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

**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)**

**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

**Top-down model**

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

**Territorial scale**
Mapping energy consumption

IVREA
(QUADRANTE)

Metropolitan City of Torino
(Cities On Power)

Legenda
Consumo energia termica edifici (MWh)

- 100
100 - 200
200 - 500
500 - 1.000
> 1.000
Nessun consumo

San Salvario neighborhood - Turin

Renewable energy sources potential
(Cities On Power)
Urban context variables

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

BD – Building Density [m\(^3\)/m\(^2\)]

BCR – Building Coverage Ratio [m\(^2\)/m\(^2\)]

BD = BCR \cdot \text{Building Height}

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

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

- **Census data**
  - Education factor (Fed)
  - Period of construction factor (Fpc)
  - Occupation factor (Fo)
  - Employment factor (Fe)
  - Age factor (Fage)

**Feasibility index (F)**

### Factors

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

- **Age 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: Feasibility Index

<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>
</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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