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Indicators for renewal at the regional level

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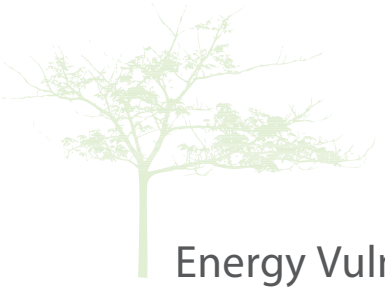

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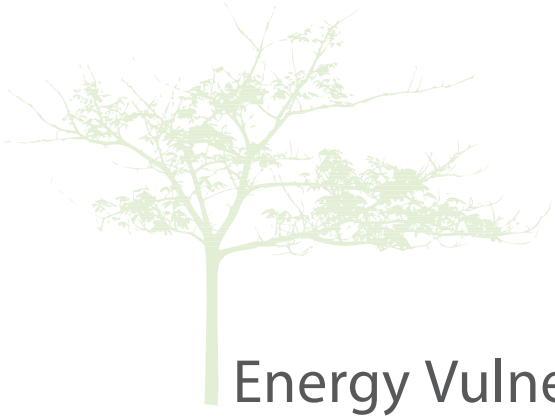

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Introduction

I

With the first energy crisis in the 1970s our perception and understanding of the fragility of the planet became more acute, making us understand the new global scale of this issue, as seen in the image of Earth taken from Apollo 17 (fig. 1).

Figure 1. Globality. The blue marble, 1972

In Greek mythology, the young priestess Cassandra was blessed with the gift of prophecy, but the god Apollo, feeling rejected, deprived her of credibility so that nobody believed her when she warned of the ploy of the Trojan horse. This myth could well be a metaphor for our current energy situation, deteriorated as a result of the passing of the years due to not having faced reality in a timely manner. We are living in complex and uncertain times, where it is hard to predict the consequences of the global changes taking place.

We now face the need to conserve and regenerate what is already in existence. Most of the social public housing stock that will exist in the coming decades has already been built, but is – for the most part – obsolete and cannot satisfy the current needs for comfort and wellbeing. Furthermore, in the next few years the current energy situation will be faced with two major challenges: the social challenge of energy poverty and the environmental one of the proven rapidly accelerating climate change. This worrying scenario, with numerous socioeconomic and environmental ramifications, also jeopardizes the health and wellbeing of users and has worsened due to the ongoing energy scarcity and economic crisis of the last decade. For this reason, increasing numbers of homes in Europe are restricting the level of use of heating and/or cooling installations, which also leads to poorer comfort conditions indoors.

It therefore becomes necessary to renew the residential stock, implementing an approach in intervention actions that does not focus solely on reducing consumption and emissions, as set out in the regulations, but also on improving the quality of life of users, especially in the most vulnerable homes.

Access to energy is included among the actions which can improve the wellbeing of people and protect the planet. This basic right of citizens, was not suitably recognized until the year 2015, when the General Assembly of the United Nations incorporated it into the 2030 Agenda as one of its Sustainable Development Goals (UN 2015). Goal 7 specifically proposes to "ensure universal access to affordable, reliable, sustainable and modern energy services" for all. This is also relevant to the fight against poverty, included within Goal 1, which proposes "to build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events."

European Union policies are focusing on actions geared towards achieving climate neutrality by 2050 through the European Green

Deal (European Commission 2019). This pays particular attention to the retrofitting of the social public housing stock, which is inextricably linked to a social dimension. Given the expected wave of renovations (European Commission 2020), major transformations are proposed for our cities and buildings, potentially aiding job creation and improving our quality of life.

II

The necessary incorporation of social justice into the process for rehabilitating the social public housing stock has led to the creation of policies for the protection of citizens, aiming to prevent social exclusion and to guarantee basic and affordable access to energy (EESC 2013) in an effort to eradicate energy poverty (European Commission 2012).

