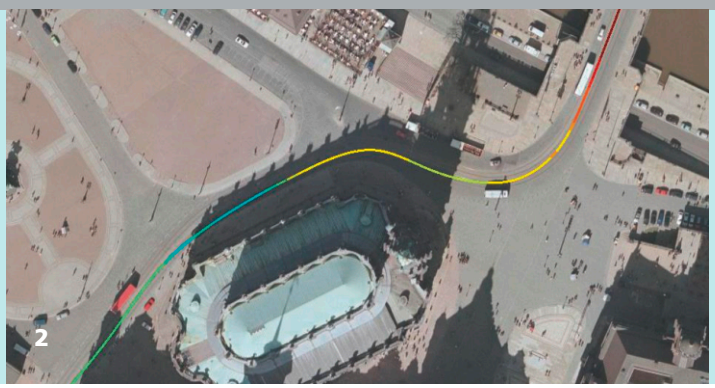
Fraunhofer
IVI

FRAUNHOFER INSTITUTE FOR TRANSPORTATION AND INFRASTRUCTURE SYSTEMS IVI



1 *Measuring in Dresden.*
2 *Visualization of measuring data and investigation results.*

ENERGY AND POWER DEMAND IN PUBLIC TRANSPORT VEHICLES

Against the background of dwindling global energy resources and increasing climate change the use of more energy efficient and low emission technologies is a central task for local public transport, too.

Vehicles with electric drive systems offer the possibility to operate the traction motors as generators. This enables the recuperation of kinetic as well as potential energy during braking. This principle is already often used in road vehicles, trams and trolleybuses. However a prerequisite is that at the same time other consumers (vehicles in the same feeding section requiring energy, auxiliaries) in the network can use the recuperated energy. Alternatively, a suitable energy storage system can be mounted. In this way it is possible to increase the utilizable part of the recuperated electrical energy.

Taking into account the thereby significantly reduced energy demand and reduced network transmission losses, energy savings of up to 30 percent can be reached, based on the total vehicle energy demand. At the same time energy storage systems can contribute to stabilize the net voltage and to reduce peak loads in the catenary grid. The determination of energy and power reserves is necessary for the dimensioning of an optimized energy storage solution. These parameters depend on a multiplicity of influencing factors. These include, for example, the local distribution of recuperation into the catenary, the route topography and the influence of ambient temperature on the auxiliary power demand.

Since vehicles as well as networks and environmental influences differ strongly according to the local characteristics, an individual analysis of these parameters, based on measuring campaigns, is necessary for the application of an optimized energy storage system solution.

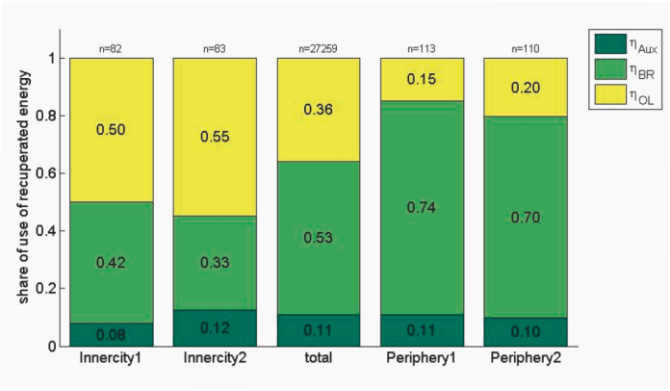
Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Director
Prof. Dr. Matthias Klingner

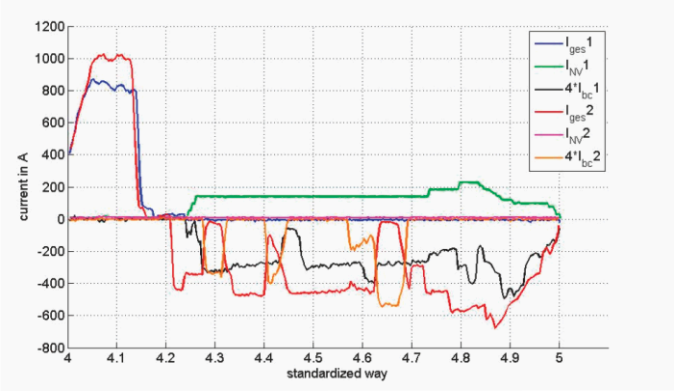
Zeunerstrasse 38
01069 Dresden
Germany

Contact
Dr. Sven Klausner
Phone +49 351 4640-812
sven.klausner@ivi.fraunhofer.de

www.ivi.fraunhofer.de



3



4

Data acquisition

Various measuring methods and test systems are possible for the measuring data acquisition. The Fraunhofer IVI determined the energy and power demand of a modern tram (45 m, NGT D12DD) during a nine-month measuring campaign [1]. The data were measured in relation to time and location during regular operation. Due to external requirements, the measurement setup was installed without interference with the vehicle controller.

The following subtasks were realized by Fraunhofer IVI:

- development of a measuring concept,
- realization of adequate measuring systems,
- integration of the measuring equipment into the vehicle as well as
- data acquisition and storage.

3 *Shares of the use of recuperated energy at an ambient temperature of more then 15°C (dark green: auxiliaries, light green: brake resistor, yellow: overhead line).*

4 *Plot of measured currents for two measurements against the standardized route.*

Evaluation of measuring data

Extensive measuring campaigns result in large data sets which must be appropriately compressed, aggregated and presented in accordance with the demanded evaluation criteria. However, the volume of data of several gigabytes often exceeds the possibilities of conventional calculation tools, like Microsoft Excel or similar.

Special software tools were developed for data evaluation and processing at Fraunhofer IVI, which lead to very exact results through complex calculations. Some functionalities which were implemented are:

- preprocessing of the measuring data with correction of missing values,
- coordinate transformations,
- determination of the local coordinates of the stops in the operator's network,
- identification and assignment of stops in the measuring data,
- integration of additional measured values (e. g. ambient temperature),
- determination of the driven routes,
- reproduction of the route network through continuous distance routes (splines),
- evaluation of the data regarding to different parameters as well as
- graphical formatting and presentation of results.

Energy storage system dimensioning

On the basis of the measurement results and with the help of simulation tools an optimized energy storage system dimensioning can be carried out for special applications considering different energy storage technologies with their specific characteristics and the fulfillment of the operating goals. An exemplary dimensioning is described in [2].

With the developed software tools a multiplicity of relevant information can be extracted like average stop distances or the distribution of dwell time, as well as selected influencing parameters on the power and energy demand of a vehicle.

References / literature

[1] Lehnert, M., Klausner, S., Bartholomäus, R.: Energieverbrauch bei Stadtbahnsystemen – Identifizierung von Einsparpotenzialen. (Energy consumption in light rail systems – Identification of potential savings.) Bahntechnik aktuell – Proceedings 14 (2008), pp.15-26.

[2] Klausner, S., Lehnert, M.: Betriebsspezifische Auslegung von Energiespeichern für Straßenbahnen. (Application specific dimensioning of energy storage systems for light rail vehicles.) eb - Elektrische Bahnen 106 (2008) 5, pp. 237-246.