Simulating energy consumption at district level

Presentation of CROCUS

Karine Laffont-Eloire, DOWEL Management

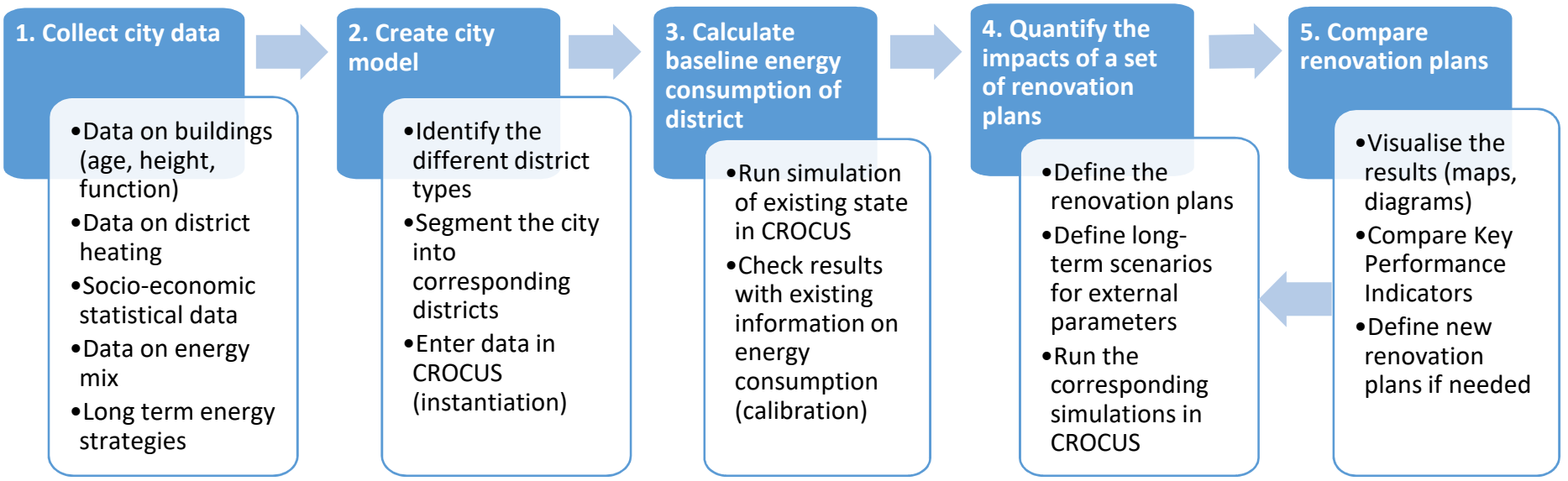
Rosenheim 12 September 2019

SINFONIA stands for “Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy” and is funded under the 7th Framework Programme for Research and Technological Innovation.

Context

- Objective of the study
  - Facilitate the implementation and replication of district-scale refurbishment plans
- Why do we need to simulate the energy consumption?
  - To better understand the energy profile of the city and estimate the potential benefits from large scale renovation
- Why the district scale?
  - Optimal scale to:
    - Simulate the interactions between buildings
    - Take into account the district heating network
    - Plan ambitious renovation plans

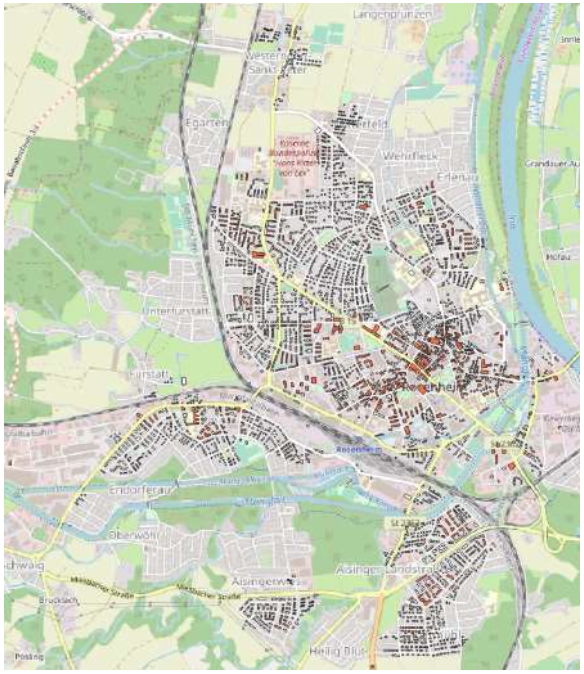
Implemented approach



- 2 levels of renovation (medium – deep)
- Scenarios for the evolution of energy prices

