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Using least cost renovation combinations in buildings for developing future heat demand density maps: case studies in three cities in Europe

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Content

(1) Aim

(2) Methodology

(3) Results

(4) Conclusions and discussion

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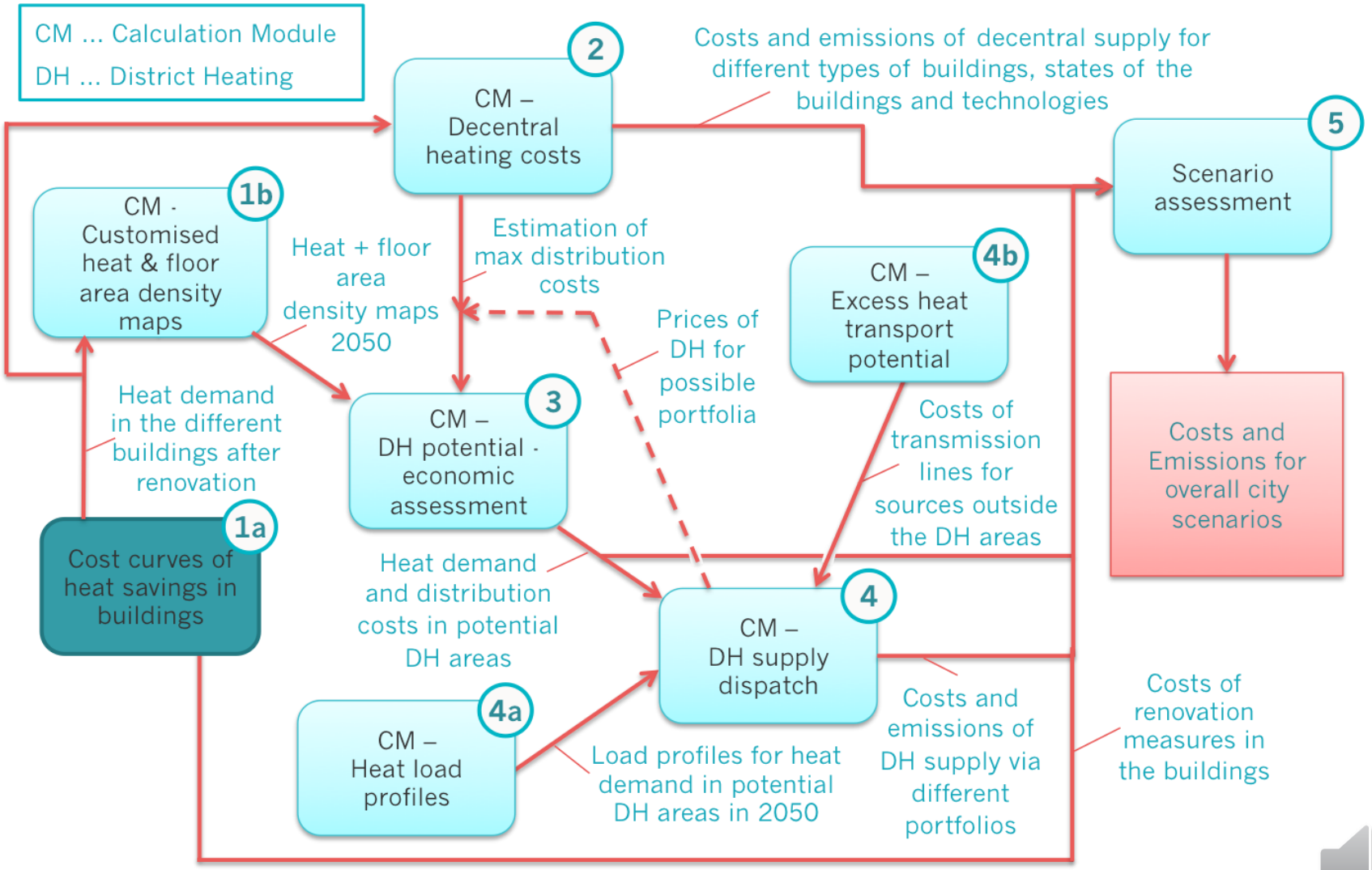
Section 1

Aim of the analysis

Derive scenarios for future H&C



Aim of the work

- Set-up databases of the buildings in the cities containing information of location, gross floor area and heat demand
- Find least cost renovation combinations for the building stock in the cities for reaching different overall saving targets
- Create several heat demand density maps per city for further analysis of the potentials for district heating

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Section 2

Methodology

Approach (for each city)

1

Set-up building database

- Collect and combine **existing datasets of the buildings** from the cities, **fill missing data** and **assign types and construction periods**
- **Merge with data on heat demand per gross floor area** according to types and construction period from Invert/EE-Lab

