ELIPTIC USER FORUM
REPORT AND MINUTES

8 - 9 November 2016 – London

Venue:

DoubleTree by Hilton Hotel London - West End

Oxford Suit

92 Southampton Row

London, WC1B 4BH, United Kingdom

AGENDA

Joint ELIPTIC User Forum and Use Cases day **Tuesday 8 November** **DoubleTree by Hilton Hotel London - West End** **92 Southampton Row** **London WC1B 4BH** **United Kingdom** **Google maps: http://bit.ly/2bprRHp**		
TIMING	**ITEM**	**WHO**
Joint Lunch 12:00 – 13:00 *Twin meetings: opportunity for ELIPTIC Twin Cities and Use Cases to meet and discuss their twinning activities. Room: Bloomsbury 1*		
13:00 – 15:00	**Joint ELIPTIC User Forum – Use Case session** Presentations of ELIPTIC Use Cases and User Forum members - First results from ELIPTIC electric bus line simulations in Barcelona Fabian Meishner, Uni Aachen - Utilisation of tram DC infrastructure for charging battery buses - experiences from Leipzig Thoralf Knote, Fraunhofer	ELIPTIC Partners + User Forum members

	- Prague electric bus operation and comparison of charging options Jan Smejkal, Cegelec - Trolley 2.0: Trolley smart grid network in Arnhem, Peter Swart, City of Arnhem	
15:00 – 18:00	**Site visit to TfL Waterloo Bus Garage** Visit to TfL Waterloo Bus Garage will host 51 electric buses operating regular scheduled services, 45 charging stations and an almost 4 MW electricity supply and will be the largest electric bus garage in London. Address: Cornwall Road, Waterloo, London	All
19:30	**Joint dinner** Belgo Holborn 67 Kingsway London WC2B 6TD United Kingdom	ELIPTIC project partners + User Forum members

User Forum day

Wednesday 9 November

DoubleTree by Hilton Hotel London - West End
92 Southampton Row
London WC1B 4BH
United Kingdom

Google maps: http://bit.ly/2bprRHp

Moderator: Bonnie Fenton, Rupprecht Consult

TIMING	ITEM	WHO
9:30 – 9:45	**Welcome and introduction**	Michael Glotz-Richter, Bremen Yannick Bousse, UITP
9:45 – 10:15	**Overview of London electric public transport**	Mark Poulton, Transport for London
10:15 – 10:35	**Simulation and Optimisation in order to find Business Cases**	Fabian Meishner, Uni Aachen
10:35 – 11:00	**Results of the pre-workshop questionnaire**: Business cases for integrating electric mobility	Yannick Bousse, UITP Bonnie Fenton, Rupprecht Consult

Coffee Break 11:00 – 11:30		
11:30– 12:45	**Business cases workshop**	ALL
Lunch 12:45 – 14:00		
14:00- 15:00	**User Forum technical session** • Batteries and buses, • Charging infrastructure • Everything else	ALL
15:00 – 15:15	**Summary and outlook**	Michael Glotz-Richter, Bremen Bonnie Fenton, Rupprecht Consult
15:15	**End of User Forum**	

MINUTES

Short welcome by coordination team by Hendrik Koch for coordination team and Bonnie Fenton for the User Forum, followed by a tour de table of all participants of the user forum.

Overview of London electric public transport
Q: How do you combine electric bus tendering into the scope of policy goals?
A: There is a political imperative to have at least 300 zero emission buses by 2020. All bus routes are all 5 years tendered. If TfL tenders a new route and the bus companies have to “absorb” the risks and are responsible for installing infrastructure.

Q: How are your commencing the shift regards to jobs?
A: So far, UK industry has moved very quickly with providing new technology (Alexander Dennis with BYD electric buses).

Q: Will TfL be responsible for the technical definition of e.g. opportunity charging or depot charging?
A: The requirements are being set: Timetable, Space, Capacity etc. The implications of energy infrastructure is currently at an early stage and needs to be incorporated most likely into the tendering (bus garage… investment / taking scale of 9.000 Diesel buses into account – huge amount of capital investment). The big question is, who will operate, maintain and own the charging infrastructure – what type is where required?

