Kick-off Market Consultation - Project Zero Emission Buses (ZEB)

29 October 2015

Program

- Opening by Inge Vermeulen, Director Operation GVB and chairwoman project steering committee
- Project introduction and elaboration by Cas Hoetelmans, Project manager ZEB
- Technology research and circumstances of the city of Amsterdam
- Purpose & process Market Consultation
- Tender Procedure and type
- Questions/Discussion

Opening

- **GVB**
- **Ambitions GVB sustainability**
  - Agreement GVB-municipality of Amsterdam
  - 2025 public transport completely zero emission
- **Operation GVB**
  - Relation between project/boundary conditions

The Project

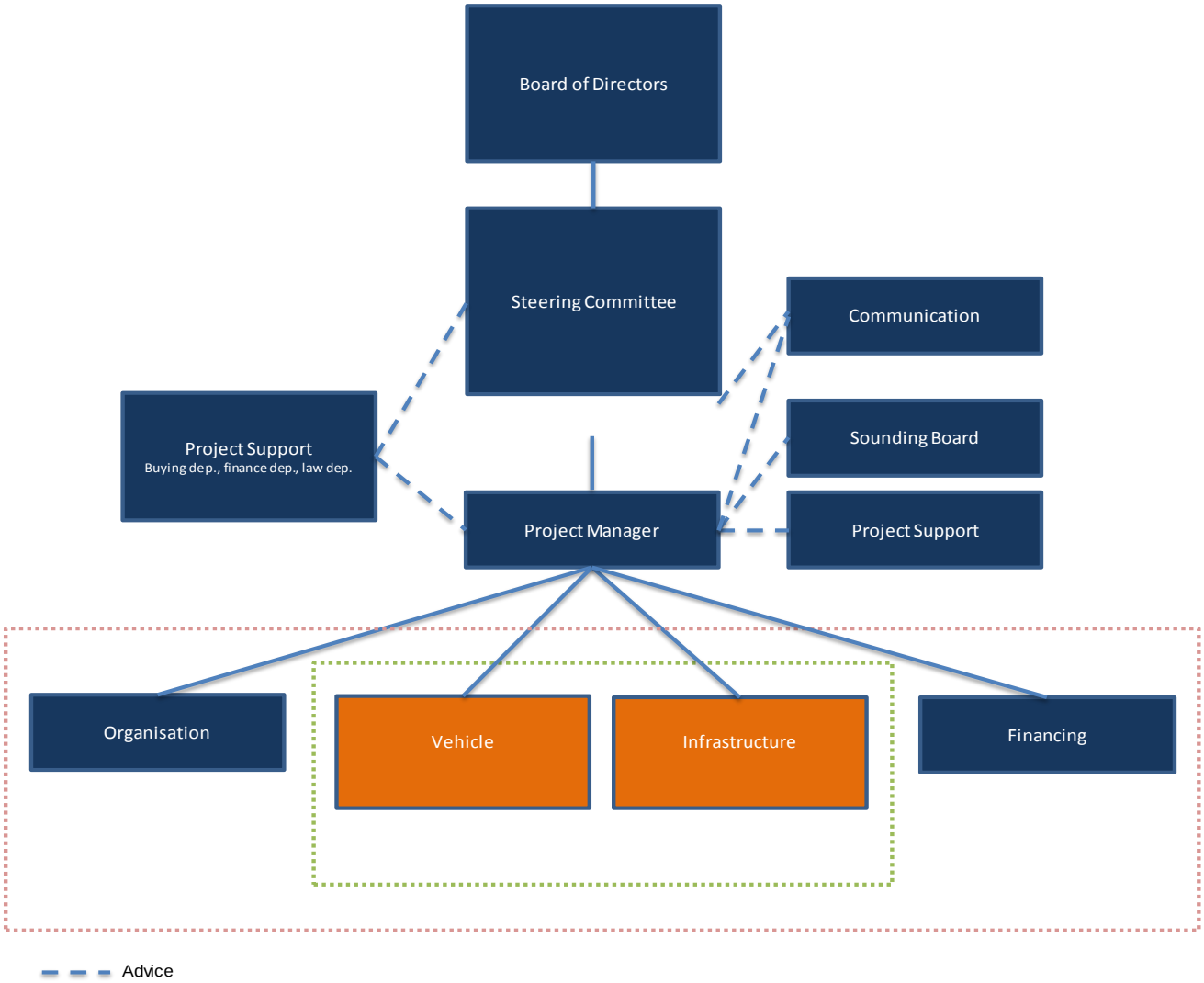
GVB has set the goal to exploit as many zero-emission buses as possible by Q1 2018 in the city of Amsterdam.

