

Environmental Sustainability of Electric Buses and their Operations

Topic: Input-Output Analysis: Sustainable Production and Consumption Policies - III

Author: Devrim Murat YAZAN

Co-Authors: Orkide Nur Kara, Luca Fraccascia

The electrification of public bus transport are carried out utilizing different technological solutions, like trolley, battery or fuel cell buses. The available technologies are broadly reliable, but in particular, there are still uncertainties about different charging scenarios.

Through a case study in the Netherlands, this study aims to analyze the environmental and economic sustainability of the electric battery bus transportation based on three charging strategies: overnight charging, opportunity charging and the combination of overnight and opportunity charging. Second, this research aims to provide a practical contribution to the stakeholders to better design the operations of electric battery bus transportation. In order to reach these goals, the research question has been identified as: What are the net environmental and economic costs/benefits of battery buses with overnight charging, opportunity charging and the combination of both strategies?

Enterprise input-output (EIO) modeling is adopted to assess the environmental and economic sustainability of the supply chain of battery bus transportation in the case of a bus line operating in a Dutch city. The impact of the implementation of the charging strategies on the sustainability of the supply chain is quantified using scenario analysis. The methodology consists of two model implementation. First, a physical input-output model is adopted to display the material, energy and CO₂ emissions which are then integrated into a monetary input-output model via cost/price vectors.

The findings show that the opportunity charging scenario has the lowest primary input consumption and CO₂ generation with a yearly emission of 164,314 kg, the lowest environmental costs with $\hat{a}, -12,324/\text{year}$, and the lowest total costs with $\hat{a}, -318,608/\text{year}$. The study is novel as the first one that analyzes the sustainability of electric buses and related operations via EIO model and provides practical implications to municipalities targeting to increase the use of the electric battery buses.