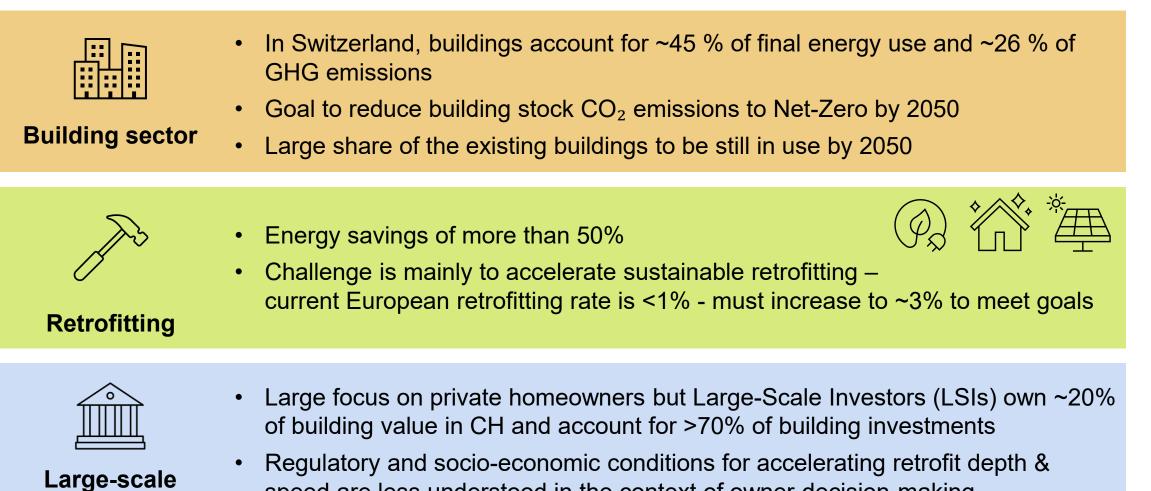ETH zürich

SusTec

PACE REFITS – Policies for accelerating renewable and efficient building and district retrofits

Alicia Lerbinger
Doctoral Candidate
February 1st, 2024

The critical role of real estate decarbonization in the energy transition

Building sector

- In Switzerland, buildings account for ~45 % of final energy use and ~26 % of GHG emissions
- Goal to reduce building stock CO_2 emissions to Net-Zero by 2050
- Large share of the existing buildings to be still in use by 2050

Retrofitting

- Energy savings of more than 50%
- Challenge is mainly to accelerate sustainable retrofitting – current European retrofitting rate is <1% - must increase to ~3% to meet goals

Large-scale investors

- Large focus on private homeowners but Large-Scale Investors (LSIs) own ~20% of building value in CH and account for >70% of building investments
- Regulatory and socio-economic conditions for accelerating retrofit depth & speed are less understood in the context of owner decision-making
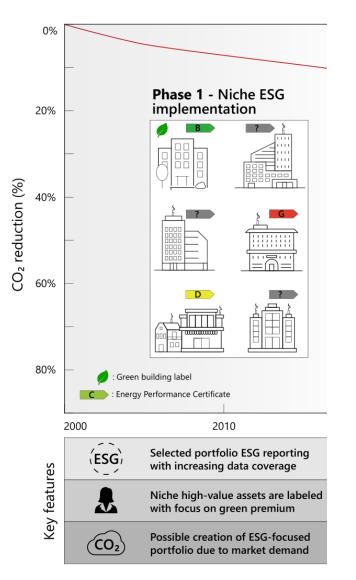
Analysis of the regulatory and techno-economic conditions supporting the investment decisions of Large-Scale Investors (LSIs)

WP 1

Real estate decarbonization – LSI retrofit decision-making
- **Phases** of real estate decarbonization
- Understanding real estate **decision making**
- The role of **policies** for real estate decarbonization

