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Best practice for acquiring opportunity charged electric buses

This note describes best practice for acquiring electric opportunity charged buses (E-buses) and charging equipment in Scandinavia. Best practice is based on acquiring processes in Copenhagen, Stockholm and Helsinki and a pre-tender process in Oslo. An expert group with experts from the four major capitals has given input to this note. All Public Transport Authorities (PTA's), cities and private companies can use this note in their acquiring processes.

This note deals only with opportunity charged buses. Overnight charged buses are not addressed in this note.

Framework

Three models have been used for acquiring opportunity buses in Copenhagen, Stockholm and Helsinki.

- Direct procurement for test and development
- Cooperation project without direct procurement
- Public procurement (tender) of buses and charging equipment

Risk handling and payment to/from the operator are different in the three models.

Direct procurement for test and development

HSL (Helsinki based PTA) and the cities of Espoo and Helsinki have decided to test electric buses with opportunity charge.



Acquiring process

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The two cities have bought charging poles and charging equipment for the cities directly from Heliox/Schunk (Direct Procurement). The PTA has made a direct procurement of 12 electric buses from the manufacturer (Linkker bus).

Direct procurement is only possible for small projects (less than about 200.000 €) and for test and development projects. This project is a test and development project. The reason is that when the buses and charging equipment were acquired, only very few e-buses were available on the market.

Direct procurement has many advantages for test and development projects, but is not available later in the development of the technologies. In this project the direct procurement makes it possible to form a close partnership between the manufacturer, the PTA and the cities. The expert group finds that direct procurement is not available anymore, since the market has grown with many serious suppliers of buses and charging equipment.

Risk handling

The operators are not interested in taking any risks in the introduction of new technology. For that reason, HSL has purchased the 12 electric buses directly from Linkker. This is an exception since the operators typically buy the buses. HSL takes the risk of technology from the electric buses, because it would be unreasonable for the bus operators to have all the responsibility and the technological risk.

The goal of the project is to be a pilot project for a larger electric bus system. Also HSL tests more detailed electric bus specifications and introduces the idea of electric buses to bus operators.

The 12 electric buses are 'extra' vehicles, so possible problems will not affect the service level of the bus system.

Each of the four largest operators can test two buses delivered by the PTA. The operators buy the buses from the PTA for 15% of the actual price. The last four buses will be distributed later.

No incentives are made for the operators except that they buy electricity at normal rate (about 0,10 €/km). The cost of diesel is about 0,40 €/km.

The two first buses are delivered in November 2015. Total price of 12 buses and 6 charging posts is 6,6 mill €

Cooperation project without direct procurement

In Stockholm, they are testing plugin hybrid for a complete line (8 buses). The test is a part of the ZeEUS EU-project. ZeEUS