1. Collection of city data

Data provided by the city of Rosenheim



GIS Data
Key information on buildings:
- age,
- type,
- source of energy
- height of buildings,
- status of connection to the district heating network

Covers ~ half of the city

Close to 4000 buildings were finally included in the study

Other data:
- Energy mix
- Primary energy factors
- CO_2 emissions factors
- Energy prices (heating oil, gas)

Other sources

- Building performance depending on age and type (U values)
- Climate data
- Cost of renovation technologies

2. City model

❑ Segmentation in ‘districts’

- Building blocks / Homogeneous sets of buildings

Districts in Rosenheim

Low Rise

Open

- LR Open Ancient
- LR Open Very Old
- LR Open Old
- LR Open Semi Modern
- LR Open Modern

Compact

- LR Compact Ancient
- LR Compact Very Old
- LR Compact Old

Midrise

Open

- MR Open Ancient
- MR Open Very Old
- MR Open Semi Modern

Compact

- MR Compact Ancient
- MR Compact Very Old
- MR Compact Semi Modern

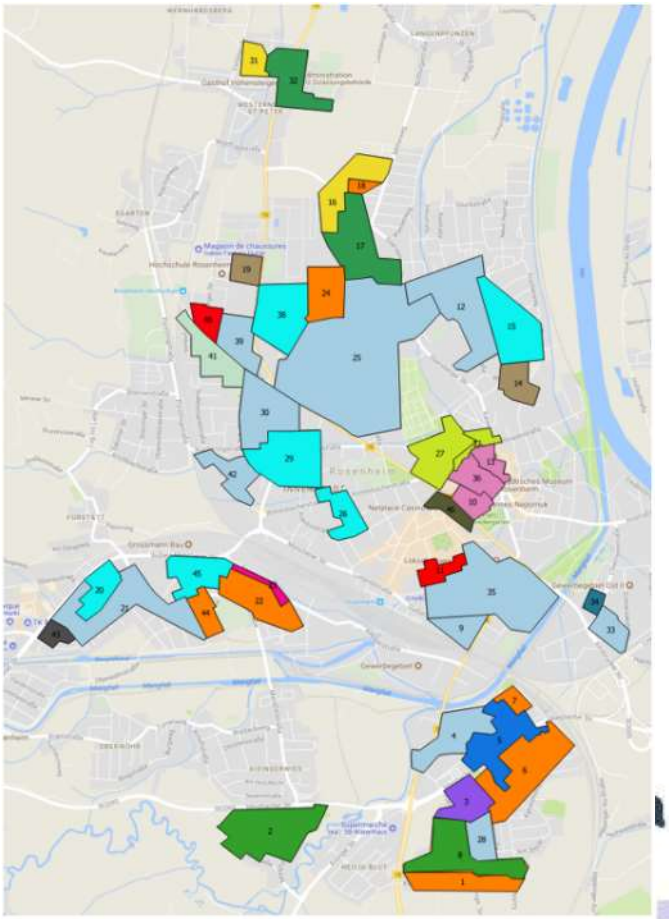
High Rise

Open

- HR Open Very Old

Compact

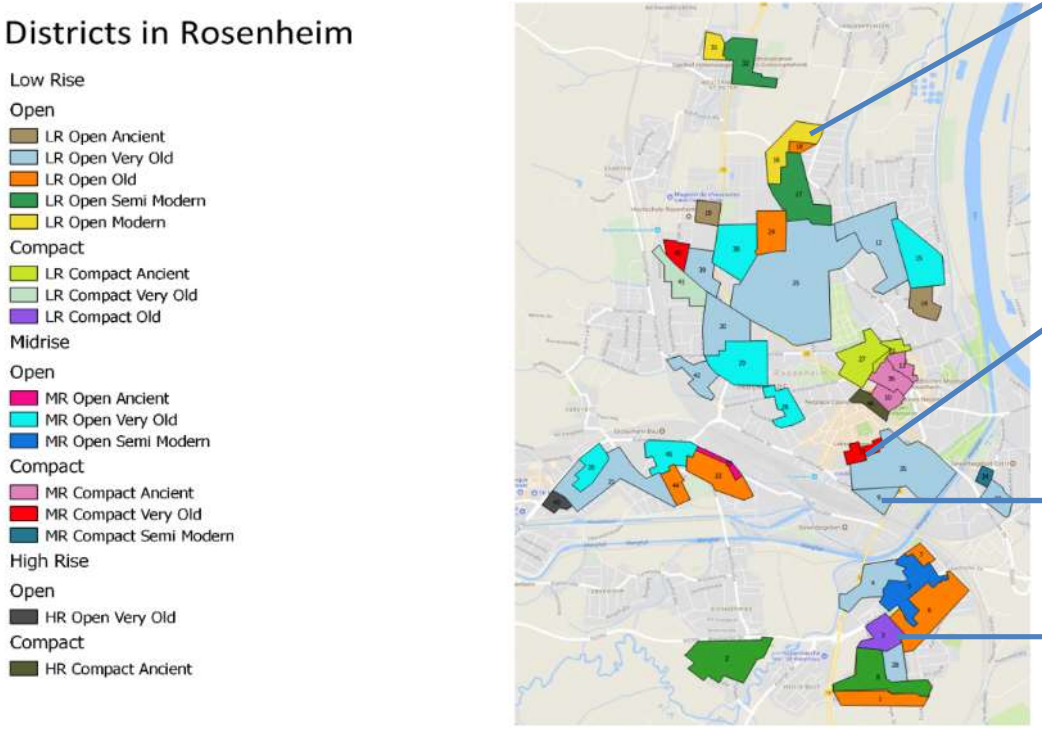
- HR Compact Ancient



2. City model

❑ Segmentation in ‘districts’

- examples



LR Open Modern	
Age/ Class	91 % After 2000 Modern
Height	100 % Low Rise (3-12)
Type of building	TH ; BMFH ; SFH
Density	1.3 ➔ Open
Energy source	Gas and Oil

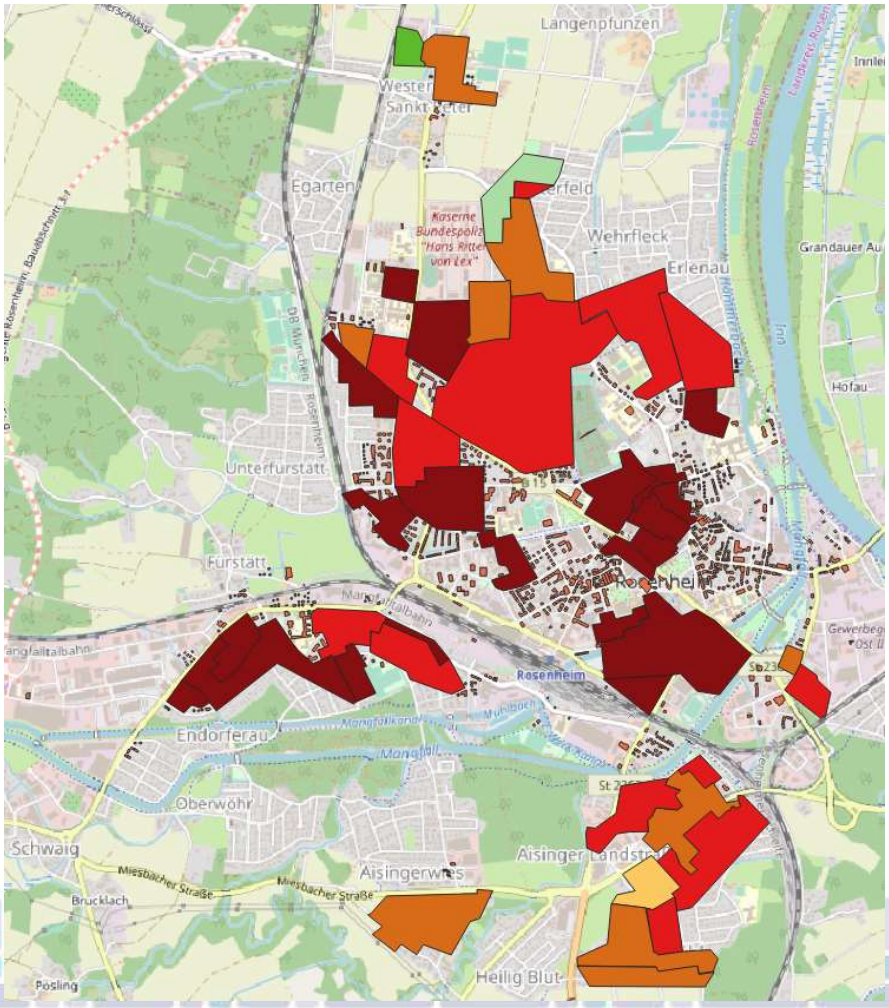
MR Compact Very Old	
Age/ Class	99% 1946-1960 Very Old
Height	100% Midrise (13-18)
Type of building	AB
Density	4.11 ➔ Compact
Energy source	District heating