(conform replacement schedule strategic material plan)

Assumptions

- ✓ Strategic material plan & concession agreements
- ✓ System choice unchanged
- ✓ No pilot, unless time is needed in the buying process for the means of testing
- ✓ As a minimum the same quality and performance compared to the current operation and Amsterdam conditions is requested.

Project structure ZEB



Advice

Co-reading and advising within the scope of the project:

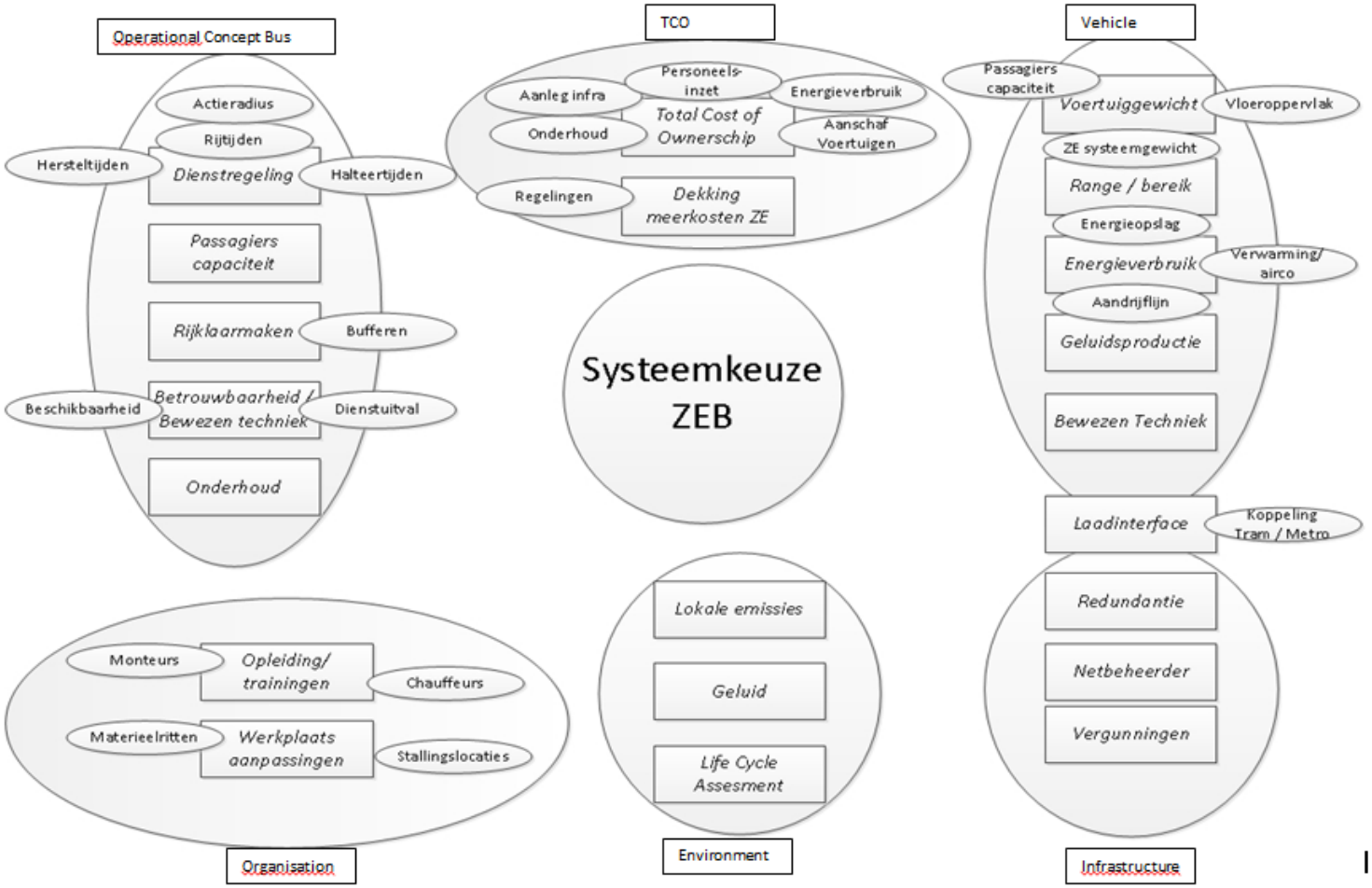
- TNO
- Amsterdam University of Applied Sciences

