

# The importance of citizen participation in improving comfort and health in obsolete neighbourhoods affected by energy poverty

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## ABSTRACT

This study analyses comfort and health in obsolete neighbourhoods in regions with high rates of energy poverty. The Polígono San Pablo in the city of Seville, Spain has been chosen as a case study.

The research aims to highlight the importance of including participatory processes in the analysis of human rights issues, such as energy poverty. A hybrid and interdisciplinary methodology is presented which incorporates a citizen participation process. The aim is to use this methodology to identify how an obsolete building stock and lack of access to a basic energy service may be affecting people's health.

The main results obtained show the need to include citizen consultation to identify shortcomings and potentialities in obsolete neighbourhoods, especially in terms of energy education. This is expected to contribute to the creation of more effective local energy policies to address the multidimensional problem of energy poverty.

## 1. Introduction

Energy is a basic requirement to maintain a good state of citizen health and well-being. Governments must ensure all citizens have access to energy, as stated in the international agreement of the 2030 Agenda and the Sustainable Development Goals (United Nations, n.d.). This guarantee must be based on energy projects that combine people's health and environmental conservation. The work to preserve this Human Right must be aligned with the principles of environmental and intergenerational justice, to ensure the availability of resources for future generations (Energy Poverty Network, 2021).

Specifically, energy poverty is a problem that affects those people who do not have basic energy services in their homes, either due to high energy prices, the lack of a connection network, or the poor quality of the construction of their homes (Castaño-Rosa, Solís-Guzmán and Marero-Meléndez, 2020a, 2020b). As it is a multidimensional problem, it manifests itself in different ways. Energy poverty is also associated with lack of access to modern energy services (e.g., due to old and inefficient technologies) (International Energy Agency, 2020), lack of energy governance (Verma, 2023), or high dependence on fossil fuels (Scott &

Pickard, n.d.), which is a growing concern in the face of the current global energy crisis (Departamento de Urbanística y Ordenación del Territorio (2011); Ministerio de Transportes Movilidad y Agenda Urbana (2011).

Access to basic energy services not only limits people's lives in their homes but also the environment in which they carry out their daily lives. The immediate environment, such as the home, and the intermediate environment, such as the neighbourhood, must be designed according to energy saving and efficiency criteria to provide citizens with basic conditions at the lowest possible cost (Ministry for Ecological Transition and Demographic Challenge, 2019a) both economically and in terms of natural resources. However, it should be noted that the relationship between health, comfort, and built environments is complex, as habitats are spaces where changing realities develop, so that variation in a single element affects the rest of the environment (Fernández Marín, 2021). A sustainable and healthy habitat must therefore be diverse and enable the relationship between individuals, and between individuals and the environment, through settlements that are safe, accessible, sustainable, and affordable (United Nations, 2017; Fernández Marín, 2021).

Generally, people living in households in energy poverty suffer from

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extreme temperatures, poor indoor air quality, lack of natural light, or even damp, and mould in the dwellings (Ortiz et al., 2019). This leads to physical impairments among the inhabitants, such as higher rates of infectious respiratory or allergic diseases and mental health problems (Hernández et al., 2016). Studies have identified how people living in households in energy poverty are more likely to suffer from emotional distress, stress, depression, and problems with social relationships (Thomson et al., 2017; Hernández et al., 2016).

This situation leads to an increase in mortality and morbidity in periods with extreme temperatures. According to the European Energy Poverty Observatory, the countries with the worst winter mortality rates are Malta, Portugal, Cyprus, and Spain. Specifically, it is estimated that in Spain there is around 20.1% excess mortality in winter (EU Energy Poverty Observatory, 2014). In this context, the World Health Organisation estimates that 30% of additional winter mortality is related to poor heating of dwellings (Tirado-Herrero et al., 2018). Regarding extreme heat spells, adults are particularly vulnerable to their health impacts, especially those suffering from age-related chronic diseases such as cardiovascular diseases, hypertension, etc. (Meade et al., 2020). In general, as people age, defence against thermal challenges becomes more difficult and hyperthermia and hypothermia can develop more easily (Székely and Garai, 2018).

This issue is accentuated in the most vulnerable neighbourhoods. Typically, these are environments that do not have quality infrastructure such as green spaces, proper lighting, efficient waste management or even adequate access to buildings. In this way, people who do not have adequate conditions in their homes can become overcrowded because they do not have a public space that is comfortable when their home is not comfortable (Delgado and López, 2020).

In order to address energy poverty from its different dimensions, it is necessary to promote strategies that ensure citizens' access to a basic energy service is evident. In this sense, public policies play a fundamental role in addressing energy poverty from a citizen governance approach. The incorporation of citizens in the definition of energy policies is a complex and continuously evolving process (Hernández P. & Huepe Minoletti, 2019). A key point in promoting citizen governance has been the transition from the fossil energy system to the renewable energy system (Lennon et al., 2019). In this context of energy transition and climate crisis, figures such as energy citizenship emerge as an integral and necessary part of addressing climate challenges (Bireselioglu et al., 2024).

Academia and research groups have a fundamental role to play in contributing to the creation of these public policies. One of the measures proposed by some research (Garzón et al., 2005; García Ramírez, 2012) to design strategies adapted to different contexts is to incorporate consultation and citizen participation processes, acting on the realities closest to them (Atutxa et al., 2020). The citizens resident in a defined territory become emitters of the real needs that are perceived in the housing and urban environment they inhabit (Espinoza Almonacid et al., 2021; Escurra and Rosso, 2020).

