

Electrification of a Public Bus Network

A framework incorporating economic and environmental impact

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Abstract. The overall goal of the project under study is the development of a holistic concept for a fully decarbonized urban bus system in Graz. As there are multiple propulsion technologies available and a mixed fleet composed of different electric bus types is promising to deliver cost-efficient solutions, an Integer Linear Program to identify the optimal technology for each bus line was developed in preceding work. The objective of the investigated model was the minimization of total cost of ownership. A comprehensive analysis of all alternatives, however, requires a systematic comparison on various levels. Though none of the evaluated technology options has tailpipe emissions, other operational processes give rise to environmental impact. A central problem of the incorporation of such effects is the evaluation of these impacts, as they are a multi-criteria concept in itself. Also finding appropriate weighting factors for environmental and monetary aspects constitutes a challenging task. To address these challenges, two solution approaches are pursued. Firstly, unintended effects are monetized with environmental valuation techniques and added to previously used cost coefficients. Secondly, the ϵ -constraint method is used to avoid monetary evaluation and derive a pareto frontier of solutions, which can be used to choose the most preferred solution.

Keywords: public transportation; electric bus; fleet composition; integer linear programming; multi-objective programming; environmental valuation techniques, epsilon constraint method