Simulation and Optimisation in order to find Business Cases
Q: Is it possible to scale it up to whole city network?
A: Yes.

Q: If electric buses would require for a best solution new lines, can the tool automatically calculate it?
A: We take the lines as they are. The tool will be able to re-calculate bus routes/ line operation for optimisation.

Q: What about the infrastructure costs?
A: The costs are split for all type of infrastructure, electricity, different buses, batteries…

Q: TCO battery electric vehicles included, what about Hydrogen?
A: We can do it for trolley buses and in-motion charging, but not Hydrogen.

Is it possible to scale up the simulations?
Yes this is possible. As many lines can be simulated as needed.
Rotterdam: Is the model also able to split up the costs? The costs are split into costs for the vehicles, grid
Rotterdam: is it possible for other vehicles such as trolley hybrid, hydrogen?
They are focussed more on batteries.

Business cases workshop
University of Gdansk present the work on cost benefit analysis being conducted in ELIPTIC. Following this, participants are divided in three corners – people may float

between groups – 3 pillar-based discussion groups look at components of a business case and at questions around a CBA. Four lists of components of a business case are provided on the walls (see Annex I).

The following questions are discussed during the workshop:
How do you calculate the real cost of energy? Do you use fixed or variable costs? How did you decide this?
What is your share of renewables? Where does this information come from (or how do you calculate it)?
(How) do you measure noise?
What are your assumptions about depreciation?
What is the residual value of the vehicle at the end of its lifetime?

Workshop Pillar A:
Charging Locations & Energy Price
- Price for slow charge and at night: 0.08 cents/kWh
- Price for quick charge: 0.12 cents/kWh
- Other parameters
    - Timing of consumption
    - Max power request
    - Copper price
    - Disposal of batteries

Power Electronics & Coupling Equipment
- The costs of quick charging: 80,000-120,000 euro

Vehicle and Batteries
- The price of the vehicle is seen as 3x a diesel bus
- Coupling system would cost 7-8,000 euro for a pantograph
- Price of the battery system is seen to be 600-1,500 euro per kWh
- The lifetime of the battery would be between 5-10 years
- Only one passenger capacity and not an average

Non-monitisable parameters
- PM emissions
- CO_2 certificates
- Diesel particulate filter

Workshop Pillar B:

Energy storage systems:

Bergamo – thoughts about starting a first electric bus line. Visit of Waterloo station was interesting because of “fixed” depot charging instead of IMC/ opportunity charging.

Rotterdam – energy storage is installed on tram, at one spot. Currently searching for an upscaling (they were partner in ticket-to-kyoto).

Greater Manchester – could not make a business case based on results from Ticket-To-Kyoto. There is no mechanism to feed energy back into standard network/ grid. Searching for consumers of recuperated energy, possibly battery at station, but atm economically not feasible. They don’t know how much exactly goes into breaking resistors …

Vienna – would be interest in project follow up of Ticket-to-Kyoto. Started pilot project (operation will starts shortly) in subway stations substations installed, will be used for “station” energy (lightning etc.)

Porto – tests for recuperated energy of metro (on surface/ train, subway) for the part of the network to be used by other trains. Pilot got abandoned. Porto did not buy it because it didn’t work out properly, the lowest expectations were 5% but it was less. The next/ new project would be required to be a reversible substation like in Brussels (STIB) – not putting it in trams, but you need more switches and transformers (more expensive).

Potsdam – 18 substations installed, different sections, the recuperation effect is therefore quite high, of up to 1/3! For the introduction of e-Buses the question is to install batteries to allow Bus charging instead of energy usage at the same time in …
Flywheel usage? Not sure… Cost – benefit analysis (not) done.
Problem: Becoming an energy provider, if you want to put it back into AC network… (due to energy law in Germany) ➔legal framework

Have / sum up a lot of different use cases on these energy recovery applications, derive policy recommendations (be clear what would be required):

- A lot of potential to recover energy
- Ticket-To-Kyoto was good, but no outcome politically / no new law

Question: “Is recuperated per se green energy?”