→ Databases of all buildings with location, floor area and current heat demand

2

Derive renovation packages

- **Derive costs** [EUR/m²] **of** various **single measures** on different parts of the surface of buildings (change of windows, insulation of walls etc.) for the countries based on (Hummel et al 2020) & compare with local data if available
- **Derive costs** [EUR/m²] **and effects** [MWh/building] **of 10 renovation packages** (= combination of single measures) for reaching different levels of savings in single buildings for each building type and construction period **based on lowest investment costs**

→ Costs and effects of 10 renovation packages for each building type and construction period

Approach (for each city)

3

Identify combination of renovations

- **Calculate costs** [EUR/MWh] and effects [MWh/building] **of all 10 renovation packages** for each building type and construction period
- **Order all possible packages** of all buildings a**ccording to costs** and **calculate absolute effects** [MWh] for all buildings
- **Identify cheapest combination of packages** in all buildings **to reach pre-defined saving targets** of heat demand for space heating **in the city**

→ Dataset of renovation packages to be applied in each building of the city to reach different levels of overall savings

4

Derive heat demand density maps

- **Derive a heat demand density map** (100 x 100 m) **for each predefined level of heat savings in the city** using the adapted buildings databases of the city

→ Heat demand density maps for each predefined level of overall heat savings in the city

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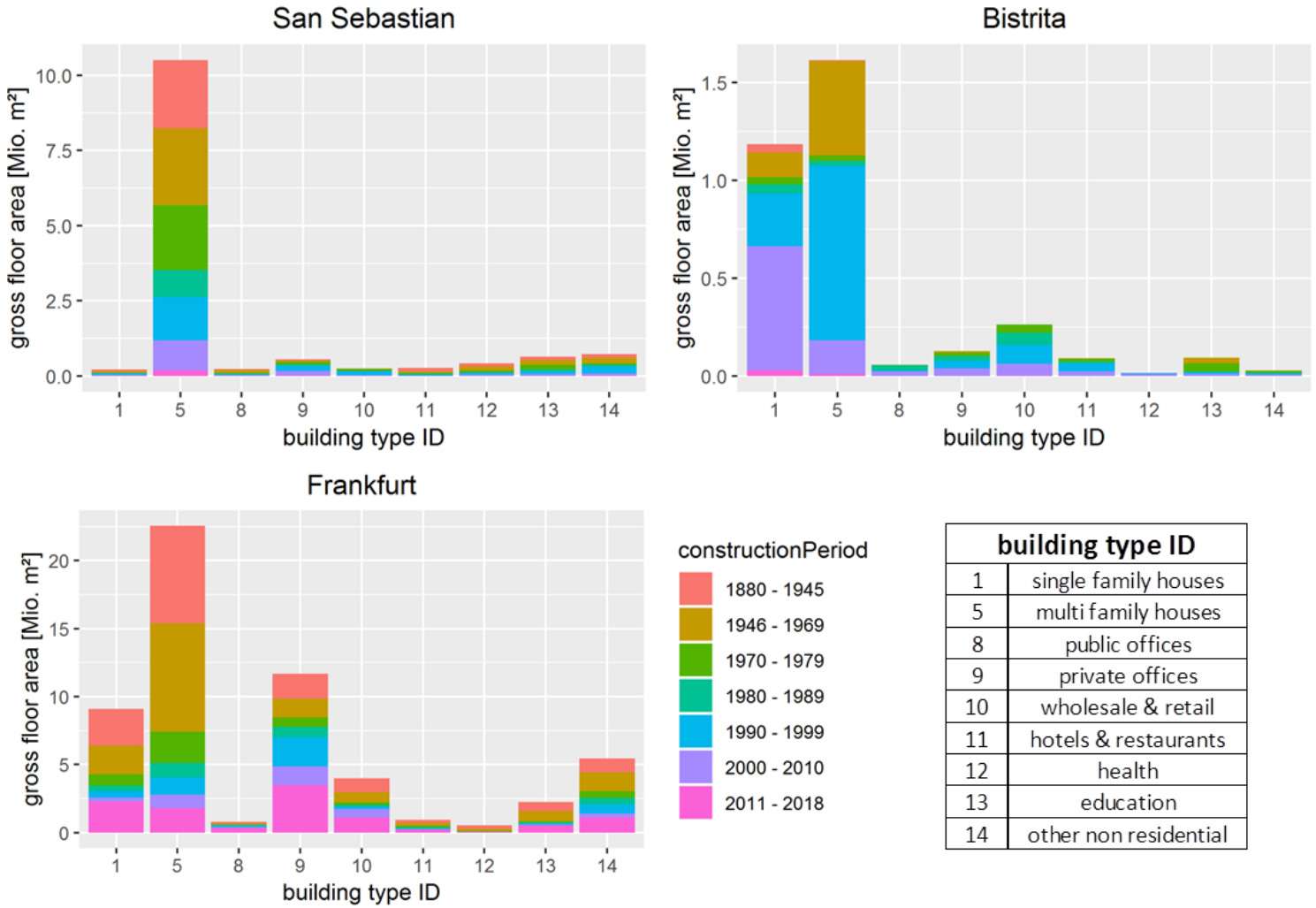
Section 3

