KU LEUVEN

Inventory of the existing residential building stock for the purpose of environmental benchmarking

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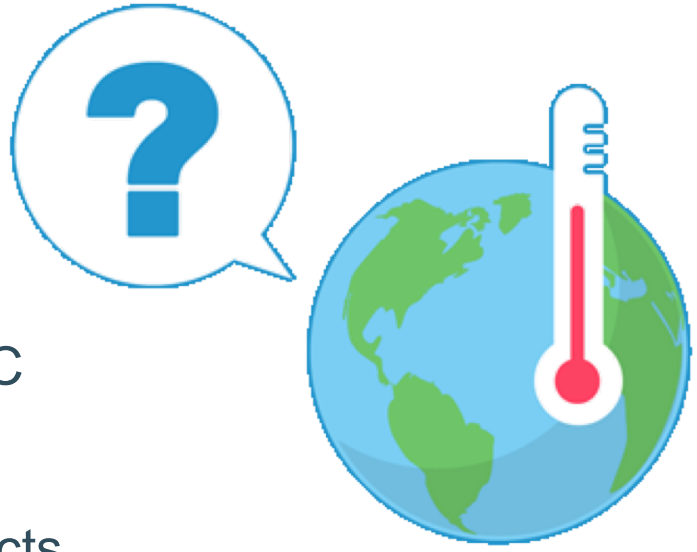
Context

CONTEXT



- Limit global warming <2°C
- Limit ecological footprint
- Limit environmental impacts

CONTEXT

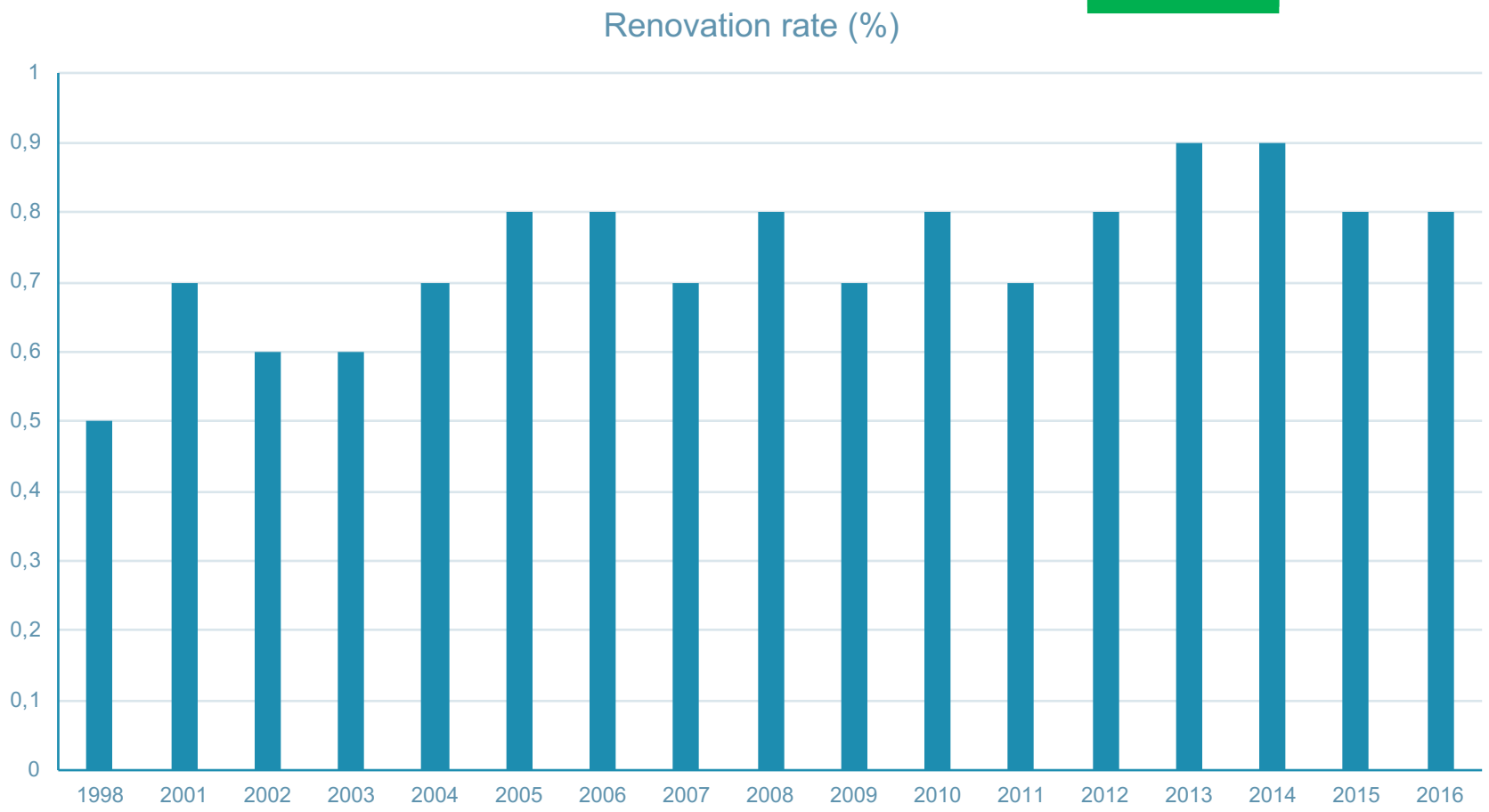
- Construction sector
  - 30% resources
  - 40% energy use
  - 36% GHG emissions
  - 30% waste
- European Union: reduce GHG emissions by 2050 with 80-95% compared to 1990

