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)

City energy use model

Drivers of energy use

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

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

New energy-use scenarios MWh/y
Mapping energy consumption
Urban context variables

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

**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

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

The Feasibility index is a composite measure that evaluates various factors influencing the potential for energy efficiency improvements. It is calculated using a weighted average of several key factors:

1. **Age factor**
   - Population with scholastic graduation / total population
   - Variables: AWARENESS
   - Active population (24-65) / total population
   - Variables: ECONOMIC, DECISION, INTEREST

2. **Education factor**
   - Population with scholastic graduation / total population
   - Variables: AWARENESS
   - Active population (24-65) / total population
   - Variables: ECONOMIC, DECISION, INTEREST

3. **Employment factor**
   - Employed people / total population
   - Variables: ECONOMIC, CREDIT ACCESS

4. **Period of construction factor**
   - Buildings built before 1945
   - Variables: DECISION, INTEREST

5. **Occupation factor**
   - Variables: ECONOMIC

### Feasibility Index Calculation

<table>
<thead>
<tr>
<th>Factor</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>
</tr>
<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

Energy savings: short-medium term objectives

Energy savings: medium-long term objectives
Input data

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

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