It is therefore necessary to create open and inclusive methodologies, which can adapt to local contexts and replicate good practices in contexts that present certain similarities. These are presented as an alternative to national policies and strategies, which are difficult to adapt to local contexts (Gallicchio, 2010).

The research aims to highlight the importance of including participatory processes in the analysis of human rights issues, such as energy poverty. By incorporating the opinion of the population, it is possible to prioritise measures in projects that respond to the real needs of the people who live in the dwellings, as opposed to the initial recommendations that technical analysis may generate. In this way, the relationship between energy poverty, comfort, and health can be better understood and thus contribute to future public policies.

The article is organized as follows. First, a theoretical framework is presented in which the relationship between energy poverty and health is highlighted, especially in obsolete neighborhoods in Mediterranean

regions that generally have high levels of energy poverty. The elderly population of the Polígono San Pablo, in the city of Seville, has been selected as the object of study. It is a neighbourhood made up of almost 9000 social housing units, built in five phases between 1964 and 1976. The Polígono San Pablo is a representative case of an obsolete residential neighbourhood in the southern region of Spain, which has a Mediterranean climate. As will be shown later, this neighbourhood has high levels of vulnerability and poverty.

The hybrid methodology used, based on qualitative and quantitative analysis, is presented below. Firstly, an analysis of the neighbourhood is carried out to identify key aspects related to energy vulnerability, comfort, and health. For this purpose, data collected by the working group of this research, as well as statistical data from the public administration, are used. Secondly, the opinion of the neighbourhood's population is incorporated through interviews with the San Pablo health staff and a group of neighbours who have voluntarily collaborated in participatory workshops.

Finally, the results are presented in three sectors: household information, public space, and energy education of the population. The objective is to analyse the relationship between energy poverty, health, and comfort in a neighbourhood previously identified as having a high rate of vulnerability and poverty, as well as to analyse whether they have the tools to combat the shortcomings of these problems. This is expected to contribute to the development of public strategies that address health and energy, through the urban regeneration of obsolete neighbourhoods. It is essential to develop this type of rehabilitation strategy as opposed to constructing new housing in the current context of climate and energy emergency.

## 2. Theoretical framework

### 2.1. Definition and measurements of energy poverty

Access to affordable, reliable, and safe energy services is essential for people's comfort, well-being, and development. However, globally, a large number of households are unable to access a basic energy service, which affects the physical and mental health of the people who live there.

In Europe, it is estimated that 8% of households are unable to keep their homes at an adequate temperature in winter (Eurostat, 2021) and 35% of homes are more than 50 years old (European Commission, 2021). This situation, coupled with current social, environmental, and economic changes, has led to a serious architectural obsolescence of buildings in the European Union (Herrera-Limones et al., 2022). 75% of buildings are considered energy inefficient, which, coupled with the dependence on fossil fuels that dominate the energy supply, explains how one in four European households cannot afford to heat, cool, or light their homes (Right to Energy Coalition, n.d.).

In this context, the terms fuel poverty, energy poverty, and energy vulnerability are used to identify and define those households that in one way or another suffer from the absence of energy services. Although these three terms are similar, they differ substantially from each other. One of the earliest definitions of fuel poverty was provided by Brenda Boardman in the UK, defining it as "the inability [for a household] to obtain an adequate amount of energy services for 10% of disposable income" (Boardman, 1991). This definition has been evolving, especially in the last decade during which more effective indicators have been developed in the context of the European Union such as the Low-Income High Costs (LIHC) indicator or Low Income Low Energy Efficiency (LILEE) indicator (Bridgen and Robinson, 2023). However, it is worth noting how the term fuel poverty is linked to territories with cold climates and particularly addresses affordability (Li et al., 2014).

On the other hand, the term "energy poverty" allows us to identify those households that do not have basic energy services and that, in addition, spend a large part of their income on energy bills (Bouzarovski and Petrova, 2015). This term applies to all types of climates and is

mostly related to availability (Li et al., 2014). Energy poverty is a manifestation of the energy vulnerability suffered by a household in a specific space and time (Tirado-Herrero et al., 2018; Bouzarovski, 2014). Specifically, this study uses the term energy poverty to refer to a methodology that can be applied in different climates and is based on the absence and availability of energy services.

## 2.2. Link to households' conditions and the building stock

Energy poverty has a direct impact on the state of health of the people living in these dwellings. This relationship is represented through four dimensions: (i) access to housing (including tenure status or emotional attachment to it), (ii) the construction and structural aspects of the dwelling, (iii) the physical environment in which the home is located, and (iv) the social and community environment (Delgado and López, 2020).

Adequate housing must therefore respect adequate conditions in all four dimensions (Delgado and López, 2020). Those homes that do not meet some of these conditions and suffer from energy poverty can become hostile spaces for health. The people who live in them have higher cases of viral and bacterial infectious processes, respiratory diseases, allergies, and problems socialising (Hernández et al., 2016). To address this relationship between sustainable housing and health, i.e. between architectural and medical disciplines, many experiences show the need to develop transdisciplinary research (Castaño-Rosa, Solís-Guzmán and Marrero-Meléndez, 2020).

In the case of Spain, a large part of the building stock was built between the 1950s and 1970s, although the first basic building regulation introducing minimum energy efficiency criteria, the NBE-CT-79 standard, was created in 1979 (Ministry for Ecological Transition and Demographic Challenge, 2019b). This situation leads to a building stock that lacks energy efficiency strategies and currently has many deficiencies. Families living in these homes are at high risk of suffering extreme temperatures and spending a large part of their income on energy bills, as the lack of insulation and adequate construction features leads to higher energy costs (Ortiz et al., 2019).