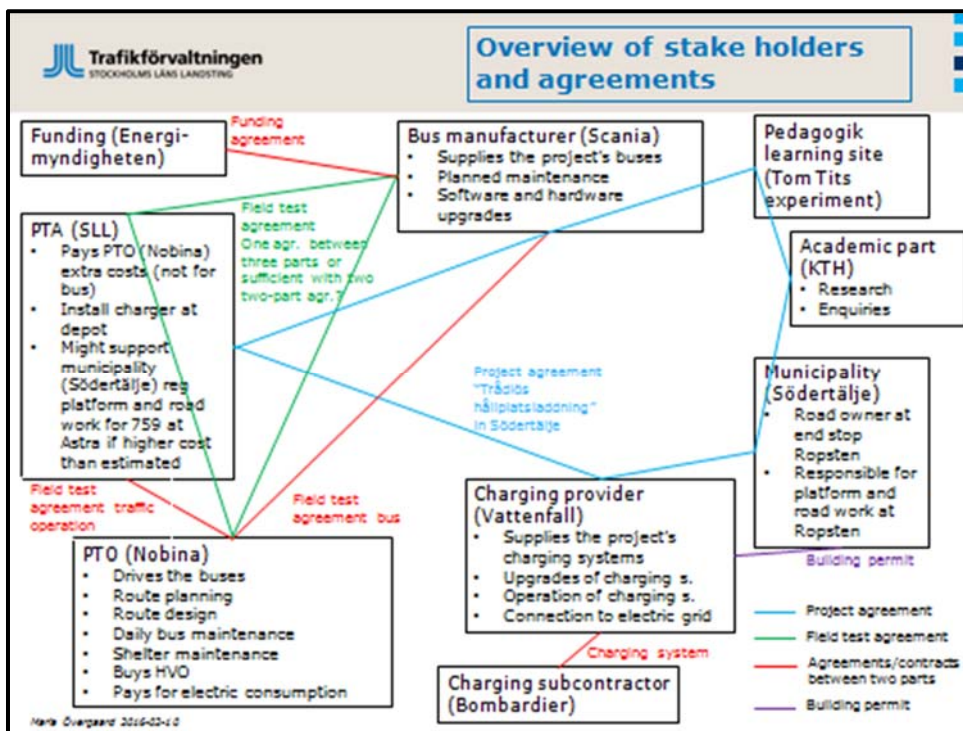
Stockholm is a cooperation project demonstrating electric hybrids, between Volvo, Vattenfall, SLL (Stockholm County Council (Transport Administration)), and Viktoria Swedish ICT. In the project Volvo contributes with the buses, Vattenfall with charging, SLL pays the added costs for the operator and slow chargers at the depot, and Viktoria Swedish ICT is the “academic part”, a research institute that is part of the ZeEUS evaluation WP.



Acquiring process

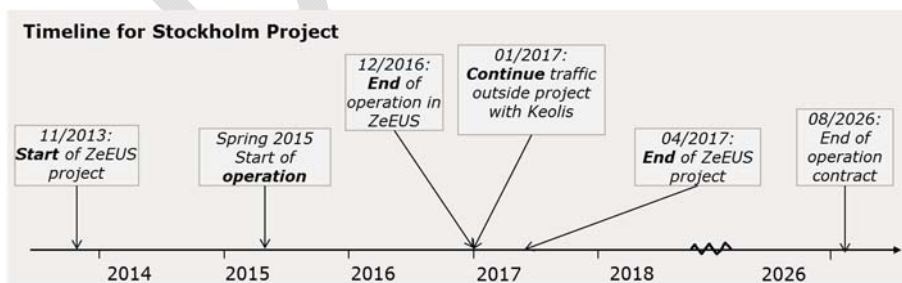
The operator is, according to the traffic operation agreement, obliged to take part in development projects initiated by SLL (the PTA). They have the right to be compensated for extra costs.

After the procurement of the traffic operation was finished, SLL made an agreement with Keolis to operate line 73 with the eight electric hybrid buses. Volvo and Keolis made a bus leasing agreement, Vattenfall and Keolis made an agreement of delivering electricity for use by Keolis. There were also a cooperation agreement between Volvo, Vattenfall and SLL, as well as an implementation agreement between the former and Keolis. These are not all agreements needed, as seen in picture 1. The latter two agreements each took about a year to agree on, so giving enough time for this is also a lesson learned.



The buses in Stockholm are acquired directly from the manufacturer by the bus operator. The PTA has facilitated the contact between the bus manufacturer, the charging manufacturer and the bus operator. Since the project is supported by EU, the price for the operator is equivalent to the price of gas buses.

The bus operation is only supported by EU in the first two years. After these two years, the bus operator is able to return operation to gas buses, if operation is less smooth than expected. The contract between SL and the operator is 10 years.



The acquiring is made after a normal bus operation tender but before the start of operation. This makes it possible for the bus operator to buy the hybrid buses. On one hand, the buses drives as in normal operation since there are no backup if the buses are malfunctioning. On the other hand, it is a demonstration project with financial support from EU.

Vattenfall is the charging operator and the charging equipment is delivered to Vattenfall by Siemens. The bus operator only pays Vattenfall for electricity, but the price is unknown to SL.

