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Location data enabling urban sustainable energy planning

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# The European Commission's science and knowledge service

Joint Research Centre

## Location data enabling urban sustainable energy planning

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*Barcelona, 30 September 2016*  
**INSPIRE Conference**





# Outline

- Overview of Use Case 4 of the EULF Energy Pilot
- Role of INSPIRE
- Energy Efficiency driven retrofit planning
- Mapping energy consumption
- Urban context variables
- Feasibility index
- Energy saving scenarios
- Input data

# Overview of the EULF Energy Pilot UC4



- Goal: To support policy makers to design and implement Energy Efficiency driven renovation plans of building stock at urban level.
- Description: Use of existing models, from bottom-up to top-down approach, for the estimation of energy needs at urban level, based on real energy consumption data of a sample of buildings:
  - for building stock renovation planning and prioritization of interventions, e.g. by class of buildings and/or geographical area of interventions (e.g. in areas having energy distribution networks or in historical centres);
  - to enable Public Authorities (e.g. Municipalities) to assess the energy saving potential related to the building stock and to local conditions (e.g. climate);
  - to allow reuse of scaling-up models (from building to urban level) in different climatic conditions and with different characteristics of the building stock.

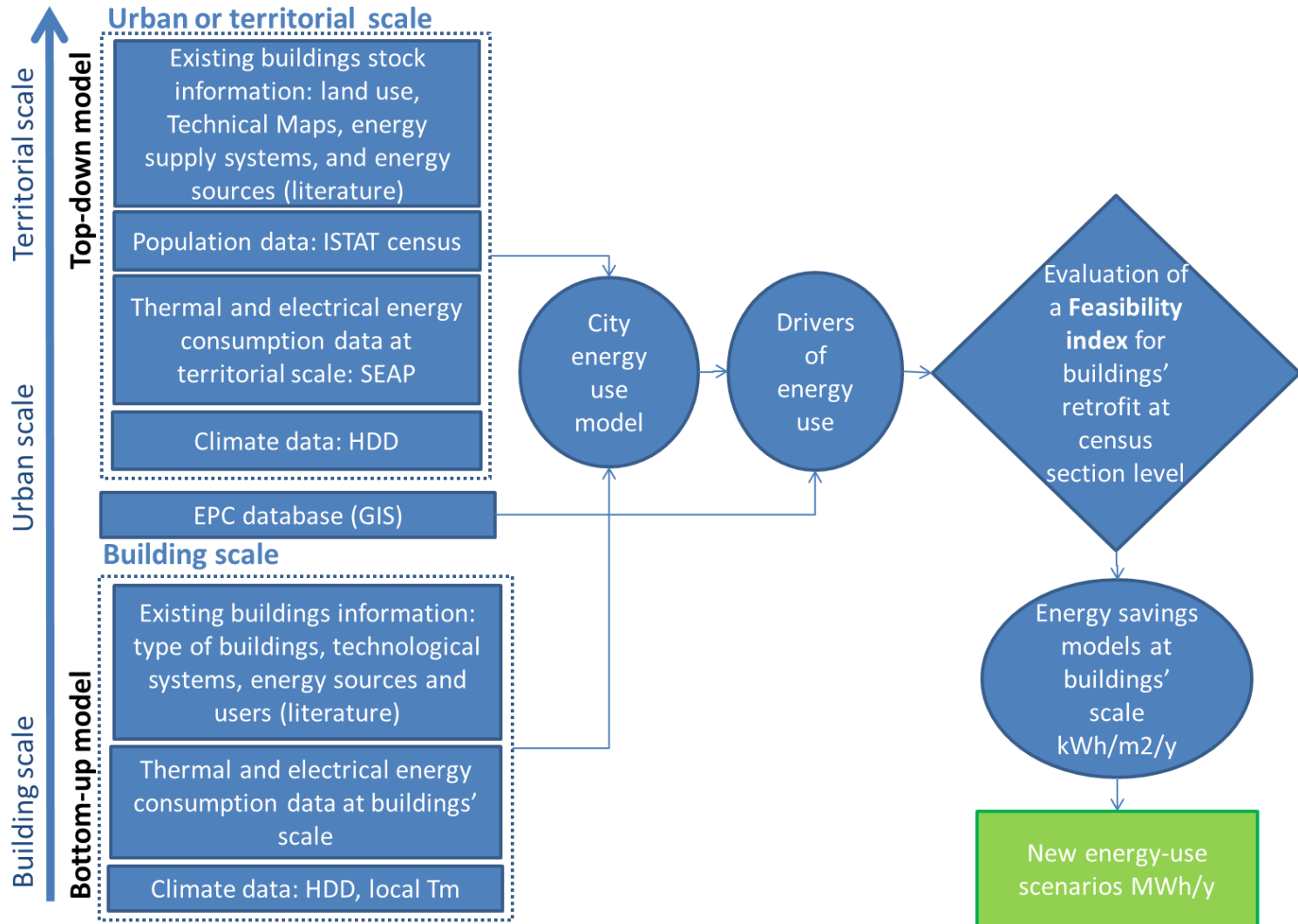


# Role of INSPIRE

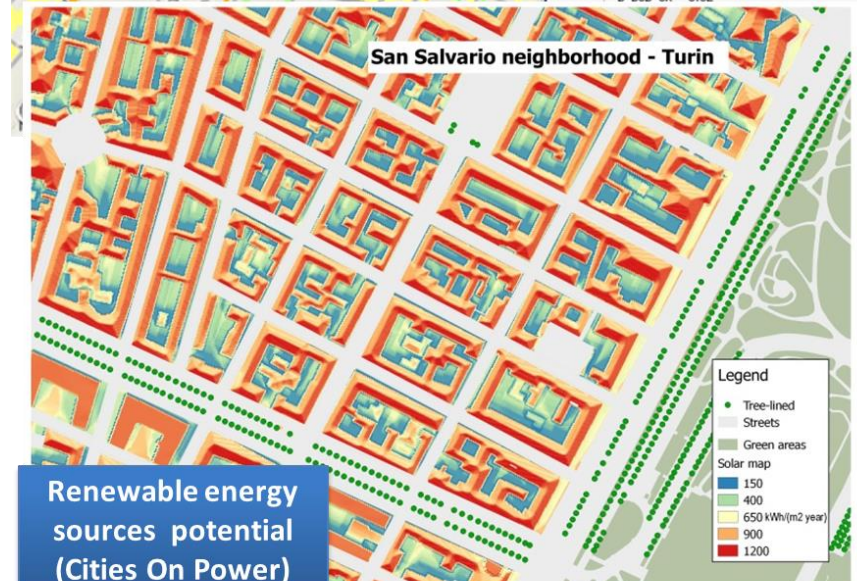
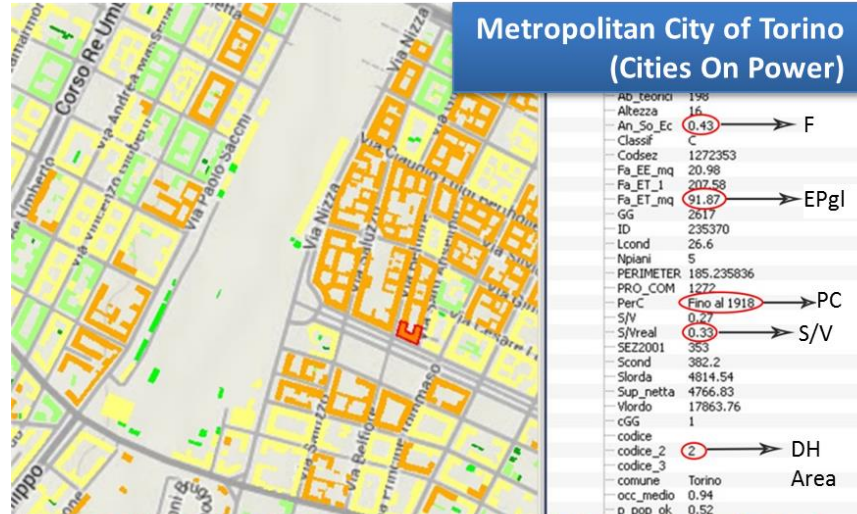
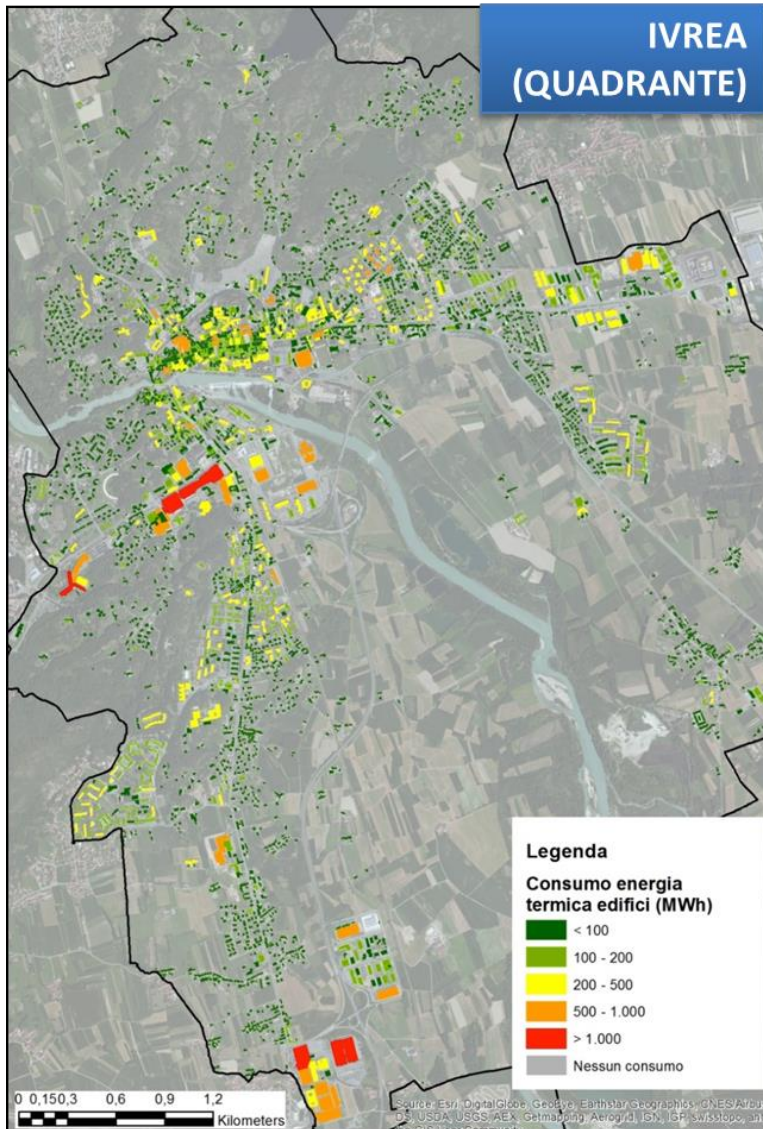
- Introduce INSPIRE into a methodology already applied to a test area (without INSPIRE), in order to facilitate the re-use of the methodology in other geographical contexts



