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1272 – Charging Strategies for Electric Busses based on Deterministic and Stochastic Optimisation Approaches: A Dutch Case Study

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Introduction

- Electricity demand for the charging of electric buses depends on several uncertain factors related to the vehicle, the route, weather conditions, and the driver.
- The potential of different charging strategies for electricity cost reductions of electric buses is investigated while accounting for uncertain factors in electricity consumption.

Methods

- Desk research was conducted for identifying uncertain factors that impact the electricity consumption of electric buses.
- An impact analysis was performed to identify the most important uncertain factors, specific to the Netherlands.
- A simulation model was developed that calculates the total electricity costs for five different charging strategies:
  1. **Naïve strategy:** the charging pattern is not controlled (reference case).
  2. **DAMdet:** deterministic optimisation based on the day-ahead market (DAM) prices.
  3. **DAMstoch:** stochastic optimisation based on the DAM prices while accounting for uncertainty and imbalance costs.
  4. **FIXdet:** deterministic optimisation for minimising electricity costs and grid fees.
  5. **Peak shaving:** deterministic optimisation for minimising the variable grid fees by shifting electricity demand from peak to off-peak periods.
- The developed model was applied to a case study based on an operational area of a Dutch bus operator, Qbuzz, and the input data included historical trip and charging transaction datasets for the year 2020.

Results

The effect of uncertain operational factors on the electricity consumption of electric buses, specific to the case study of the Netherlands, was assessed, and the results are listed in **Table 1**. The uncertain factors listed in this table were considered in developing the demand scenarios for the stochastic optimisation approach.

Table 1. Impact analysis for critical uncertain operational factors. Results are expressed in % of deviations from average electricity consumption.

Uncertain factors	Minimum	Maximum
Ambient temperature	15 °C	-1 °C
	-9%	+22%
Wind speed	0 m/s	15 m/s
	-8%	+11 %
Day of the week	Sunday	Friday
	-6%	+2%

The case study results for all charging strategies are illustrated in **Figure 2,** for indicative months to capture the seasonal variations. The simulation results indicate a significant potential for total electricity cost reduction up to 35% and peak power reduction up to 58% on a monthly basis.

Figure 1. Peak power demand (top), and total electricity costs (bottom) for all charging strategies.

Conclusions

The analysis provided insights on various charging strategies for electric buses and potential operational cost reduction, which outweigh the high capital cost, and supports future applications.