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Protocol for the energy behaviour assessment of social housing stock: the case of southern Europe.

Rocío Escandón[a,]*, Rafael Suárez[a], Juan José Sendra[a]

[a]*Instituto Universitario de Arquitectura y Ciencias de la Construcción, Escuela Técnica Superior de Arquitectura, Universidad de Sevilla, Av. de Reina Mercedes 2, Seville (41012), Spain.*

Abstract

The aim of recent European Directives and Regulations is the establishment of a common framework for increasing energy efficiency, encouraging the retrofitting of existing housing stock, obsolete in energy terms. Most of the studies carried out on the energy characterisation of existing housing stock for their subsequent retrofitting focus on climate areas in central and northern Europe, but there are fewer studies for southern Europe. This research was initiated in order to contribute to a better understanding of social housing in southern Europe, specifically southern Spain. A protocol was proposed for the assessment of the end-use energy behaviour of social housing stock, taking into consideration geographical location, building typologies, and morphological and constructive characteristics of the envelopes of this housing stock. This protocol is divided into two different phases: a first phase for a general energy assessment and a second phase for a detailed energy assessment. It aims to provide a general energy behaviour assessment as the first step in the proposal of guidelines and strategies for the energy retrofitting of existing social housing stock. In order to achieve these objectives, the first phase of the proposed protocol includes a typological classification of buildings and a morphological and constructive characterisation of thermal envelopes by construction period. The second phase of the protocol includes onsite data collection on hygrothermal behaviour and energy consumption and generation and validation of energy models in the buildings selected for their subsequent energy simulation and rating. In this study, the first phase of the protocol was applied to five case studies built between 1950 and 1980 in the different climate zones in the south of Spain, with the main conclusion that the existing general high level of demand due to the poor thermal performance of the envelope leads to a very low energy rating.

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Keywords: Housing stock; energy assessment; energy performance; energy retrofitting.

* Corresponding author. Tel.: +3-495-455-7024; fax: +3-495-455-7024.
E-mail address: rescandon@us.es

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1. Introduction

The most significant urban growth in major Spanish cities took place between 1939 and 1980, when over 50% of 20th-century residential units were built [1]. In the case of Andalusia, the most important period of urban growth was after 1950. The residential stock built between 1950 and 1980 accounts for 40% of the total built during the 20th century [1]. These data reflect the high percentage of dwellings built with no general guidelines on thermal regulation, given that the Basic Building Standard "Thermal Conditions in Buildings" (NBE CT 79 [2]) was not implemented in Spain until 1979. There is therefore an extensive housing stock that is not subject to specific thermal insulation measures, much of which does not meet current energy standards. The energy assessment and retrofitting of this housing stock, particularly social housing, is therefore necessary. Aware of the importance of investing in retrofitting and the potential of energy savings the different public administrations have incorporated policies as part of the strategies of Horizon 2020. Directive 2012/27/EU [3] and Spanish Royal Decrees RD 233/2013 [4] and RD 235/2013 [5] are a faithful reflection of this.

Most of the studies to date on the energy characterisation of housing stock refer to climate zones in central and northern Europe and Spain [6,7,8,9], although some notable exceptions focus on the southernmost areas of the Mediterranean arch [10,11]. Santamouris worked extensively on the characterisation of environments and energy consumption of social housing stock in Athens, analysing the relationship between low-income families and the quality of the housing they reside in [12,13,14]. Dall'O' [15,16] developed a methodology for the analysis of existing buildings in Italy in order to calculate their energy rating, based on the search for correlations between building characterisation and energy consumption.

When examining the environmental characterisation of a series of residential buildings the studies carried out show that the construction period, building typology, constructive definition of the envelope, and climate zone in which they are located are the four most influential variables for the results obtained [17,18,19].

The aim of this research is to propose a protocol for the assessment of the end-use energy behaviour of social housing stock in climate zones in southern Europe. This assessment is the first step towards the proposal of guidelines and strategies for the energy retrofitting of this social housing stock. The application of this protocol aims to carry out a general study for the south of Spain, characterising energy behaviour by climate zone and focusing on major residential neighbourhoods built between 1950 and 1980.

2. Methodology

A protocol is proposed for the characterisation of the current energy conditions of a large part of the social housing stock of the south of Europe. This protocol is divided into two different phases: the first phase consists in the general assessment of the energy behaviour of residential complexes, while the second provides a detailed energy assessment of the dwellings.

Phase 1 of the protocol, which is applied to the residential complexes in general, is composed of four tasks:

- Task 1.1: Compiling typological, morphological and constructive data on the residential complexes in the sample.
- Task 1.2: Generating energy models for the residential complexes.
- Task 1.3: Simulating energy models for the residential complexes.
- Task 1.4: Discussion of results.

Task 1.1. focused on the statistics and context analysis of social housing stock built in the south of Europe in the period under study, aiming to cover all the climate zones in the region. This research therefore identified and subsequently defined the main social housing developments built in the south of Spain between 1950 and 1980 (the period under study), locating them on a GIS platform (Fig. 1), using QGIS v.2.14.0 software [20]. The necessary information for energy characterisation was uploaded to this platform. The data added were: location, architect, developer, year of construction, number of stories, number of dwellings, building typology, constructed area, original plans, constructive description of envelope, thermal installations and current condition of buildings. For this it was necessary to compile the documentation from the original designs of the sample selected by consulting Municipal Archives as well as bibliography and documents from the archives. The different housing developments were also visited for the assessment of the degree of intervention or decay since construction.