SINFONIA webinar “Tools to get urban energy planning right”

2/04/20

# Support to the long-term planning of energy-efficient renovation at district scale

***- Presentation of the CROCUS tool -***

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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.

# Why CROCUS?

- Take energy into account in urban planning
  - Decision support tool to target the districts to be refurbished in priority and compare the impact (energy / economic) of different long term refurbishment plans
- Bring together different types of data (too often used in silo) and find alternatives when data are missing
  - Tool that can work with a first limited dataset
  - Answer the needs of cities that don't have consumption data at building scale



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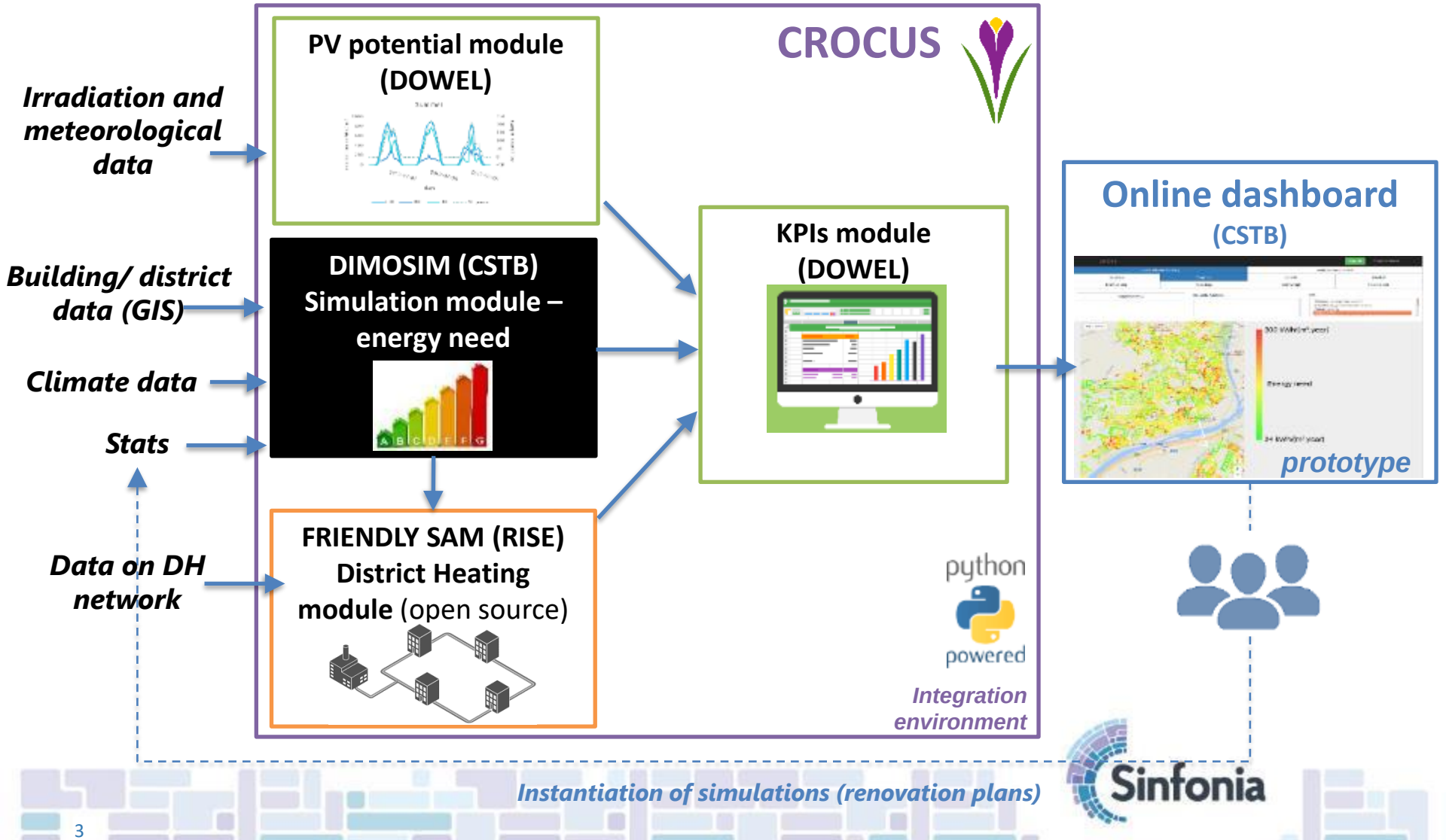
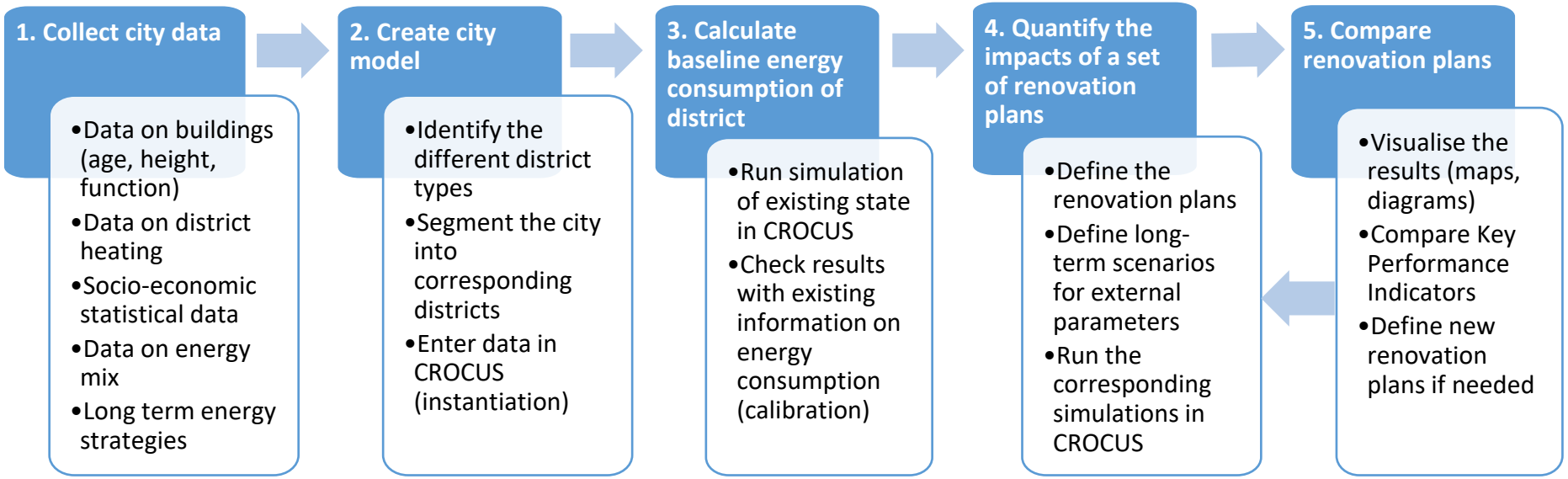
# What has been developed