## 2.3. Regional and local strategies to address energy poverty

Over the last decade, the number of programs and strategies addressing energy poverty in Europe has increased exponentially. However, national strategies to address energy poverty are not able to adapt to local contexts, as this is a multidimensional problem (Clavijo-Núñez et al., 2022). Some research has opted to use territorial boundaries such as climatic regions, where the factors present are more homogeneous. This is the case of the EmpowerMed project, which aims to mitigate the impact of energy poverty on households on the Mediterranean coast (European Commission, 2019). Among the main results of the project, it is worth highlighting how the lack of basic energy service is related to forms of stress and domestic discomfort, affecting the mental health of vulnerable households. These conditions are especially relevant in households with bills in arrears, debts, or disconnections from the electricity grid (Tirado-Herrero, 2020).

Andalusia, as part of the Mediterranean region, shows high levels of energy poverty compared to regions in Northern and Western Europe, where this problem is less significant and concentrated in vulnerable groups (Bouzarovski and Tirado Herrero, 2015). In the Spanish context, this region presents indicators with values much higher than the national average (Tirado-Herrero et al., 2018; Clavijo-Núñez et al., 2022). Among the factors affecting the health of the Andalusian population, problems associated with extreme temperatures in both summer and winter, the lack of pre-installed air-conditioning systems in homes, the low rate of homes with energy efficiency improvements or the dependence on very costly electrical heating systems due to their high electricity consumption are evident (Castaño-Rosa, Solís-Guzmán and Marrero, 2020).

In this sense, technical work related to architecture, design, and urban planning plays an important role. It is necessary to develop new local strategies to improve energy saving and efficiency in homes, to reduce energy costs, and be able to live in dwellings under basic conditions of comfort and well-being. For these types of transdisciplinary and decentralised studies, it is ideal to use methodologies with a focus on social transformation as opposed to a quantitative and qualitative duality (Bassi Follari, 2014). Citizen consultations, for example, are an important tool that incorporate the social transformation approach. This methodology allows not only the analysis of housing deprivation but also reflection on the specific ways in which households face energy poverty (Delgado and López, 2020).

According to Wahlund and Palm, there are three main ways to include citizens in energy policies (Wahlund and Palm, 2022). First, participation in energy planning through policy co-design, public consultation, and participatory design (Mullally et al., 2018; Picchi, 2013; Wahlund and Palm, 2022). Second, through increased local control of communities or remunicipalization of utilities (Alarcón-Ferrari and Chartier, 2018; Davies et al., 2018; Wahlund and Palm, 2022). Thirdly, through the role of people as an engaged part of the policy and not only as consumers (Welton, 2018).

Focusing on the first proposed route, the complexity of involving the general public that is not an expert and has not had access to an energy education system is evident. In general, in citizen consultations, there is a greater participation of people who do not have energy shortages or difficulties, so that a real representation of the interests of the entire population is not achieved (Hernández P. & Huepe Minoletti, 2019).

In this sense, the work of local authorities and entities is key to addressing this challenge, as they know the territory and can identify different sectors to work with to achieve greater representativeness. In particular, it is important to apply this methodology to obsolete neighbourhoods where energy vulnerability and its impact on health is visible in different ways.

## 2.4. "Aura strategy" applied in obsolete neighbourhoods

A successful case of methodology to address the obsolescence of neighbourhoods from a transdisciplinary approach is the "Aura Strategy" of the Solar Decathlon Team of the University of Seville. This is an intervention methodology aimed at regenerating obsolete neighbourhoods with high levels of architectural, socioeconomic, and urban vulnerability (Herrera-Limones et al., 2020, 2022).

The "Aura Strategy" has been applied in the AURA 3.1 prototype developed for the Solar Decathlon Europe 2019 Competition. This prototype was based on an urban regeneration strategy, which addressed four lines of action for its development (Fig. 1): Hygienic-sanitary, Cultural identity, Materiality, and Conditioning and energy (Herrera-Limones et al., 2022). The house incorporated active and passive comfort strategies, to create a healthy and non-polluting habitat, responding to the Mediterranean climate and characteristics (López-Escamilla et al., 2020). For the design of the AURA 3.1. prototype, the Polígono San Pablo district was chosen as a case study. The results showed such significant improvements for this district in the city of Seville, that its applicability in this territory could lead to positive impacts on citizens (Millán-Jiménez and Vargas-Palomo, 2022; Herrera-Limones et al., 2022).

Based on this experience, it was decided to develop the project "Direct application of the Aura Strategy of the Solar Decathlon-U.S. Team, in the rehabilitation of obsolete Andalusian neighbourhoods" in San Pablo, as a case study for the extrapolation of results to similar environments in the autonomous region, financed by the Department of Development, Infrastructures and Territorial Planning of the Regional Government of Andalusia.

