Powering tomorrow's mobility: assessing the techno-economic potential of solar-powered carpooling hubs

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Introduction

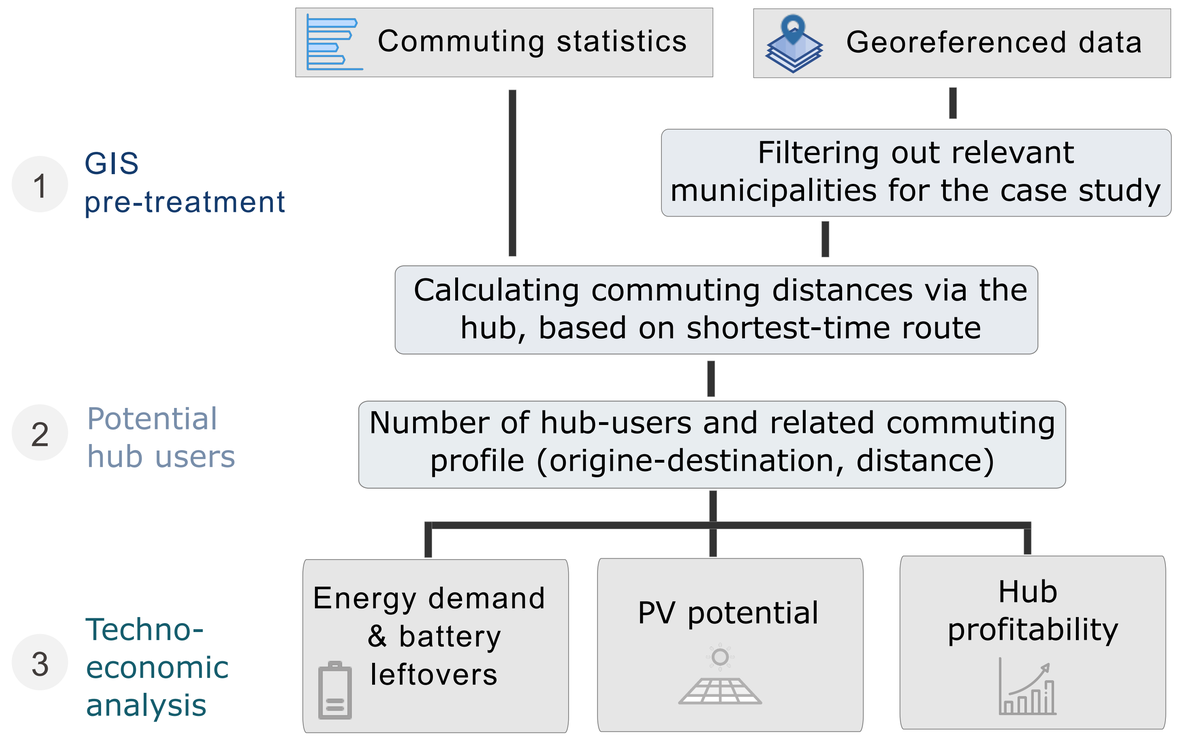
Carpooling brings numerous environmental, social, and economic benefits [1] and is generally perceived positively in Switzerland [2]. With the transition to electric vehicles (EVs), it offers additional opportunities, not least that of developing carpooling hubs incorporating solar-powered charging stations. These hubs could optimize the utilization of photovoltaic (PV) energy to meet the charging demand, while providing storage capacity for additionnal flexibility via vehicle-to-X [3].

However, quantitative studies aimed at assessing the potential of such mobility hubs remain scarce. In fact, this type of analysis requires in-depth knowledge of mobility patterns, which vary considerably from one location to another.

OBJECTIVE

Using statistical and georeferenced data, we present a modelling approach capable of assessing the **techno-economic potential of solar-powered mobility hubs**. As a case study, we evaluate the potential for a home-work commuting hub located in **Nyon**.

