sweet swiss energy research for the energy transition

PATHFNDR

Market + policy

Co-designing policy and technology packages to decarbonize the Swiss building sector

Work package 7

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1 Motivation

Decarbonizing the Swiss building sector is urgent, given its significant energy demand and emissions. The sector accounts for over 40% of total energy use and a third of CO2 emissions[1], with more than 80% of buildings dating before 1990[2]. Retrofitting efforts have fallen short of 2020 targets, highlighting the need for more ambitious policies. This study aims to:

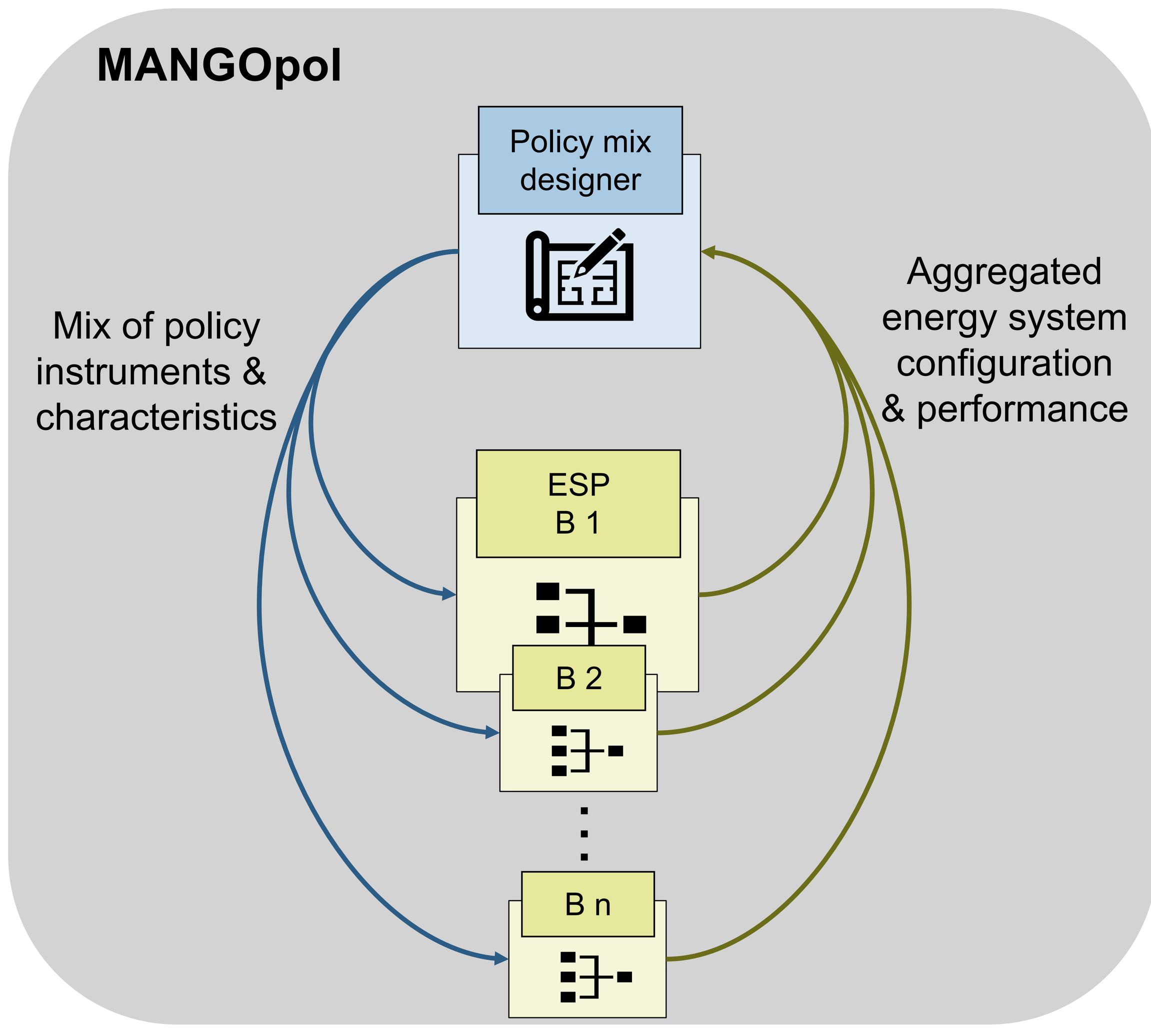
- Evaluate how Energy System Models (ESMs) can be used for co-designing policy and technology packages to decarbonize the Swiss building stock
- Account for the temporal sequencing of policy implementation and investments.
- Investigate the trade-offs between different levels of policy tailoring on buildings.