Process until now

- **14/7 Project approval GVB**
- **14/7 System choice electric**
  - Visits public transport companies
  - Supervisory board, GVB and Employees Council
  - Municipality/ SRA/ MET (Metro and Tram)
- **15/10 Determination system preference**
- **15/10 Approval Market Consultation**
- **20/10 Communicating Market Consultation**
- **29/10 Kick/off presentation Market Consultation**

Technology

Complexity System Choice ZEB



The road to a system choice

- What does the current operation look like?
- What conditions / requirements follow from the operation?
- Other conditions/requirements?
- Are there synergy advantages/economies of scale?
- Which systems have been researched?
- What is the preferred system after this research?

Operational Concept Bus Operation GVB

- **Characteristics average GVB bus line:**

Line characteristics	Standard	Articulated	Unit
Maximum length route from Garage	10	10	km
Line length	11	11,2	km
Average bus stop distance	450	450	meter
Number of bus stops per direction	25	25	Number
Average stopping time	16	20	Seconds
Average speed	23,5	21,1	km/h
Halting/stopping percentage	35	35	Percentage
Moving percentage	65	65	Percentage
Average moved speed	36,2	32,5	km/h
Halting time per circulation (bus stops, traffic lights, jams)	19,7	22,3	Min
Recovery time during rush hour per end point/stop (guaranteed charging time)	2 (0)	2 (0)	Min
Charging time outside rush hour (1 end point, personal care)	3	3	Min
Maximal length service (day service)	450	450	km

- Rush hour times: 7.00 – 9.00 hour and 15.30 – 18.30 uur
- During rush hour no guaranteed charging time, outside rush our 3 min.
- 25 day lines and 12 night lines (mostly articulated)
- The buses of the night line originate directly, without a garage stop, from the day lines (effect on the operating range ca. 600 km to achieve)
- Yearly production standard 76.000km, articulated 94.000 km
- Passenger offer and capacity determine the type of system

Most important requirements from the OCB

- **Proven reliability**

  Punctuality and low failure rate are very important

- **Passenger capacity**

  Standard min. 67 passengers, articulated min. 104 passengers

- **Operational length**

  The longest operational lenght during the day is 450 km, 75 percent is longer than 200 km. Day + Night is 600 km.

- **No negative impact on the bus schedule**

  During the morning rush hour (7:00-9:00 hour) and the afternoon rush hour (15:30-18:30 hour) there is no guaranteed time available to charge the bus. Outside of the rush hours there is a maximum of 3 minutes per circulation for charging.

- **Flexibility**

  Often the end points/stops and bus routes are adusted to a changing transportation request. Next to that, there are often detours.

- **Top speed and acceleration:**

  0-30 km/h in max. 8 seconds and top speed min.70 km/h

Is it possible to adjust the requirements?

- **No adjustments to the bus schedule**
  - Contractual conditions between GVB and SRA
  - The efficiency of the bus schedule is a definite condition in order to drive cost efficiently
  - Standing still with vehicles, but mostly the driver, costs money

- **GVB is looking for a widely applicable solution**
  - No products that require concessions to the OCB
  - With specific solutions for specific lines a big impact arises on required technical reserve

Other requirements/ Assumptions

Worst case situation as an assumption:

- System has to function under the worst possible circumstances and offer sufficient comfort:
  - Also with End of Life of the battery systems (80 percent remaining capacity)
  - Also with extreme climatological circumstances (-15 till +35 degree Celsius)
  - Also with high passenger capacity
  - Also with eruption of a charging utility
- Most demanding use (articulated bus) is the assumption:
  - Energy use articulated bus factor 1,35 higher than a standard bus
  - As a worst-case energy use, we counted with 3 kWh/km (= 1,5 times the average energy use that is set at 2 kWh/km)
- Vehicle is provided with electrical heating:
  - Heating by means of a system with fossil fuel causes emission (that are possibly more harmful than the Euro VI diesel enging) so this is no zero-emission!