The same setup is currently being used to a new bus line with inductive charge. This trial is however with only one hybrid bus and one charging station. The bus manufacturer is delivering bus and charging equipment to a price as if it were a biogas bus. Scania contributes with one bus, Vattenfall with building and maintaining the charging station at one end stop, SLL with the extra costs for the operator and slow chargers in the depot. The Royal Institute of Technology, KTH, is academic part. In this project the municipality is a more involved part and builds the bus stop platform. This project is part financed by the Swedish Energy Agency.

Risk handling

Since both projects are based on normal bus operation contracts, the bus operators have all risks in case of malfunctioning. The bus operators have made it possible in their agreements with the bus manufactures to change buses after the first two years, if the buses are working worse than expected.

Lessons learned

In demo projects choosing the route might be tricky. The route and the buses have to fit to each other and there needs to be enough vacant electricity in the grid.

Charging infrastructures requires more space than expected. This is not only the case above ground, but also underground, where foundation to the charging pole is quite large.

It is important to time tendering of bus operation with the e-bus projects. It is too late to introduce e-buses when a tender is decided, so all major decisions have to be made prior to the tender process.

It takes a lot of time to initiate a demo project. In Stockholm, they have used 3 years from the first contact between SL and Volvo to the buses started operating.

Demo projects are easy compared to real operation. The business models are harder to decide on than hardware, and the real question is how to organise infrastructure ownership, bus ownership and interface between bus and charger.

Public procurement (tender) of buses and charging equipment

Copenhagen tests opportunity charged e-buses from 2016 to 2018. The buses are to be tested at line 3A, a line with 9 km between terminal stops and 4 min average waiting time at terminal stops. Total budget for trial is 11 mill DKK (1,5 mill €). The trial is a cooperation between City of Copenhagen (lead), Movia, E.ON and Danish Transport Authority.

The Copenhagen trial was initiated later than the projects in Stockholm and Helsinki. A prestudy made in 2014 showed many possible manufactures of buses (Volvo, Solaris, VDL, and Ebusco among others) and charging equipment (Bombardier, Siemens, ABB, and Heliox). Because of the existence of a real market, City of Copenhagen assessed that public procurement as the only legal way of acquiring the buses.

Acquiring process

The city wanted on one hand to make an innovative partnership with the manufacturers and on the other hand to make an open and fair public procurement of buses and charging equipment.

The tendering process was formed as a tender with negotiation. The prequalification was in March 2015 followed by the main tender from April to October 2015. Five bidders made the final bid.

To make sure, that charging equipment and buses work together, only one tender were made. The bidders were asked to form consortiums of bus and charging manufacturers.

The scope of the trial was that the buses should run at the existing time schedule. Furthermore Copenhagen wants to test the buses at the heaviest circulation plans to make sure that they are able to run in any circumstances in Copenhagen. A number of other demands were set up in the tender document:

- Able to run for 4 hours with only one functional charger
- Maximum battery size: 120 kWh
- Maximum noise from charger: 55 dB(A), 1 meter from charger at 1,8 meter height
- Maximum noise from connecting the charger: 55 dB(A) at 10 meter
- Maximum noise inside the bus: 68 dB(A)

Since this project is a trial, Movia (PTA in Copenhagen) has reduced some demands to buses (passenger capacity, automatic fire extinguisher, IT cabinet, platform, kneeling and more).

The bids were evaluated by a number of relevant factors:

- Price
- Energy efficiency
- Uptime
- Connection noise – max 55 dB @ 10 meter
- Delivery time
- Internal noise – max 68 dB
- Passenger capacity
- Emissions
- Battery lifetime
- Flexibility regarding chargers
- Urban space integration

Electric buses have no SORT-test and no standardised calculations of battery life time and energy efficiency. Furthermore uptime, delivery time and emissions are impossible to confirm prior to evaluation of the bids. Energy efficiency was evaluated based on the estimates from the bidders. Any deviation from the energy efficiency stated in the bid will be regulated in the final payment rate.