The extensive attention paid to the issue of energy poverty has increased since Boardman (1991) defined this concept as the economic inability of a household to satisfy its energy needs, spending over 10 % of its income on basic energy needs. The climatic, construction and socioeconomic differences of every region call for the implementation of a distinct approach (Healy and Clinch 2002). In northern European countries energy poverty is the result of public housing with poor energy efficiency, low income and high energy costs, all of which make it difficult to cover the cost of energy bills in the wintertime (Boardman, 2010). In contrast, in southern European countries such as Portugal, Spain and Greece, energy poverty levels are higher (Tirado and Bouzarovski 2014) as, despite the milder winters, many people live in cold energy-poor buildings, with a limited use of energy systems. There is an additional need for cooling due to overheating problems in summer.

Energy poverty indicators do not adequately reflect the complex energy issues identified in homes, as these are difficult to record with a single indicator (Siksnelyte *et al.* 2021). However, the EU Energy Poverty Observatory (EPOV 2020) proposed this approach, which could potentially lead to the use of deficient policies for the eradication of energy poverty (Simcok *et al.* 2021). These issues should therefore be addressed from a broader and more complex perspective, applying the concept of energy vulnerability.

Initial examinations of energy vulnerability were carried out by Plummer (1982), while Bouzarovski (2014) proposed a conceptual shift from a more limited approach examining the factors of energy

poverty to a wider more complex interpretation which transcends the individual household scale[11]. This author defines energy vulnerability as "the inability of a household to secure a socially and materially necessitated level of energy services in the home." This requires it to be viewed as a socio-spatial phenomenon (Bouzarovski *et al.* 2017), with a holistic approach incorporating the energy deficits of the public housing unit, rather than just as consumption, difficulties in making payment and the lack of access to energy services, also highlighting issues such as resilience and precariousness. In addition, this approach to energy vulnerability takes into consideration both the population identified as being in energy poverty, as well as the exposure to the risk (Bouzarovski and Petrova 2015) of a dwelling falling into a future situation of energy poverty. Thus, a dwelling in a situation of energy vulnerability is at greater risk of increased energy costs, as well as of a reduction in income or an increase in energy needs due to changes in climate.

Among the vulnerability factors proposed by Bouzarovski and Petrova (2015) it is worth noting the determining factors of buildings (building characteristics), users (income level), and climate. Energy vulnerability has frequently been assessed in relation to needs deriving from undercooling, the approach followed by the European Energy Poverty Observatory. However, in a context of climate change and in the setting of Mediterranean climate it becomes necessary to address the risk of overheating (Santamouris and Kolokotsa 2015), which also leads to situations of low energy performance and a possible increase in the use of cooling systems (Sanchez-Guevara 2019).

III

Social dwellings tend to be occupied by low-income users, generally in buildings with poor energy efficiency. Moreover, given that most of the social public housing stock in the European Union is publicly owned, the assessment, prevention and mitigation of energy vulnerability ought to be viewed as a public concern.

Faced with the imminent and much-needed plan for the intensive retrofitting of the social public housing stock resulting from the energy

1. According to Lindley *et al*. (2011) the concept of vulnerability comprises three interconnected dimensions: risk to exposure, sensitivity and capacity for adaptation.

policies of the European Union, the following research hypotheses are proposed:

— What is the degree of energy vulnerability of social public housing?
— How much more vulnerable is a given group of homes in relation to others?
— What would the effect of a climate change scenario be?
— What could the order of priorities in retrofitting actions be?

The main aim of this research is the definition of a composite index, incorporating energy and socioeconomic assessments, in order to identify and evaluate the level of energy vulnerability of the public housing stock. This will then constitute a starting point for the decision-making processes in the retrofitting process and will help to determine priority objectives for intervention in a more dynamic and sensitive manner.

In order to evaluate the validity of the index as a tool in decision-making processes, the energy vulnerability index defined was applied to a sample on a regional scale within the social public housing stock available under the rental scheme applied by the Andalusian Agency for Housing and Rehabilitation (AVRA) of the Junta de Andalucía, built between 1970 and 2005.