Economies of Scale/ Synergy Advantages

Existing tram and subway infrastructure offers opportunities:

- 600/750 Volt DC with large available capacity available at many strategical places
- “Connecting” to this is easier to realize than placing charging infrastructure in the middle of the city that requires its own high capacity of electricity and where accommodating the capacity electronics is very difficult to realize.
- Maintaining the infrastructure with own control is possible; material and knowledge is already (mostly) available.

Researched Technologies

- **We have looked at all sorts of completely electric buses, except from electric buses with fuel cell (technology not yet ready for mass/serial production , TCO is still extremely high).**

- **The electric buses are divided in 4 categories:**

  - TROL: Trolley bus that makes 100% use of the overhead wire.
  - IMC: A battery bus that charges whilst driving (partly overhead wire)
  - OC: A battery bus that charges whilst standing still, mostly with charging infrastructure at the side of the road
  - BAT: A battery bus that charges fully at the depot/garage

Research Results

- **Only the IMC buses completely meet the set requirements:**
  - No impact on the time schedule, flexible, possibility to have an unlimited operating range, sufficient performances and passenger capacity, proven reliability with the right choice of components. Charging whilst standing still is also possible.

- **BAT, TROL and OC buses are dropped out <u>for the time being</u>:**
  - The BAT buses have an unsatisfying operating range (worst case situation maximum 100 to 150 km). In order to make this solution fit to the OCB/requirements there need to be 2 times as many buses compared to the current situation.
  - Because of the large quantity of extra buses that are needed, the TCO of battery buses is extremely high.
  - The TROL buses are too inflexible in the situation of changing bus routes.
  - The TCO of TROL buses is extremely high because of the high costs of the required infrastructure.
  - The OC bus requires the use of extra buses (changing over to a charged vehicle and own vehicle needs to be charged for the next driver/change)
  - Because of this the TCO of the OC bus is higher than the IMC solution.

Preferred Technology

In motion charging (IMC) system with the following characteristics:

- Charging via connection with existing tram/subway infrastructure
- Preventing from double isolation just as the trolley bus by means of a seperation transformer to keep the cost price of the vehicle as low as possible
- Trolley bar as charging infrastructure (proven reliability)
- Required fraction overhead wire < 30 percent
- Buses also need to be able to charge when standing still at place where it is not possible to create an overhead wire

Optimal flexibility during operation, no impact on the time schedule and TCO as close as possible to diesel engine technology

Planning Consequences

- Depending on the duration of the development and construction of the vehicles

- The realisation of the required infrastructure is still an insecure factor
  - The final technology choice will determine the type and complexity of the charging infrastructure
  - The more it is within the public domain the harder it gets (in a busy street it is more complex than a remote end stop. On own terrain it is even less difficult)
  - The more parties involved the more complex
  - Making use of current knowledge the realisation can be quicker
  - Lack of clarity about law and rules/standards of the interface vehicle/infrastructure

Market Consultation

Market Consultation

- **Purpose:**
  - Sharing the preference of GVB
  - Receiving feedback from suppliers
    - Sharing ideas
    - Validating GVB's ideas or adjusting these before starting the (possible) tender
    - Using relevant market information to improve the quality of the PvE (statement of requirements)
  - Insight in possible alternatives

Planning Market Consultation

4/11	Publication questionnaire market consultation
4/11	Possibility to submit questions by suppliers
11/11	End date possibility to sumbit questions
16/11	Information Note
27/11	End date for handing in the answers of the market consultation questionnaire

2/3/4 December → possible interviews as a reaction to the answers of the questionnaire

Contents Questionnaire

- Purpose: finding out whether the preferred technology is available within the set terms and what the financial consequences are.
- Possibility to suggest an alternative technology (within the set conditions/requirements)
- A clear answer is expected without further clarification needed.

Tender procedure

- **Type of Tender**
  - “Partnership”
  - Risk of damage/harm
  - Vision on type of tender
- **Program of Requirements**
  - Performance
- **Funnel**
  - Selection process in steps

Planning

- 04/12 End of Market Consultation
- 31/12 Go/ No Go Board of Directors
- Q1-2016 Decision making stakeholders
- 2016 Tender
- 2017 Realisation
- Q1-2018 Exploitation

Questions/Discussion