# Focus on DIMOSIM

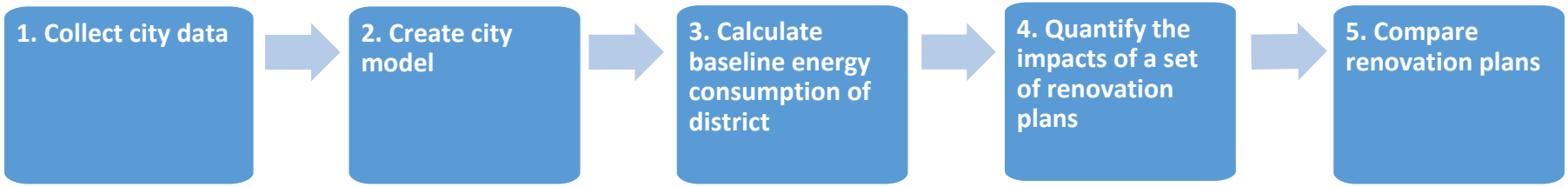
- DIstrict MOdeller and SIMulator
- Proprietary tool of CSTB
- What it does:
  - Generation of building thermal models (calculation of matrices from physical building parameter as Uwall etc.), calculation of nominal loads (depending on chosen setpoints)
  - Generation of electrical and thermal loads in buildings

# Implemented approach




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

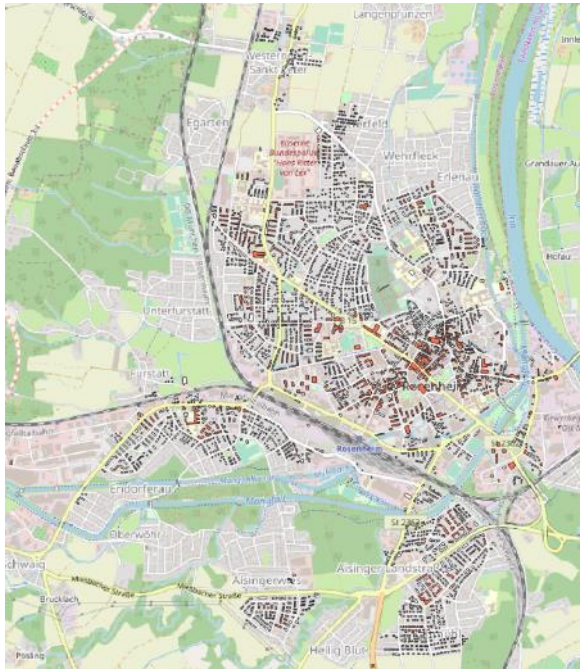
# Approach and tool tested with 5 SINFONIA cities




| | | | | |
|---|---|---|---|---|
| *Pilot cities* | | | Innsbruck | Bolzano |
| *Early Adopter Cities* | Boras | La Rochelle | | Rosenheim |

# 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, electricity)
- Cost of renovation technologies

## *Other sources*

- Building performance depending on age and type (U values)
- Climate data

*Example of Rosenheim & Bolzano*

# 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

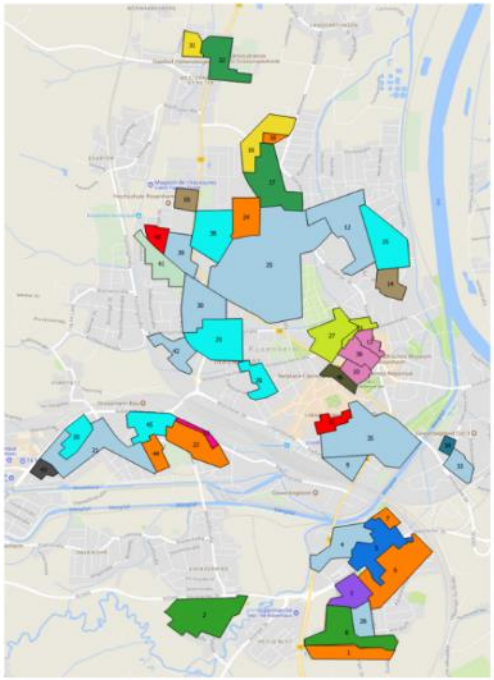
Compact
- LR Compact Ancient
- LR Compact Very Old
- LR Compact Old

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

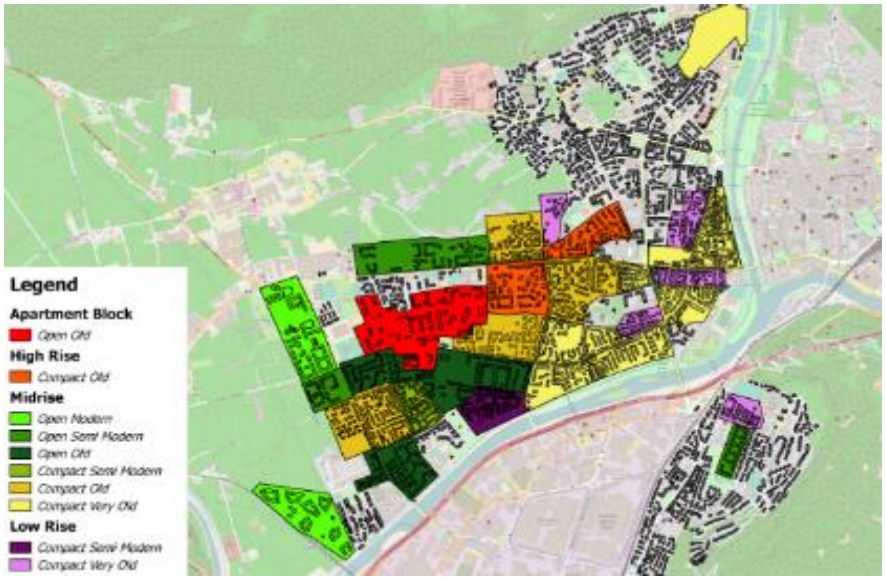
Compact
- MR Compact Ancient
- MR Compact Very Old
- MR Compact Semi Modern