# Energy Efficiency driven retrofit planning



# Mapping energy consumption



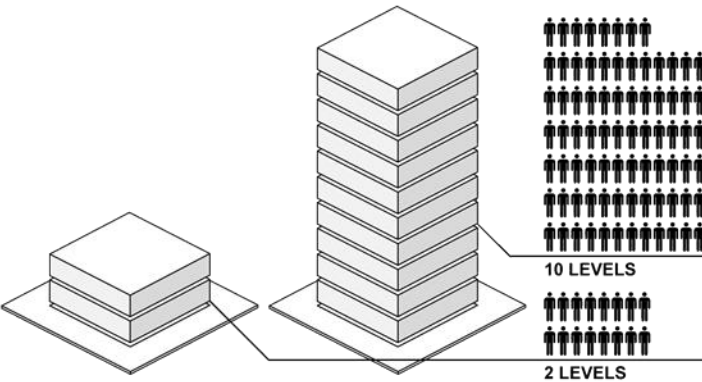
Renewable energy sources potential (Cities On Power)

# Urban context variables

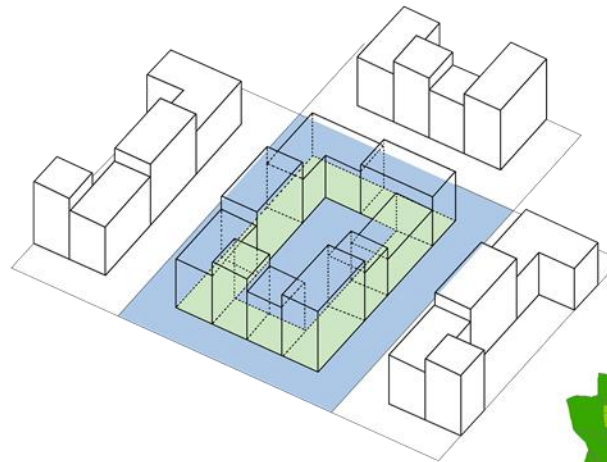
$$\text{kWh/m}^3_{[\text{CONTEXT}]} = f(\mathbf{BD}, \mathbf{BCR}, H/W, H/H_{\text{avg}}, \text{MOS}, A)$$

