

Memorandum of Information Market Consultation Recovering Braking Energy Metro Amsterdam

Below you will find the questions that were asked in the first information round and their answers, and any corrections and additions on our part.

Date: February 12, 2021

Answering asked questions

Number/ Category	Document	Question	Answer
01	Marketconsultation document braking energy recovery systems Jan 19, 2021. Annex 5. Page 11	In the Market consultation document, the requirements of the equipment's seems to be described in the "Appendix 5 Concept technical specifications for braking energy recovery systems". The actual Appendix 5 we have is a three pages single line drawing of the 10kV system and the Noord traction substation. We do not see where are the requirements for the braking energy recovery system	In error, the wrong attachment is attached. The correct appendix is attached to this Memorandum of Information.
02	Marketconsultation document braking energy recovery systems Jan 19, 2021. Page 11	Power of the device: according to the first simulations GVB has performed. What is the peak power needed?	See appendix 5, requirement 3.1.0.1.1.7
03	Marketconsultation document braking energy recovery systems Jan 19, 2021. Page 11	Did GVB already chose between a storage device solution or an inverter solution? or are they open for a proposal on any of them?	On the basis of investment costs and efficiency, an inverter (energy recovery) solution was chosen. If stakeholder can substantiate that a storage solution is more effective, then GVB is certainly interested.

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04	Marketconsultation document bracking energy recovery systems Jan 19, 2021. Page 11	For the inverter solution, can we propose 10kV connection ?	The starting point should be the description in Annex 5, but GVB is also interested in alternative proposals.
05	Market consultation braking energy recovery systems. Page 6, Aim of market consultation	The potential for braking energy recovery with any technology lies in the energy that is dissipated on the vehicles braking resistors. Has GVB measured or estimated this value? Has GVB accounted for the influence of several parameters (e.g. HVAC, Chopper voltage, traffic, etc.) on this value?	The amount of energy dissipated in the braking resistors could not be measured directly. However, the amount of energy absorbed, the amount of energy returned, the speed, the starting acceleration and the deceleration were measured. The dissipated energy was determined indirectly. The influence of the aforementioned parameters was taken into account.
06	Market consultation braking energy recovery systems. Page 11, Scope determination	Adding inverters increases the energy consumption of the traction rectifiers. Therefore, the energy recovered by the inverters are not equal to energy savings. To calculate the real energy savings, the net energy consumption at the AC side of the substations has to be compared in a base scenario without inverters and the scenarios with N inverters. How has GVB calculated the energy savings and the return of investment?	The measurements mentioned in question 05 were used to create a simulation model. Based on this model, the energy savings and the investment return were calculated. It was found that the investment return is still positive even with lower efficiency of the inverters.
07	Market consultation braking energy recovery systems, page 6, Aim of market consultation	Has GVB also considered to simulate lower open circuit voltages in the substations or higher recuperation voltages on the vehicles? These parameters may have a strong influence on energy recovery.	At the start of the simulations, these effects were examined. Based on the results and the technical possibilities, choices were made for the simulations.
08	Market consultation braking energy recovery systems, page 6, Aim of market consultation	Has GVB validated the simulation results (of the network as it is now) through a measurement campaign in the vehicles and/or substations?	No this has not happened (yet).
09	Market consultation braking energy recovery systems. Page 11, Scope determination	There are many control strategies on how to activate the inverters, for example fixed voltage controls and moving average controls that follow the voltage on the bus bar of the substation (e.g. 15min). Which control strategy has GVB simulated?	In the simulations, a control with a fixed voltage was applied. Here, the no-load voltage was taken as the tipping point.

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10	Market consultation braking energy recovery systems. Page 11, Scope determination	The vehicles' HVAC consumption parameter from the vehicles is a key parameter which has a major influence on the recuperated energy of the has a major influence on the network receptivity and therefore on the inverters' performance. Which HVAC consumption has been used for the simulation? Has a sensibility study been done?	The simulations took into account the HVAC usage. An average value of 100 kW was assumed for this. No sensitivity study was performed.
11	Market consultation braking energy recovery systems. Page 11, Scope determination	Has GVB considered different prices for the energy purchased (down) and for the energy fed back (up)?	Yes this has been taken into account. With the current energy supplier, up to a certain maximum, an equal price applies to the purchase of energy and the sale of energy.
12	Market consultation braking energy recovery systems. Page 11, Scope determination	Are the installation and maintenance costs also considered in the LCC calculation of the inverters?	Yes assumptions have been made for this.
13	Market consultation braking energy recovery systems. Page 11, Scope determination	Has GVB considered possible effects of the recirculation current between the inverter and traction rectifier in the simulations?	The simulations are intended to have a first indication of the efficiency of the inverters. The necessary margins of uncertainty were then applied in determining the investment return.
14	Market consultation braking energy recovery systems. Page 11, Scope determination	Two substation that are next to another could be good candidates to install an inverter if there is no interconnection in the DC side. Has GVB considered the switching/isolation configuration on the DC side for the simulations?	The starting point for the simulations is that between each rectifier station with an inverter, there are two rectifier stations without an inverter.
15	Market consultation braking energy recovery systems. Page 11, Scope determination	Has GVB considered the mutual influence of two or more inverters located on the same feeding section in the DC side?	See the answer to question 14.
16	Market consultation braking energy recovery systems. Page 11, Scope determination	Has GVB considered the effect of synchronizing accelerations and braking of the vehicles as an alternative measure to reduce the overall energy consumption?	GVB is aware that this can also have a positive effect on the recovery of braking energy. However, it is far from always possible to synchronize acceleration and braking.

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17	Market consultation braking energy recovery systems. Page 11, Scope determination	What selection criteria will GVB use to determine the number, power and location of inverters? Net profit at the end of life, payback time, ROI, energy saved?	As part of the simulations, a ranking of locations where inverters are most effective has been established. Based on this, the return on investment was determined under different economic scenarios. The payback period was also determined.
18	Market consultation braking energy recovery systems, page 6, Aim of market consultation	Is GVB considering only inverters in parallel with existing traction rectifiers? Are integrated reversible substations based on VSC converters an option?	Within the area of GVB there are locations with old installations and locations with newer installations. For the locations with old installations, consideration could be given to replacing them with an inverter without a rectifier.

Changes and additions to documents by the client

- New questions have been added to Annex 2
- Annex 5 has been replaced

Expired documents

The following market consultation documents have expired:

- Annex 2 (old version)
- Annex 5 (old version)

Changed documents

The following market consultation documents have been added:

- Annex 2 (New version with additional questions)
- Annex 5 (New version)

*****End Memorandum of Information*****