Results

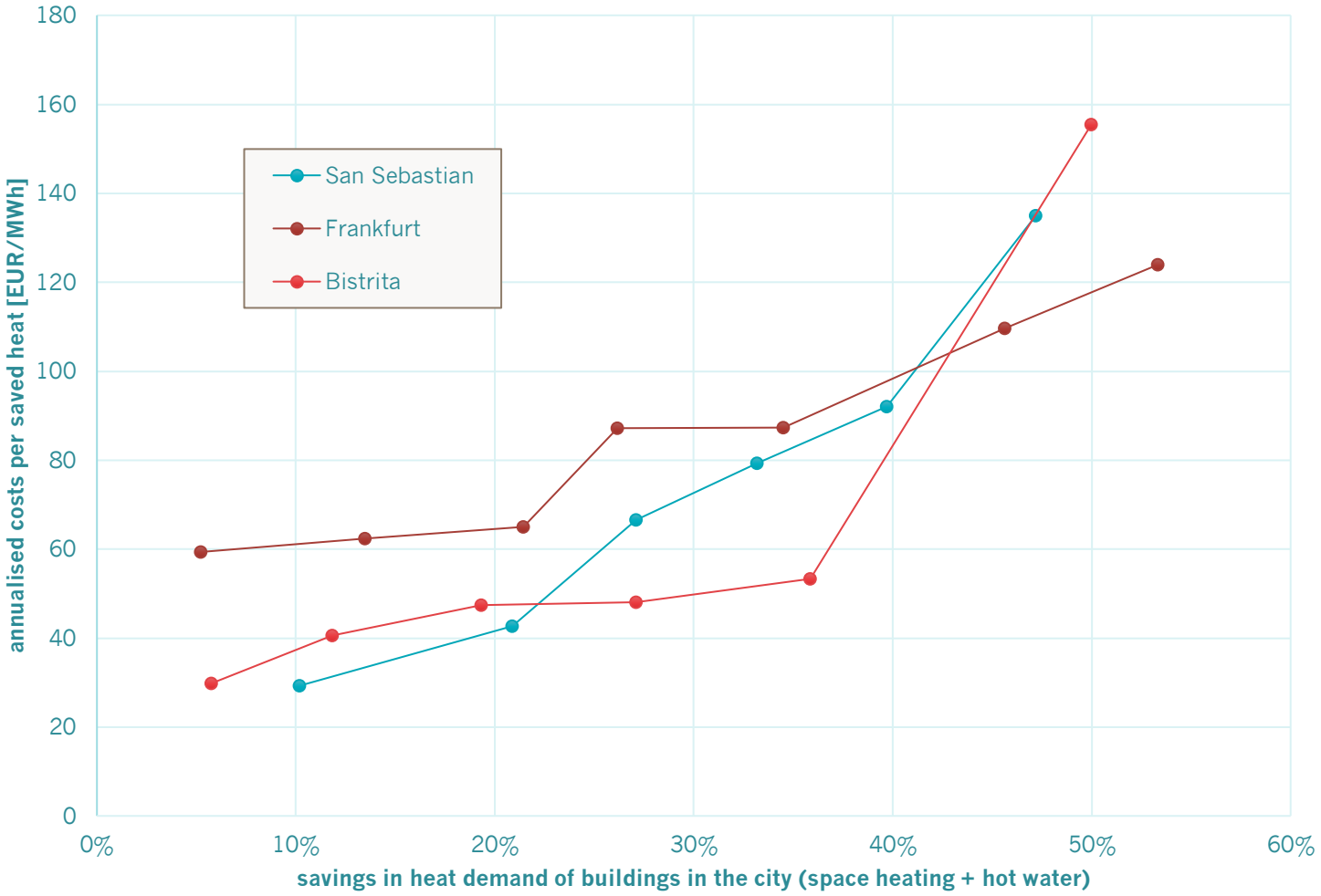
Differences in the building stocks



building type ID	
1	single family houses
5	multi family houses
8	public offices
9	private offices
10	wholesale & retail
11	hotels & restaurants
12	health
13	education
14	other non residential