High Rise
Open
- HR Open Very Old

Compact
- HR Compact Ancient



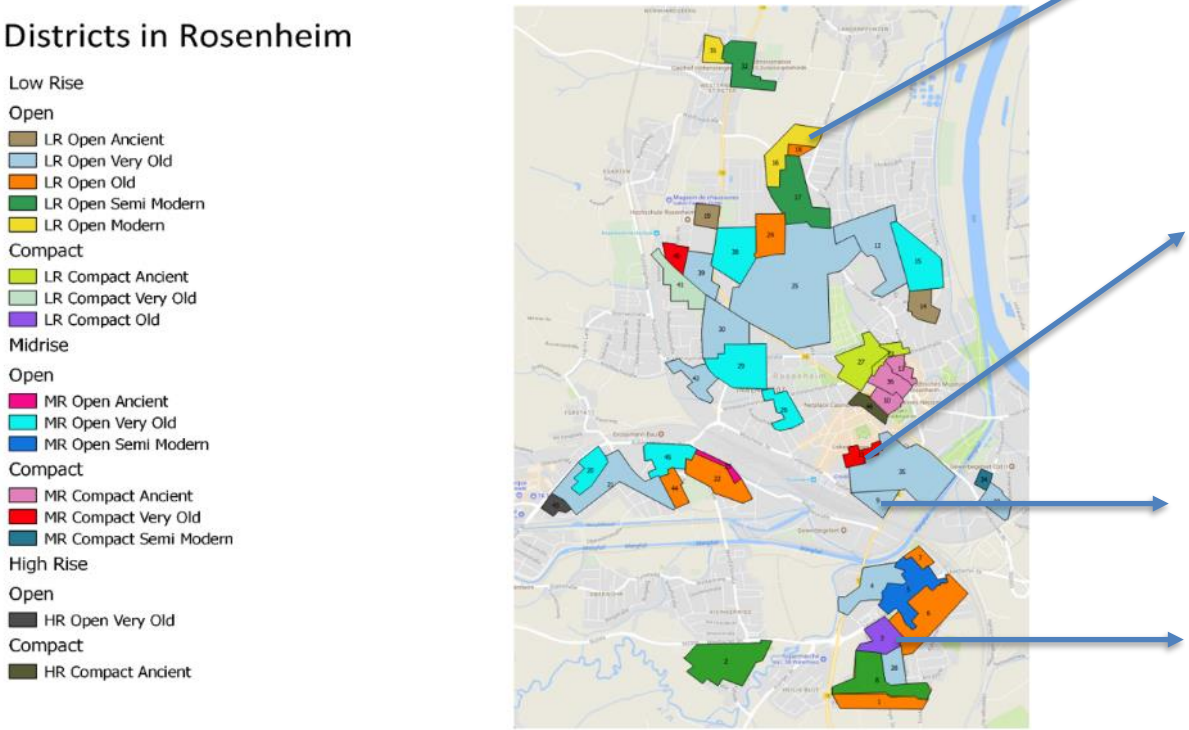
Districts in Bolzano



# 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 |

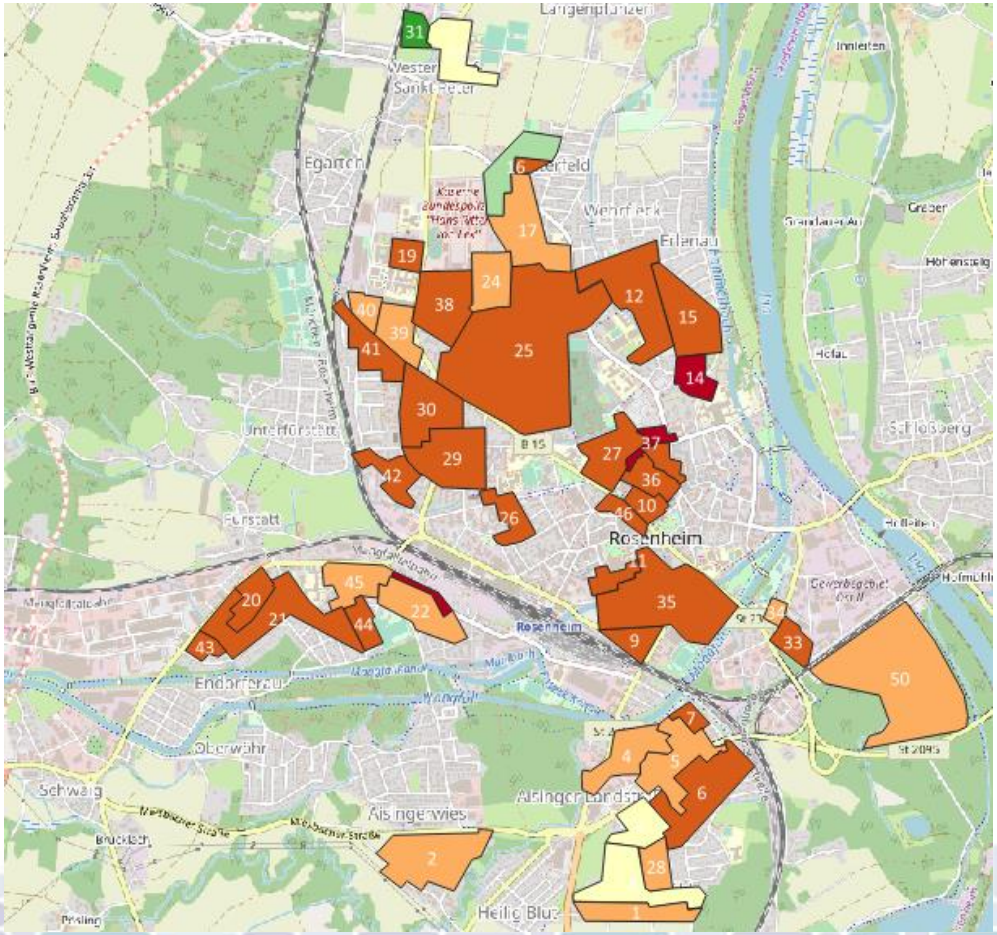
| MR Compact Very Old | |
|---|---|
| Age/ Class | 99% 1946-1960 Very Old |
| Height | 100% Midrise (13-18) |
| Type of building | AB |
| Density | 4.11 ➔ Compact |
| Energy source | District heating |

| 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)