WP 2 + 3

Optimal long-term retrofit investment planning
- **Method: MANGOret** (**M**ulti-st**A**ge e**N**er**G**y **O**ptimization) for retrofitting
- Long-term **building** decarbonization strategies
- Long-term **portfolio** decarbonization strategies
- Long-term **district** decarbonization strategies
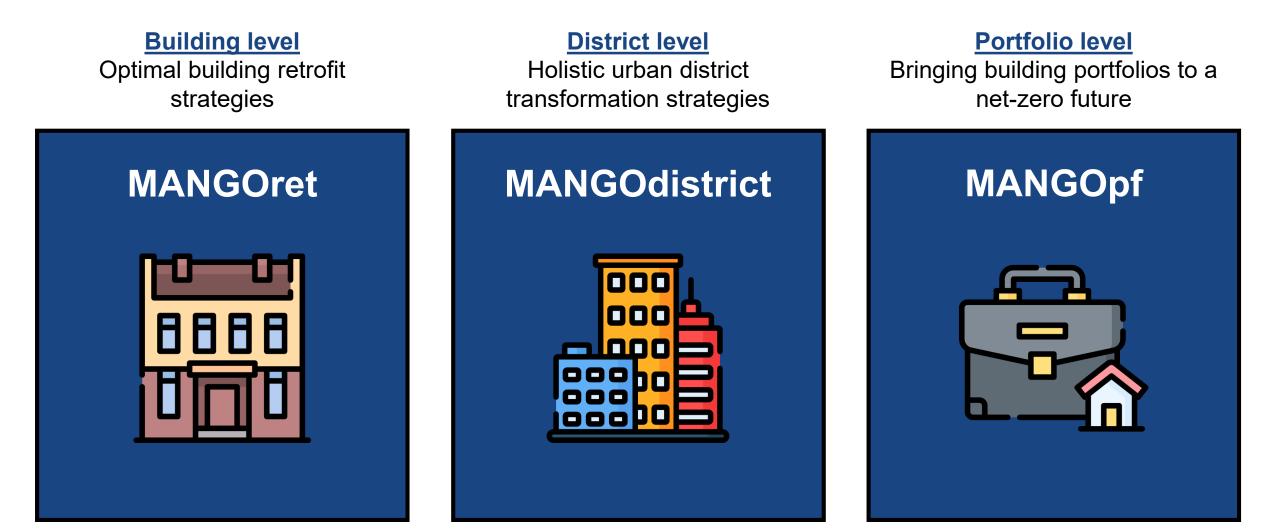
Real estate decarbonization
Two observed real estate decarbonization phases and one envisioned
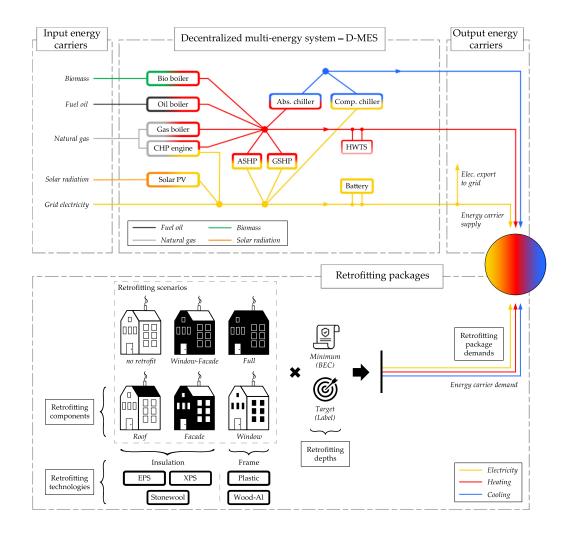

Categories:

- ESG considerations
- Management strategies
- CO_2 topics

Optimal long-term retrofit investment planning
MANGOret (**M**ulti-st**A**ge-e**N**er**G**y **O**ptimization) for retrofitting

Building level
Optimal building retrofit strategies

District level
Holistic urban district transformation strategies

Portfolio level
Bringing building portfolios to a net-zero future

MANGOret

MANGOdistrict

MANGOpf

Optimal long-term retrofit investment planning
MANGOret enabling long-term building decarbonization strategies

What is the optimal long-term asset investment strategy?