CONTEXT

Challenge

- Renovation rate ↗
- Renovatiepact ↗2,5%
- Leuven 2030 ↗3%

→ Benchmarks should be defined to set targets!



Type Benchmarks

Approaches

- Top-down
- Bottom-up
  - Analysis building stock
  - Representative buildings

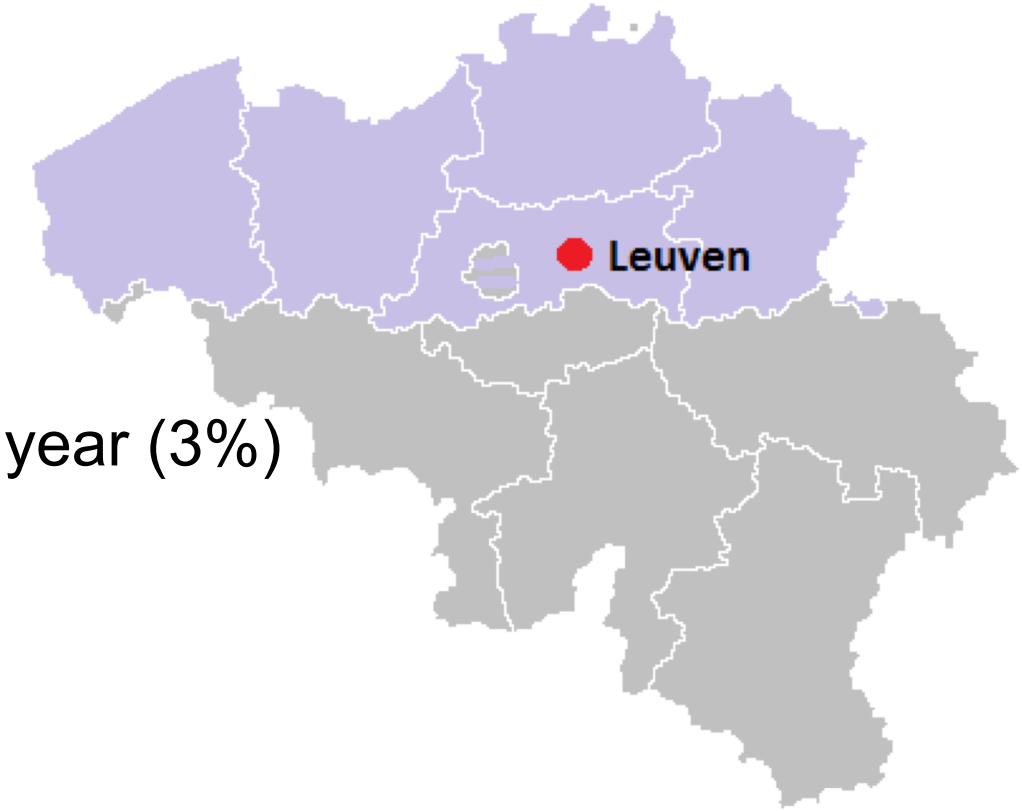
Typology

- Target value
- Best-practice value
- Reference value
- Limit value

Methodology – Building Stock Modelling

LEUVEN

- Medium size european city (100.414 citizens in 2017)
- Environmental engagement
  → Leuven Climate neutral program
  → CO2 monitoring
  → Goal: renovation of 1000 buildings each year (3%)



BOTTOM-UP APPROACH

Building Stock model:

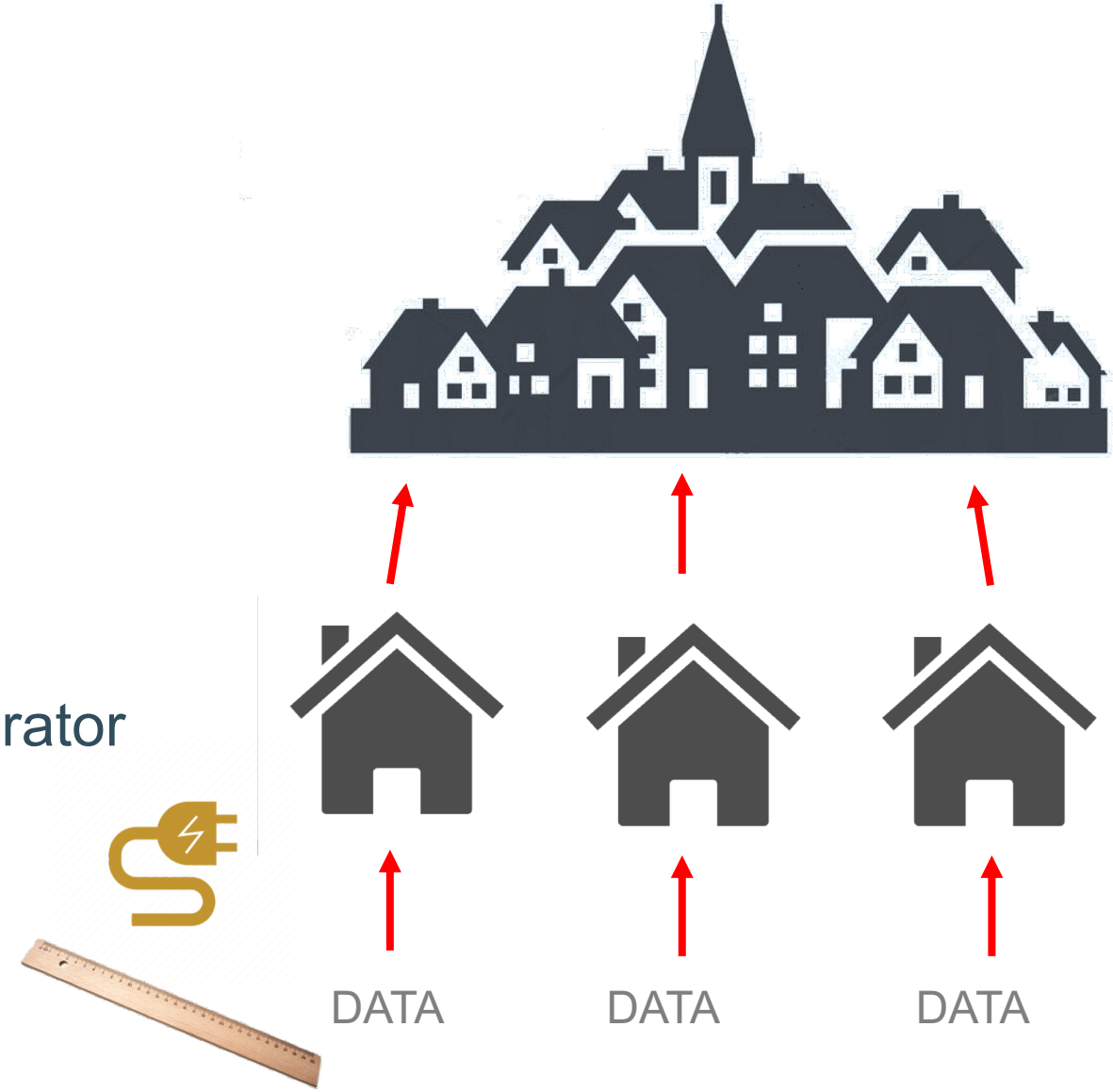
- Geometry based on GIS

→ Building-by-building approach

- Energy use based on
  - Anonymised EPB/EPC data
  - Data energy distribution network operator (Fluvius) at street level

  → DATA GAPS

→ Archetype approach



Building-By-Building Approach

Available data

Data	Available?	Data Source
Geospatial Information	Yes	Dataset Leuven/Flanders
Ground floor surface	Yes	Dataset Flanders
Perimeter	Yes	Dataset Flanders
Ridge height	Yes	Dataset Flanders
Roof type	Yes	Dataset Leuven
Energy Consumption (at street level)	Yes	Fluvius (energy network operator)
Function	Yes	Dataset Leuven
Number of floors	Yes	Dataset Leuven
Number of residential units	Yes	Dataset Leuven
Wall surfaces	Can be derived	Dataset Flanders
Window surfaces	No	-
Building typology	Can be derived	Dataset Leuven
Construction year	Partial	Dataset Leuven
U-values	No	IEE-Tabula project
U-values	No	VEA EPC/EPB data (not GIS)