IV

The research carried out proposes to evaluate the vulnerability of social public housing, understood as the deprivation of capabilities. This issue is relevant both at present, when minimum levels to guarantee comfort conditions are not met, and to the future, given the modification of factors affecting vulnerability. The application of this capability-based approach is removed from measurement-based approaches, commonly applied to energy poverty, and makes it possible to incorporate policies for adaptation and mitigation over time when considering future levels of energy vulnerability.

The first chapter addresses the establishment of a metric for energy vulnerability based on thermal comfort and using a double approach. This is done by firstly incorporating the assessment of two indicators obtained from public databases: the first, linked to users, shows income level to value the economic capacity to maintain comfort conditions, while the second, linked to the building, examines the energy

demand for attaining comfort conditions. Parametric simulation models on a regional scale are then used to show the two main social public housing typologies, linear block and H block, carrying out an assessment - under free running conditions - of the percentage of hours of comfort recorded in the time period in which the user cannot cover demand due to financial constraints.

The second chapter, looking to the future, examines the effect of a climate change scenario on these conditions of energy vulnerability. Heatwave episodes observed anticipate the effects of climate change. Rising temperatures and the increased intensity, frequency and duration of extreme heat events result in increased vulnerability and risk of mortality (Linares *et al.* 2015). The effects of excess death rates due to heatwaves and the potential for reducing them through adaptation processes are analysed and quantified (Arbuthnott *et al.* 2016). Continuing the research initiated in the previous chapter, the influence of rising temperatures on the modification of comfort conditions in social public housing stock is assessed through the application of parametric models for energy simulation.

The third chapter presents an assessment of the energy vulnerability of the public housing stock in Andalusia through the development of a composite index based on two indicators, one linked to the building and another to the users. This energy vulnerability index was initially developed for a current climate scenario, examined on a regional scale using public databases. To avoid limiting the study to a current overview of the issue, a projected climate scenario for the year 2050, focusing on the neighbourhood scale, is proposed through the use of energy simulation models.

The final chapter presents the conclusions reached during this research. Based on the analysis in the previous chapters the proposed energy vulnerability index offers a depiction of energy vulnerability, while the future projection carried out using parametric simulation models can predict certain capabilities. However, since this is a complex phenomenon, both cases should be viewed as instruments for comparison. This tool, which is necessary for decision-making processes in a regional context, will make it easier to prioritize actions for developing an intensive energy retrofitting plan, using specific public policies geared towards combatting energy vulnerability, and implementing an approach in which social justice is a decisive factor in political decisions.

V

This book is mostly the result of research carried out by the authors as part of the regional research project "Vulnerabilidad Energética del parque Residencial Andaluz. Indicadores para la toma de decisiones en la rehabilitación energética a escala regional" ["Energy vulnerability of housing stock in Andalusia. Indicators for decision-making in energy rehabilitation on a regional scale"] developed during the period 2022-2023, and funded by the Department of Economy, Knowledge, Business and University of the Junta de Andalucía and the European Union through the European Regional Development Fund (ERDF).

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Figure 2. AEMET, 2018, p.13. Open Data.

Figure 4. Agencia Andaluza de la Energía, 2012

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Energy Vulnerability of the public social housing stock in Andalusia

What could be the order of priority for retrofitting actions at a regional level considering a climate change scenario?

The challenge of achieving climate neutrality requires a process of energy renovation of the Andalusian public social housing stock based on retrofitting strategies that consider energy vulnerability, taking into account the current state of the obsolete residential stock, the economic capacity of its occupants and the climate.

This paper addresses energy vulnerability by integrating the capacity of the building and the user to meet the energy needs of the dwelling, incorporating risk to exposure risk and the capacity for adaptation. To this end, the energy vulnerability of public social housing in the main climatic zones of Andalusia is analysed from an approach focused on thermal comfort, using an energy vulnerability index based on two indicators for the assessment of the energy behaviour of the building and the socioeconomic data of its occupants. The different levels of energy vulnerability identified are of great interest for the renovation of the residential stock, assisting in establishing priority action guidelines.

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