- Optimization of energy supply-side technologies (top) and retrofitting measures (bottom)

- Determines when interventions should take place over a long-term horizon

- Optimizing for costs and emissions (and in between)

- Takes into account asset-specific characteristics such as the condition of building components as well as real estate market trends
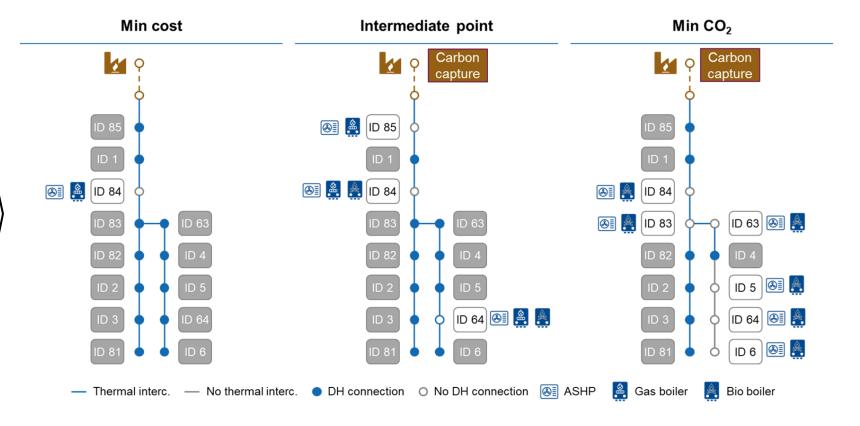
Optimal long-term retrofit investment planning
MANGOdistrict

Description

- Optimization model for the design of optimal decarbonization strategies for existing districts

Key features

- Considers both demand- and supply-side options
- Considers both building- vs district-level solutions
- Incorporates existing infrastructure and allows network expansions
- Integrates carbon capture & storage (CCS) as an emission-reduction technology for the waste incinerator
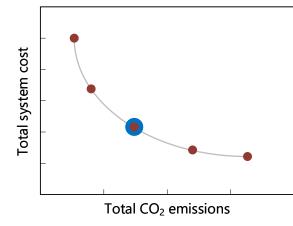
Optimal long-term retrofit investment planning
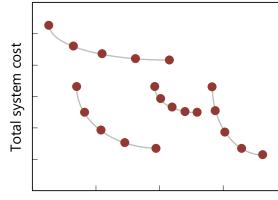## MANGOpf supports the decarbonization of LSI building portfolios

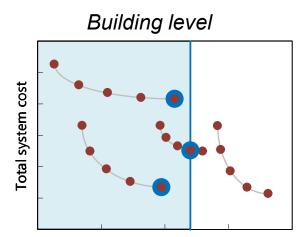## Portfolio-level decision-making

Building level - MANGOret

Choice based on project budget and/or desired CO_2 level

Portfolio level

Define optimization model that uses building-level strategies and:
- Seeks to choose one strategy per building
- Minimizes portfolio-level cost and considers CO_2 constraints

Policy conditions

Building level

Define CO_2 limit for each building in a portfolio
- Choose cheapest option that meets goal
- Treat carbon-intensive buildings (how?)

Portfolio level

Define portfolio-average CO_2 limit
- Enable flexibility that allows deeper retrofits for some buildings to offset emissions of carbon-intensive ones

Optimal long-term retrofit investment planning
MANGOpf supports the decarbonization of LSI building portfolios

