Smart city concepts in Curitiba
Task 3: Analysis and demonstrator platform for charging logistics for hybrid buses

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Abstract
A consortium of Swedish and Brazilian stakeholders will promote system innovation, combining information technology and smart grids to develop electromobility, and energy efficient and low-carbon transport services in the city of Curitiba aiming at sustainable urban development. The project includes demonstration of technological solutions by VOLVO and Combitech to provide smart mobility and a platform for information monitoring and sharing. Research work is carried out by KTH and UTFPR to test and adapt concepts to the context of Curitiba. Task 3 has been designed to provide a demonstrator platform for studying the impact of introducing plug-in hybrid electric buses into a conventional terminal (or hub) integrating several bus routes. A discrete event simulation model is developed to provide information to a data acquisition system. Partial results obtained so far show the circulation of buses in Pinheirinho terminal that integrates 34 routes with 180 cars operating from 05:00 am to 02:00 am hours, and transporting approximately 102.000 passengers during a weekday.

Keywords: Plug-in hybrid electric bus, battery charging logistic, discrete event simulation, data acquisition system.

Introduction
The changing requirements for the terminals as well as a probable need of a support system for the real time planning of the logistic process regarding charging is studied in this task. The overall purpose is to allow the efficient use of hybrid electric buses and the associated charging stations. When adding charging infrastructure for electrical buses to a terminal the flow of the terminal is changed in a number of ways:
• Charging stations are a limited shared resource among the electric buses;
• A bus can’t get access to a charging station immediately when entering the terminal and is queued for charging;
• Charging stations might not be placed with passenger’s pick-up stops, which increases the time spent at the terminal;
• To compensate for buses tied up in the charging process it might be necessary to add additional buses to the fleet to meet timetables.

The objective of Task 3 is to develop a study regarding suitable strategies for yard management and dimensioning of charging infrastructure when using hybrid electric buses as well as a demonstration platform illustrating a Possible Charging Yard Management System for the real time management of the charging logistics.

Methodology
The behavior of arrivals and departures of buses in Pinheirinho Terminal is simulated by Simio1 (a discrete event simulation software). The simulation model is developed to capture the behavior of buses in the terminal that affects their timetables such as stops for boarding of passengers, time for charging batteries as well as conflicts generated by shared paths.

The simulation is then used to generate information to a data acquisition system which is able to monitor operational variables such as charging demand, utilization of charging stations and priorities to provide a suitable coordination of charging activities based on different criteria.

Pinheirinho Terminal

Results

Table 01 – Comparative Results

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