

Research topic:

*Energy*

DII research group  
 BETA\_Lab: Building Energy  
 Technology Assessment



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The research activity was supported by Padua University and is ongoing and carried out in collaboration with:

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Main research topics

- Modeling and Field Measurements of Radiant Systems
- Ground Source Heat Pumps
- Solar Systems Design for Heating and Cooling
- Double Skin Facades
- Energy Analysis and Temperature Distributions in Large Spaces
- Simulations and Measurements in Buildings
- Energy Efficiency of Building Plant System
- Nearly Zero Energy Buildings (nZEB)
- Low Exergy Systems in Buildings
- Thermally Activated Building Systems
- District Heating and Cooling Networks
- Thermal Comfort
- Modelling and Development

## Energy Modelling Of Historical Buildings

The existing buildings are responsible of about the 40% of the primary energy demand in Europe. As widely known and discussed in literature, the energy efficiency improvement, especially in building sector is one of the most important actions for the reduction of the greenhouse gases emissions in the atmosphere. In Italy, the total amount of heritage monuments is about 4,000,000 of 5,367,000 present in the worldwide. Many buildings have been built before the 1919 and today are used as residential buildings or for public services. From the UNESCO World Heritage List, Italy has 4.7% of the world architectural heritage that occupies 46% about of the entire country.

This work presents two case studies. The first one is the retrofitting of a historical building of the University of Padua, equipped with a hybrid heat pump system, which uses as heat source/sink the ground and ambient air. The building is located in Padua and it is a historical complex of the late 1800, previously used as a geriatric hospital, in which a retrofit process is occurring in order to build the new humanistic campus of the Padua University reaching the highest energy efficiency. The refurbishment is in progress and regards both the building envelope and the plant-system. The building is equipped with two types of heat pumps: the first one is coupled to the ground with borehole heat exchangers and the second is a common air-to-water heat pump. The entire building plant system has been investigated through integrated computer simulations making use of EnergyPlus Software. A new control strategy in order to manage the two types of the heat pumps has been developed in order to increase the energy efficiency. The results outline the potential of the computer simulations in order to control the hybrid heat pump system. In fact, a suitable switch temperature was found in order to move from ground to air source/sink for the heat pumps. In addition, this strategy allows the control of the thermal drift of the ground temperature throughout the years.

The second case study is Palazzo Bo, one of the oldest University buildings sited in the central area of the city, developing specific retrofit solutions according to national regulations and constraints for the protection of historical-cultural architecture heritage. This work is part of a project on energy sustainability supported by the University of Padua. Energy simulations have been implemented and the thermal behavior of the building has been investigated considering the peculiarities of the envelope and real weather data. The developed model can be used to improve the management of the plants and / or to design energy efficiency measures, even though, for a building subject to historical protection, it is very complex to work on the envelope.