GIS - TYPOLOGY

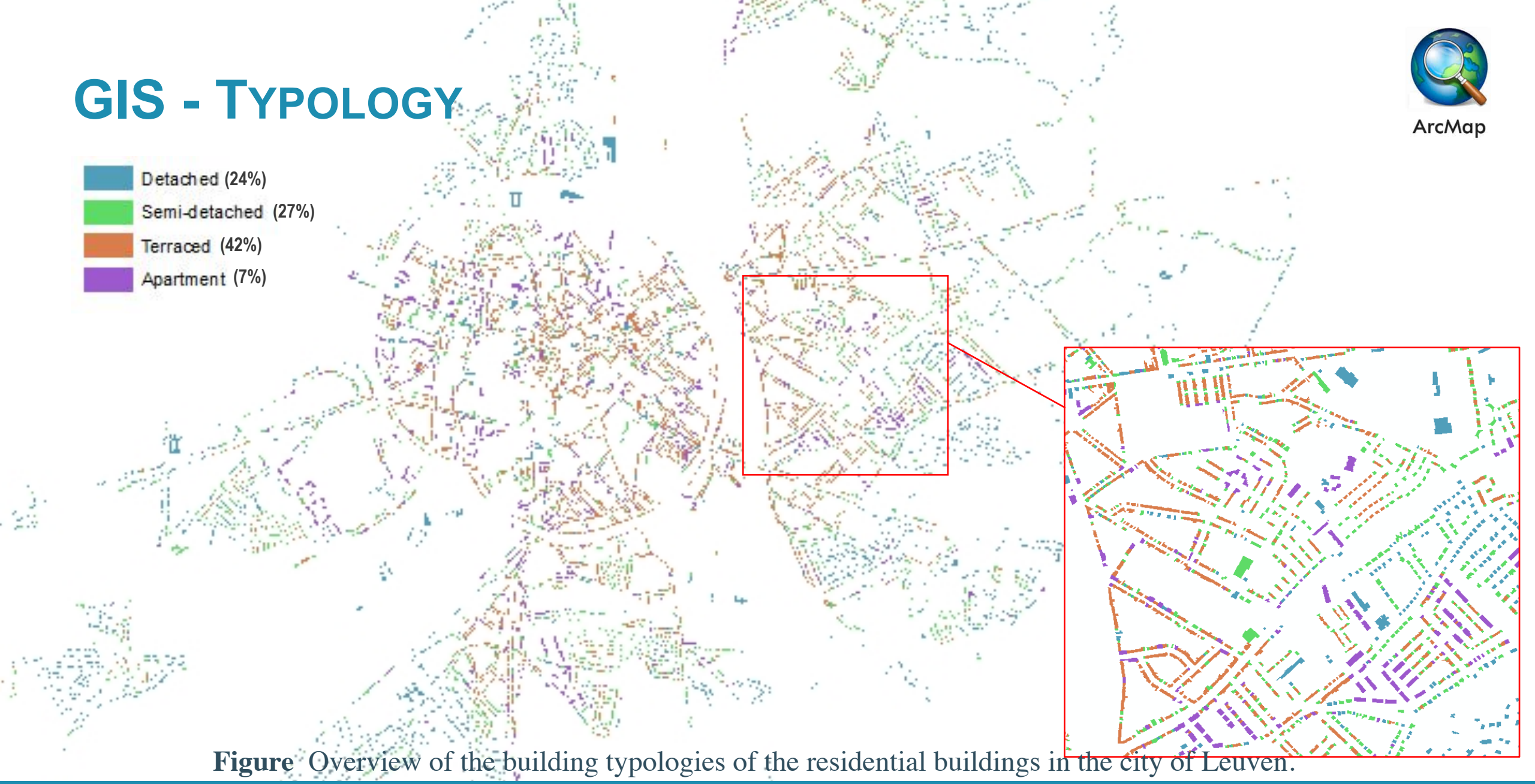


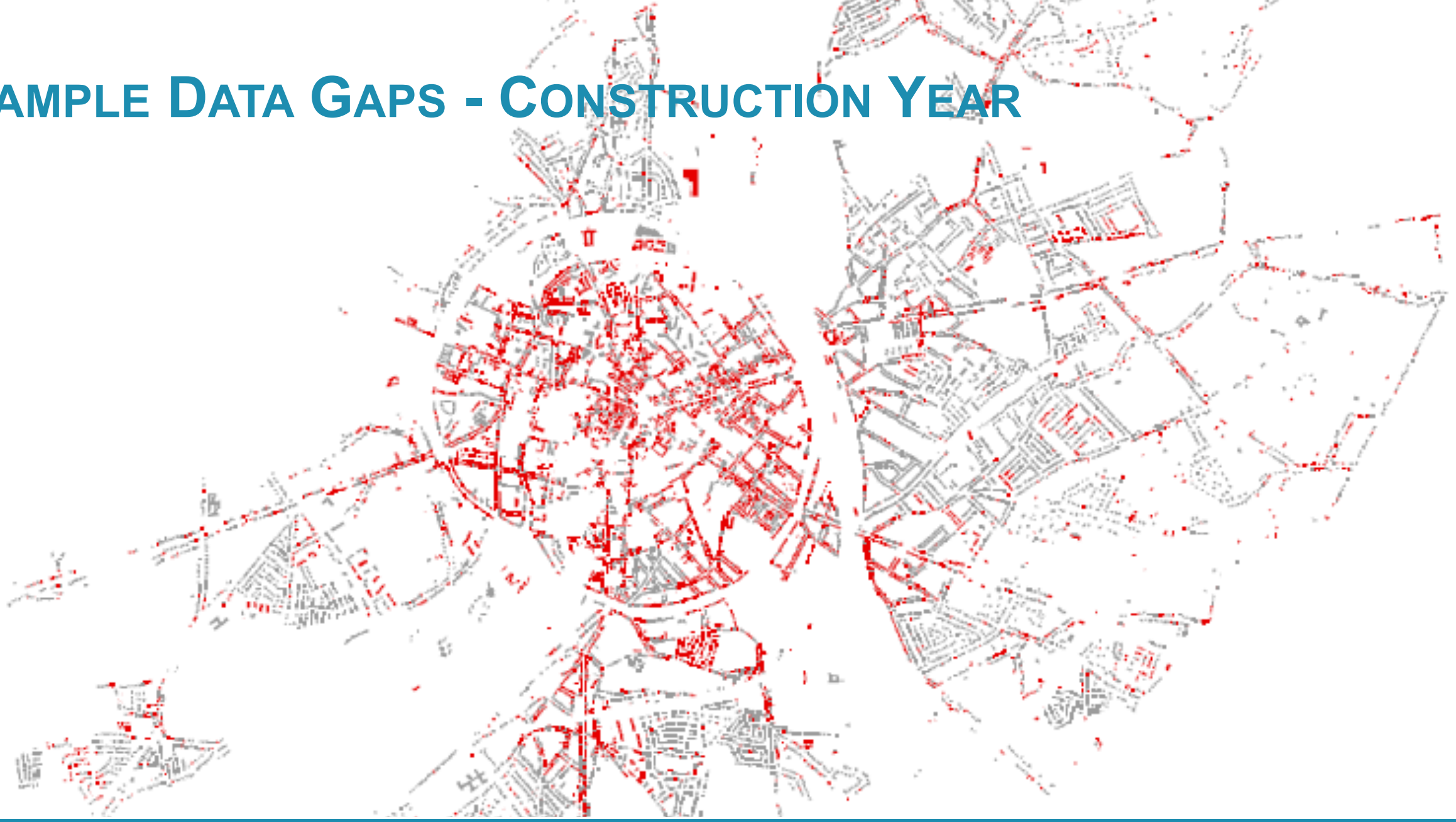
Figure Overview of the building typologies of the residential buildings in the city of Leuven.

Data Gaps

Detached							
<1945			**% total known**	**% distribution of known**		**Distribution of unknown**	
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
67	473	12.41%	10%	10%	10%	39	183
1946-1970			**% total known**	**1946-1970**			
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
248	1720	12.60%	36.76%	37%	37%	145	667
1971-1990			**% total known**	**1971-1990**			
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
214	1501	12.48%	32.03%	32%	32%	125	582
1991-2005			**% total known**	**1991-2005**			
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
65	886	6.83%	17.76%	10%	19%	38	343
2006-2011			**% total known**	**2006-2011**			
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