LR Open Very Old	
Age/ Class	100% 1946-1960 Very Old
Height	100% Low Rise (3-12)
Type of building	BMFH
Density	1.89 ➔ Open
Energy source	Gas and Oil

LR Compact Old	
Age/ Class	100% 1961-1980 Old
Height	63% Low rise (3-12)
Type of building	BMFH
Density	3.2 ➔ Compact
Energy source	Gas

3. Baseline energy consumption

- Heat demand within each district (kWh/m².year)



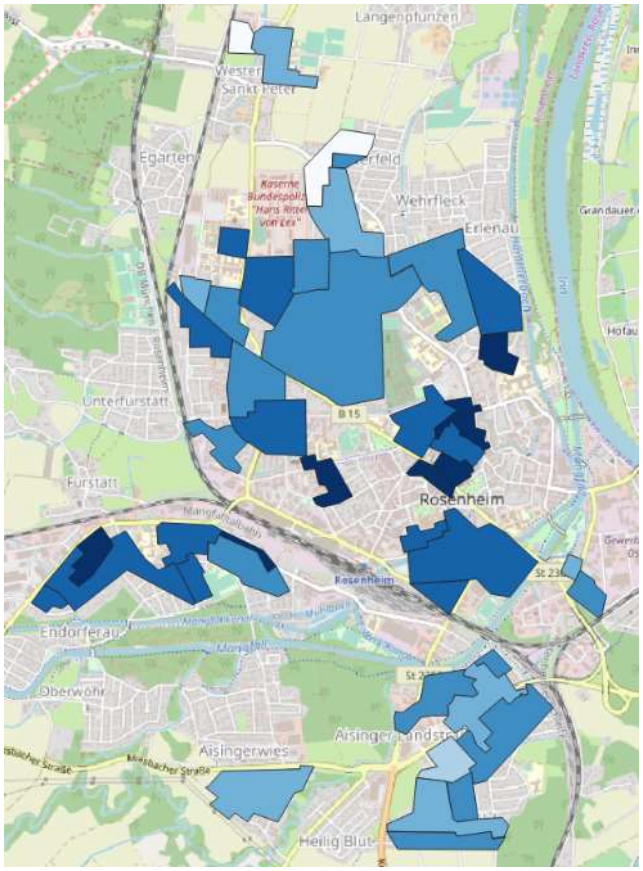
Energy need for space heating kWh/(m².a)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- >300