Battery lifetime, uptime, delivery time and emissions were accepted as stated by the bidders. When the project ends after two years, these factors will be evaluated and published. If the bidder is not able to live up to their promised values, this will be stated in an report. It is the impression of the evaluators that all bidders had fairly credible bids.

Elements like smart solutions, acceleration noise, noise at specific frequencies and passenger flow were not evaluated.

Risk handling

In Copenhagen two major risks are present.

- 1) *The buses or charging equipment will not work when delivered*
No payment are made prior to satisfactory delivery. Payment will only be made if the bus live up the the promised specifications.
- 2) *The OEM do not comply fully with the promised factors regarding noise, energy efficiency etc.*
Element measurable on delivery will be measured. The bus will only be accepted as satisfied if the bus comply with the specified factors.

Some factors are not measurable and will therefore only be measured during the trial and after end of trial. These factors will if possible be solved during trial. In the final report, these factors will be mentioned. As a result, the OEM has an incentive to live up to the promised factors.

Lessons learned

The tender was evaluated based on different figures. However some of these figures were only promises from the OEM's and the City of Copenhagen was not able to test if these figures were true during the tender evaluation. If the tender was to be done again, some of these figures would be excluded and for the rest the bidders would be asked to support their figures by some kind of explanation. In the evaluation, the explanation would then be included.

The tender was a tender with pre-qualification. Seven consortiums was approved in the pre-qualification. However these companies had very different financial capabilities and experience. In evaluation of the tender financial capability and experience was assumed equal for all bidders. The risk following contracting with a smaller and less experienced company could have some weight in the evaluation of the final bids.

Noise was evaluated like for a diesel bus (Noise level inside the bus at 50 km/h). Some electric buses are especially quiet when accelerating, while the noise at 50 km/h basically are wind and tyre noise. Furthermore some electric buses has an annoying high frequency noise. Noise while acceleration and at certain frequency bands should be included in the tender evaluation

Passenger flow and passenger capacity are opponents. If the bus has many doors, fewer seats are available. Furthermore some buses use a lot of space for batteries making less space available for passengers. Therefore the number of seats is very important and different from OEM to OEM. How to evaluate bus layout, doors, seats etc should be very clear for the bidders in the tender documents.

Smart solutions are difficult to include in the tenders and should either be excluded in the tender or added as some kind of option to buy afterwards.

The bidders are typically not dealing with cities and PTA's. They are not used to make bids and to read or write public procurement documents. This means that almost no bids were meeting the minimum requirements at the first bidding round. Negotiations are really important to make sure that the bidders meet the minimum requirements.

How to include e-buses in tenders of bus operation

The difficult part of getting e-buses to run on a larger scale is the business models. Who owns the buses, who owns the batteries and who owns the charging equipment? And further who operates the buses and the charging equipment?

Seen from the cities and the PTA's there is a risk, if charging equipment, batteries and buses are owned and/or operated by different entities. If something is out of order, they will blame each other.

Seen from the bus operators, there is a risk dealing directly with a charging operator (owner and operator of charging equipment). If the charging equipment is not working (or not working with the buses) then the bus operator will get a fine from the PTA because of cancelled bus operation.

Furthermore charging equipment has a long depreciation time compared to buses. The existing contracts in the four capitals, cannot handle contracts where charging infrastructure will be depreciated during 15-20 years.

If opportunity charged e-buses are to be introduced in the larger cities, some have to take the risks. On the long run, solutions where a charging operator owns and operates the charging equipment are expected, but for the present the risks for the bus operator are too high. Until then cities or PTA's could

- 1) make separate tenders for charging operation and bus operation. In this way charging operation is separated from bus operation and some of the risks are handled by the charging tender. Some communication problems will probably occur.
- 2) own buses and charging equipment. If the city or the PTA owns the charging and bus equipment and includes operation of these buses in a tender, the risks of malfunction in the communication between buses and chargers are reduced and handled by the city or the PTA.