<u>Workshop Pillar C:</u>

Other parameters:

Legal issues:

- selling energy might encompass legal issues for PT operators, e.g. in the Netherlands and Hungary; might not be an issue in all EU countries (e.g. UK)

Other cost revenues:

- Are there other cost revenues than selling energy that can be imagined for PT operators?
- E.g. grid stabilisation, energy storage
- However, PT operators need to make sure that these revenues are higher than the costs associated with the ageing of batteries

Positive health aspects:

- Cleaner PT will have positive impact on health conditions – this should be taken into consideration in KPIs and CBAs

Knowledge/demonstration impact:

- Electrification of PT can have positive impact on other city infrastructure operators, e.g. waste collection, city support vehicles – raising awareness in other departments and municipal staff about the positive impacts of electrified transport

Future energy system:

- PT batteries are part of a larger energy system in the future
- Ex. Gdynia: installing PVs on the bus depot will also provide energy to neighbouring school
- Begs the question: what role will PT providers play in the future? A piece of the larger smart energy puzzle
- However, PT providers main goal should still be to carry people around and not to sell energy (e.g. sufficient back-up of electricity still needs to be a given to ensure safe and reliable transport)

Renewable energies:

- Need to adjust for jurisdictions: take regional RE production in account in bus procurement (□ clean energy provision), e.g. Deutsche Bahn, Osnabrück, Arnhem

Noise:

- Noise is often not measured but calculated: rolling noise is taken as standard (for which there is no difference to conventionally-fuelled vehicles). However, noise emissions are much lower for electric buses with speeds of up to 20kmh (e.g. buses departing from stops)
- Less vibrations resulting from electric buses (e.g. positive impact on elderly people, people living close to PT stops)

User Forum technical session
RET present their approach to the user forum and their needs and expectations of what they would like to get out of ELIPTIC.

Q: Plan by 2028 to have zero emission buses in Rotterdam, what is the political will for this?
A: The political will comes from all 14 municipalities that have signed up to do this.

Following the presentation and discussion, participants are divided into three groups and take part in a World Café workshop where they discuss questions of Batteries and Buses, Charging Infrastructure and Everything else.

Batteries and Buses

Smaller batteries and opportunity charging or bigger batteries and overnight charging?

- This depends on the characteristics of the service and territory of the city.
- The choice depends on how the technology will evolve.
- All options should be used in a fleet. This includes overnight, opportunity and fast charging.
- It depends on the number of buses in the fleet and the fleet composition.
- It depends on the consumption of the HVAC and other on board auxiliaries.

If smaller batteries, how far between charging points?

- In motion charging would be a solution to help smaller batteries.
- This will depend on the technology path.
- Depending on the time between the stops and the time at the terminal.
- This will depend on the network however the network should not be made more complex.
- This will depend on the dimension of the fleet.

What is the energy use of heating, AC and other auxiliaries? Is it (must it be) all electric?

- The HVAC and other auxiliaries should be all electric.
- Better efficient systems are needed.
- The simulation of the temperature has a large influence on the modelling.

Standardisation of protocols and connectors between vehicles and chargers?

- Standardisation is needed asap.

Assumptions or expectations about life time of vehicles and batteries?

- No large breakthroughs are currently expected
- A battery would last 5-10 years. 5 for the cheaper battery and 10 for the more expensive.

What is the optimal mix between capacity, charging system, charging time, weight and costs of batteries and vehicles?

- There is a mix of options needed. However this can lead to a problem of interoperability within the fleet.
- This will depend on the route.

Maintenance

- The costs of maintenance should be added to the business case.
- Staff will have to be retrained and skills added.
- This will depend on the national safety legislation and context.

Charging Infrastructure

What are standards for power and voltage?
How is the planning of charging points integrated into your urban mobility planning?
What are possibilities of connecting charging points to existing infrastructure like grids for tram, trolley and metro or for street lightning?
How can you integrate renewable energy sources in charging infrastructure?
What are main barriers for a multipurpose use of charging infrastructure?

Maribor cable car/ 5MW: feasibility?
- Opportunity charging: fast/ ultrafast charging
- Multipurpose use: multimodal use?

