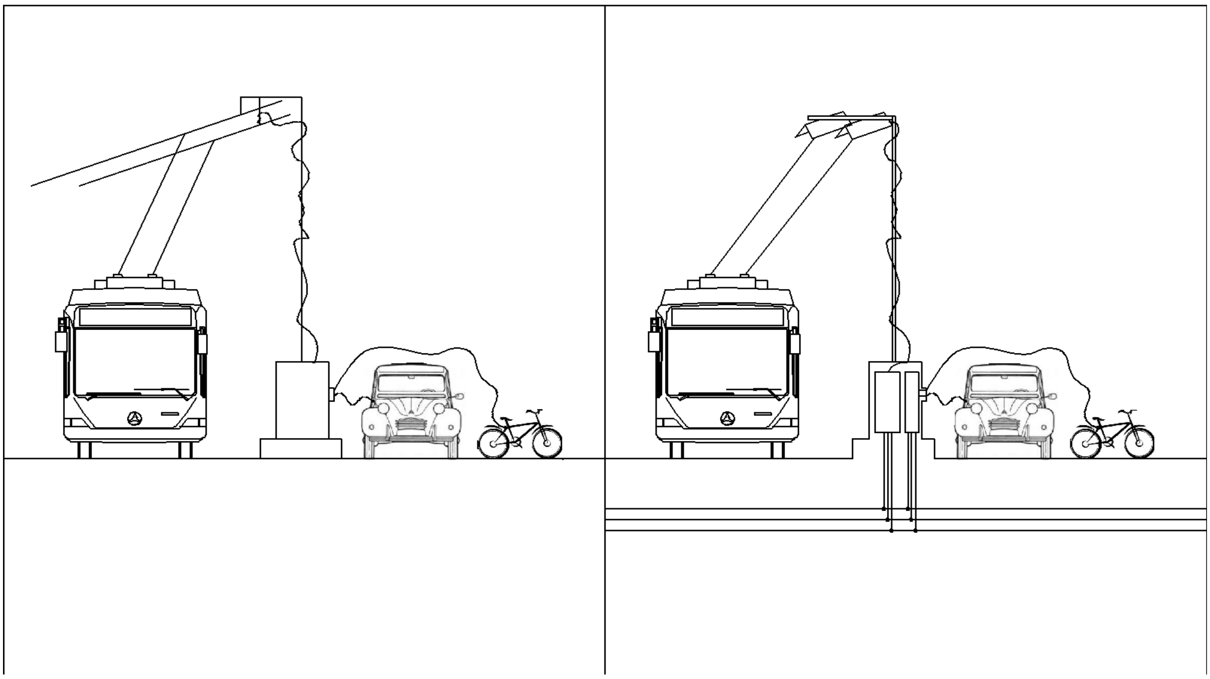

Figure C 7 - Diagram of the planned multi-purpose e-vehicle charger

The diagram above shows the planned multi-purpose e-vehicle charging station supplied from existing trolley/tram catenary system/independent multipurpose e-vehicle and hybrid trolley charging station supplied from city power grid.

14.2. Use Case constraints

In the preparation and feasibility study phases the data and information collection will be based on the public information from partners and from the market.

In the execution phase the existing on-board data register on vehicles and the station will be used to collect data. The data processing will be done off-line from the registered data and SZKT will use its tools to do this (we don’t plan to develop new data collecting system).

Unfortunately the network of e-vehicle charging stations isn’t well developed in Hungary – especially in the Szeged area. The current network of such charging stations and the relating electric infrastructure is limiting the options of SZKT as well.

Another constraint is the hybrid fleet of SZKT and local amount of e-vehicles. The number of e-vehicles is low in Csongrád county and the variety of these is poor. This gives to SZKT a limited testing opportunities on a temporary/finalized charger network. In Szeged (and in the whole Csongrád county) is one major electricity supplier: EDF-DÉMÁSZ. At this moment EDF doesn’t operate any e-vehicle charging station in Hungary.