28	29	49.12%	1.06%	4%	1%	16	11
>2012			**% total known**	**>2012**			
Flat roof	Pitched roof	% flat		Flat roof	Pitched roof	Flat roof	Pitched roof
57	66	46.34%	2.30%	8%	1%	33	26
unknown			**Total known**		**Total**	396	1812
Flat roof	Pitched roof	% flat					
398	1812	18.01%	5354				
			Total unknown				
			2210				

Table Distribution of the roof types and construction years of the detached buildings in Leuven

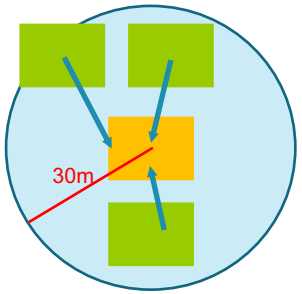
Example Data Gaps - Construction Year



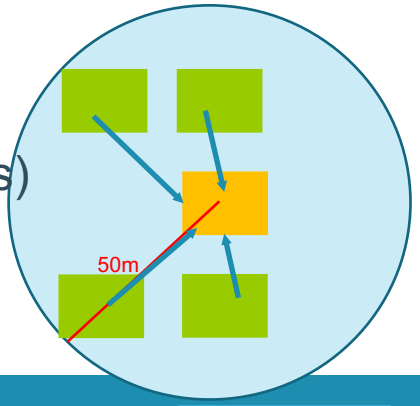
FUTURE OUTLOOK – OTHER APPROACHES

- Known data (20.331 buildings) (60,6%)
- Random based on statistics (100%)
- The average of the 1 or 2 neighbours (15.951 buildings) (47,6%)

- The average of all buildings with a known construction year in radius 30m (32.009 buildings) (95,5%)



- The average of all buildings with a known construction year in radius 50m (33.037 buildings) (98,5%)



