

Extending a Swiss energy system model with heterogeneous mobility consumer groups

The Swiss TIMES energy system model applies a cost-optimization approach to show potential developments of the Swiss energy system. While this approach is well suited for simulating most sectors of the energy system, it has limitations for passenger transportation where decisions are strongly driven by consumer behavior. In this context, this work aims to **enrich the cost-optimization approach with behavioral realism**. For this, the single homogeneous representative of all

consumers is replaced with **heterogeneous consumer groups**, which differ in heuristic mobility-relevant socio-demographics. Each group is **attributed with a set of techno- and socio-economic characteristics** to reflect their **mobility behavior/decisions**. The work conducted so far provides insights on the size of each consumer group and their driving patterns. This would enable to identify critical target groups for **tailored decarbonization policies**.

Sandro Luh (Sandro.Luh@psi.ch)

Energy Economics Group, Laboratory for Energy Systems Analysis, Paul Scherrer Institut, Forschungsstrasse 111, 5232 Villigen PSI, Switzerland

1 Introduction

The **Swiss TIMES Energy Systems Model (STEM)** generates potential future pathways (2050+) for the whole energy system of Switzerland.

- Cost-optimization model
- Technology-rich bottom-up approach with detailed techno-economic technology definition

Shortcomings in STEM passenger transport:

- Real-world transportation dynamics are strongly driven by consumer behavior, while cost minimization plays a minor role.
- **Limited representation of consumer behavior** in STEM, due to the underlying **pure** cost-optimization approach.
- For transportation, the **cost-optimization approach should be enriched with behavioral realism**.

2 Overcoming the limited mobility behavior representation

Aims

1. **Heterogeneous consumer groups** replace the current homogeneous mean representative consumer.
2. **Behavioral attributes** for each consumer group characterize differing mobility preferences.

Expected benefits:

- Enriching cost optimization approach with behavioral aspects leads to improved representation of decisions for **mobility investments and technology use**.
- **Tailored policy measures** for **targeted consumer groups** can be identified and evaluated for decarbonizing transportation.
- This enables to find pathways leading to **effective decarbonization** with **minimum perceived negative influence** for the overall society.

3 Current state: one homogeneous representative of all consumers

Swiss population is represented by one «**mean representative decision-agent**» [2]:

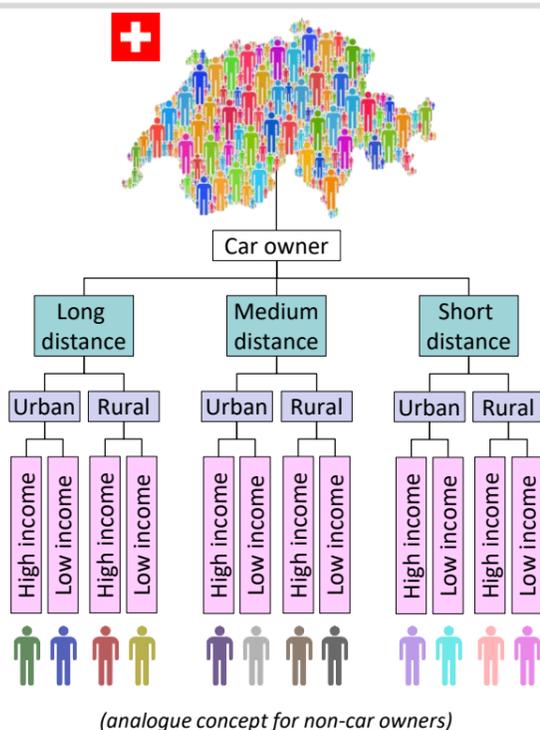


This consumer will always select the most cost-efficient mobility option, within given boundary conditions.

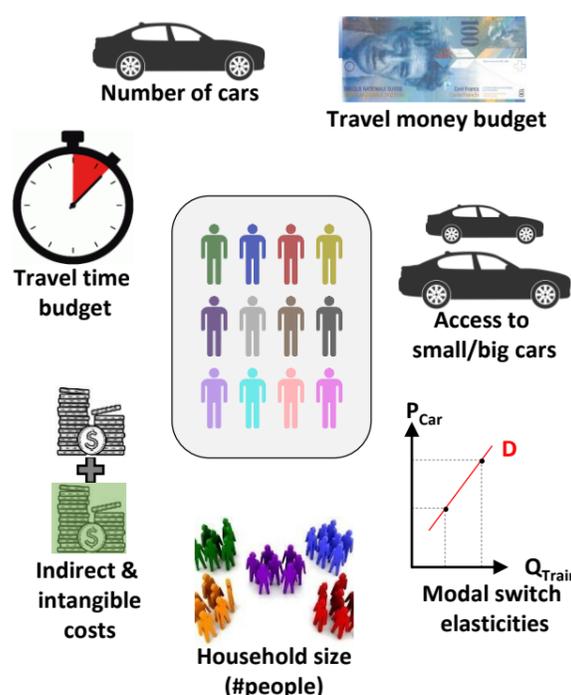
No consideration of differing...:

- ...socio-economic situations
- ...mobility demands
- ...car preferences

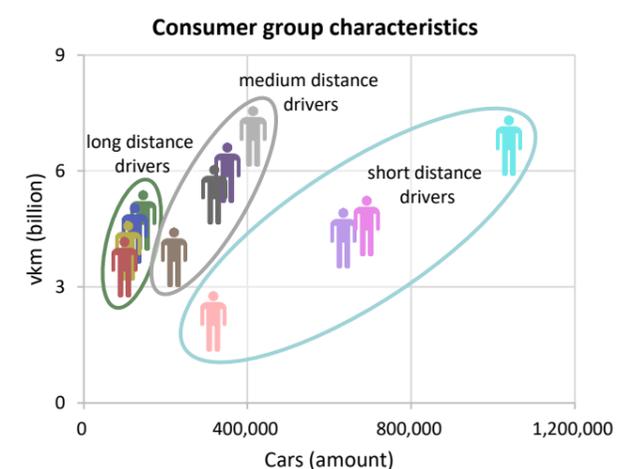
4 Improved methodology: heterogeneous consumer groups



5 Techno- and socio-economics represent behavioral attributes



6 Preliminary output and challenges



Main challenges:

- Future mobility behaviors are unknown. Reasonable assumptions are necessary.
- Calibrating the model
- Validating model outcomes

References

- [1] Kannan, R., Hirschberg, S., 2016. Interplay between electricity and transport sectors – Integrating the Swiss car fleet and electricity system. *Transp. Res. Part A Policy Pract.* 94, 514–531. <https://doi.org/10.1016/j.tra.2016.10.007>
- [2] McCollum, D. L., Wilson, C., Pettifor, H., Ramea, K., Krey, V., Riahi, K., ... Fujisawa, S. (2017). Improving the behavioral realism of global integrated assessment models: An application to consumers' vehicle choices. *Transportation Research Part D: Transport and Environment*, 55, 322–342. <https://doi.org/10.1016/j.trd.2016.04.003>

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