Considering dynamics of electricity demand and production for the environmental benchmark of Swiss residential buildings

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Dynamics of Energy in Buildings

Proportion of operational energy over the life cycle energy

Based on values from:

Energy sources

Long-term evolution

Short-term variation

images: Freepik.com
@macrovector (energy/buildings)
Previous dynamic studies for buildings

~16 **Dynamic LCA (DLCA)** studies on buildings

<table>
<thead>
<tr>
<th># of studies</th>
<th>Focus of DLCA</th>
<th>Environmental indicator</th>
<th>Observed difference with standard LCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Long-term evolution</td>
<td>Global warming potential</td>
<td>From -70% to +60%</td>
</tr>
<tr>
<td>8</td>
<td>Short-term variation</td>
<td>Many (e.g. ReCiPe)</td>
<td>From -60% to +40%</td>
</tr>
</tbody>
</table>

**DLCA frameworks and methods**

Swiss context of building LCA

**Goal:** Identify key model parameters for the DLCA of Swiss buildings

### LCA benchmark

**KBOB 2016**

- Database: ecoinvent v2.2+
- Electricity: *annual average*
- Impact categories:
  1. Ecopoints (UBP 2013)
  2. Non-renewable
  3. Renewable
  4. GWP IPCC 2013


### Electricity

![Image of Europe with yellow and blue sections representing energy sources]

- **2020**

### Recent studies


- × variation between neighbours
- × analysis of temporal precision
Case study

- Single-family house
- Energy reference area (ERA): 199 m²
- Considered demand (hourly): 44 kWh/year·m² ERA
  - Appliances
  - Lighting equipment
  - Domestic hot water
  - Heat pump
  - Based on SIA 2024
- Decentralised production (hourly): 19 kWh/year·m² ERA
  - PV installation (mono-crystalline)
  - Peak power: 4.5 kW
  - Orientation: East
  - Inclination: 45°
  - Grid connected
  - Priority to self consumption

![Graph showing energy consumption and photovoltaic production]
Scope and dynamic model

Energy sources

Mix & Network losses

Short-term variation 2016, 2017, 2018

Building

Energy sources: Freepik.com
@macrovector (energy/buildings)
@luis_molinero (flags)
Sources of data and mapping

Between 2016 and 2018

For the Swiss electricity mix:
1 Natural gas plant
1 Hydro, pumped storage process
1 Run-of-river dam
1 Reservoir dam (alpine region)
2 Technologies of nuclear plant
3 Sizes of Wind turbine
16 Types of PV installations

Environmental impacts of electricity mix for every hour in Switzerland

https://transparency.entsoe.eu/dashboard/show
Results for 2016

- **Global warming potential**: (kg of CO₂ eq. / m²·year)
- **Renewable primary energy**: (MJ / m²·year)
Results for all years

Global warming potential (kg of CO$_2$ eq./m$^2$.year)

Renewable primary energy (MJ/m$^2$.year)

- Year
- Month
- Day
- Hour
Conclusions

- Confirmation of expected variations between databases
- System dynamics also bring changes in results for Swiss buildings
  - Increase for GWP, Non-renewable energy use and ecological scarcity
  - Decrease for renewable energy use
  - Importation of neighbouring countries should be considered
  - Data sources for electricity flows should be validated
- Monthly precision is sufficient to consider most of the difference
- Significant variations are observed only for global warming potential
Thank you for your attention

While the results do not engage the provider of research funds, we would like to thank the Swiss federal office of energy (SFOE) for supporting this project under contract SI/501814-01.

For further questions, please contact: dib@empa.ch