3 Case Study

- The analysis is based on comprehensive data from EMPA, which provides an extensive representation of the Swiss building stock.
- The focus is on **Multi-Family Homes** (MFH) **and Single-Family Homes** (SFH) in **urban areas**, covering **5 different age categories**. Each configuration includes 4 clusters used as representative buildings. Hence, in total, **40 representative buildings** are analyzed using MANGOpol.
- The policy landscape includes subsidies for supply, storage, and retrofit options, carbon taxes, and regulatory measures such as technology bans.
- MANGOpol determines the optimal values and timing for each policy instrument within the predefined policy landscape, using seven 4-year periods between 2023 and 2050.

2 Methodology - MANGOpol

- MANGOpol is a new approach that integrates policy decisions within an ESM, considering also their temporal dimension thanks to its two modules, which operate using bi-level optimization:
    - The **Energy System Planner** (ESP), which represents the **techno-economic** energy system of each building and aims to **minimize system cost** using the MANGOret[3] model.
    - The **Policy Mix Designer** (PMD), which acts as a leader and represents the **policy maker, and aims** both **minimize CO2** and minimizes the **total societal cost**, using a metaheuristic algorithm



3 Results (Preliminary)

- **Deep decarbonization requires a policy mix approach**. A combination of policy instruments is essential to achieve significant emissions reductions.
- The model effectively identifies "must-have" and "must-avoid" policies by exploring a broad range of policy options. For example, **early subsidies for retrofit** measures emerge as critical levers for success.
- **Heat pump deployment is critical** for effective decarbonization, making it crucial to identify policies that effectively support proliferation
- **Tailoring policies** according to building age categories results in lower overall costs at the same decarbonization level compared to tailoring per building type.

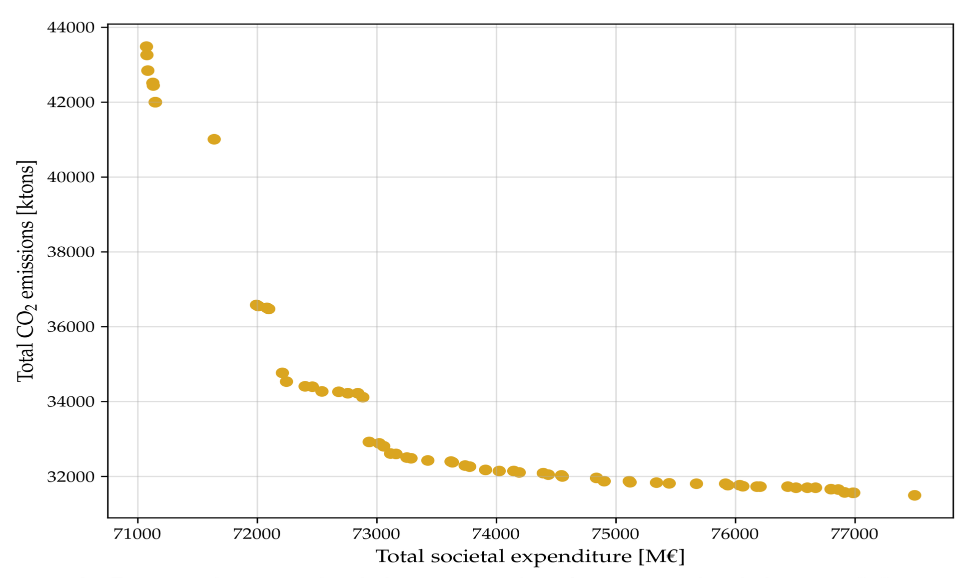


Figure 1: Pareto fronts of minimum societal cost and minimum CO_2 emissions.

