Location data enabling urban sustainable energy planning

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Location data enabling urban sustainable energy planning

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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

Urban or territorial scale
- Existing buildings stock information: land use, Technical Maps, energy supply systems, and energy sources (literature)
- Population data: ISTAT census
- Thermal and electrical energy consumption data at territorial scale: SEAP
- Climate data: HDD
- EPC database (GIS)

Territorial scale
- Top-down model

Urban scale
- Building scale
- Existing buildings information: type of buildings, technological systems, energy sources and users (literature)
- Thermal and electrical energy consumption data at buildings’ scale
- Climate data: HDD, local Tm

Evaluation of a Feasibility index for buildings’ retrofit at census section level

City energy use model

Drivers of energy use

Energy savings models at buildings’ scale kWh/m2/y

New energy-use scenarios MWh/y

European Commission
Mapping energy consumption
Urban context variables

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

**BD – Building Density [m}^3/m^2]**

**BCR – Building Coverage Ratio [m}\^2/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)

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

\[ T_{\text{air}} = 23.05 \cdot G_{m,T} + 2.69 \cdot BCR + 0.03 \cdot H/W + 0.65 \cdot MOS + 1.07 \cdot H/H_{\text{avg}} - 1.17 \cdot A - 0.6 \cdot H_2O \]
Feasibility index

1. **Census data**
2. **Education factor** ([Fed])
3. **Age factor** ([Fage])
4. **Period of construction factor** ([Fpc])
5. **Occupation factor** ([Fo])
6. **Employment factor** ([Fe])

### Feasibility index (F)

- **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

### Table

<table>
<thead>
<tr>
<th></th>
<th>First class</th>
<th>Second class</th>
<th>Third class</th>
<th>Fourth class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility index</td>
<td>&lt;0.42</td>
<td>0.42 - 0.50</td>
<td>0.50 - 0.58</td>
<td>&gt; 0.58</td>
</tr>
<tr>
<td>Number of buildings in the Metropolitan City of Torino</td>
<td>13%</td>
<td>42%</td>
<td>39%</td>
<td>6%</td>
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<tr>
<td>Number of buildings in Torino</td>
<td>20%</td>
<td>54%</td>
<td>23%</td>
<td>3%</td>
</tr>
<tr>
<td>Renovation level</td>
<td>windows substitution</td>
<td>+ boiler substitution</td>
<td>+ thermal insulation of slab and roof</td>
<td>+ thermal insulation of facades</td>
</tr>
</tbody>
</table>
Feasibility index
Energy savings scenarios
### Input data

- energy consumption data at building level
- building characteristics
- energy networks
- land use
- population distribution
- socio-economic variables

![Image](image.png)
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