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- > 250

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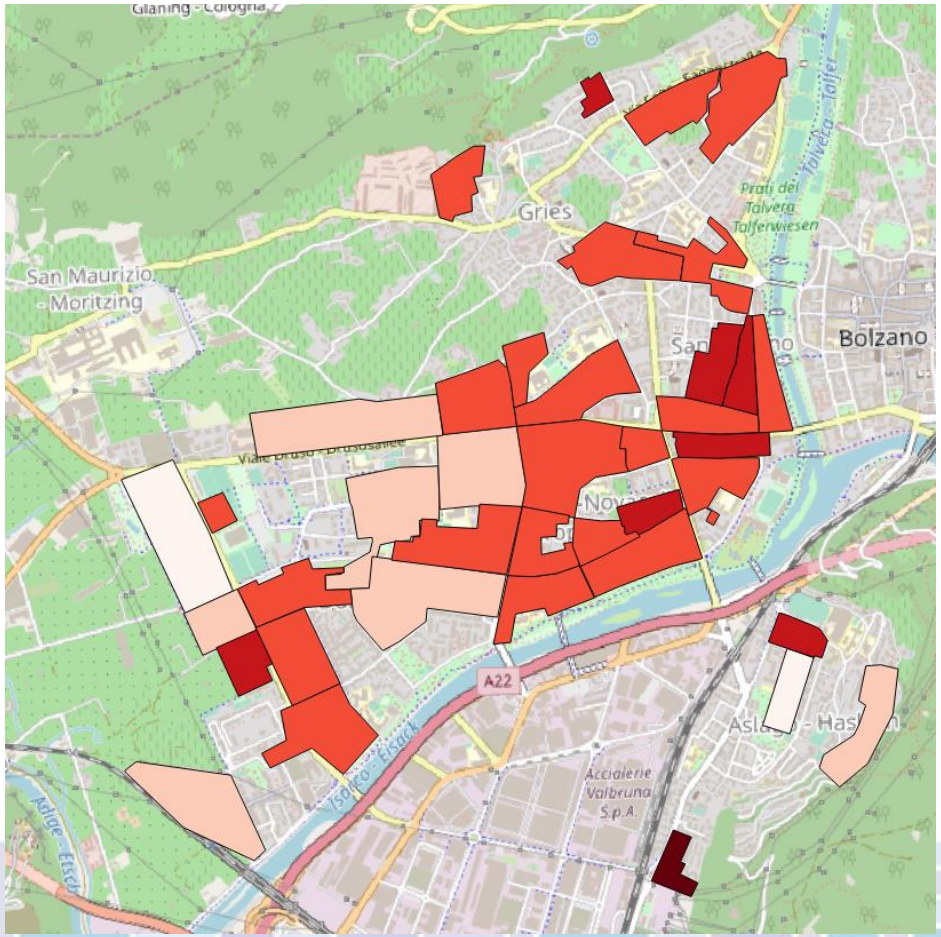
# 3. Baseline energy consumption

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




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

- < 50 kWh/m².year
- 50-100 kWh/m².year
- 100-150 kWh/m².year
- 150-200 kWh/m².year
- >200 kWh/m².year

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# 4. Impact of renovation

*Example of Rosenheim*

**Alternatives simulated:**

1) "Standard refurbishment ": targeting the energy consumption values set by the current regulation on renovation : Energieeinsparverordnung (EnEV)
2) "Advanced refurbishment": U-values for optimal energy related refurbishment, as defined by PHI for the study of the Kastenau district

*Example of Bolzano*

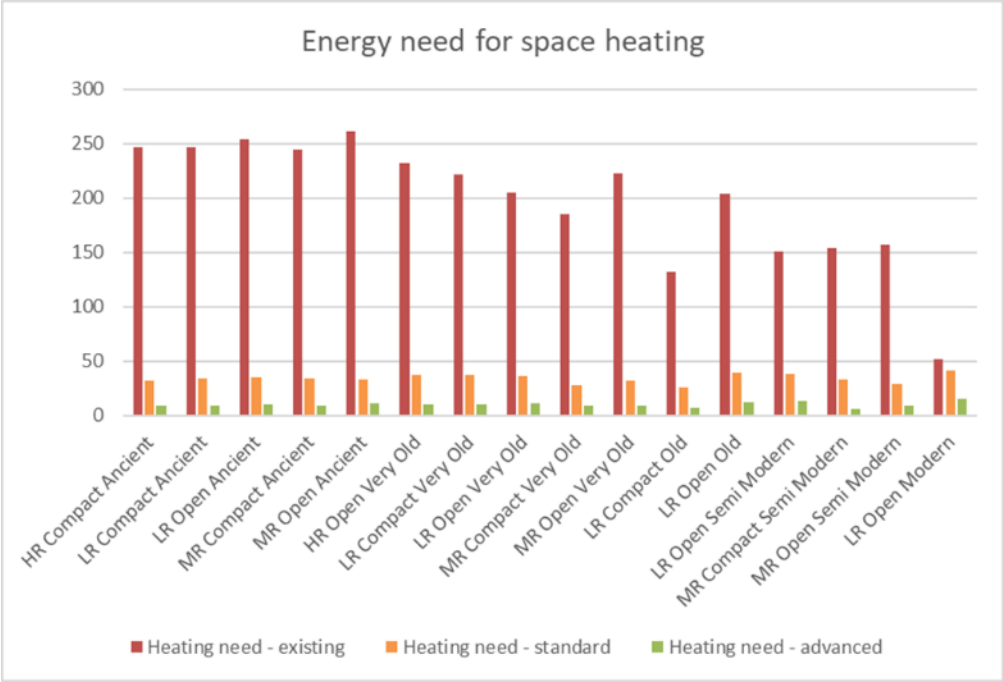
**Alternatives simulated:**

1) "Usual refurbishment ": shallow renovations most commonly carried out up to now (Roof & windows)