BD – Building Density [ $\text{m}^3/\text{m}^2$ ]

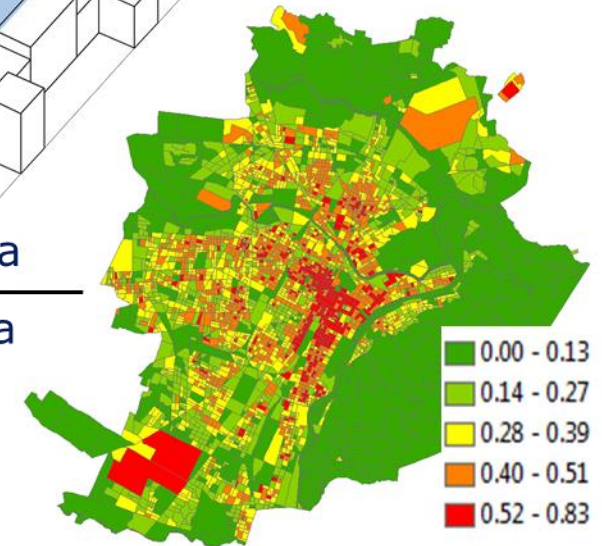
BCR – Building Coverage Ratio [ $\text{m}^2/\text{m}^2$ ]



$$\text{BD} = \text{BCR} \cdot \text{Building Height}$$



$$\text{BCR} = \frac{\text{Built Area}}{\text{Site Area}}$$

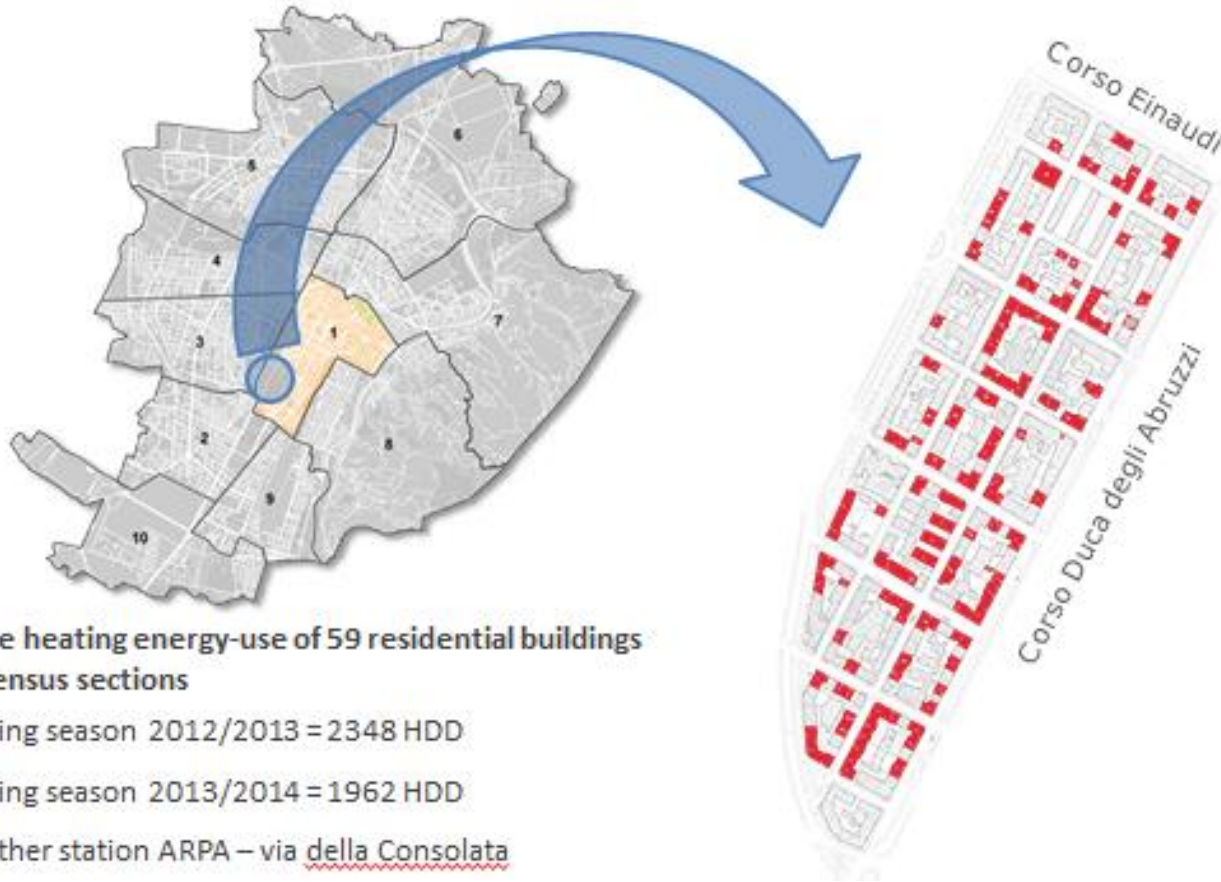




# Mapping energy consumption

Case study: Turin (IT)