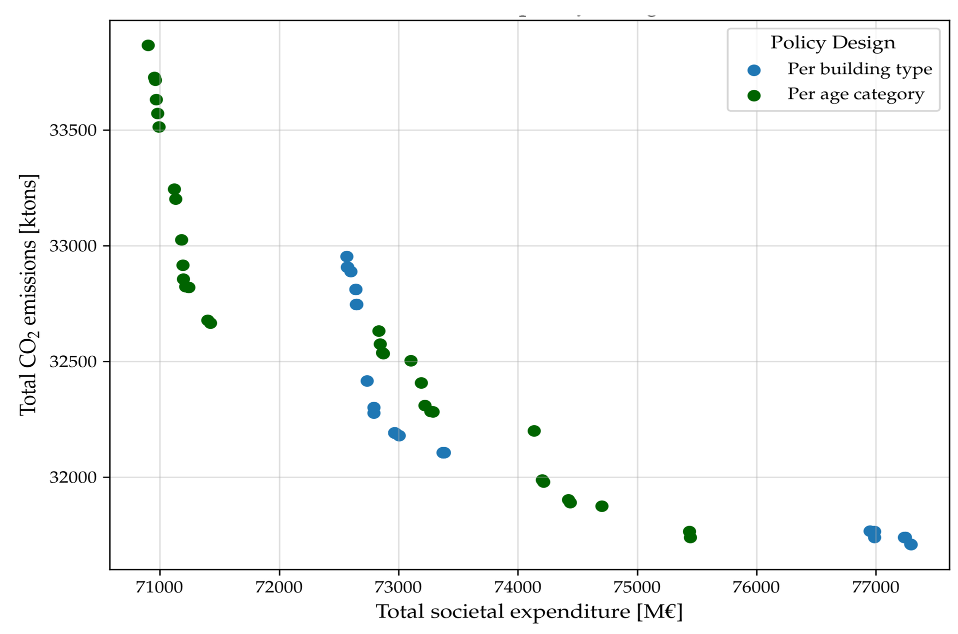


Figure 2: Pareto fronts of minimum societal cost and minimum CO_2 emissions when tailoring the policy design per building type or per age category

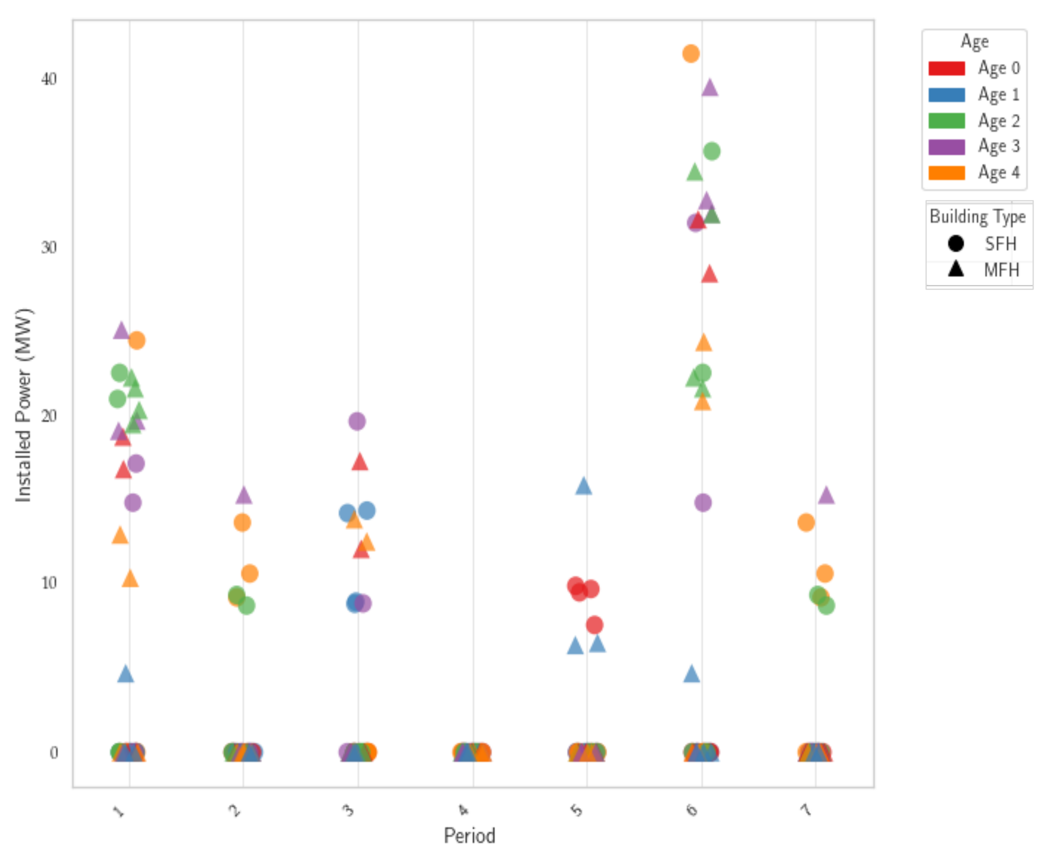


Figure 3: Newly installed heat pump capacity by building type and age across seven periods (2023–2050) for a low emission point. Shapes indicate building type (circles: SFH, triangles: MFH), and colors represent age categories.

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