Potential for metro/tram energy for charging: eBuses or cars?
Trolleys
- Infrastructure old
- Tram/ trolley points are oversized
- Charging points

Osnabrück
- 150V/DC
- Slow charging
- Energy balancing

Leipzig: limitations
Standardisation process ongoing: target 2018-2019
Industry-led (Siemens etc.)
- Interoperability: protocols, software
- CEN/CENELEC

Standard charging process
Overnight charging: feasibility
- Small depots, etc.

Time table
- vs. charging demand

Integrated, strategic, cooperative approach
- authorities/ city is not participating in this process

Multipurpose use: waste/ garbage trucks
Pressure on space use: e.g. in Manchester
New neighbourhood: strategic planning
Availability of spots
End terminals: charger/ flexibility
Public fleets/ taxis

<u>Everything else</u>
What is a realistic time planning for introduction of 50–100–250 e-buses (infrastructure, rolling stock)?

- Timeframe: influenced by national government
- Common tendering for eBuses?
- Pool of e-vehicles (governmental/public/ private?)
- Standardisation of specifications
- Tfl: sets specifications for bus operators (EU level for e-vehicles? Similar to H2)
- London timeframe: from 50 eBuses to 300 in 2019

What are options for use of sustainable energy storage systems and reuse of batteries?

- H2 + renewable energy
- Interreg project to be launched (Tfl + Rotterdam…)
- Better utilisation/ use of grid
- having batteries
- Where electricity comes from?
- Global shift from fossils
- Depreciation of batteries -> used again after (part of business case)

What are main barriers to install charging points in city area and what is a realistic time frame for the realisation of charging points?

- Tfl: 25000 GBP/ bus
- Spatial limitations
- More space into bus stations
- NIMY problem for opportunity charging (radiation?)
- Time
- Capacity of the grid in the place of charging

What changes are needed in route- and timetable-planning etc. for optimal use of charging points?

- Dependence on charging infrastructure

Essential differences in maintenance between diesel & electric vehicles:

- knowledge and skills of staff
- equipment, tools and modifications needed in workshops/depots
- safety issues

- Staff transformation
- Demand for mechatronics, computer scientists
- Average age problem
- Training in advance -> safety
- Maintenance model of e-vehicles
- Different model for employment

PARTICIPANTS LIST

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Annex I: Components of a business case: Unedited version

Charging Locations & Energy Price

Parameter	**Unit**	**Notes**
Installation costs fixed	€	*Building costs, terminal costs, technical equipment etc.*
Installation costs var.	€/kW	
Network level	400 V, 10 kV 30 kV, DC	*Network level the energy is taken from*
Grid connection	€/m	*Costs for cables, connection work*
Grid distance	m	*Distance from network to charging station*
Max. power	kW	*Maximal available power at this location*
Transformer (if required)		
Price total	€	*transformer + building costs*
Rated Power	kVA	-
Energy Price		

Price for kWh	€/kWh	*Production, system usage charge, renewable energy tax, energy tax, VAT*
Other parameters (please enter)		

Power Electronics & Coupling Equipment

Parameter	Unit	Notes
Power Electronics / Recharger		
Price fix	€	*For the power electronics*
Price per kW	€/kW	*For the power electronics*
Efficiency	%	*For the power electronics (from grid to battery)*
Lifetime	h, cyc.	*Of the power electronics*
Maintenance costs	€/y,kW	*Expected costs per year and kW*
Max. power	kW	*Max. available charging power*

Standardization		*Ability to charge buses from different manufacturers*
Coupling Equipment		
Price	€	*e.g. charging-roof & mast …*
Lifetime	y	*Of the connector*
Availability	-	*Operational (100 % = charging always possible)*
Standardization		*Ability to connect to buses from different manufacturers*

Vehicles & Batteries

Parameter	Unit	Notes
Vehicle		
Price	€	*Price for vehicle without battery*
Maintenance costs	€/y	*Expected Costs per year*
Length/Max. weight	m/t	*Basic vehicle information*
Passenger capacity	n	*Total, average*
Traction power	kW	*Max., average*
Power aux. consumers	kW	*Average, minimal, maximal, worst case*
Coupling system	-	*Pantograph, plug etc.*
Battery system		
Price	€	*Initial price for the whole battery system*
Price per kWh	€/kWh	*Initial price per kWh*
Type	LFP, LTO ..	*Cell-chemistry*
Energy density pack	kWh/kg kWh/l	*Basic information*

