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Going electric?
Critical barriers precluding the electrification of road public transport in Southern Switzerland

Following the growing trend for passenger cars, due to their lower environmental and climate impacts, a trend towards the electrification of public transport is emerging, particularly regarding urban buses. However, the reliability of the service offered by electric alternatives to diesel-powered buses and the costs of such a transition have not been fully explored. To get insights on these aspects, we simulated the transition to electric bus powertrains for two bus lines in Locarno, by comparing the currently available electric technologies and charging schemes, based on their level of operation and their overall cost. According to these simulations, "opportunity charging" schemes emerged as the most promising ones for the urban lines in Locarno; however, in the short period barriers against them still exist, including the lack of capability to guarantee the service in case of delays above three minutes, their cost (between 25% and 59% more than Euro VI diesel buses, also hampered by cashback on diesel custom duties), the need for proper training by the transport company staff, and time needed install the charging stations.

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Introduction

Local transport companies are looking for alternative bus powertrains that can maintain the level of service of diesel powertrains, while reducing their environmental and climate impacts. Due to their low emissions and the fast improvement in their performances, electric powertrains have recently gained interest.

Today, in Switzerland less than 1% of the buses are electric, corresponding to less than 100 units in service[1]. However in the next years this number is likely to increase, since a number of cities have developed plans towards full transition to electric buses. For example, Zürich plans to replace 150 diesel buses with electric buses by 2030[2] and Schaffhausen plans to have 15 electric buses operating by 2023[3].

In this context, the local public transport company of Locarno aimed at assessing the practical feasibility and impacts of a possible purchase of a new fleet of 27 electric buses, to be put into operation on late 2020. To address this need, we developed a decision support system (DSS).

Methodology

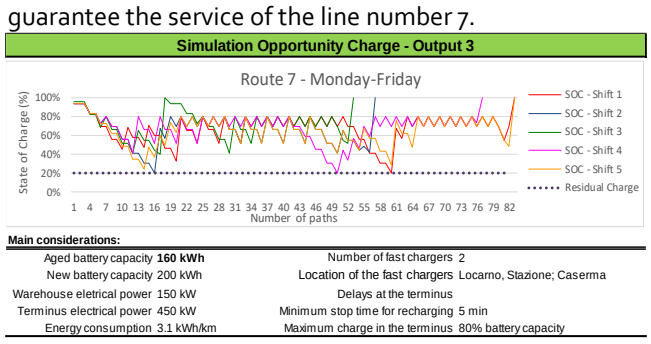
The DSS simulates the service of the FART urban lines 1 and 7, by estimating the «reliability of the service» and the «costs per kilometer», both at the 2020 and 2030 time horizons, for five electric bus alternatives:

- *Overnight charging*: buses with large batteries that are usually charged overnight in the depot;
- *Opportunity charging*: buses with small batteries that must be regularly charged during service;
- *Combi charging*: buses with large batteries that are both charged overnight in the depot and also during service;
- *In motion charging*: trolley buses, that charge their batteries on the overhead line while moving, with an autonomy of about 40 to 60% of the route without the overhead lines;
- *Euro VI Diesel*: business as usual alternative.

For each alternative, we made hypotheses on the battery capacity, the electric power of the charging stations, the location of the charging stations and the minutes of delays.

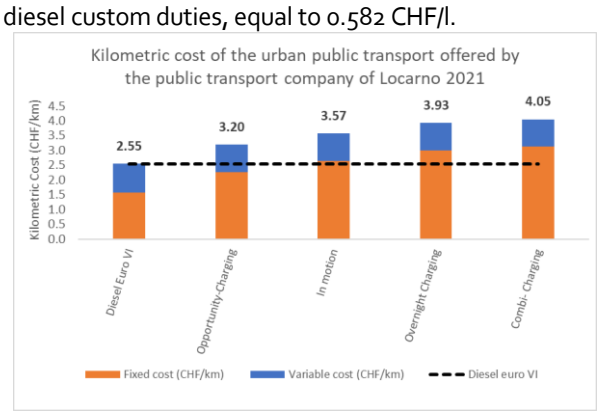
Reliability of the service (year 2020)

The simulations have shown that, due to their limited range, "overnight charging" electric buses would not be able to perform the needed service, unless additional buses are bought. "Opportunity" and "combi" charging buses would instead allow to perform the service with the current number of buses; however, any delays higher than three minutes at the terminal stops (which is quite likely) would put at risk the whole service, since buses would not have enough time for battery charging. For example, the figure shows that a fleet of 5 "opportunity charged" buses equipped with a 200 kW battery, with a maximum of three minutes delay, would guarantee the service of the line number 7.



Costs per kilometer (year 2020)

Costs are estimated by accounting for bus depreciation, insurances, infrastructure, administration, energy, maintenance and personal costs. Euro VI diesel buses are currently the most economic option and purely electric alternatives are between 25% and 59% more expensive than diesel. This is mainly due to fixed costs (especially buses depreciation and infrastructure cost). By only considering variable costs (energy and maintenance cost), electric buses have a comparable cost as diesel – though current diesel variable costs are artificially kept low by federal financial incentives (public transport companies are given back the amount of the diesel custom duties, equal to 0.582 CHF/l.



Barriers against bus electrification

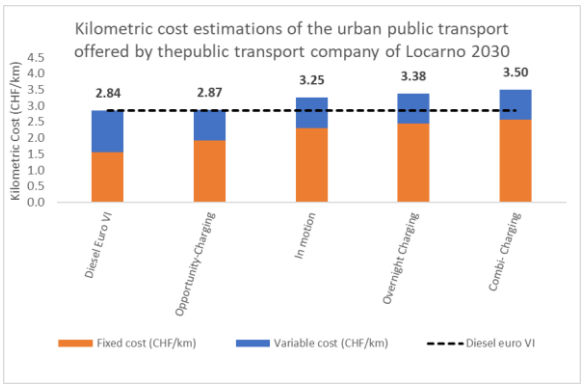
By further investigation with the public transport company, we found additional elements precluding a short term electrification of the bus lines, that imply the company is strongly locked-in to the diesel technology. This transition is in fact affected by the following barriers, which can be generalized to other contexts:

1. In the rush hour, car traffic related delays are likely to hinder possibility to recharge at the terminal stops, which would stop the bus service;
2. Costs for infrastructures and purchase of electric bus are still too high;
3. Cashback of the custom duties on diesel artificially supports diesel powertrain;
4. Installation of fast charging station requires time, therefore it has to be programmed well in advance (at least one year and half for authorisations and interventions on the grid);
5. The staff of the transport company, at all levels, need to be properly trained in order to adjust their skills (for instance, different "driving styles" and maintenance operations).

Acknowledging such barriers, the transport company opted not to buy a new fleet of electric buses in 2020, preferring the purchase of Euro VI diesel buses.

Future perspectives

The transport company committed to start addressing the identified barriers, by interacting with the relevant actors: municipal and cantonal authorities to improve traffic management measures and reduce the risk of delays, lobbying groups to abolish cashbacks for diesel, the local utility company to plan new charging stations, and other transport companies to get staff training. Regarding costs, our simulations for 2030 time horizon show that, thanks to progress in battery storage technology and the related decrease in costs[4], and provided that cashbacks for diesel are no longer attributed, parity of costs between electric and Euro VI diesel alternatives will be achieved.



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