Archetype Approach

Data gaps

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ARCHETYPE - TABULA/EPISCOPE

Archetypes

- 6 construction periods
  - <1945
  - 1946-1970
  - 1971-1990
  - 1991-2005
  - 2005-2011
  - >2012
- 6 building typologies
  - Single Family House
  - Semi-Detached SFH
  - Terraced House
  - Small Multi-Family House
  - Multi-Family House
  - Apartment Block

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Belgie)	... 1945	generic	 BE.N.SFH.01.Gen	 BE.N.TH.01.Gen	 BE.N.MFH.01.Gen	
2	national (Belgie)	1946 ... 1970	generic	 BE.N.SFH.02.Gen	 BE.N.TH.02.Gen	 BE.N.MFH.02.Gen	 BE.N.AB.02.Gen
3	national (Belgie)	1971 ... 1990	generic	 BE.N.SFH.03.Gen	 BE.N.TH.03.Gen	 BE.N.MFH.03.Gen	 BE.N.AB.03.Gen
4	national (Belgie)	1991 ... 2005	generic	 BE.N.SFH.04.Gen	 BE.N.TH.04.Gen	 BE.N.MFH.04.Gen	 BE.N.AB.04.Gen
5	national (Belgie)	2006 ... 2011	generic	 BE.N.SFH.05.Gen	 BE.N.TH.05.Gen	 BE.N.MFH.05.Gen	 BE.N.AB.05.Gen
6	national (Belgie)	2012 ...	generic	 BE.N.SFH.06.Gen	 BE.N.TH.06.Gen	 BE.N.MFH.06.Gen	 BE.N.AB.06.Gen

Apartment

7	national (Belgie)	... 1945	semi detached sfh		 BE.N.TH.01.Semi		
8	national (Belgie)	... 1945	small mfh			 BE.N.MFH.01.Small	
9	national (Belgie)	1946 ... 1970	semi detached sfh		 BE.N.TH.02.Semi		
10	national (Belgie)	1946 ... 1970	small mfh			 BE.N.MFH.02.Small	
11	national (Belgie)	1971 ... 1990	semi detached sfh		 BE.N.TH.03.Semi		
12	national (Belgie)	1971 ... 1990	small mfh			 BE.N.MFH.03.Small	
13	national (Belgie)	1991 ... 2005	semi detached sfh		 BE.N.TH.04.Semi		
14	national (Belgie)	1991 ... 2005	small mfh			 BE.N.MFH.04.Small	
15	national (Belgie)	2006 ... 2011	semi detached sfh		 BE.N.TH.05.Semi		
16	national (Belgie)	2006 ... 2011	small mfh			 BE.N.MFH.05.Small	
17	national (Belgie)	2012 ...	semi detached sfh		 BE.N.TH.06.Semi		
18	national (Belgie)	2012 ...	small mfh			 BE.N.MFH.06.Small	