Modelling approach



Results: a case study in Nyon

1 Potential hub users

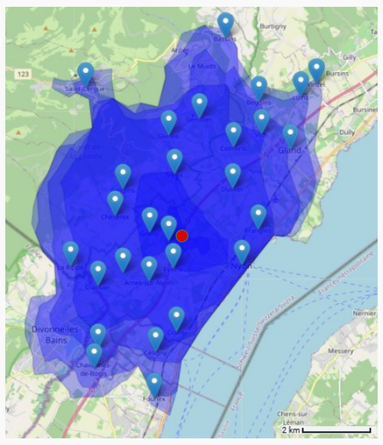


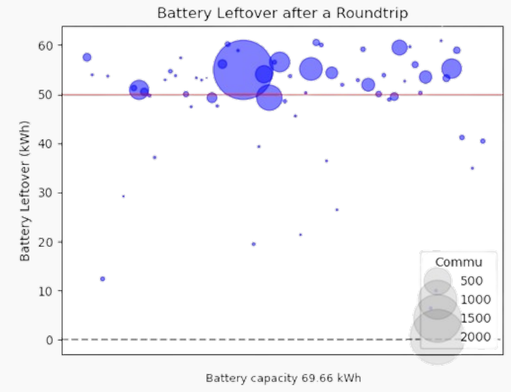
Fig. 1: Candidate municipalities, located at less than 15 minutes driving time (isochrones shown in blue) of the hub (red point) and avoiding highways.

- ☑ Excluding short-distance commuters (< 10 km)
- ☑ Share of car commuters: 75% [4]

→ Up to **5270 potential daily users** of the hub in Nyon

2 Battery leftover for V2X

Fig. 2: Battery leftoover after the roundtrips of the car fleet. A roundtrip is defined as the travel distance until the EV gets parked and charged again at the Hub (2 x Home - Hub - Home, 1 x Hub - Work - Hub).



- ☑ 87% of the potential hub-users have more than **50 kWh leftover** in the battery (see Fig. 3)
- ☑ Home to hub average distance is only ~4 km

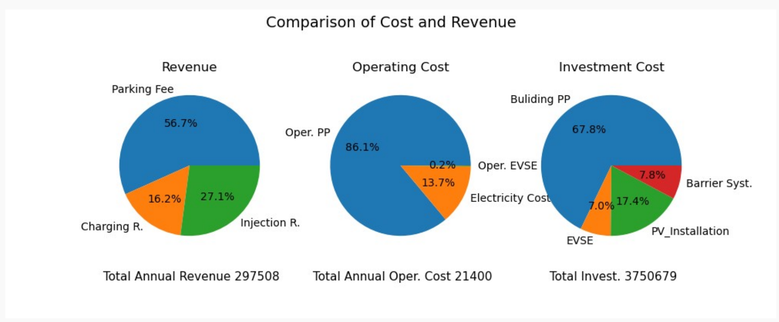


Fig. 4: Economic numbers for a hub with 390 participants and an 80% utilisation of the parking places (PP). Costs in CHF.

- ☑ Cost per parking field is crucial
- ☑ With ~7% of the total number of users, the break-even point is reached in around 20 years

? *For hub users, savings can reach ~2000 CHF a year*

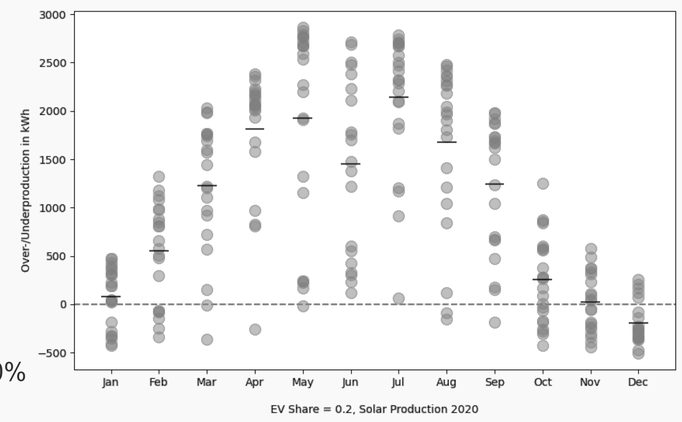


Fig. 3: PV production of the hub with only the parking field covered with solar panels, minus the charging need of the parked EV. Assumed that we have a EV share of 20% and that EVs only get charged at the hub, two people do carpooling together and they use their car. alternating to drive from hub to work.

- ☑ PV production exceeds the charging need of the hub in 80% of the days
- ☑ Cost of PV investment: low compared with the cost of parking (see Fig. 4)

4 Business case

3 PV potential

Conclusion & Outlook

Battery capacity leftover >50 kWh for most of the cars, which could be used for flexibility through V2X

A solar-powered carpooling hub could be economically attractive, both for the owner-operator and the hub user (~2000 CHF in annual savings)

PV could cover the charging needs most of the days

Towards the integration in the open-source **Citiwatts** tool

https://citiwatts.eu/map

Citiwatts is an open-source GIS online tool used for energy planning at a territoriale scale, already including some feature for electric mobility planning developed at PV-Lab. Initial results indicate that this work could also be integrated into Citiwatts, paving the way for a fully GIS-based tool carpooling hub studies.

References

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The central image was generated using DALL-E 2.
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