The objective of this action is to intervene by juxtaposing a technological-structural system to linear blocks of obsolete dwellings. This allows the dwellings to incorporate new energy, technological and



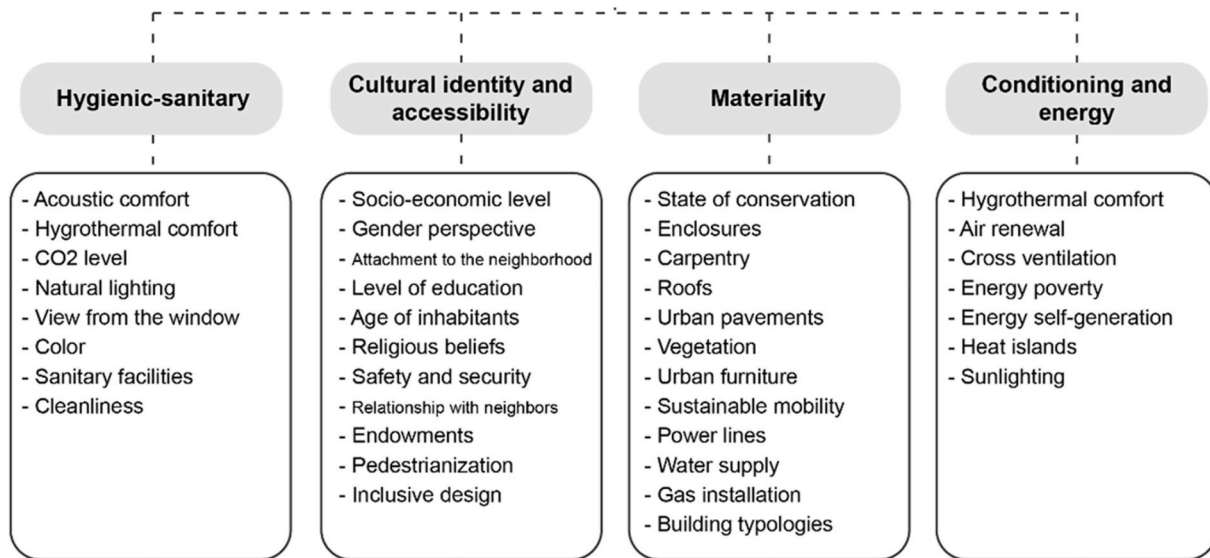


Fig. 1. The four lines of work on which the “Aura Strategy” focuses.

spatial possibilities (Herrera-Limones et al., 2020, 2022).

This research focuses on the study of two of the four strands of the “Aura Strategy”. Specifically, it deals with the hygienic-sanitary line and the conditioning and energy line (Herrera-Limones et al., 2020).

Based on the different experiences developed, this research continues to focus its case study on the Polígono San Pablo in the city of Seville, specifically on the San Pablo A and B neighbourhoods, shown in Figs. 2 and 3. The aim of delimiting the households under study is to be able to create personalised processes with the citizens and extrapolate the results to the Polígono San Pablo as a whole. The Polígono San Pablo neighbourhood is further presented in the next section.

### 2.5. Case study: the polígono San Pablo neighbourhood

The Polígono San Pablo was built between the 1960s and 1970s, with the aim of housing 8800 social housing units built in 5 phases. Each phase gave rise to one of the districts that make up the neighbourhood: District A, District B, District C, District D and District E. The project had great potential thanks to the facilities that were incorporated and its central location in the city of Seville (Obra Sindical del Hogar y de Arquitectura, 1966).

As depicted in Figs. 2 and 3, the neighbourhood currently presents a favourable urban situation for regeneration, due to its proximity to one of the city’s tertiary activity centres (towards Seville airport, to the north-east of the neighbourhood), to the main Santa Justa train station or the proximity to some of the city’s main arteries, such as Kansas City Avenue (to the north of the neighbourhood).

The building stock of the Polígono San Pablo is made up of blocks of flats of varying heights. Most of the buildings are open five-storey blocks without lifts. There are also nine and thirteen-storey buildings that present substantial advantages such as greater conservation of their envelopes or even lifts. Thus, the height of the buildings is directly related to the socio-economic status of the inhabitants (Departamento de Urbanística y Ordenación del Territorio, 2011).

The neighbourhood is made up of compact neighbourhood units that are mixed with small businesses and public spaces for people to develop their social relationships. Dwellings in the San Pablo A and B neighbourhood are arranged around communal spaces to provide the population with their own services (Herrera-Limones et al., 2022).

However, multiple studies have categorized the San Pablo A and B neighbourhood, and the Polígono San Pablo in general, as a vulnerable area of the city of Seville. Seville’s Local Health Plan 2019/2023 for the San Pablo-Santa Justa District identifies the San Pablo A and B neighbourhood as a vulnerable area. Likewise, the Atlas of Urban Vulnerability in Spain (2011) catalogues this territory as an area with a medium level of vulnerability (Hernández Aja et al., 2018)(Ministerio de Transportes Movilidad y Agenda Urbana, 2011; Rodríguez Pérez, 2019). Furthermore, according to the results of the 2011 census, the San Pablo-Santa Justa district is one of the Vulnerable Territories in the city of Seville (Hernández Aja et al., 2018). This is why the San Pablo neighbourhood was chosen as a case study to analyse how energy poverty and health are related in a territory identified as vulnerable and, moreover, influenced by a Mediterranean climate.