C-Rate charging/discharging	x C	*Important for fast/slow charging concepts*
Maintenance costs	€/y	*Expected costs per year*
Lifetime calendaric/cyclic	y / n	*Expected & promised lifetime / guarantee*
Other parameters (please enter)		

Non monitisable parameters

Parameter	Unit	Notes
Environmental		
Political		

Public image		
Other parameters (please enter)		

Annex I: Components of a business case: Edited by Pillar B

Vehicles & Batteries

Parameter	Unit	Notes
Vehicle		
Tendering/ modernization - Only if on-board - Braking voltage, braking curves, acceleration		
Price	€	*~~Price for vehicle without battery~~*
Maintenance costs	€/y	*Expected Costs per year*
Length/Max. weight	m/t	*Basic vehicle information*
Passenger capacity	n	*Total, average*
Traction power	kW	*Max., average*
Power aux. consumers	kW	*Average, minimal, maximal, worst case*
Coupling system	-	*Pantograph, plug etc.*
Configuration of vehicles (axles, etc.)		
~~Battery~~ Storage system/ inverter		

Price 1 Mio€/ 3MW container	€	*Initial price for the whole battery system*
Price per kWh	€/kWh	*Initial price per kWh*
Type	LFP, LTO ..	*Cell-chemistry*
Energy density pack	kWh/kg kWh/l	*Basic information*
C-Rate charging/discharging	x C	*Important for fast/slow charging concepts*
Maintenance costs	€/y	*Expected costs per year*
Lifetime calendaric/cyclic	y / n	*Expected & promised lifetime / guarantee*
Other parameters (please enter)		
supercaps		
Flywheel: 400.000€/ unit		

Charging Locations & Energy Price

Parameter	Unit	Notes

Installation costs fixed	€	*Building costs, terminal costs, technical equipment etc.*
Installation costs var.	€/kW	
Network level	400 V, 10 kV 30 kV, DC	*Network level the energy is taken from*
Grid connection	€/m	*Costs for cables, connection work*
~~Grid~~ distance to potential consumers	m	*Distance from network to charging station*
Max. power which can be used/ produced -> different voltage	kW	*Maximal available power at this location*
Transformer (if required)		
Price total	€	*transformer + building costs*
Rated Power	kVA	-
Energy Price		
Price for kWh ->scenarios	€/kWh	*Production, system usage charge, renewable energy tax, energy tax, VAT*
Other parameters (please enter)		
Integration costs -> interfaces (300.000€ example WL)		

Building costs		
Space availability		

Power Electronics & Coupling Equipment

Parameter	Unit	Notes
~~*Power Electronics / Recharger*~~		
~~Price fix~~	~~€~~	~~*For the power electronics*~~
~~Price per kW~~	~~€/kW~~	~~*For the power electronics*~~
~~Efficiency~~	~~%~~	~~*For the power electronics (from grid to battery)*~~
~~Lifetime~~	~~h, cyc.~~	~~*Of the power electronics*~~
~~Maintenance costs~~	~~€/y,kW~~	~~*Expected costs per year and kW*~~
~~Max. power~~	~~kW~~	~~*Max. available charging power*~~
~~Standardization~~		~~*Ability to charge buses from different manufacturers*~~
~~*Coupling Equipment*~~		

~~Price~~	€	*e.g. charging-roof & mast …*
~~Lifetime~~	y	*Of the connector*
Availability/ reliability (dependent on producer)	-	*Operational (100 % = charging always possible)*
Standardization (interfaces, software problems)		*Ability to connect to buses from different manufacturers*
Maintenance costs: inverter vs supercaps/ batteries		

Non-monitisable parameters

Parameter	Unit	Notes
Environmental		
Noise? (ex. flywheel)		
Heat -> side product -> Energy efficiency		
Use of space (green field vs. concrete)		

Political		
Public image		
Positive effect: brake energy is recuperated energy: “green energy” (ex. WL)		
Other parameters (please enter)		
Energy legislation: use cases -> recommended		
Length of vehicles		
Distance to end user services		