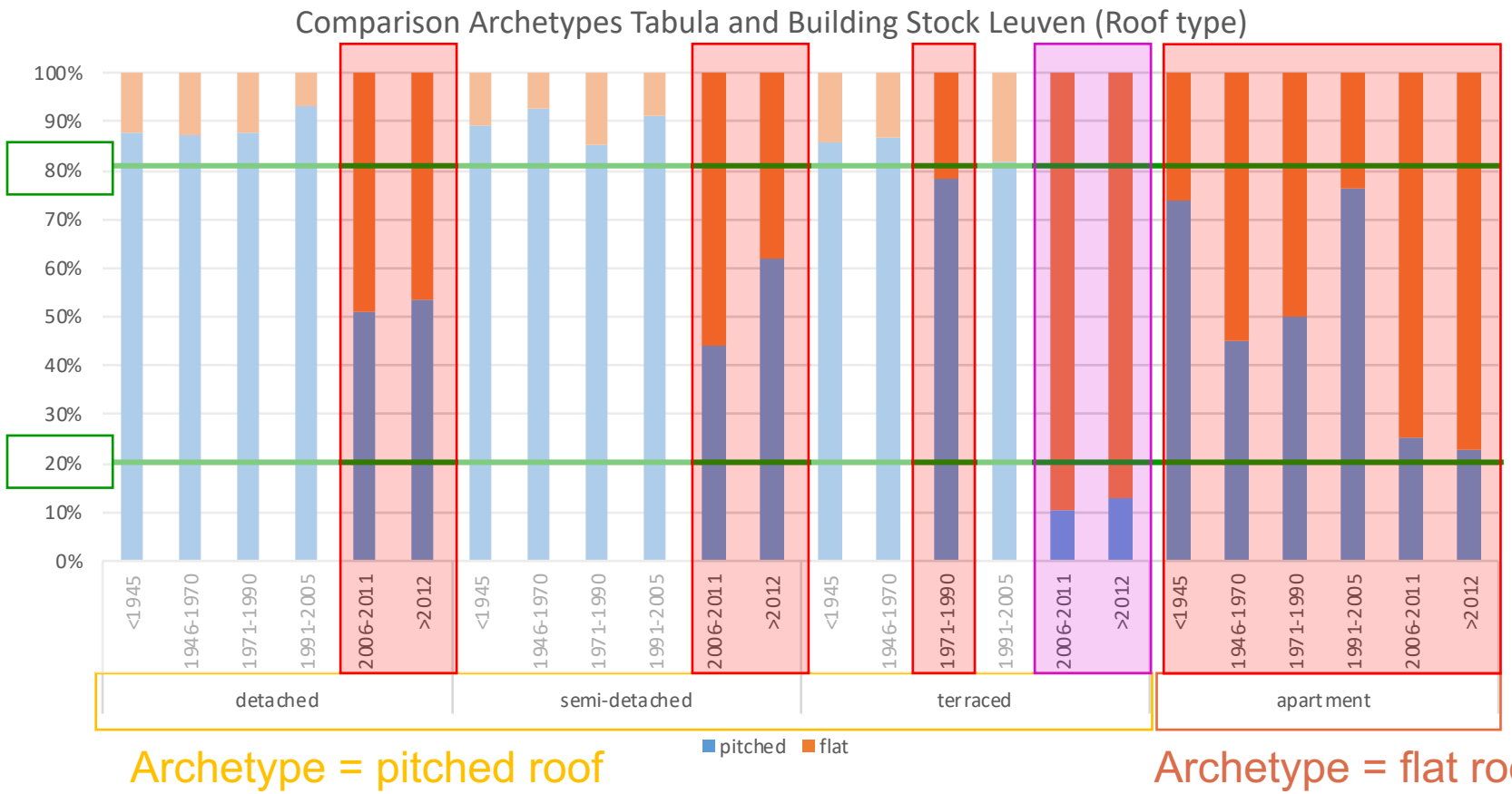
ARCHETYPE TABULA

	U-value		
	Original state	Usual refurbishment	Advanced refurbishment
Detached buildings			
<1945			
roof	1,7	0,28	0,14
wall	2,2	0,3	0,18
floor	0,85	0,25	0,18
window	5	2	1,6
door	4	4	4
1946-1970			
roof	1,9	0,28	0,14
wall	1,7	0,29	0,18
floor	0,85	0,25	0,18
window	5	2	1,6
door	4	4	4
1971-1990			
roof	0,85	0,31	0,15
wall	1	0,32	0,19
floor	0,85	0,3	0,18
window	3,5	2	1,6
door	4	4	4
1991-2005			
roof	0,6	0,27	0,16
wall	0,6	0,37	0,22
floor	0,7	0,28	0,23
window	3,5	2	1,6
door	3,5	3,5	3,5
2006-2011			
roof	0,3	0,3	0,16
wall	0,4	0,4	0,22
floor	0,6	0,6	0,22
window	2	2	1,6
door	2,9	2,9	2,9
>2012			
roof	0,21	0,13	0,1
wall	0,23	0,23	0,23
floor	0,22	0,22	0,22
window	1,7	1,7	1,5
door	1,7	1,7	1,5