Applying the “Aura Strategy” in the San Pablo A and B neighbourhood identifies some of its main deficiencies and weaknesses. With

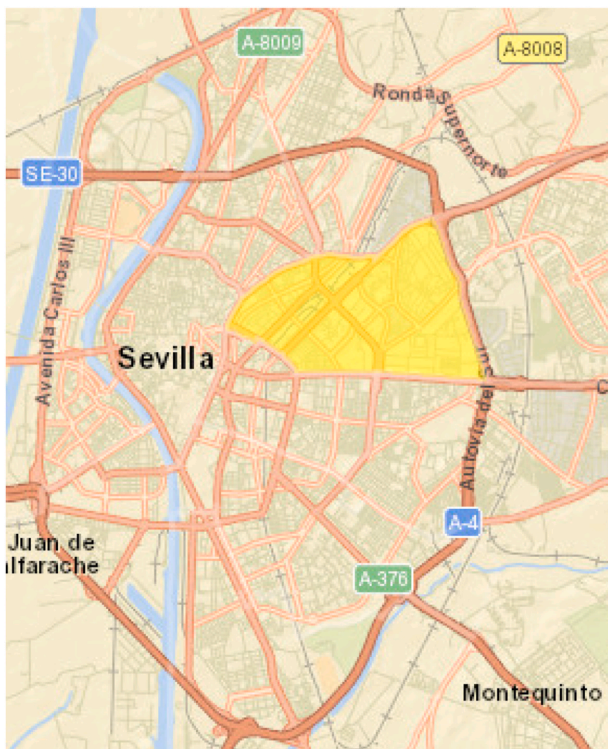


Fig. 2. District of San Pablo-Santa Justa. Source: Gerencia de Urbanismo de Sevilla, 2017.



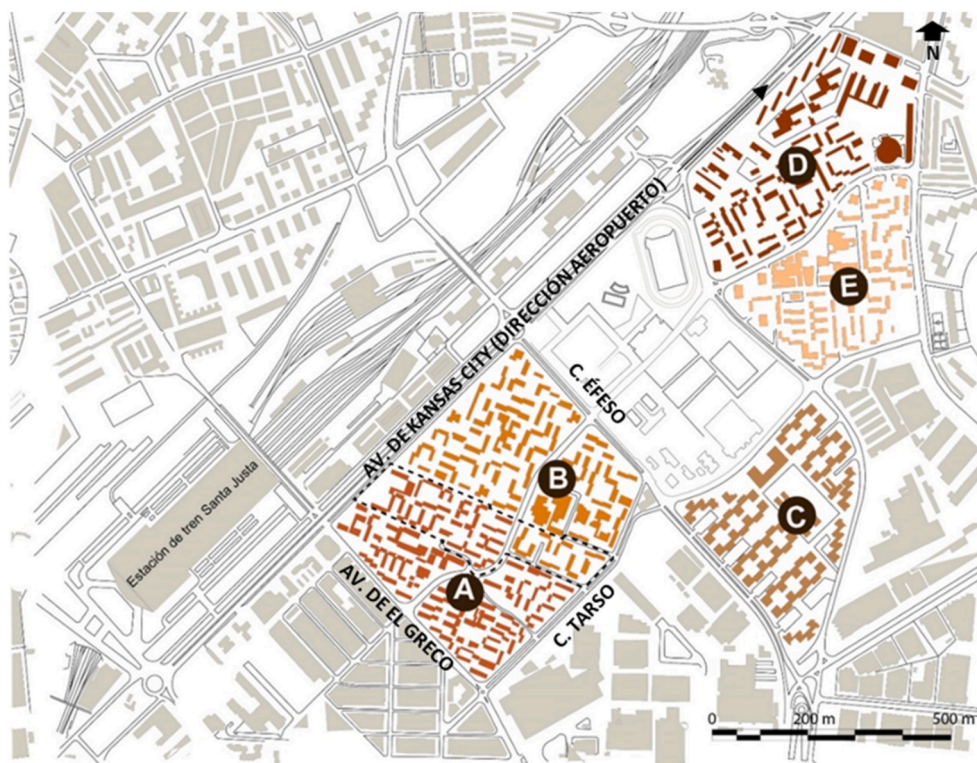


Fig. 3. Districts into which the San Pablo neighbourhood is divided approximate indicative scale. Authors' own.

regard to health, it is worth highlighting the high rate of ageing in the San Pablo area, with 22.2% of the population aged 65 and over (Rodríguez Pérez, 2019). Generally, this range of the population has special requirements as they need accessible homes, with adequate temperatures or easy-to-use technologies. Aspects related to health care should also be considered, as this type of population requires more time for their care, more frequent visits by doctors and nurses to their homes and, generally, they suffer from various pathologies associated with their age that require multiple medications. All this should be taken into account to reduce the number of patients per doctor.

In terms of cultural identity and accessibility, the neighbourhood presents a major problem with regard to accessibility to housing, as the lower buildings, i.e., those with 5 floors, were designed without lifts. Moreover, access to many of them is below street level, which means that the ageing population of the Polígono San Pablo is often unable to leave their homes. This aspect is even more serious when the resident suffers from a pathology for which outdoor exercise is a priority, such as diabetes mellitus or rehabilitation after an osteoarticular injury such as a hip fracture, which is common in the elderly. In addition, there is also a lack of accessibility on an urban scale, as there has been a loss of pedestrian space as a result of the increase in the number of roads and parking areas.

In terms of materiality, the building stock in San Pablo is made up of a heterogeneous group of high and low blocks, between which are created both more intimate spaces close to the neighbourhood units, and more open spaces where points of interest such as churches or commercial spaces are found. Improvements to housing and common areas usually depend on public subsidies, as the neighbourhood is one of the areas with the lowest economic level in the city of Seville. While the average income per consumption unit in Seville is estimated at €18,035 per year, the average income in the San Pablo A and B neighbourhood does not exceed €12,478 per year (Institute of National Statistics, 2018).

Coinciding with two of the scales of work and intervention proposed by the "Aura Strategy": hygienic-sanitary, as well as conditioning and energy, situations prevailing in the surroundings of the housing blocks in

the San Pablo neighbourhood are analysed (Herrera-Limones et al., 2020). From an urbanistic perspective, the different orientations of the blocks of flats must be taken into account, as the level of comfort of the residents depends on this, as well as the conditioning of the interior of the flats. The proposed actions should provide solutions in line with the typology of each residential building and should be independent at the building level. It is necessary to create strategies that adapt to the different typologies of building blocks. For such interventions, current situations such as accessibility to the building blocks, energy efficiency measures, etc., must be considered.

