POLITECNICO
DI TORINO

Honors thesis

Master Degree in Architecture Construction City

Abstract

Buildings heating and cooling demand and the urban form.
The case studies of Turin and Dubai.

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This reasearch aims to demonstrate the thesis that the buildings heating demand is influenced not only by its intrinsic characteristics (envelop, equipment and occupants), but also by the urban context in which it is located. The starting point of this study is the following equation:

$$[KWh / m^2]_{MEASURED} = [kWh / m^2]_{BUILDING} \pm [kWh / m^2]_{URBAN\ CONTEXT}$$

Knowing the first term of the equation, the impact of the urban form on buildings heating demand was analyzed. From the study of the state of the art, some urban parameters were chosen for the analysis:

- Building Coverage Ratio, BCR [m^2 / m^2]
- Building Density, BD [m^3 / m^2]
- Building Height, BH [m]
- Aspect ratio (Urban Horizon Angle, UHA), HW [m / m]
- Height of building and the average height of the sorrounding, HHM [-]
- Orientation of the Main Street, MOS [-]
- Building Orientation, BO [-]
- Albedo, A [-]

These indicators were calculated, using ArcGIS 10.2.1 (ESRI), for each census parcel of the city of Turin. After that, the analysis was limited to the "Crocetta" district, characterized by a homogeneous urban texture and by buildings built the '70s. This area was chosen by following a methodology which is well explained in the thesis. At this point, three-dimensional model was created, using AutoCAD and Rhinoceros, and to the urban energy simulation tool CitySim Pro was used to estimate the buildings heating and cooling demand, and then, the energy models have been validated comparing the calculated data with the real consumption data of buildings heating demand, provided by IREN, taking into account two monitoring seasons. After the validation of the model, the urban form of the selected district was modified. Since the census parcels of Crocetta are characterized by a very similar urban form, it was necessary to create fictitious layouts with different values of the urban parameters, in order to estimate the variation of the buildings heating demand.

Finally, a preliminary study of two neighborhoods of the city of Dubai was carried out, trying to apply the methodology in a hot and dry climate context. The aim of this part of the thesis is to analyze the impact on buildings cooling demand and on the cool islands phenomenon of a traditional Arabic urban form (like that of Al Bastakya district) versus the urban form of a modern district (such as the Dubai Marina district). In this case, the research has not gone as far as for Turin, for lack of informations, in fact, this study can only be considered as the first step towards the definition of a building cooling demand model.

The proposed methodology, based on a multi-variate compensation approach, can be a support tool for urban planning and improved energy sustainability of cities.

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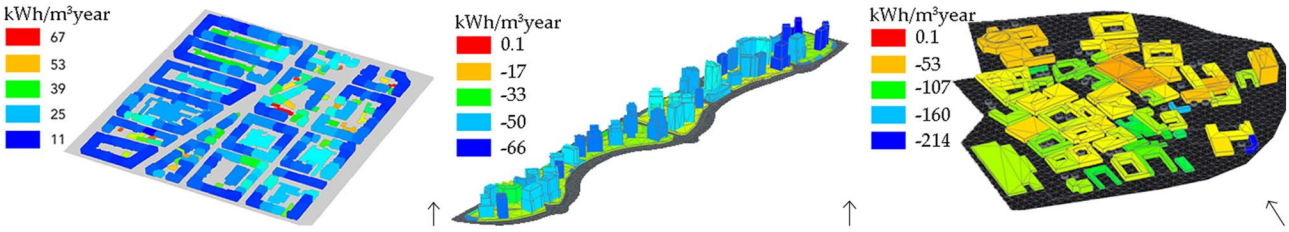

Fig. 1 - Yearly heating and cooling demand for Crocetta district in Turin (left), Dubai Marina district (middle) and Al Bastakiya district in Dubai (right), calculated by CitySim Pro.