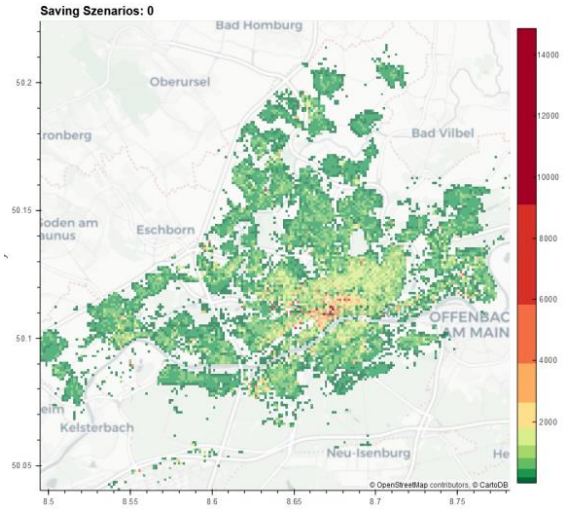
Figure: Distribution of gross floor areas of buildings in the different types and construction periods within the three case study cities

Costs for heat savings

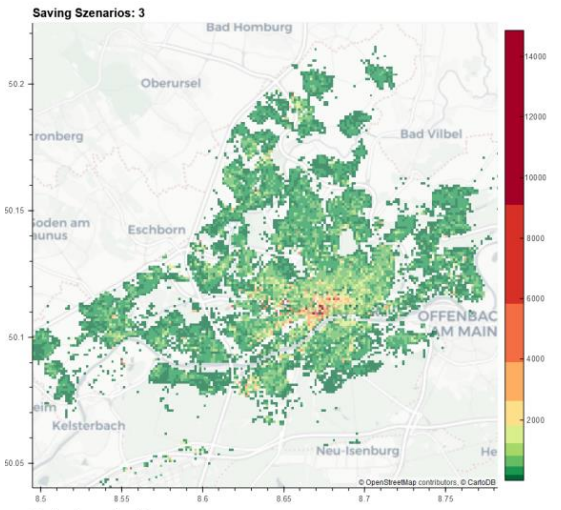


Heat demand density maps

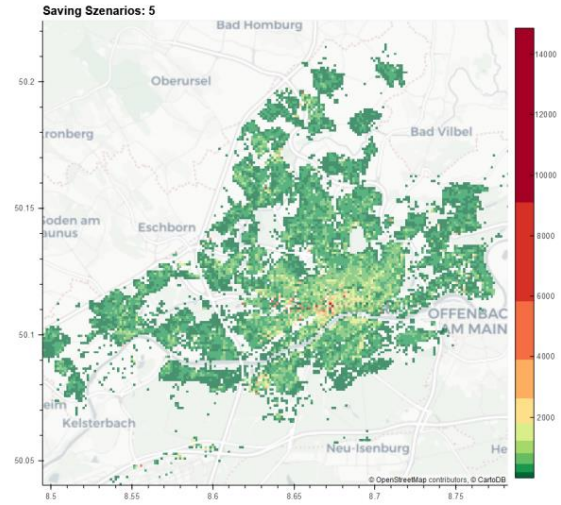
Current state



21% savings



35% savings



53% savings

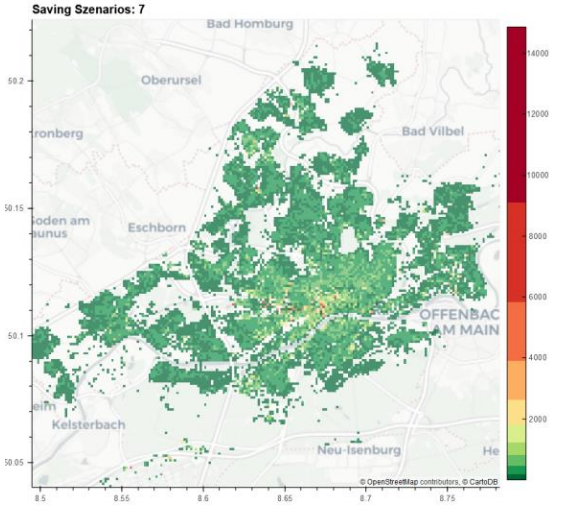


Figure: Heat demand density maps for current situation and for different renovation states for the city of Frankfurt

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Section 4

Conclusions and discussion

Conclusions and discussion

- **Costs for savings**
  - Remarkable differences in the costs for savings in the different cities up to around 35% savings of overall heat demand
  - To save more heat the costs increase rapidly in all cities
- **Overall approach**
  - Method is working and is suitable to derive geographically explicit renovation scenarios
  - Resulting data and maps are useful for analysing future potentials for district heating
- **Uncertainty due to missing information on** the **current status of renovation** of the existing buildings
  - Data on the status was not available in any of the cities → an average status is included for each of the building types and construction periods
  - Remarkable difference in the costs per saving in the buildings [EUR/MWh] between the case it is renovated and it is not renovated
- **Further uncertainties**
  - Missing entries / values in the building databases of the cities
  - If building is not occupied, renovation does not lead to savings
  - New construction currently reflected as increase in gross floor area on the existing buildings
  - Suitability of renovation measures and costs in the concrete buildings

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