San Pablo is an ideal case study when analysing a typical obsolete neighbourhood in the Mediterranean region. It is a typical example of urban planning in Spain in the 1960s that has not been able to adapt to contemporary typological, usage, or energy efficiency needs. The housing typologies used do not respond to the needs of today's diverse family models, as the blocks are almost entirely made up of the repetition of a single type of three-bedroom dwelling with an approximate average useful surface area of 60 m<sup>2</sup>.

### 3. Methodology: participatory experience with citizens

The research has followed a hybrid and interdisciplinary methodology, to include a quantitative and qualitative analysis. Phase 1 corresponds to a technical study to identify key aspects related to energy vulnerability, comfort, and health. Phase 2 shows how the population's opinion has been incorporated into the analysis through different citizen consultation tools. Phase 3 presents how the indicators and data collected have been categorized and compared.

The aim is to provide new ways of representing how energy poverty affects the health of the population and thus highlight the importance of working with the public to design public health strategies.

#### 3.1. Phase I. Technical-architectural and heritage analysis

The analysis has used both data compiled by the working group of

this research, composed by eight researchers from the University of Seville, as well as statistical data from the public administration. Given the long background of work in San Pablo, over the last few years different problems have been identified in the neighbourhood that are affecting the health of the citizens. It is worth noting that the research team is made up of people from different disciplines, from architecture to medicine and engineering, which has enabled a transdisciplinary technical analysis to be generated.

With regard to the different public data sources, we have used the data provided by the Population and Housing Census carried out by the National Institute of Statistics (INE, by its Spanish acronym). This data can be broken down by census sections, which has allowed us to obtain information for the San Pablo neighbourhood. The information on Urban Indicators of the National Institute of Statistics has also been used, as this information is disaggregated by districts. In addition, the results of the INE's Living Conditions Surveys were used, although this information is only available at the Autonomous Community level. Finally, information provided by Seville City Council has been used, both data on Health in Dwellings and Spaces and the results of the Seville Local Health Plan 2019/2023 for the District of San Pablo-Santa Justa (Rodríguez Pérez, 2019).

Through the analysis of indicators of these databases, such as % of people with homes without a lift, % of people with dilapidated, bad, or substandard homes, or % of complaints in Seville about bad smells, rubbish, and filth in public spaces, a first approximation of the health, comfort, and energy poverty situation in the San Pablo neighbourhood has been generated. All the indicators analysed are presented, together with the results and the source from which they were obtained, in Tables 1, 2 and 3 in Annex 4. The choice of these indicators was based on the experience of the working group (based on the Aura Strategy approach) and, above all, on the availability of data, as the case study is a neighbourhood, there was hardly any disaggregated data available at this level.

Although all these data and analyses are vital to understand and represent the health and comfort situation of the neighbourhood, they are not enough. It is necessary to incorporate the user's opinion to develop efficient retrofitting measures and strategies that respond to the behavioural pattern of the citizens. This is why this research incorporates the perception of the population of the San Pablo neighbourhood, so that the users themselves can define the main deficiencies, barriers, and problems in the neighbourhood.

### 3.2. Phase II. Perception of the target population

To incorporate the opinion of the population of San Pablo, the collection of information from two sources was proposed: from the health professionals and social workers at the Health Centre and from the population itself. The working group that participated in these actions consisted of eight researchers from the University of Seville, including the authors of this article.

To discover the views of the health professionals in the neighbourhood, a meeting was organised with the staff of the San Pablo Health Centre. In this interview, issues such as the state of health of the population, the main limitations of the people they attend, the state of the homes they visit and of the neighbourhood in general, the Health Centre facilities, etc. were addressed. The vision of the health professionals, as a service that monitors the health of the population, is fundamental for proposing rehabilitation measures in the neighbourhood. Annex 1 lists the main points raised during the interview.

After this first contact with the population, a public workshop was organised, in which questionnaires and exercises on health, comfort, and the situation of energy poverty in the neighbourhood were worked on. Although this documentation can be replicated in other localities or neighbourhoods, it is important to adapt it to the target population. It should be noted that once the workshop had been carried out and the information gathered had been analysed, a feedback session was

organised with the participants to present the main conclusions and impressions gathered.

The workshop was held at the Alfonso de Cossío senior citizens' centre, so the issues were presented in literature adapted to the elderly. Prior to the workshop, permission was requested for the use of the facilities, as well as from all the participants who gave their personal consent to collaborate in the workshop.

This workshop was organised in two parts. Firstly, a survey was carried out in which questions about comfort and health in the neighbourhood were collected (Fig. 4). This survey, as set out in Annex 2, is answered individually, and consists of a series of questions about the social profile of the person interviewed (age, socio-cultural level, block in which they live, etc.), followed by a total of 26 questions. Some of the questions are open-ended, others present a selection of possible answers, and the vast majority are questions that are evaluated from 0 to 5 points, 5 being a comfortable state and 0 the lowest possible state of well-being. In terms of themes, questions are collected on health, on the neighbourhood and public space and, finally, on childhood in the neighbourhood and the high rates of ageing.

