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Dynamic Life Cycle Assessment of Electricity Demand in Swiss Buildings

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WHY

- The environmental assessment of the Swiss consumed electricity is based currently on average annual statistics of energy flows
- This modelling simplification raises concerns because:
  - The environmental impacts of the Swiss electricity mix varies substantially throughout the year
  - The buildings' energy consumption also fluctuates but rarely with similar trends

➔ **It is therefore necessary to investigate how this mismatch between production and consumption can influence the impacts of building uses (or charging of electric vehicles)**

WHAT

- To consider the dynamics of energy flows when assessing the life cycle environmental impacts of buildings
- **To evaluate how the environmental impacts of the Swiss electricity mix evolve on a hourly basis**
- To analyse how different time resolutions might affect the environmental assessments of energy demands in buildings

WHO

- School of Management and Engineering Vaud (HES-SO / HEIG-VD – project leader)
- Swiss Federal Laboratories for Materials Science and Technology (Empa)
- Scuola Universitaria Professionale della Svizzera Italiana (SUPSI)
- Advisory board: ecoinvent, PSI, ETHZ, EWZ, Stadt Zürich - Amt für Hochbauten

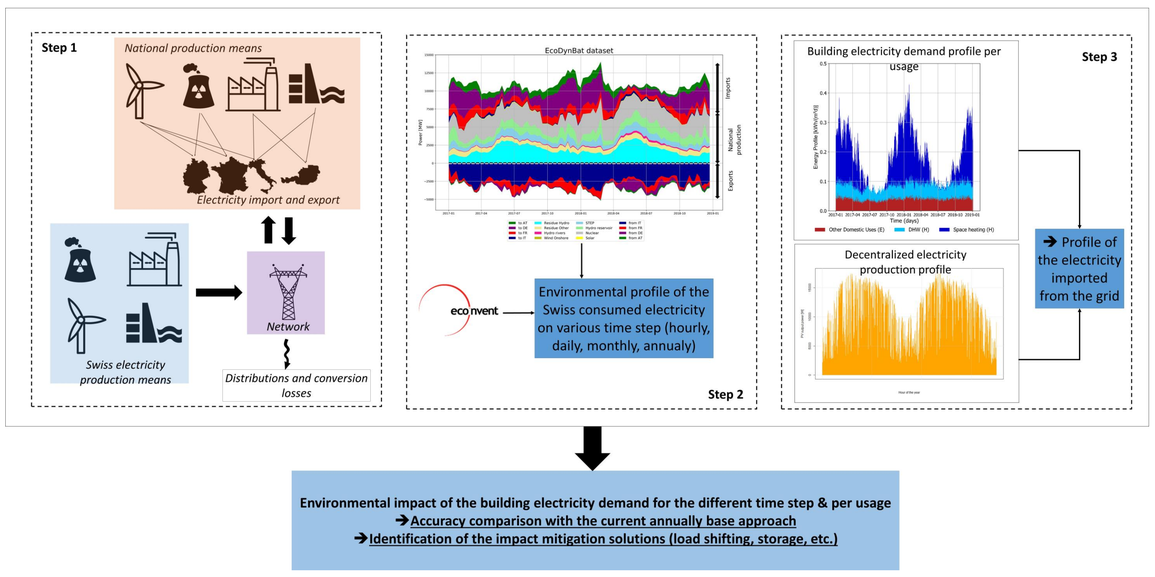
HOW

Three-step approach:

1. Collect data on hourly electricity production mixes for Switzerland & neighbouring countries (Big data approach)
2. Model the hourly Swiss electricity supply mix with imports & characterise its environmental impacts
3. Collect data regarding buildings' electricity demand per usage & decentralised electricity production (monitoring approach)

➔**Environmental impacts of the building electricity demand per usage and for various time step known**

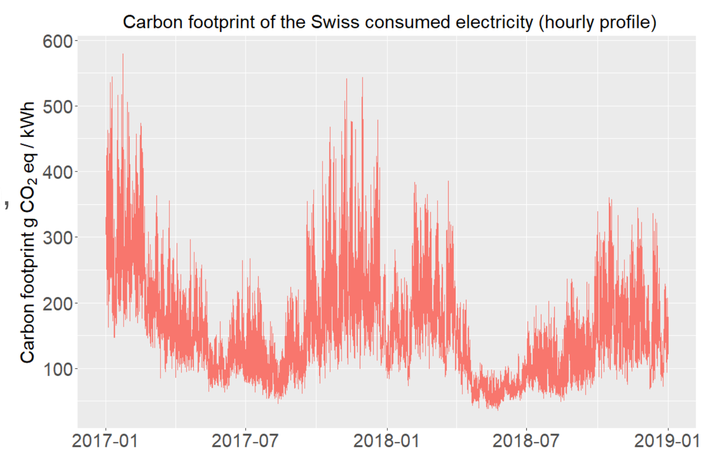
➔**Variability of the electricity impact characterized and proposal to reduce the building energy demand environmental footprints**



KEY RESULTS

- Carbon footprint of the Swiss consumed electricity:
  - Substantial seasonal fluctuations:
    - Winter peaks are mainly explained by high imports from neighbouring countries
      ➔ High impact of the imported electricity
    - Lower values for Spring & Summer are linked to indigenous electricity production
      ➔ Swiss national production has a low impact (but can not supply alone the winter demand), the impacts are driven by imports

➔**Performing hourly assessments every year would be necessary to identify the influence of the energy turnaround**



- At the building level:
  - Winter seasonal electricity demand (in particular related to heat pump use for space heating)
    ➔ Higher impact with hourly carbon footprint profile instead of annual value (+25%)
  - Non seasonal demand (electric appliances has low seasonal fluctuation)
    ➔Hourly considerations do not affect the result substantially

➔**Considering the carbon footprint fluctuations is especially important when energy demands change substantially over a certain period like the seasonality of space heating**

➔**Energy management strategies could fit consumption periods with moments when the carbon footprint is lower**

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