$$\left. \frac{kWh}{m^3} \right|_{\text{measured}} = \left. \frac{kWh}{m^3} \right|_{\text{building}} \pm \left. \frac{kWh}{m^3} \right|_{\text{context}}$$



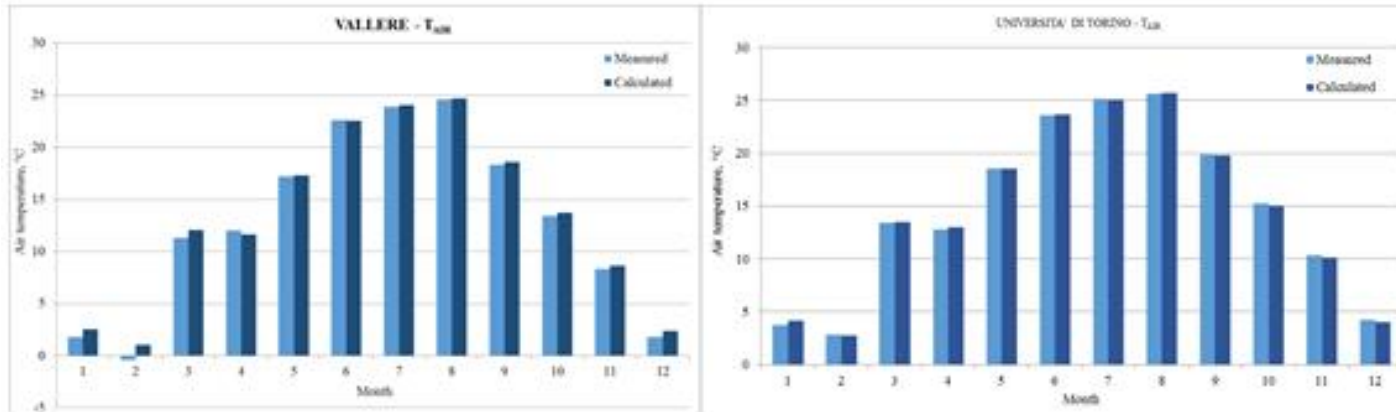
Space heating energy-use of 59 residential buildings  
22 census sections

Heating season 2012/2013 = 2348 HDD

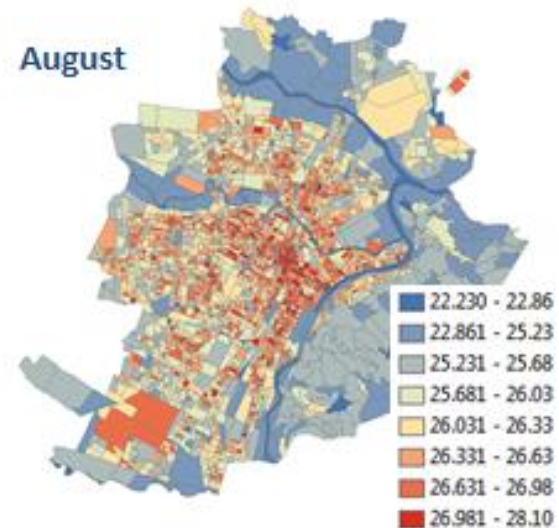
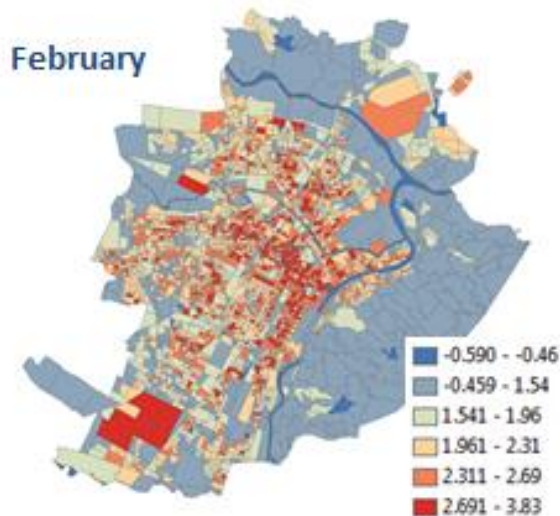
Heating season 2013/2014 = 1962 HDD