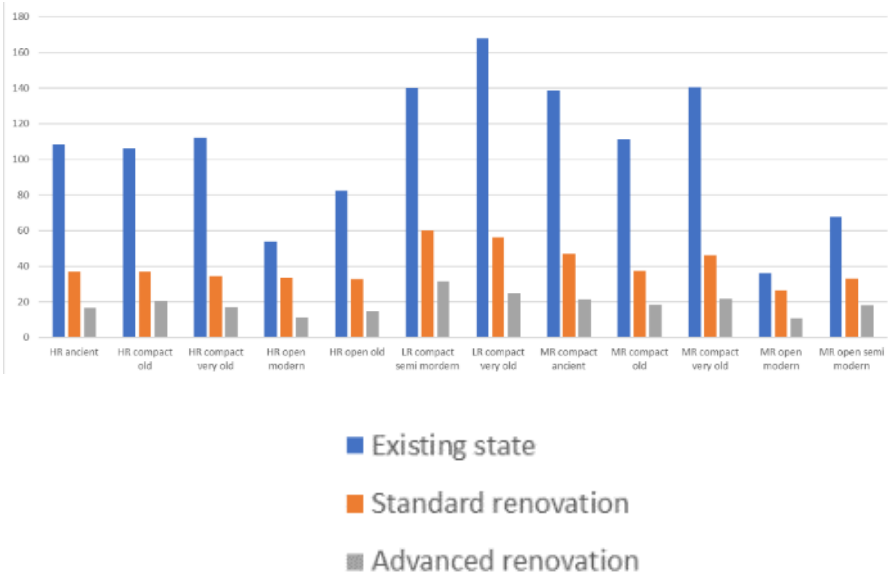
2) "Advanced refurbishment": targeting the energy consumption values set by the latest regulation on renovation

# 4. Impact of renovation on the energy demand

*Example of Rosenheim*



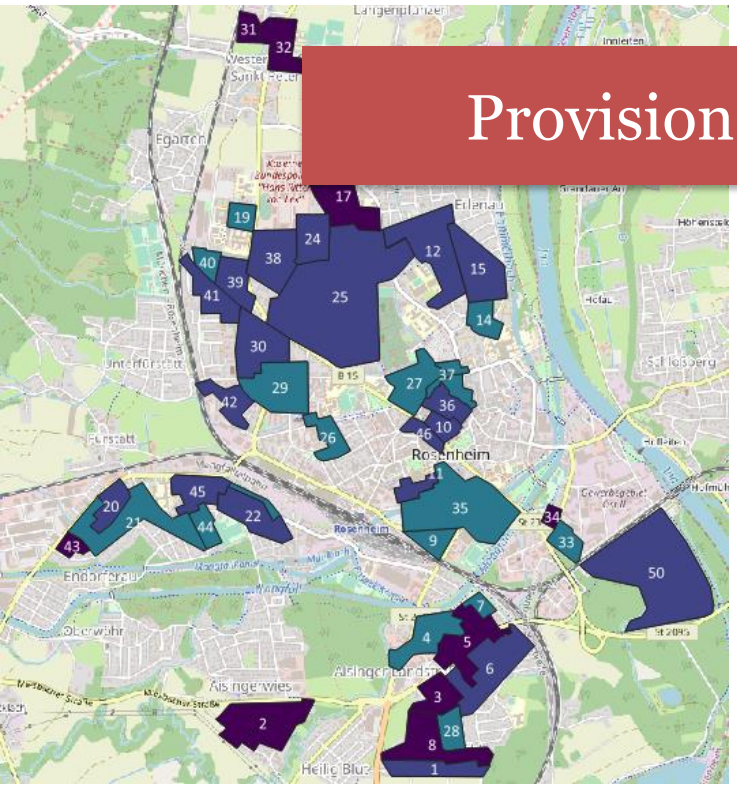

*Example of Bolzano*

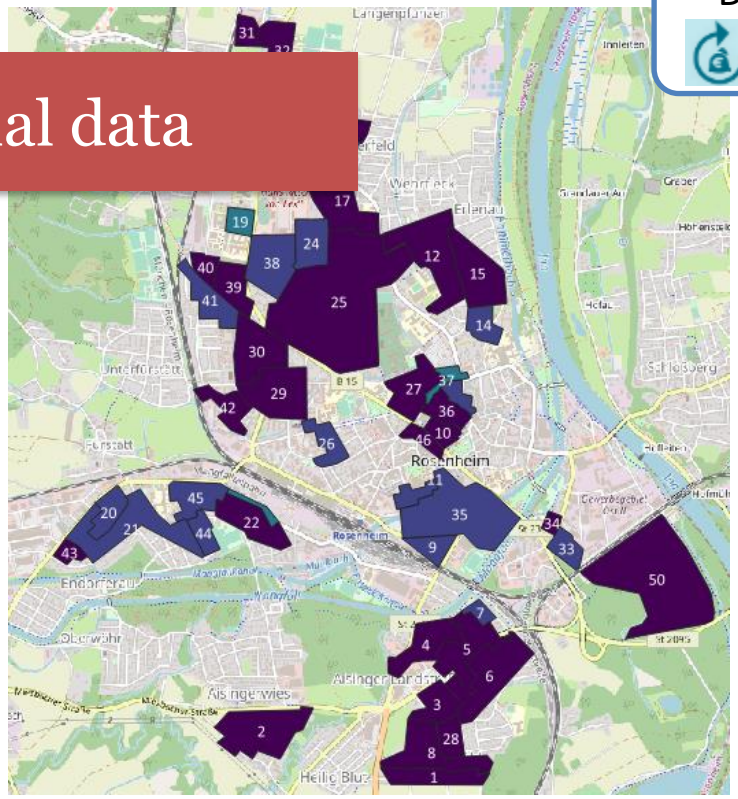


# 5. Comparison of indicators

## Average Payback Time within each district

Provisional data




Discounted payback period (years)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- > 50

