

# Green Line – strategies for environmentally improved railway vehicles

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## Abstract

In 2004 the Vienna University of Technology and Siemens Transportation Systems in Vienna launched a project, called Green Line, focused on optimizing the environmental performance of metro vehicles. Green Line should create design strategies for a new generation of environmentally sound transport vehicles based on Life Cycle Assessment (LCA). As a reference project the new metro train for Oslo has been chosen. The improvement potentials indicated by the LCA are discussed in this paper to increase the environmental performance of the train. The recommendations given are discussed considering feasibility studies and prospective trends.

## Keywords:

Ecodesign, Life Cycle Assessment, railway design

## 1 INTRODUCTION

More than 75% of the population of the European Union (EU) live in urban areas. Therefore, urban transport accounts for a significant share of total mobility. One fifth of all person kilometers travelled within the EU are urban trips of less than 15 kilometer. Between 1995 and 2030, total kilometers travelled in EU urban areas are expected to increase by 40%. Urban areas suffer heavily from congestion and nuisances caused by the excessive use of private cars. Pollution, noise and accidents are particularly acute in large urban environments and affect the lives of thousands of people. Urban transport is a significant contributor to climate change. 28% of greenhouse gas emissions in the EU presently emerge from transportation, 84% of that refer to road transportation alone. The Kyoto Protocol calls for an 8% cut in total EU CO<sub>2</sub> emissions by 2008-2012 based on 1990 levels. If current trends continue, CO<sub>2</sub> from transport will be some 40% higher by 2010 than it was in 1990. Innovative solutions to clean urban public transport are therefore fundamental for achieving the EU targets set under the Kyoto Protocol and improving air quality [1].

This target can be requires also environmental product design of transport vehicles. The intention of environmental design is to reduce the environmental impacts along the entire life cycle of a product [2]. The rail vehicle should achieve requirements such as a low energy demand, high recycling rate, low emissions, etc. The implementation of those requirements is the key to solve a huge part of the environmental problem arising from the increase of traffic emissions.

The paper intends to give an overview about the aspects concerning environmental design of metro trains and discusses solutions how to improve metro vehicles in an environmentally sound manner.



Figure 1 : Metro train Oslo in operation

## 2 LIFE CYCLE ASSESSMENT OF THE METRO OSLO

This chapter gives an overview about the Life Cycle Assessment study, which was prepared in the time period 2005/06. The LCA was done in accordance with ISO 14040 [3]. The life cycle assessment data for materials and energies were provided by Siemens Transportation Systems and their suppliers.

The functional unit of the study is related to a fully occupied three car train (the tare weight of the train is approximately 100 tons) operated in Oslo (Norway) for a time period of 30 years.

### 2.1 Goal and scope of the LCA study

The reasons for carrying out the LCA study are the following:

- The detection of product improvement potentials for prospective metro design strategies. The inventory results are used to identify improvement potentials and design recommendations for vehicle components as well.
- Presenting key environmental performance indicators of a metro vehicle, to be able to draw comparisons with similar transport vehicles. These environmental performance (e.g. tonne CO<sub>2</sub> per kilometer - tonne) indicators are mostly used to describe the environmental performance of transport vehicles.

This LCA study is a stand-alone study with the intention to achieve base information about the environmental performance of metro vehicles.

### 2.2 System boundaries

The LCA model for the Metro Oslo is defined by three kinds of boundaries.

#### 1. System environment

The system boundary considers six life cycle stages (see figure 2) of the metro, which are "Raw materials", "Manufacturing", "Distribution", "Use", "Maintenance" and "End of Life".

Some life cycle stages ("Manufacturing", "Maintenance" and "End of life") are generating waste, which has to be treated by recycling, incineration or landfill.

In the applied LCA model neither manufacturing processes of the suppliers nor transport from the suppliers are considered.