Weather station ARPA – via della Consolata

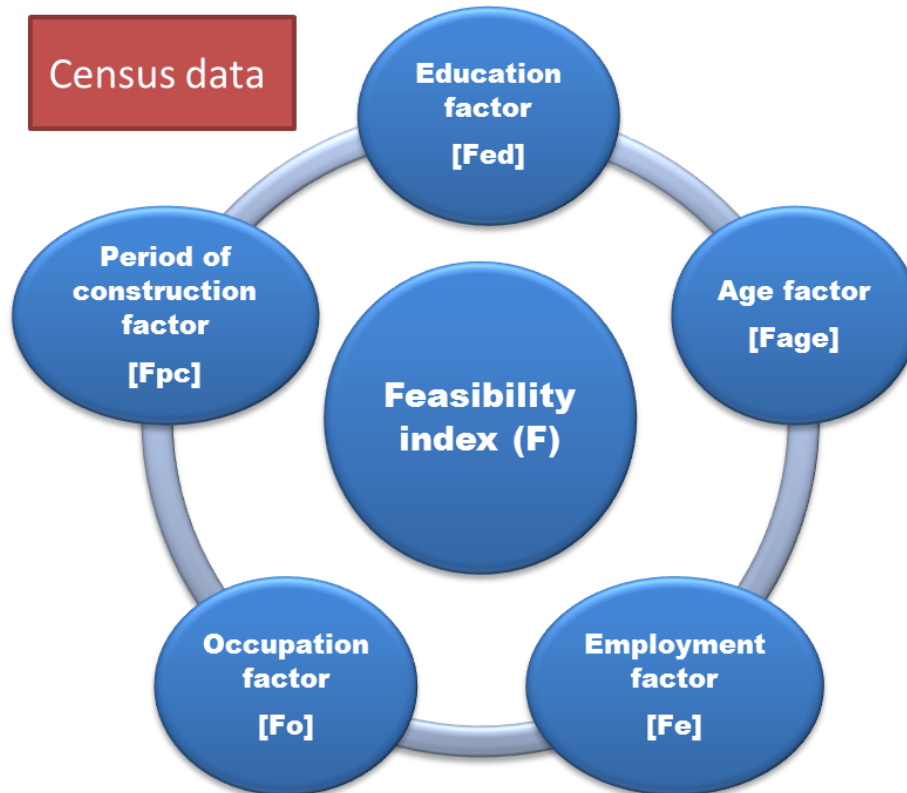
# Mapping energy consumption



$$T_{air} = 23.05 \cdot G_{mT} + 2.69 \cdot BCR + 0.03 \cdot H/W + 0.65 \cdot MOS + 1.07 \cdot H/H_{avg} - 1.17 \cdot A - 0.6 \cdot H_2O$$