ARCHETYPES

2 Archetypes

Switch Archetype



Archetype = pitched roof

Archetype = flat roof

GIS – ENERGY CONSUMPTION

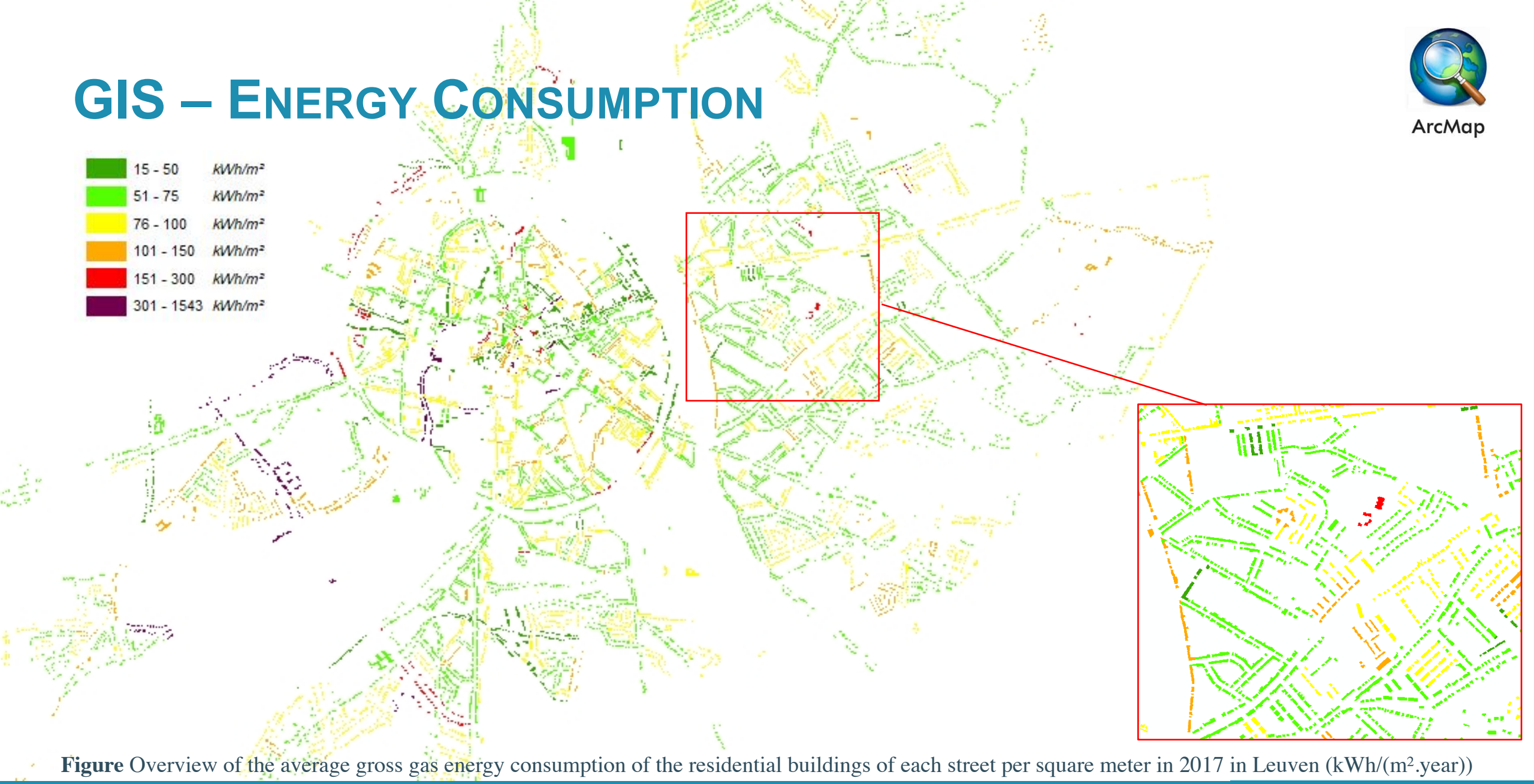
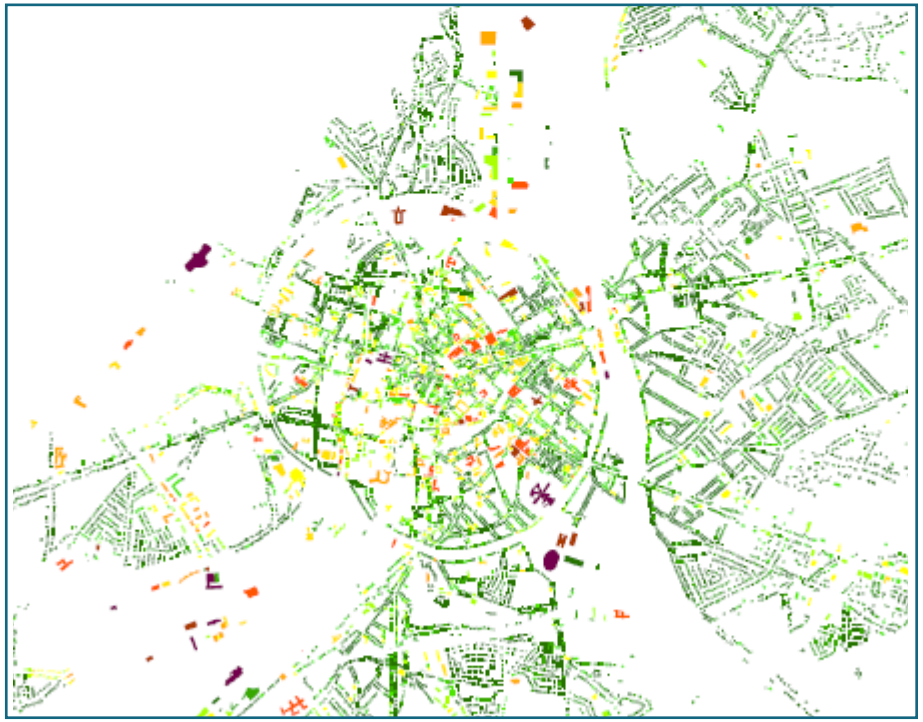


Figure Overview of the average gross gas energy consumption of the residential buildings of each street per square meter in 2017 in Leuven (kWh/(m².year))

GIS – Energy Consumption

Fluvius data
- According to the surface
- According to the construction year

+ EPC/EPB data → Machine learning techniques: clustering



Surface

Construction Year

Conclusions

Conclusions – Building Stock Modelling

Bottom-up approach, a combination of

- Building-by-building approach (GIS-data)
- Archetype approach (data gaps - energy data: privacy issues)

→ Inventory of the building Stock

→ Environmental benchmarks

Thank you for your attention!