



POLITECNICO
DI TORINO

Honors thesis

DEGREE IN SUSTAINABILITY DESIGN

Abstract

**Definition of a model of energy planning for sustainable
diffuse university campuses. Evaluation of existing models
and application to a case study**

Tutor

Stefano Paolo Corgnato

by

Roberta Lami

Correlator

Cristina Becchio, Valentina Fabi,
Minna Sunikka Blank

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This thesis has the objective of analyzing critically the Energy Planning Model of the Politecnico di Torino, evaluating the pros and cons after a comparison with the "top ranking universities" (in particular Cambridge and Harvard, chosen to compare both an European and Extra-European system).

The analysis focuses on the "Energy and buildings" topic, the most important aspect to evaluate the effectiveness of the actions taken by the Polytechnic of Turin in this field. To this aim, these has been applied to a reference case study, highlighting and prioritizing the best possible practices to be implemented in our system.

The attention is focused on the university campuses because they are so vast and complex that can be considered as "small towns". Their large size, the indexes of crowding and the variety of activities that take place in the university campuses buildings have important effects - direct and indirect - on the environment. As a result, the issue of sustainable campuses has become a matter of interest for world political leaders and university management teams. A further reason why universities should pay particular attention to energy efficiency is represented by the decisive role that they play in the energy planning of future urban systems and "smart cities", as hubs of culture, education and research, and as examples for the entire society.

To this purpose, we take in consideration two main documents as a reference to delineate the energy efficiency policies commonly exploited to support universities in this task.

In particular, a document written by IEA ("*Building Energy Performance Metrics*") has been analyzed. Starting by existing buildings, it suggests a way to properly implement energy efficiency policies across different economies. This evaluation process is divided in several steps:

Improve the quality of data;

Perform preliminary analysis;

Use metrics to evaluate energy performances, such as the energy consumption area;

Generate a model to evaluate the proper use of energy.

Subsequently, information from the ISCN (International Sustainability Campus Network), a network that supports universities in the exchange of information, ideas and strategies to integrate sustainability in research and teaching, have been collected to provide the basic guidelines for evaluation of the energy planning of campuses.

The project is based on three principles: (i) buildings and their impact of sustainability, (ii) planning and goal setting, (iii) integration of teaching, research and sensitization.

Then, the energy planning of the Politecnico di Torino has been examined in detail, in order to underle the main strategies entailed, assess their effectiveness and compare them with that implemented in other models.

Within this model, the interventions are divided into five dimensions: (i) Energy and Buildings, (ii) Purchases and waste, (iii) Urban Outreach, (iv) Mobility and metropolitan area, (v) People and food. Each dimension is committed to follow the three guiding principles proposed by ISCN and for each principle are highlighted the interventions put in place with the relative reference metrics, as defined in the Report of the IEA ("*Building Energy Performance Metrics*").

The analysis focuses on the first dimension ("Energy & Building") of the planning model of the Politecnico di Torino. In particular, different types of interventions are proposed, in order to improve the energy performances of the different locations which compose it. The head

office of Corso Duca degli Abruzzi appears to be the main focus of action because, as clear from the analysis of the consumptions recorded in the last years (2011-2014), present one of the highest level of consumption. It is also possible to highlight a reduction of them due to the interventions implemented from 2012 to 2014 (the last year for which we have data), although it has not been possible to identify which of the different interventions has been more incisive, hindering the effectiveness of every the single action.

Furthermore, to improve the organization and the management of sustainability strategies, including strategies for the energy efficiency of buildings in the campus of the Polytechnic of Turin, a comparison with other models, Harvard and Cambridge, has been performed. This comparison shows the need to fill the gaps emerged (indicated in the table below as “cons”). In particular, about the dimension of “Energy and Buildings”, the lack of a preliminary energy audit is evident; it would have been useful to understand the needs of the buildings of interest, the impact and effectiveness of the interventions.

PRO	CONS
Macro reference area (five dimension)	Lack of a general goal
Objectives and future commitments for each macro area	Lack of priority
Synergy between the different areas	Lack of organization strategies
Interventions to improve the energy performance of buildings	Lack of an energy audit

Moreover, a case study has been chosen, in order to make the energy audit and trace a strategy to follow. Although there are considerable differences in the architectural composition between the Cambridge University campus and the Polytechnic of Turin, the Engineering Department of the University of Cambridge (and specifically on the Baker Building) has been chosen for this purpose, as it has similar characteristics to the headquarters in Corso Duca degli Abruzzi, which, as noted, is the site on which Polytechnic focused mainly in the implementation of retrofit.

All information related to the case study required for the creation of the energy audit have been collected and, once gathered, it has been possible to carry out this diagnosis, of which all the steps have been reported. At the end of the energy evaluation processes, the results obtained have been compared with the available values of consumption of the energy certification, to estimate the exactness of the work. In addition, the actions proposed and implemented by the Politecnico di Torino has been assumed to improve the energy performances of the case study. These appear to be the most appropriate and effective choices, if compared with other possible energy retrofit interventions based on the preliminary analysis. Nevertheless, they don't appear to be the least intrusive measures; for this purpose, some different actions have been suggested, perhaps less efficient but also less invasive.

For further information please contact:
 Roberta Lami, mail: robby.lami@hotmail.it