*Standard renovation*

*Advanced renovation*

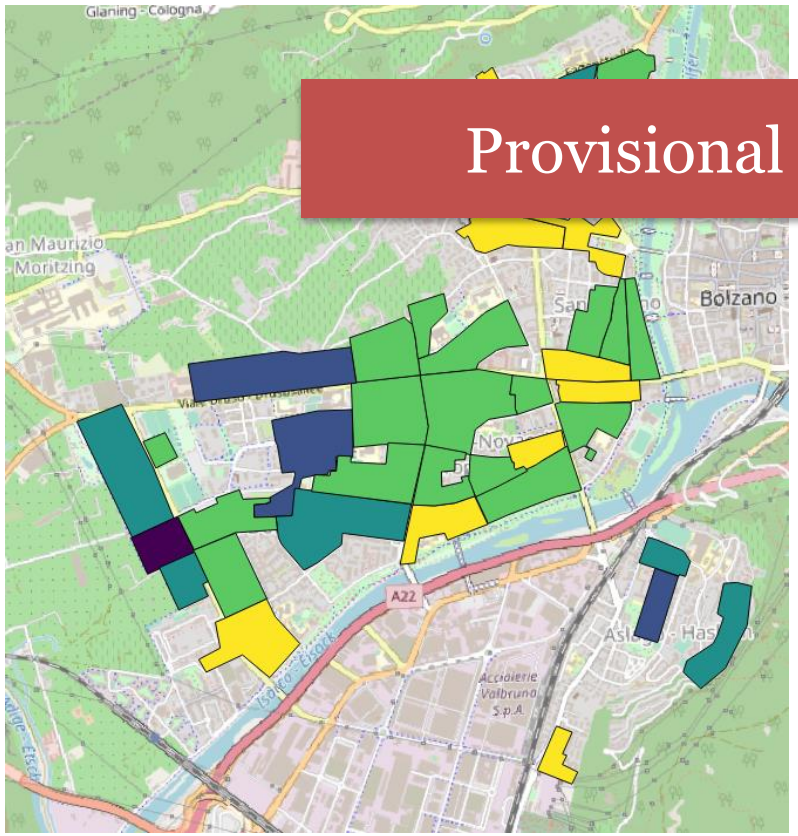
# 5. Comparison of indicators

## Average Payback Time within each district

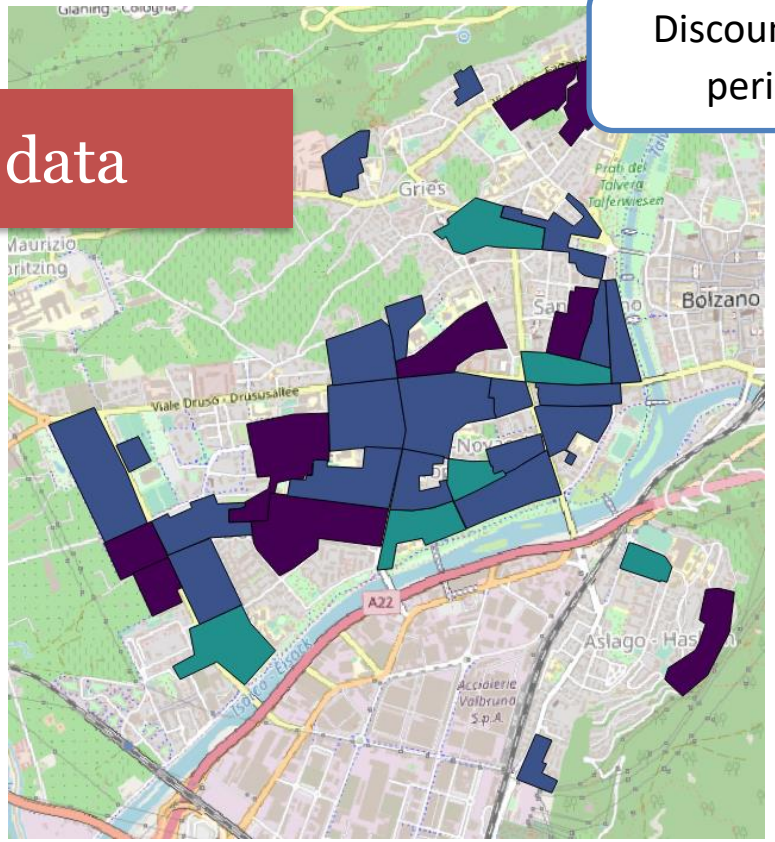
Provisional data

Discounted payback period (years)

<12
12 - 15
15 - 20
20 - 25
> 25




*Usual renovation*




*Advanced renovation*

# 5. Comparison of indicators

- WARNING: provides **relative rather than absolute** values!
  - the payback time, which is the indicator most often used when assessing the profitability of an investment, provides a biased and rather incomplete picture, with a preference for the "low hanging fruits", and not the most energy efficient measures.
    - The Internal Rate of Return and the Net Present Value may be more adequate indicators (provided they are calculated over long period, for instance 25 years).
  - The calculation of the payback usually only accounts for the financial benefits related to energy efficiency, and not for other non-energy benefits which are more difficult to monetise.
    - Co-benefits include improvement of comfort, health, well-being and accessibility, increase in productivity, green property value, environmental benefits, tackling fuel poverty, etc…