# Feasibility index



**Age factor:**  
 active population (24-65) / total population  
 Variables: **ECONOMIC, DECISION, INTEREST**

**Education factor:**  
 population with scholastic graduation / total population  
 Variables: **AWARENESS**

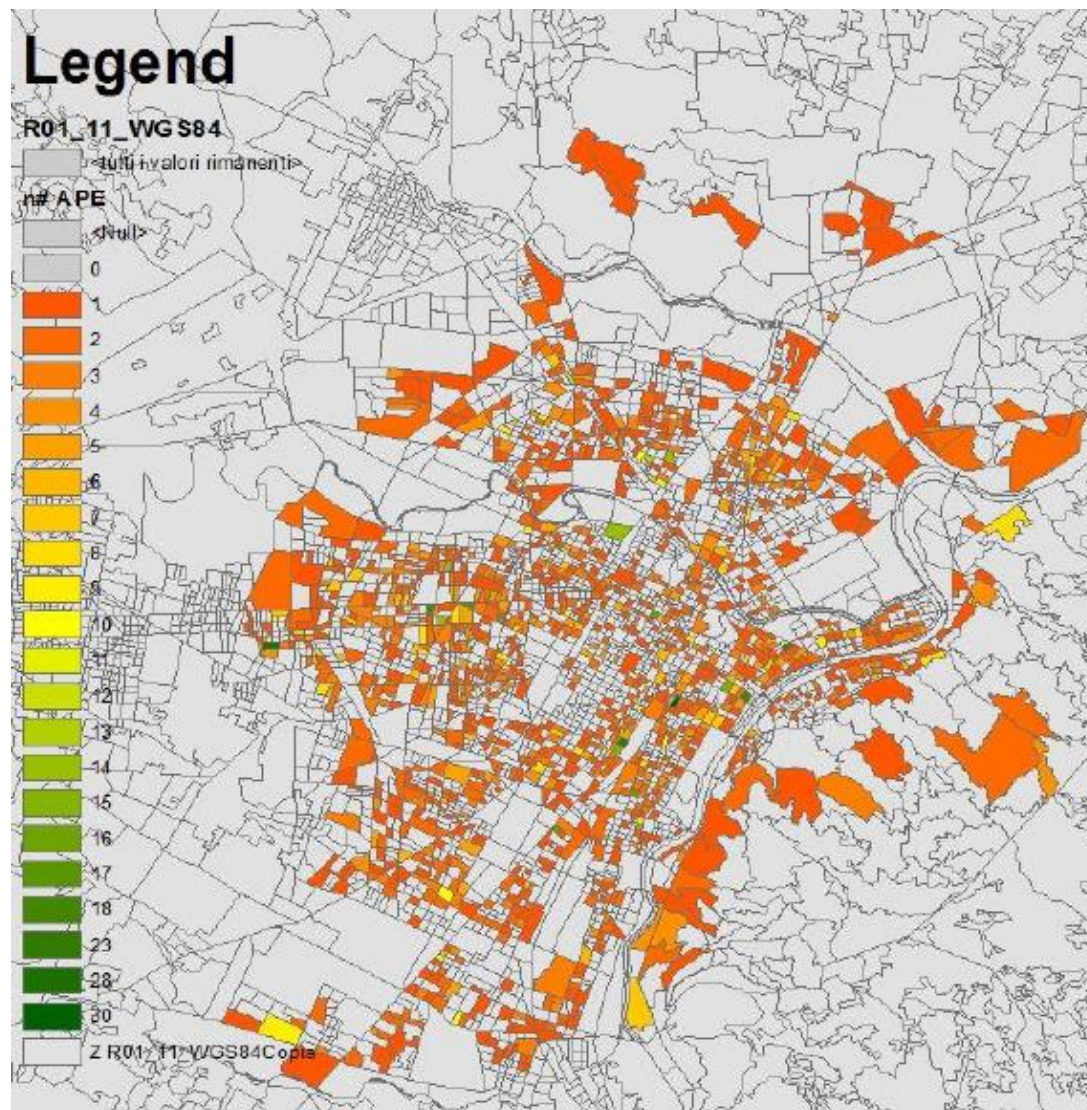
**Employment factor:**  
 employed people / total population  
 Variables: **ECONOMIC, CREDIT ACCESS**