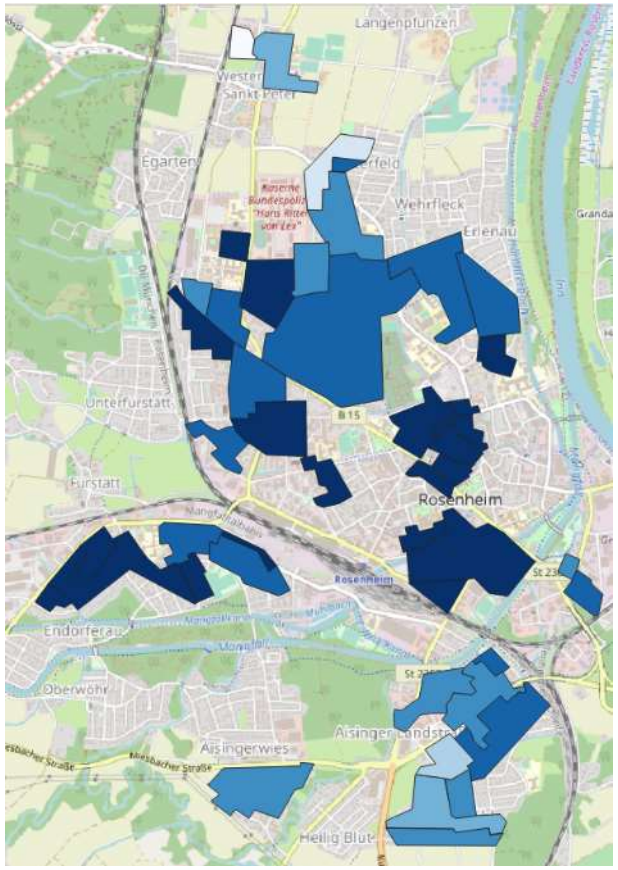
Sinfonia

4. Impact of renovation

Gains from renovation (final energy) – if all districts are completely renovated



Standard renovation



Advanced renovation

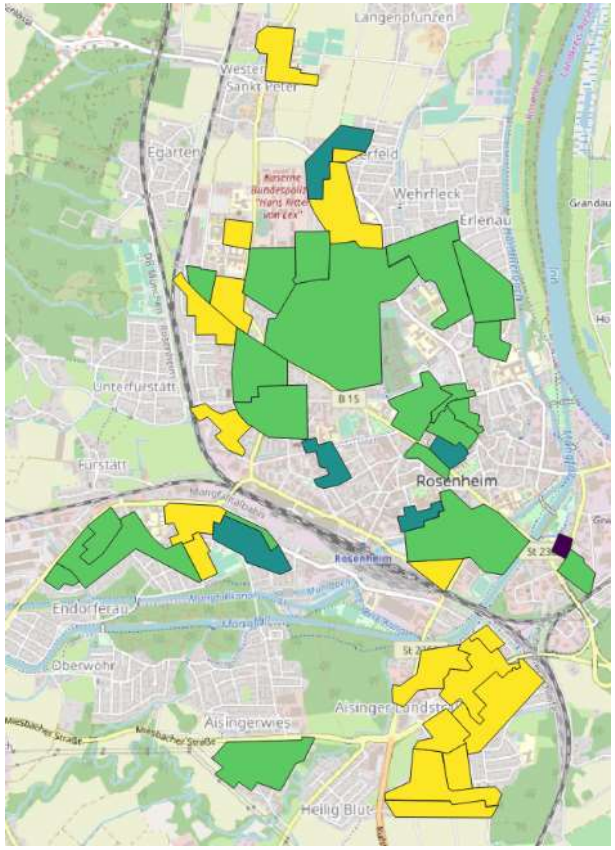
Energy gains (kWh.m²/year)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- >300

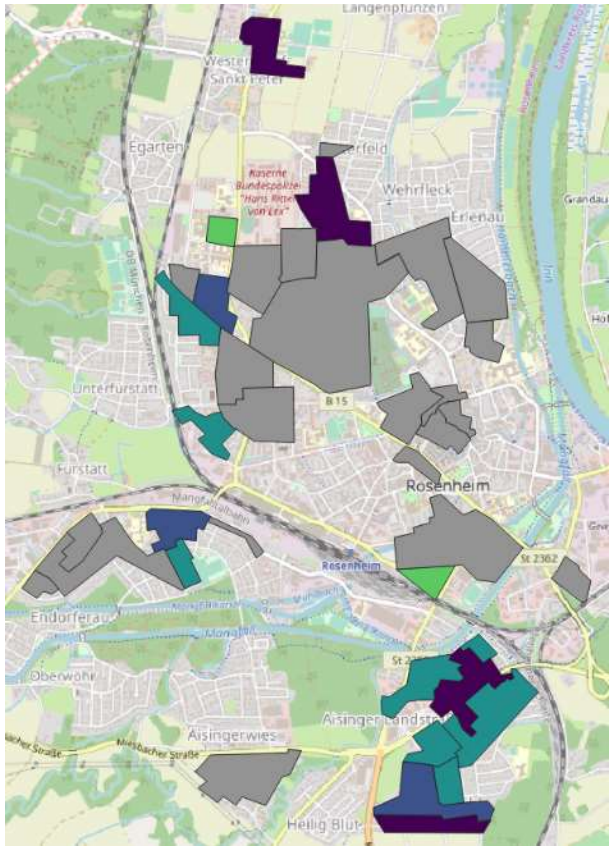
Sinfonia

5. Comparison of indicators

Average Payback Time within each district



Standard renovation



Advanced renovation

Discounted payback period (years)