# 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

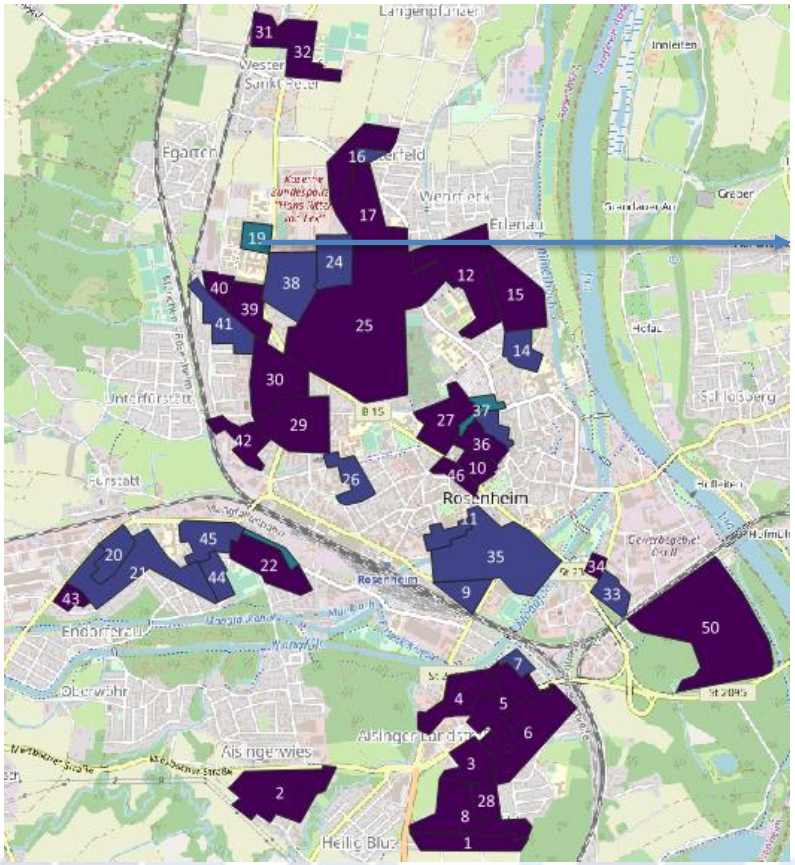
Net Present Value

Internal Rate of Return

# THEN WHAT ?

# Selection of districts to be targeted in priority

- If the Payback Time is the criteria of selection:



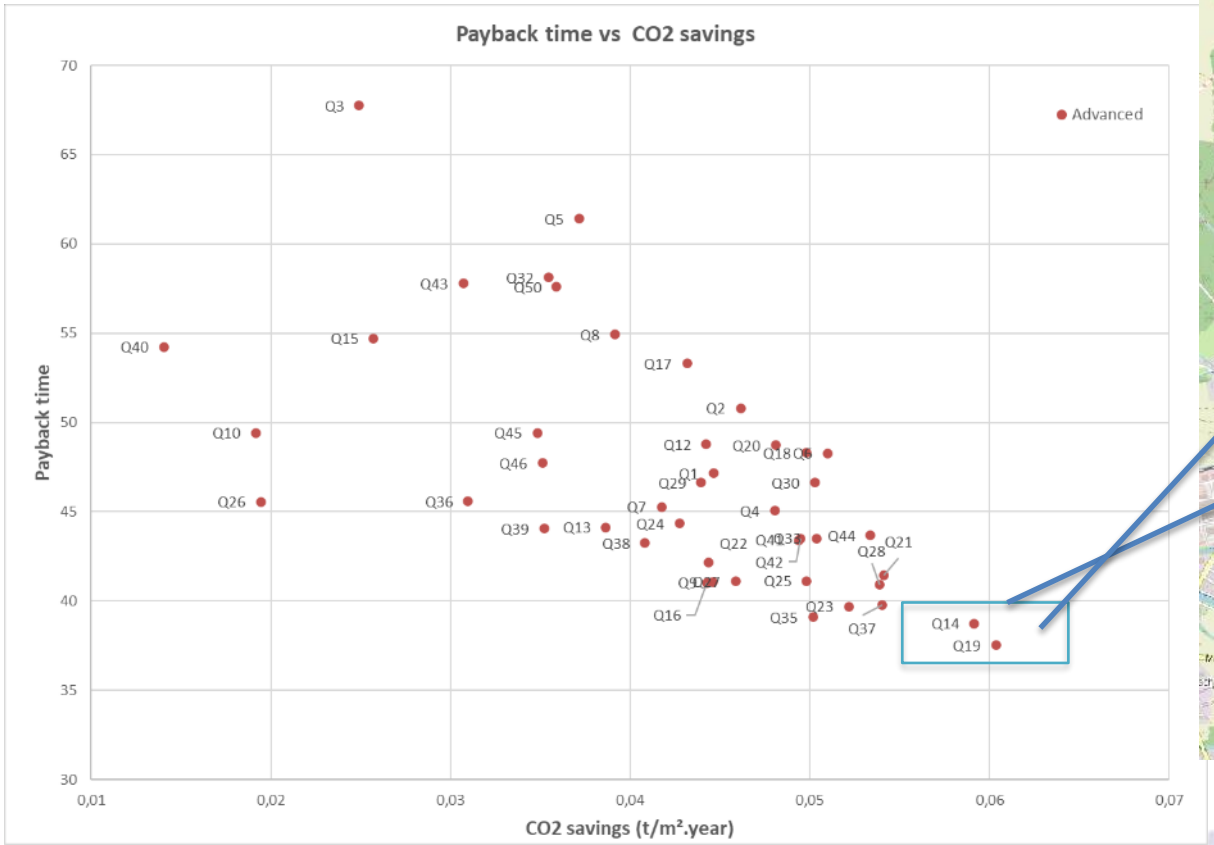

Required overall investment for deep renovation: 3.2 M€

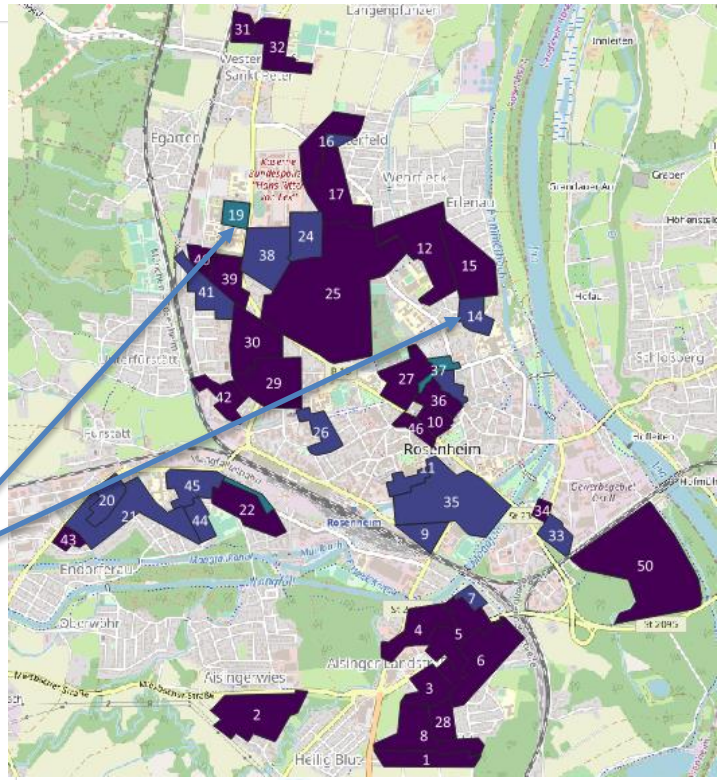
Other KPIs may be more relevant, depending on city strategy:

- CO2 emissions
- Energy savings

# Selection of districts to be targeted in priority

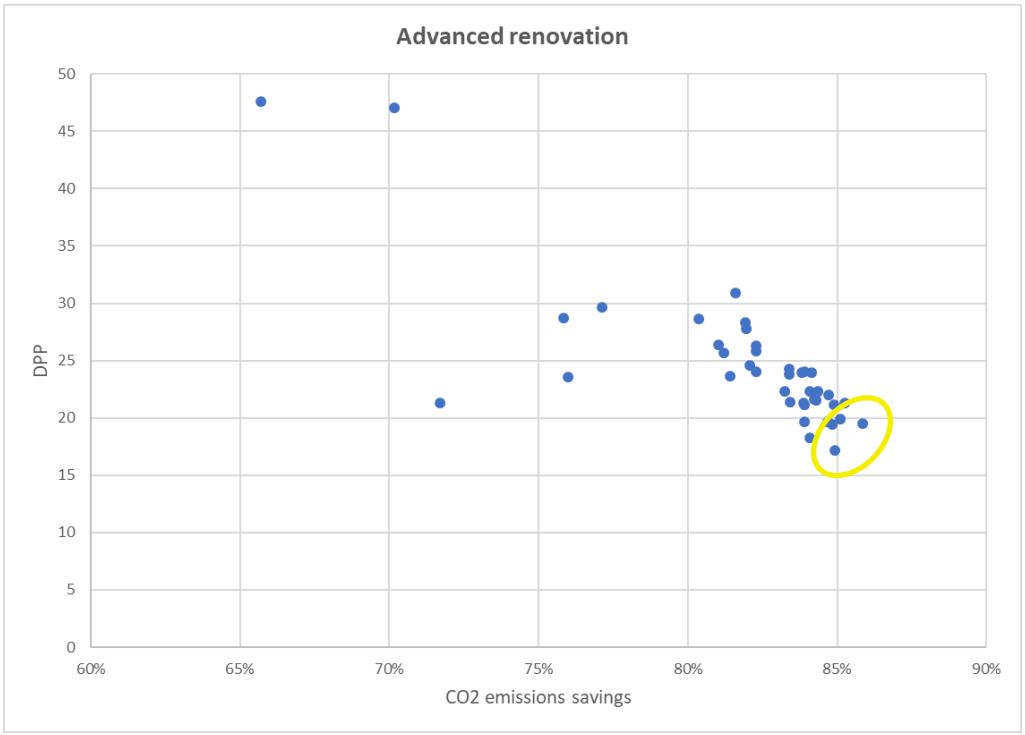
- With Payback Time + CO2 emissions reduction

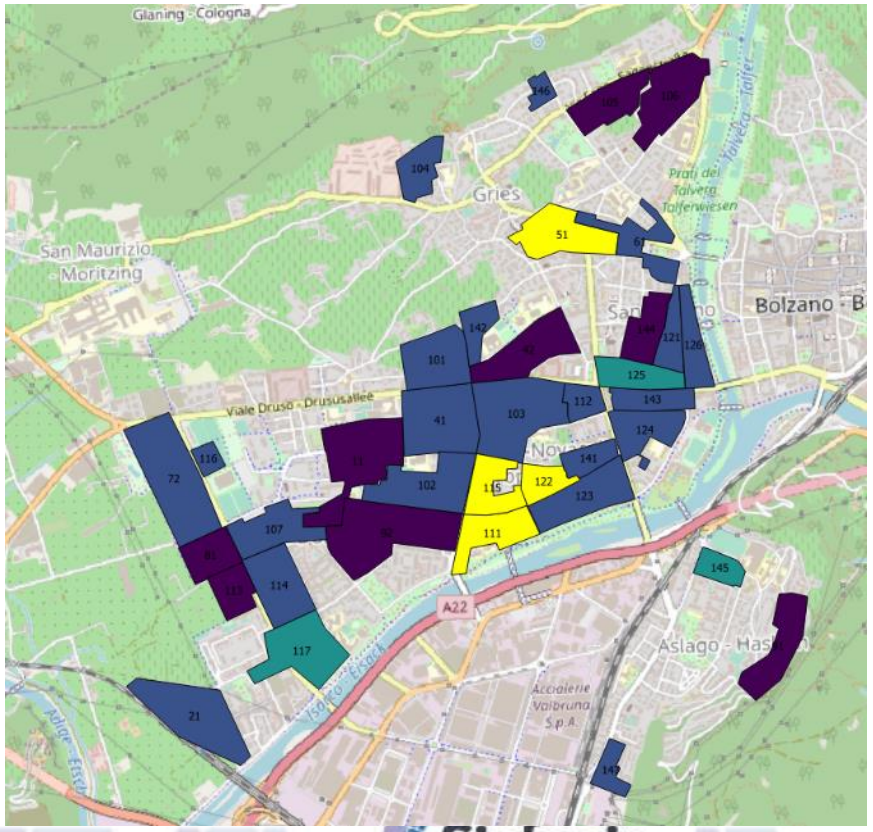


# Selection of districts to be targeted in priority

- 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 and better estimation of the required investment
  - **Unlocking financing and motivating building owners**
    - Incl. the municipality, social housing associations, owners of single family houses, condominiums, etc.

# CONCLUSIONS

# Lessons learned when developing and using CROCUS

- Software / integration of different modules
  - Complex environment with several computer languages
  - Regular update of the modules ⇨ impact on integration
- Data !
  - Different conditions for data collection (regulations/ local constraints) ⇨ different model outcomes for the cities
  - Data on buildings footprint and height:
    - thanks to the work performed by EURAC, no issue in Bolzano.
    - in some of the EACs: pre-processing required to 'clean' the data and keep only the spaces likely to be heated
    - …and when data are not accessible? ⇨ approach to be adapted (district approach)
  - In all cases, data pre-processing and post-processing are heavily time-consuming

# Next steps

- Ongoing work with Bolzano and Rosenheim to validate the results and fine-tune the content and format of the reports
- Completion of analyses for Innsbruck, La Rochelle and Boras
- Delivery of good practices & recommendations