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COURSE OF ARCHITECTURE FOR THE
SUSTAINABILITY DESIGN

Abstract

**Urban form and heating energy consumption in residential
buildings. The case study of Settimo Torinese.**

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In recent years the buildings are playing an increasingly important role in energy-saving strategies. Just consider the fact that in Italy more than 80% of the buildings were constructed before the 70s, when any regulation in order to reduce the energy expenditure was still absent.

On the other hand, recently in the process of urban planning issues related to urban morphology are increasingly taken into account, even considering their influence on energy consumption, thermal comfort of urban spaces and district air quality.

In order to understand the interaction between the urban structure and the buildings' energy needs, it is assumed that the density of the built involves a direct effect on energy consumption, but also a strong impact on urban climate, which indirectly affects the energy consumption for services such as heating and cooling. The direct effects are related to the orientation, exposure and shape of individual buildings, whereas indirect ones are due to the increase in temperature that occurs in urban areas, a phenomenon known as the urban heat island (UHI).

Thus, considering only economically and climatically efficient solutions it is not enough to improve the buildings' energy performance, but also building's relationship with its surroundings must be considered. Therefore it is necessary to investigate how urban form affects the energy consumption not only to aim to energy saving, but also with the purpose of defining new urban areas in order to improve air quality and liveability of urban spaces through a more sustainable planning.

The aim of this study is to identify the correlation between the heating energy consumption of residential buildings and urban morphology parameters, through the case study of Settimo Torinese, a small town on the outskirts of Turin, in Italy. Thus the purpose consists in analyzing how the urban scale energy consumption is influenced not only by its own characteristics of the building (such as technological solutions, types of plant or shape, compactness, etc.), but also by an external component determined by the context itself.

Therefore the above study, taking into account both components, is useful in order to be able to describe the energy consumption as an equation that can be defined as:

$$\text{“ [kWh]}_{\text{MEASURED}} = \text{[kWh]}_{\text{BUILDING}} \pm f \text{ [kWh]}_{\text{URBAN CONTEXT}} \text{”}$$

Considering as known the use of energy of a building, the goal is to determine and quantify the change in the energy consumption of buildings only varying the parameters that characterize the urban context. In order to reach this aim, the morphological parameters that mainly influence the variation of the buildings' consumption and that define the value of $f \text{ [kWh]}_{\text{URBAN CONTEXT}}$ have been identified :

- Building density, BD [m^3/m^2];
- Building height, BH [m];
- Building coverage ratio, BCR [m^2/m^2];
- Aspect ratio (canyon effect), H/W [-];
- Main orientation of the streets, MOS [-];
- Albedo of outer surfaces, A [-].

The results of this study show that the energy consumption of an individual building depends not only on its intrinsic characteristics, but there is also a direct correspondence between some urban morphological variables and energy needs.

The increasing problems related to urban environments highlight the need to make cities more liveable and sustainable from the energetic and environmental point of view; this study can become a planning tool:

- in the spatial definition of new urban areas, defining optimal conditions for the environmental and energetic sustainability of neighbourhoods, as a function of the urban form and the type of materials;
- in the case of NZEB design, where “ $[KWh]_{MEASURED} = [kWh]_{BUILDING} \pm f[kWh]_{URBAN\ CONTEXT}$ ” it will be zero when the building will be placed in a context that allows it ;
- in urban areas where it is difficult to find renewable resources, so the study of the urban morphology can help in order to achieve energy sustainability .

This study has been presented and awarded at the ESRI User Conference 2016 in San Diego (CA), as an exemplary work using GIS technologies.