**Building's occupation factor:**  
 percentage of occupied buildings  
 Variables: **DECISION, INTEREST**

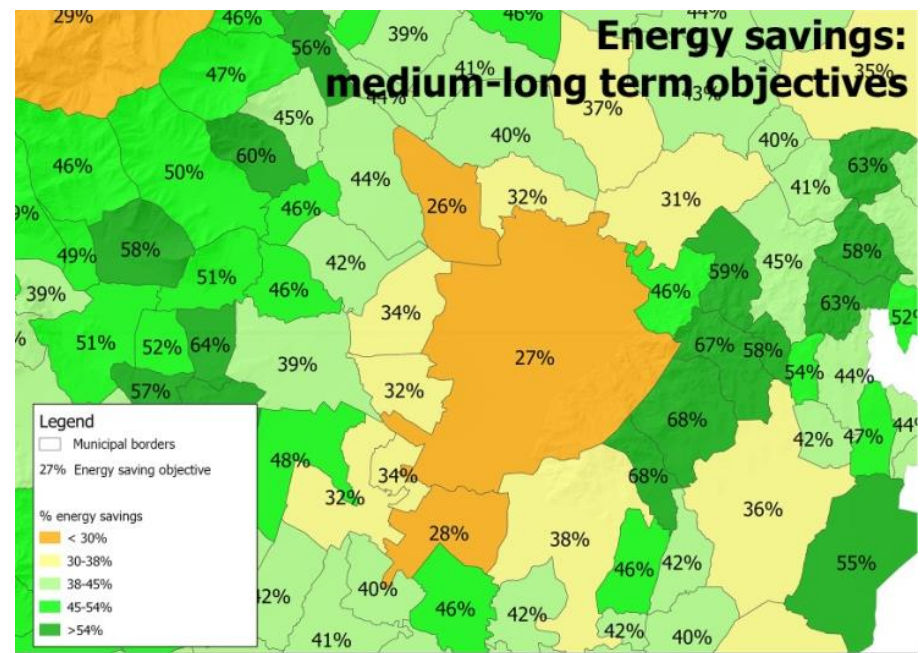
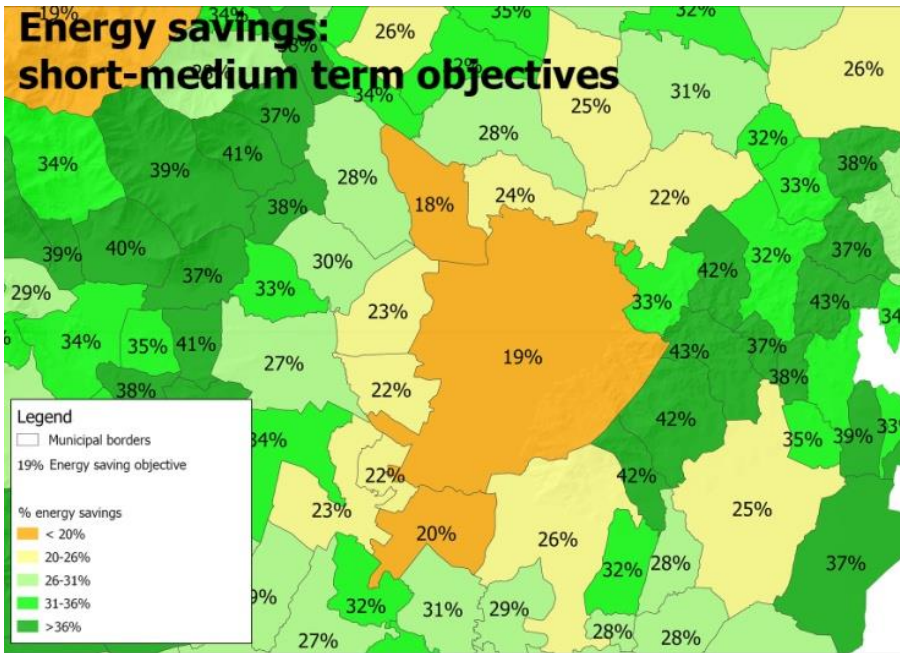
**Period of construction factor:**  
 buildings built before 1945  
 Variables: **DECISION, INTEREST PROCESS**

	First class	Second class	Third class	Fourth class
Feasibility index	<0.42	0.42 - 0.50	0.50 - 0.58	> 0.58
Number of buildings in the Metropolitan City of Torino	13%	42%	39%	6%
Number of buildings in Torino	20%	54%	23%	3%
Renovation level	windows substitution	+ boiler substitution	+ thermal insulation of slab and roof	+ thermal insulation of facades

# Feasibility index



# Energy savings scenarios





# Input data

- |  |        |
|--|--------|
| <ul style="list-style-type: none"><li>energy consumption data at building level</li><li>building characteristics</li></ul> | BU ext |
| <ul style="list-style-type: none"><li>energy networks</li></ul>  | US     |
| <ul style="list-style-type: none"><li>land use</li></ul>   | LU, LC |
| <ul style="list-style-type: none"><li>population distribution</li><li>socio-economic variables</li></ul>                   | SU+PD  |



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website: [http://ec.europa.eu/isa/actions/02-interoperability-architecture/2-13action\\_en.htm](http://ec.europa.eu/isa/actions/02-interoperability-architecture/2-13action_en.htm)

EULF Joinup Community: <https://joinup.ec.europa.eu/community/eulf/description>

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