In the second part of the workshop, the energy poverty situation in the neighbourhood was addressed (Fig. 5). To facilitate participation in this topic and to present it in a way that citizens could easily understand, a dynamic called the "energy poverty dartboard" was used (Fig. 6). This is a dartboard that is divided into four sectors related to energy vulnerability: household conditions, public space, access to energy, and energy education. For each of these sectors, two key questions are defined to understand and analyse the situation in the neighbourhood. Participants are asked to reflect on each of these questions and place a circle on one of the three strips of the dartboard, so that the closer to the centre, the more they agree with the question posed.

Finally, a feedback session was organised with the participants in the workshop (Figs. 7 and 8). In this space, an infographic was shared with the citizens, which included results on the health status of the population of San Pablo, the state of the households, as well as economic and cultural results. The panel incorporated simple, visual information, to be easily understandable. Annex 3 shows the panels presented.

It should be noted that the qualitative and quantitative indicators developed from these workshops are statistical and represent the proportion of people who suffer from or perceive some of the problems listed in Annex 4 with respect to the total number of participants.

### 3.3. Phase III. Design of indicators and analysis of the results

Once the results on the state of health in Seville had been obtained,



Fig. 4. Workshop in San Pablo: organisation of participatory roundtables with residents of San Pablo. Own source.





Fig. 5. Workshop in San Pablo: development of the energy poverty dynamic. Own source.

an analysis of this information was carried out. The aim was to show how energy vulnerability affects the health and comfort of citizens, as well as to highlight the importance of working with the population at a local level to design strategies to improve their living conditions.

The data and indicators collected from the different sources of information (architectural technical analysis, perception of health personnel, and perception of citizens) were compared and classified into three sectors: information related to households, public space, and energy education of the population (see Fig. 9).

Based on these indicators, the main problems in the neighbourhood in terms of health and comfort were identified. To do this, the data collected from the different sources of information used was corroborated using the following criteria.

- For the household and public space indicators, a comparison was made between the three data sources. In this way, only those issues that are repeated in the three data sources were considered, either through qualitative or quantitative indicators.
- With regard to the data collected on energy education, only the two databases of the activities carried out in the neighbourhood were used, as this sector is not analysed in the municipal, regional, or national databases.

#### 4. Results

The main problems and indicators collected through the hybrid methodology presented here are listed below. As it is an obsolete neighbourhood with a deficient building stock, many of the problems are related to the lack of household maintenance, the need for rehabilitation of buildings, and the lack of care for public space. On the other hand, the results show a low level of energy education among the population, which further accentuates the implications of energy vulnerability on the health of the inhabitants.

##### 4.1. Results grouped by action sectors

The results and indices obtained during the data collection phase have been analysed and grouped according to the proposed action sectors: households, public space, and energy education of the population. Tables 1, 2, and 3 in Annex 4 present the results obtained from different sources for each of these sectors. The aim is to be able to compare the data collected and identify the priority issues on which to act.

Some of the most noteworthy results obtained for each of the proposed sectors are presented below.

Fig. 10 shows how the different information sources agree that the building stock has poor accessibility, either due to the lack of lifts in the buildings or to the difficult access to the dwellings from the public road. Concerning the availability of heating and air conditioning equipment in

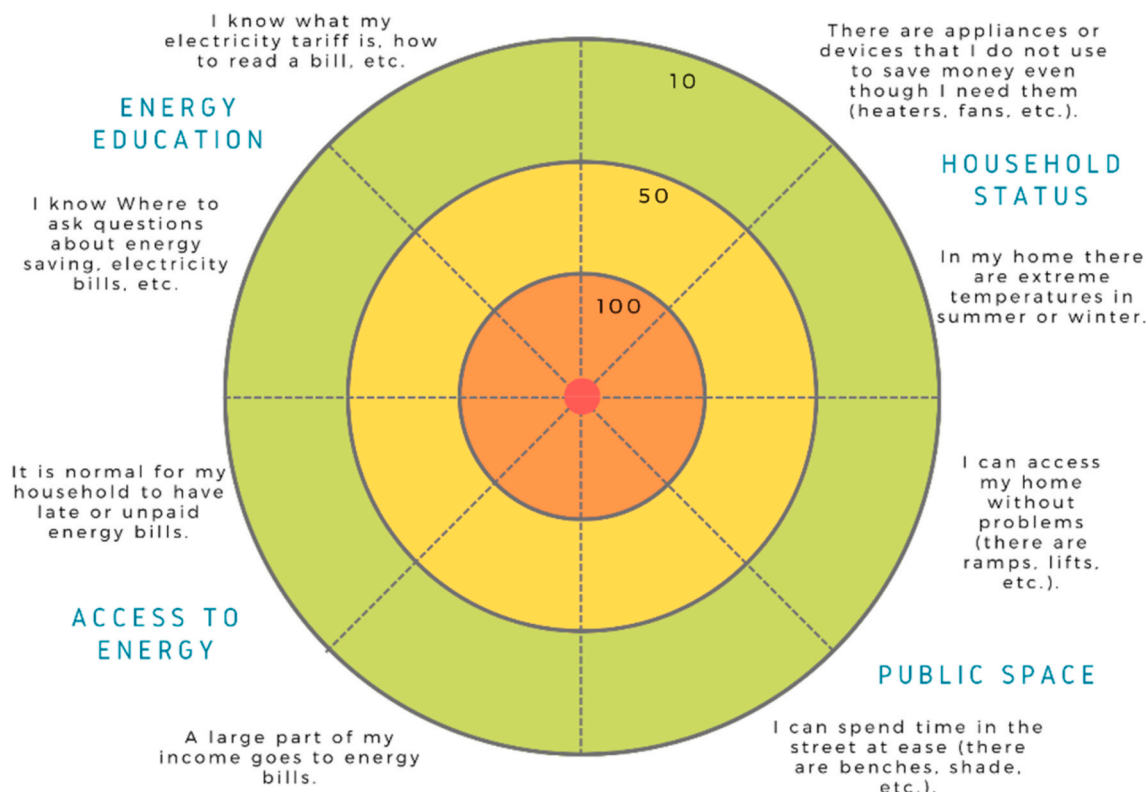


Fig. 6. Energy poverty dashboard used in the workshop. Own source.





