INTERCHARGE: Secure Integration of the Future Swiss E-mobility Charging Infrastructure with the Electricity Grid

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1 Introduction

The uptake of battery Electric Vehicles (EVs) can create **challenges**:
- increasing the overall electricity **demand**.
- creating **power spikes** especially with fast charging.
- **distributed charging** can increase the risk of local network violation.
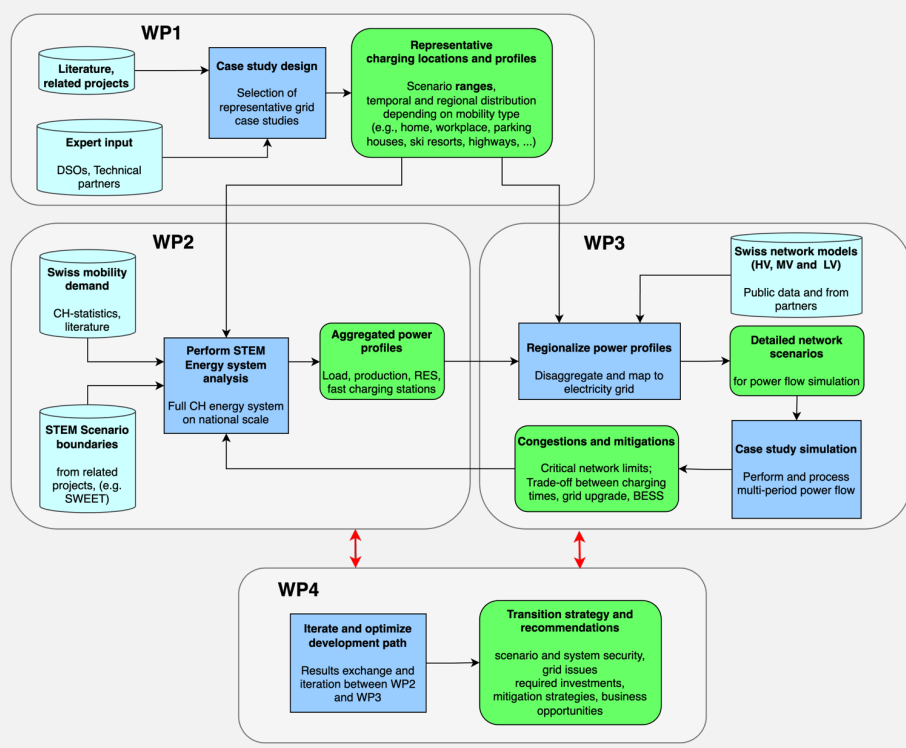
Research questions:
- How does EV and its **electricity demand evolve** in Switzerland?
- What are **expected power spikes** from charging infrastructure under different charging behaviors?
- Are **capacities** at the different grid levels adequate to cope with the power spikes from home and public charging?
- What strategies can **avoid grid bottlenecks**?
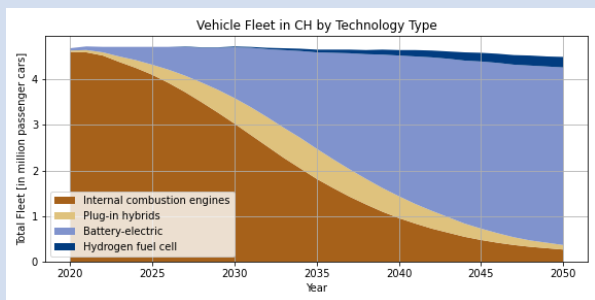
Source: BFE(2023): Verständnis Ladeinfrastruktur 2050

2 Project approach

Integrated approach to assess the energy system impact of the future Swiss EV charging infrastructure.