14.3. Use Case monitoring criteria

In 2016 SZKT will collect data from the market (technical, economic, passenger data, samples) and will cooperate with USZ and BKK to elaborate a solid plan for the Use Case monitoring.

USZ will collect passenger questionnaire (mainly) using its well-educated human resources and survey execution experience. SZKT, BKK and energy suppliers will measure and collect data in relation the following categories: operations, economy, energy and environment.

15. Use Case work plan Pillar C

15.1. Use Case development logic

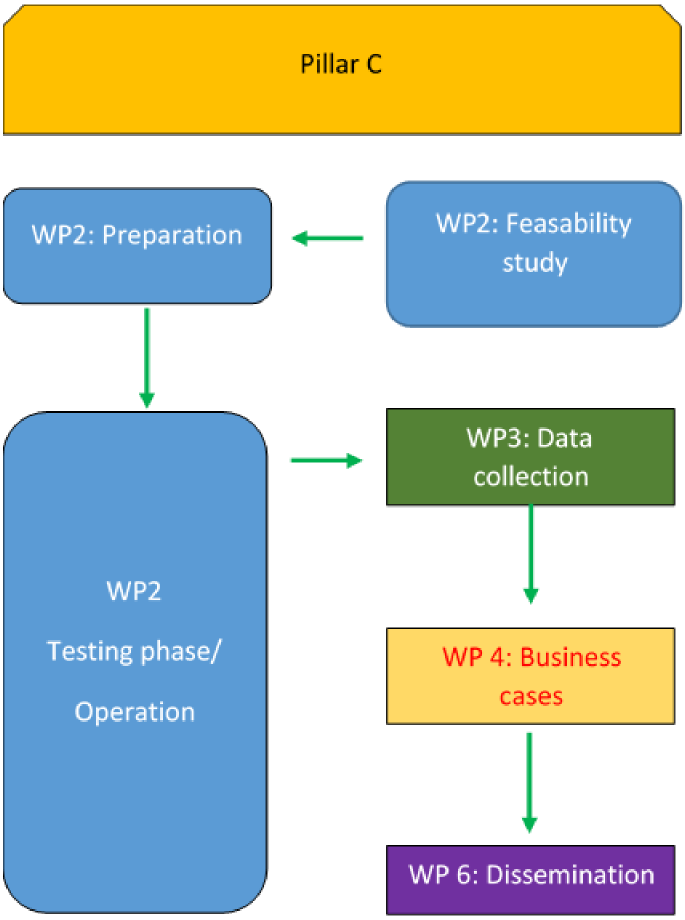

Figure C 8 - Use Case Development Logic

15.2. Work plan

SZKT developed a work plan considering the following steps in the planning and execution phase:

Planning phase:

1. Examination of legal environment (under change):
    a. energy trading regulations
    b. regulations for charging station
    c. regulations for charging station installation
    d. regulations for charging station operators
    e. regulations for e-vehicles
2. Connecting potential partners from the market (energy supplier companies, technology developers).
3. Possible connection point analysis and definition between the trolleybus and other electric vehicle technologies. Definition of the charging station parameters
4. Definition of charging stations location
5. Feasibility study of charging station (demonstration)

Demonstration (Execution) phase:

6. charging station procurement
7. charging station installation
8. charging station testing.
9. Data collection and processing (KPI), local evaluation.
10. Monitoring of charging infrastructure
11. Final Use-Case report

At the first phase SZKT and USZ together allocated their roles/tasks to certain time intervals considering the available frame of working hours. SZKT has allocated the most of PM's to its 2016 and 2017 business year, as the major part of the demonstration phase will be realized in this period.