- <10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- > 30

Sinfonia

5. Comparison of indicators

❑ Other calculated indicators:

Energy need for Domestic Hot Water and Cooling kWh/(m².a) 

Primary energy – kWh/(m².a) 

Greenhouse gas emissions - t CO2 eq / (m².a) 

Total investments 

Net Present Value 

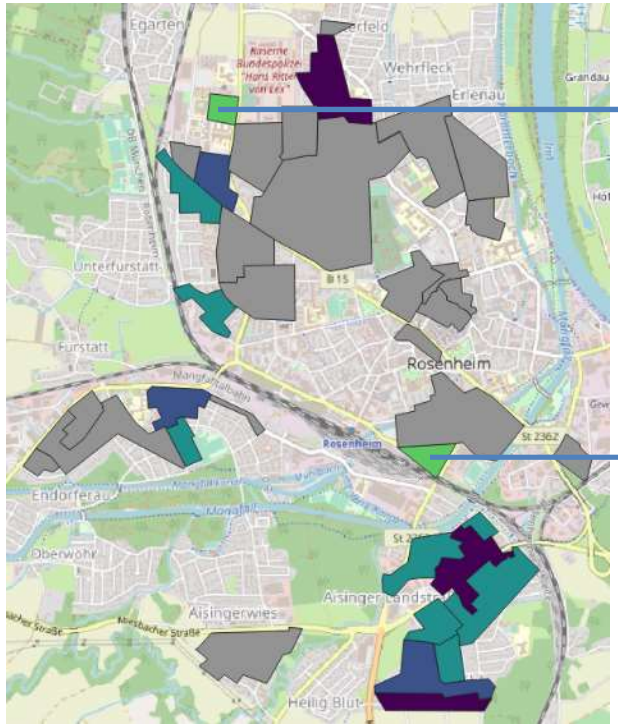
Internal Rate of Return

Sinfonia

THEN WHAT ?

Selection of districts to be targeted in priority

- If the Payback Time is the criteria of selection:



Required overall investment for deep renovation: 2,7 M€

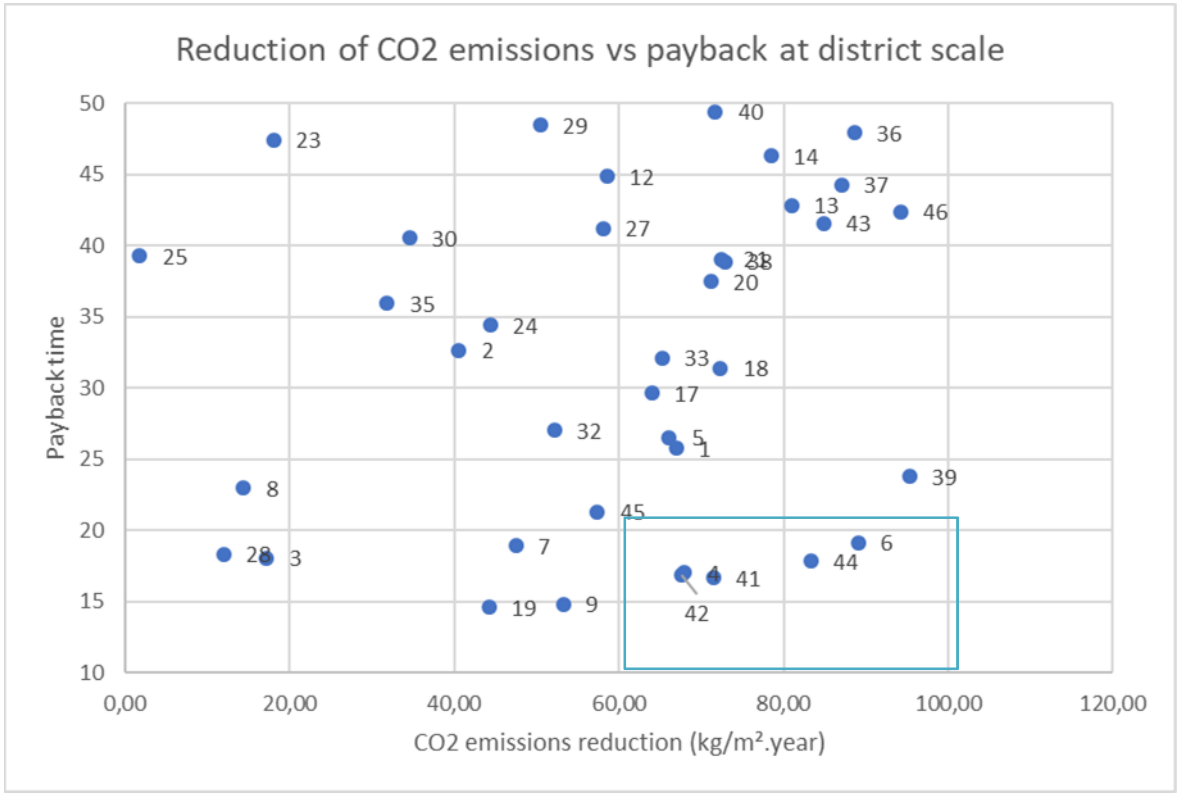
Required overall investment for deep renovation: 2,2 M€