3 Energy system assessment

STEM model for assessing car fleet transition and electricity demand:
- Develop a regional mobility demand and charging infrastructure
- Introduce behavior or habitual charging patterns
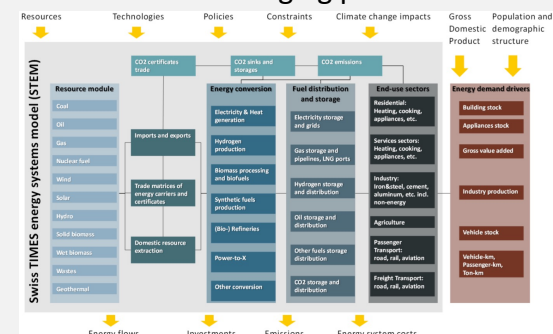
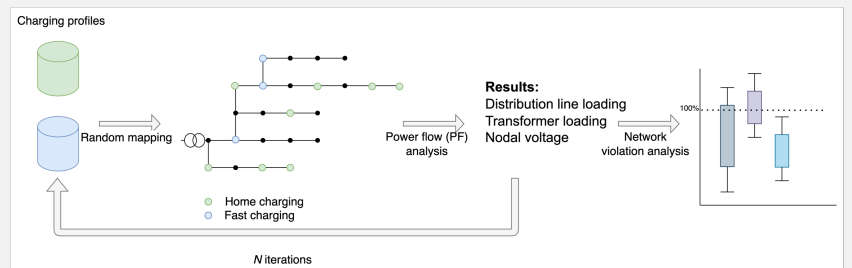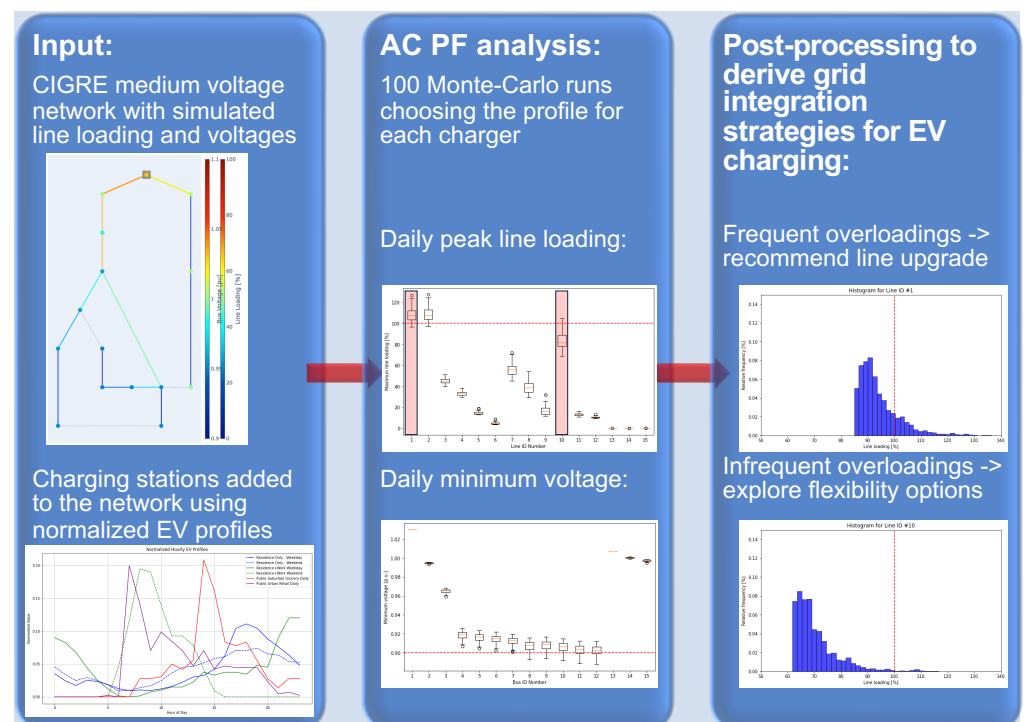## 4 Method grid assessment

Probabilistic simulation of grid loading from EV-charging:
- Reference charging profiles are randomly selected and combined to **reflect realistic patterns.**
- Profiles are **randomly mapped** to each potential charging.

5 Preliminary results illustrating modeling approach

Input:
CIGRE medium voltage network with simulated line loading and voltages

Charging stations added to the network using normalized EV profiles

AC PF analysis:
100 Monte-Carlo runs choosing the profile for each charger

Daily peak line loading:

Daily minimum voltage:

Post-processing to derive grid integration strategies for EV charging:

Frequent overloadings -> recommend line upgrade

Infrequent overloadings -> explore flexibility options

6 Outlook

- Select and analyze **representative Swiss case studies** (urban, rural, industry, tourism, highway ...) at different network levels.
- Explore **uncertain variables** through Monte-Carlo analysis.
- Assess value of different **grid integration strategies.**

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