Preface

Due to the prevailing climatic conditions, buildings in most European countries are characterised by a greater need for heating than cooling.

Several simplifications can be generally adopted for the calculation of the thermal balance of a building when considering the heating side. In fact, the assessment of the heating energy needs of a building mainly depends on the amount of indoor air volumes to be renewed to ensure the well-being of the occupants, regardless of the construction features, and on the performance of the building envelope in preventing the heat loss through transmission. As a matter of fact, it is common practice in the building sector to consider the level of thermal insulation of the envelope as the first indicator for describing the energy quality of the building.

Actually, the warmer climatic conditions in areas of southern Europe strongly influence the building thermal energy balance in terms of cooling needs. Therefore, the glazed percentage of the building envelope and the way the openings are shaded should also be taken into account among the main indicators of the building energy quality. Another important indicator should be the thermal capacity of the construction, since it significantly affects energy performance in the case of daily variations in the direction of the thermal flux through the envelope over long periods of time (buffer effect during summer and intermediate seasons). Moreover, the useful effect of thermal mass during the warm season can even increase, depending on the way the building is ventilated (i.e. free cooling strategies): in the warmer areas, in fact, the ventilation rates usually exceed the amount strictly needed to guarantee the indoor air quality, often through window management by the users, as mechanical ventilation systems are rarely provided.

In order to properly take into account all these aspects, the assessments of the building energy balance should be performed by means of detailed evaluations (i.e. dynamic calculation procedures). In this case, however, the calculation methods are too complex to be widely adopted in common practice, even using proper simulation tools: an accurate physics model, with detailed boundary conditions defined at least on an hourly base (building usage patterns, climate, etc.), and therefore producing reliable results, can only be achieved by users with sufficient competence and experience.

Furthermore, the set-points regulating building climatization systems, defined as the “suitable indoor temperatures” providing comfortable thermal conditions, and therefore the corresponding values assumed for the building energy balance calculation, are still commonly defined according to the thermal comfort theory formulated by Fanger in the 1970s.

This approach bases the definition of thermal comfort on pure physics, neglecting social and psychological aspects of thermal perception, while in the Southern European context, and in particular in the Mediterranean region, the building solutions and users’ habits reveal certain peculiarities. Buildings are in fact widely naturally ventilated even when active cooling systems are installed, because people are traditionally used to maintain contact with the outdoors, and are usually equipped with operable window shading devices. Under these conditions, the real cooling needs strongly depend on the comfort mitigation strategies adopted by the users, and the thermal expectations are strictly related to the mean outdoor climatic conditions of the considered period (thermal experience).

In this respect, the very narrow range of allowable indoor set-point temperatures defined by a completely steady-state approach for assessing building thermal energy needs is questionable.

The main alternative approach to determining, on a variable basis, comfortable environmental conditions is the adaptive approach, which has a dynamic form depending on a transient parameter, i.e. the external temperature. This approach was developed on the assumption that the occupants are an active part of the enclosed environment: i.e. they can interact with the construction and can affect the building boundary conditions regardless of the presence of an active climatization system.

Once again, however, this climatic-related indoor temperature can only be set by means of a detailed simulation analysis.

Another important aspect that can be properly taken into account only by performing a dynamic analysis is the operative temperature in the spaces, which considers the surface radiant temperatures and therefore more accurately represents the performances of the building envelope in contributing to overall thermal comfort sensation.

The operative temperature parameter can strongly influence the real building energy need, especially during summer when the solar radiation affects the glazed surfaces, and is commonly neglected in simplified building energy assessment, which considers only the air temperature. As a matter of fact, in the case of unfavourable radiant temperatures, the air temperature set-point is usually corrected by the users in order to adjust the indoor condition to compensate the radiative component, and the consequent overuse of the active climatization systems causes an unpredicted increase in building energy consumptions.

Summarizing, simplified procedures and assumptions have been common practice for a long time in assessing the energy performances of buildings in Europe: currently, the quasi-steady-state energy balance calculation method (the simplest among those provided for by EN ISO 13790) is still the main reference for implementing procedures at national level and is also widely adopted for the energy certification of buildings. Nevertheless, a proper evaluation of building energy performance, with particular reference to the southern climatic area, should be significantly more complex.

This book discusses the related issues, besides the theoretical basis, through several application case studies carried out with reference to the Italian context, considered as representative of southern Europe. These descriptions will support energy consultants and other interested parties in assessing building energy performance beyond the mere simplified standard assumptions. Furthermore, the numerous graphs and tables documenting the analysis of a set of typical building solutions can be easily adopted to serve as design tools for both new constructions and retrofits.

Finally, I hope that this book, bringing together results from some of the most significant researches that I have promoted and coordinated in recent years on the issue, will contribute to increasing awareness of the actual consequences of architectural design choices, contrasting the trends to construct excessively light, largely glazed and improperly sealed buildings, and to encouraging the definition of more suitable energy policies for the building sector in the Southern European context.

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