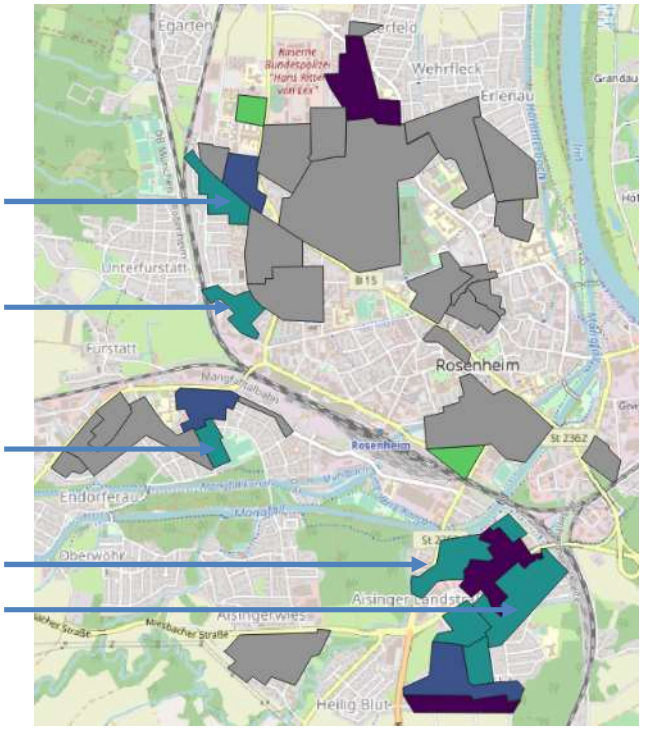
Other KPIs may be more relevant, depending on city strategy:

- CO2 emissions
- Energy savings

Selection of districts to be targeted in priority

- With Payback Time + CO2 emissions reduction





Selection of districts to be targeted in priority

- Should also account for uban planning strategies (i.e. required renewal of specific districts, etc.)
- In all cases, **stakeholder consultation is key**!
- Once the districts are selected
  - More detailed analysis of the targeted districts (energy audits of buildings), optimisation of refurbishment choices andbetter estimation of the required investment
  - **Unlocking financing and motivating building owners**
    - Incl. the municipality, social housing associations, owners of single family houses, condominiums, etc.

How to support the renovation of the building stock?

- Effective **business models** need to be found
- Tailored to each type of building owner
  - For **buildings owned by the city**: Energy Performance Contracts might be an interesting option
    - Require large projects (minimum energy cost baseline of 200k€/year)
  - For **social housing**:
    - Energiesprong business model. Renovate a whole building block to benefit from economies of scale and the industrialisation of solutions
    - Vertical extension of buildings can generate revenues to compensate the investment.
  - For **single family houses**: One Stop Shops
    - with third party financing or other smart financing schemes
    - + incentives
  - Interesting outcomes from EU projects on business models!

Conclusions & next steps

- This study tries to provide guidance to:
  - Better take into account energy performance when planning urban renewal
  - Assess the contribution of renovation to the city energy strategy
- Next steps: Improvement of the analysis before delivering final report to the city of Rosenheim
  - Better calibration of simulated consumption
  - Adjustment of simulated renovation plans
  - Choice of most relevant KPIs with the city and selection of districts
  - Evaluation in terms of investment required and payback time

Thank you!

Any suggestion? Please contact us:

Karine Laffont-Eloire, DOWEL Management
karine.laffont@dowel.eu