Publications

ENVIRONMENTAL RESEARCH
INFRASTRUCTURE AND SUSTAINABILITY

PAPER

The interplay of policy and energy retrofit decision-making for real estate decarbonization
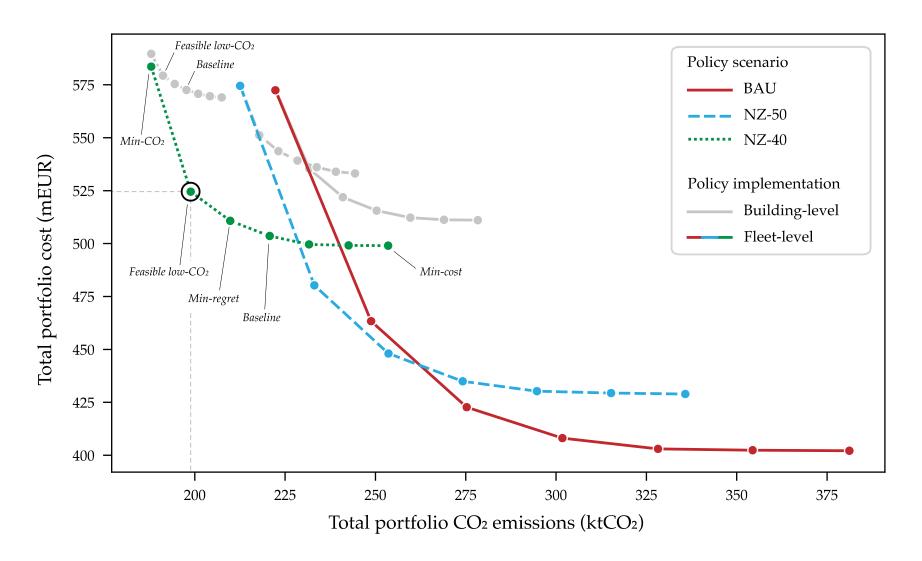
Ivalin Petkov[*], Christof Knoeri and Volker H Hoffmann

Group for Sustainability and Technology, ETH Zurich, 8092 Zurich, Switzerland
* Author to whom any correspondence should be addressed.

MANGO: A novel optimization model for the long-term, multi-stage planning of decentralized multi-energy systems

Georgios Mavromatidis[*], Ivalin Petkov

Group for Sustainability and Technology, ETH Zurich, 8092 Zurich, Switzerland

MANGOret: An optimization framework for the long-term investment planning of building multi-energy system and envelope retrofits

Ivalin Petkov[a,*], Georgios Mavromatidis[a], Christof Knoeri[a], James Allan[b], Volker H. Hoffmann[a]

[a] Group for Sustainability and Technology, ETH Zurich, 8092 Zurich, Switzerland
[b] Urban Energy Systems Laboratory, Swiss Federal Laboratories for Materials Science and Technology, Empa, 8600 Dübendorf, Switzerland

Optimal decarbonization strategies for existing districts considering energy systems and retrofits

Alicia Lerbinger[a,*], Ivalin Petkov[a,b], Georgios Mavromatidis[a], Christof Knoeri[a]

[a] Group for Sustainability and Technology, ETH Zurich, 8092 Zurich, Switzerland
[b] OPTIML AG, 8003 Zurich, Switzerland

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Article

Decarbonizing real estate portfolios considering optimal retrofit investment and policy conditions to 2050

Ivalin Petkov,[1,2,3,*] Alicia Lerbinger,[1] Georgios Mavromatidis,[1] Christof Knoeri,[1] and Volker H. Hoffmann[1]

Optiml

Alicia Lerbinger
Doctoral Candidate
alerbinger@ethz.ch

ETH Zürich
Group for Sustainability and Technology
sustec.ethz.ch

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- Petkov, I., Mavromatidis, G., Knoeri, C., Allan, J., Hoffmann, V. H. (2022), MANGOret: An optimization framework for the long-term investment planning of building multi-energy system and envelope retrofits. Applied Energy, Volume 314, https://doi.org/10.1016/j.apenergy.2022.118901

- Petkov, I., Lerbinger, A., Mavromatidis, G., Knoeri, C., Hoffmann, V. (2023). Decarbonizing real estate portfolios considering optimal retrofit investment and policy conditions to 2050. iScience, Volume 26, Issue 5, 106619, ISSN 2589-0042. https://doi.org/10.1016/j.isci.2023.106619

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