Boosting energy efficiency and RES in urban contexts: from the plan to the project

Original
Boosting energy efficiency and RES in urban contexts: from the plan to the project / Giovanni Vicentini; Guglielmina Mutani. - (2014).

Availability:
This version is available at: 11583/2588826 since:

Publisher:

Published
DOI:

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Boosting energy efficiency and RES in urban context: from the plan to the project

Giovanni Vicentini
Guglielmina Mutani

The concept

Objective of the work: finding the appropriate solutions at municipal level to boost energy efficiency and RES through the energy dossier of the building code

- Analysis of the geometric and typological features of the building stock
- Average energetic situation of the building stock
- Analysis of the climatic variables (ex. Degree days)

Evaluation of renovation potential
- Analysis of the socio-economical variables
- Feasibility factor (how many buildings will be renovated?)

Estimation of energy demand

Evaluation of RES potential
- Analysis of renewables energy supply potential
- Realistic objectives at municipal level (how much do the renewables will weight on?)
The estimation of thermal and electric energy demand

Space heating and DHW energy demand

Climatic data (degree days)

Energy data for residential sector [collected from energy distributors]

Building stock information [heated volume, construction period and form factor (S/V)]

Energy data for residential sector [collected from energy distributors]

Climatic data [degree days]

From SEAPs

From Environment Agency

From GIS software

The estimation of thermal and electric energy demand

Torino – 1 mln inhabitants

Pianezza – 10000 inhabitants

Electric demand

Per capita electric consumption from SEAP

Number of occupants

Geometric data (ex. total floor area)

Occupancy factor from statistic agency

Per capita floor area from regional law

<table>
<thead>
<tr>
<th>Label</th>
<th>Torino</th>
<th>Pianezza</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>C</td>
<td>997</td>
<td>176</td>
</tr>
<tr>
<td>D</td>
<td>7541</td>
<td>6249</td>
</tr>
<tr>
<td>E</td>
<td>68</td>
<td>2095</td>
</tr>
<tr>
<td>F</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G</td>
<td>-</td>
<td>905</td>
</tr>
<tr>
<td>%</td>
<td>21%</td>
<td>21%</td>
</tr>
</tbody>
</table>

Per capita electric consumption from SEAP

Number of occupants

Geometric data (ex. total floor area)

Occupancy factor from statistic agency

Per capita floor area from regional law

Ex. Torino

Ex. Pianezza

The estimation of thermal and electric energy demand

<table>
<thead>
<tr>
<th>Electric demand</th>
<th>Number of occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita electric consumption from SEAP</td>
<td>Torino – 1 mln inhabitants</td>
</tr>
<tr>
<td>Pianezza – 10000 inhabitants</td>
<td>Geometric data (ex. total floor area)</td>
</tr>
<tr>
<td>Occupancy factor from statistic agency</td>
<td>Per capita floor area from regional law</td>
</tr>
</tbody>
</table>
The renovation of residential buildings

To adapt the building code at local level is crucial to analyse the renovation feasibility factor.

Feasibility factor: estimation of the statistical inclination of citizens to renovate their own building, considering the physical condition of the object and the socio-economical variables.

\[
F = F_{age} \times 0.30 + F_{edu} \times 0.20 + F_{employed} \times 0.20 + F_{owner} \times 0.15 + F_{building} \times 0.15
\]

Census data

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

Ownership factor: dwellings owned / total dwellings
Variables: DECISION, INTEREST

Building factor: small buildings (<2 dwellings) / total buildings
Variables: DECISION PROCESS

The location factor

Historical centers (red): no external insulation
District heating networks (blue): no boiler substitution

Application of the interventions - example of short term objectives:
thermal energy demand reduction

The number of buildings (%)

<table>
<thead>
<tr>
<th>Province of Torino</th>
<th>First class (%)</th>
<th>Second class (%)</th>
<th>Third class (%)</th>
<th>Fourth class (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Torino</td>
<td>13%</td>
<td>42%</td>
<td>39%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>54%</td>
<td>23%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Satisfying energy demand with RES

The solar resource

- DSM
- Sky model
- Sun model

Software: GRASS GIS - Tool: r.sun

Solar radiation maps

Sky model

Sun model

Terrain + 3D buildings

Turbidity factor, direct/diffuse radiation, etc.

The biomass resource

- Thermal energy demand in residential buildings
- Commercial survey in retailers
- Number and capacity of installed devices
- 2020 potential estimation
- Efficiency of devices

RES potentials

Municipalities

<table>
<thead>
<tr>
<th></th>
<th>Torino</th>
<th>Pecetto T.</th>
<th>Nichelino</th>
<th>Pianezza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants 2011</td>
<td>874.000</td>
<td>3.867</td>
<td>48.011</td>
<td>14.006</td>
</tr>
<tr>
<td>Buildings (A)</td>
<td>35.800</td>
<td>1.033</td>
<td>2.936</td>
<td>2.503</td>
</tr>
<tr>
<td>Apartments (B)</td>
<td>440.000</td>
<td>1.775</td>
<td>20.352</td>
<td>7.090</td>
</tr>
<tr>
<td>Typology (B/A)</td>
<td>12,3</td>
<td>1,7</td>
<td>6,9</td>
<td>2,8</td>
</tr>
<tr>
<td>Potentials (MWh)</td>
<td>PV 0,22</td>
<td>2,60</td>
<td>0,26</td>
<td>0,51</td>
</tr>
<tr>
<td></td>
<td>ST 0,22*</td>
<td>0,21*</td>
<td>0,21*</td>
<td>0,18*</td>
</tr>
<tr>
<td>Per capita values</td>
<td>Biom 0,15</td>
<td>3,40</td>
<td>0,42</td>
<td>1,40</td>
</tr>
<tr>
<td>Electric/thermal consumption from RES (max. %)</td>
<td>7%</td>
<td>60%</td>
<td>15%</td>
<td>27%</td>
</tr>
</tbody>
</table>

* Fixed value for the ST technology/ Residual roof space for PV
Conclusions

The policies must be adapted to local needs: each group of buildings (target of the analysis) will be renovated stimulating in different ways the owners/tenants (ex. Awareness, Financial incentives or split incentives, Grants, etc).

GIS softwares have a great potential with multi-level and territorial topics. The open source solutions are really competitive with commercial ones.

The open data are a very powerful instrument, but:
- the availability is low
- the goodness is unfrequent
- we must intercept also data coming from the private sector
- not so many data are georeferenced

The smart cities need smart policies based on deeper analysis but also a real involvement of citizens and private stakeholders is essential.

The end!

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