The following work plan shows the main activities required to carry out the Use Case Pillar C in Szeged:

Nr.	Action	Total PMs	Staff 1	Staff 2	External	Start-month	End-month
1.	Legal feasibility	0.4	Staff from Technical and Operational Units (Maintenance, Supervision etc)	Staff from Administrative Units (Marketing, Planning)	USZ (University of Szeged)	1 (Jun15)	21 (Feb17)
2.	Market analysis	0,8	Staff from Administrative Units	Staff from Technical and Operational Units	USZ, Technology Provider	4 (Sep15)	22 (Mar17)
3.	Infrastructure analysis	1	Staff from	Staff from	USZ, BKK,	4 (Sep15)	24 (May17)

Nr.	Action	Total PMs	Staff 1	Staff 2	External	Start-month	End-month
			Technical and Operational Units	Administrative Units	Technology Provider		
4.	Determination of technical parameters	0,6	Staff from Technical and Operational Units	Staff from Administrative Units	USZ	8 (Jan17)	24 (May17)
5.	Feasibility study	1	Staff from Technical and Operational Units	Staff from Administrative Units	USZ	10 (Oct17)	24 (May17)
6.	Charging station procurement	0,2	Staff from Technical and Operational Units	Staff from Administrative Units	Technology Provider	18 (Nov16)	28 (Sep17)
7.	Charging station installation	1	Staff from Technical and Operational Units		Technology Provider	18 (Nov16)	30 (Nov17)
8.	Charging station Testing	2	Staff from Technical and Operational Units		USZ, Technology Provider	20 (Jan17)	30 (Nov17)
9.	Data collection according to the selected KPIs	2	Staff from Technical and Operational Units		Technology Provider	14 (Jul16)	34 (Mar18)
10.	Monitoring of charging station infrastructure	1	Staff from Technical and Operational Units		Technology Provider	20 (Jan17)	36 (May18)
11.	Status of Delivery: Final use case report	1	Staff from Administrative Units	Staff from Technical and Operational Units	USZ	13 (Jun16)	36 (May18)
	In total	**11**					

Table C 8 - Main UC activities

15.3. Detailed timeline

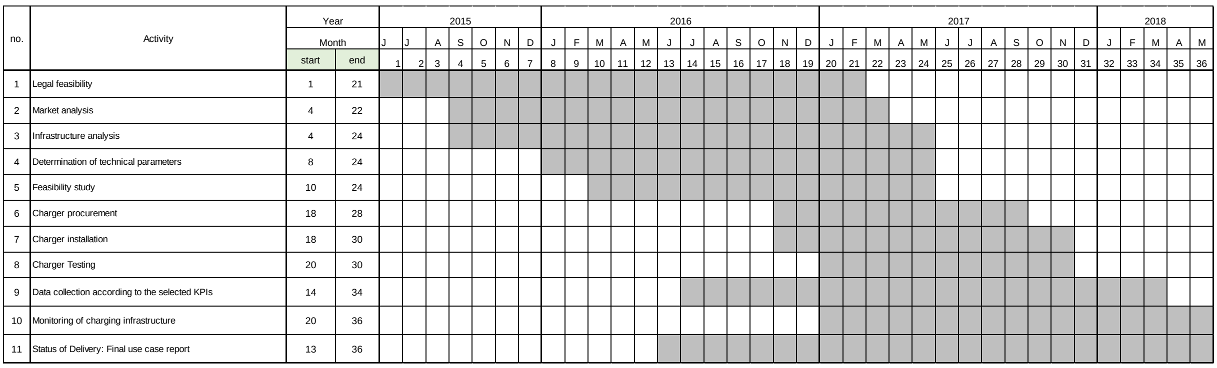

Figure C 9 - Work plan and schedule for Pillar C

16. Expected results Pillar C

The Use Case regarding Pillar C should prove the feasibility and reliability of a deployed multi-purpose charging station or network of charging stations. SZKT is expecting to get more information about the acceptance, reliability, feasibility and maintenance of such multipurpose charging stations.

Concrete implications of the feasibility study and demonstration:

- Supporting the local transport developments (example: input for SUMP (Sustainable Urban Mobility Plan).
- Promote hybrid trolley line extensions for longer distance reducing diesel/LPG fuelled bus capacity.
- Recommendations for further steps to cooperate with other stakeholders.
- Possible connection points for everyday users.