Fig. 7. feedback session organised at the Alfonso de Cossío Senior Citizens' Centre. Own source.



Fig. 8. feedback session organised at the Alfonso de Cossío Senior Citizens' Centre. Own source.

homes, around 10% of the dwellings in San Pablo do not have such equipment. However, the figure rises to 60% for those households that do not use the equipment to save on their energy bills. In this case, it is difficult to make a comparison between indicators because the sources of information refer to different problems. However, even though they cannot be compared, they show the lack of equipment to air-condition homes in a city like Seville with extreme temperatures during the summer.

With regard to the data on public space, Fig. 11 shows very similar data for the percentage of people who perceive the public spaces in the neighbourhood to be uncomfortable or inadequate: around 69% of people. The results also coincide in the percentage of people who think that there is not enough vegetation on public roads: around 24% of people.

Finally, it is worth noting that the only source of data that yields information on the energy education of the population of San Pablo was the dynamic carried out in the energy poverty workshop developed by the research group, as shown in Fig. 12. It is worth noting the high value of the indicators collected, since a large part of the population does not have a basic energy education and does not know where to go for energy consultations.

#### 4.2. Main problems identified

Based on the data collected in Tables 1, 2 and 3 in Annex 4, the main problems and deficiencies in the health, comfort, and energy poverty situation in the San Pablo neighbourhood have been identified. To this end, the data on households and public space have been filtered, so that only those indices that are repeated in the three data sources, either quantitatively or qualitatively, have been considered. As for data related

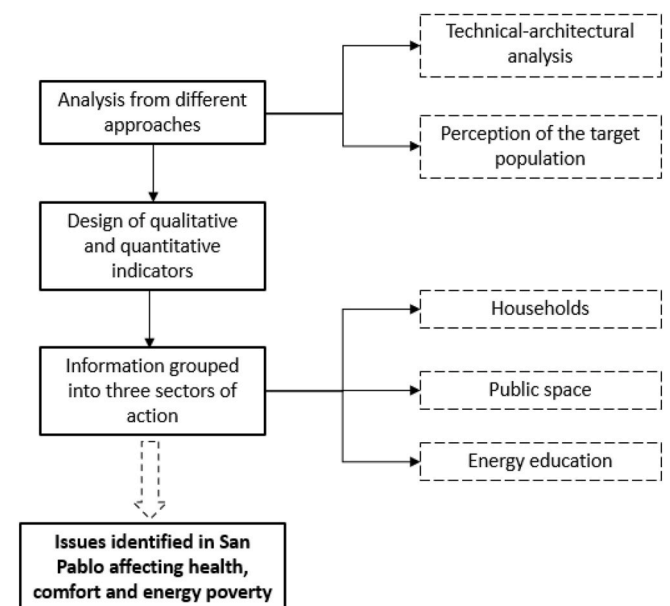


Fig. 9. Methodology developed. Own source.

to citizen energy education, it is not possible to apply this criterion as there is no information available from public databases on this issue.

Table 1 shows the problems identified, grouped according to the proposed sectors of action.

As shown in Table 1, one of the main problems affecting the health

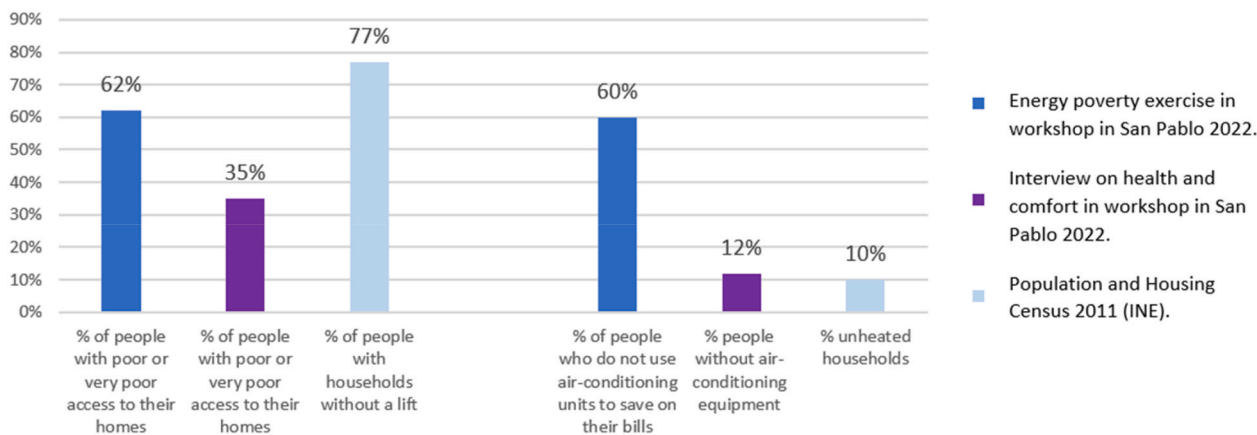


Fig. 10. Results on households in San Pablo. Source: own elaboration.

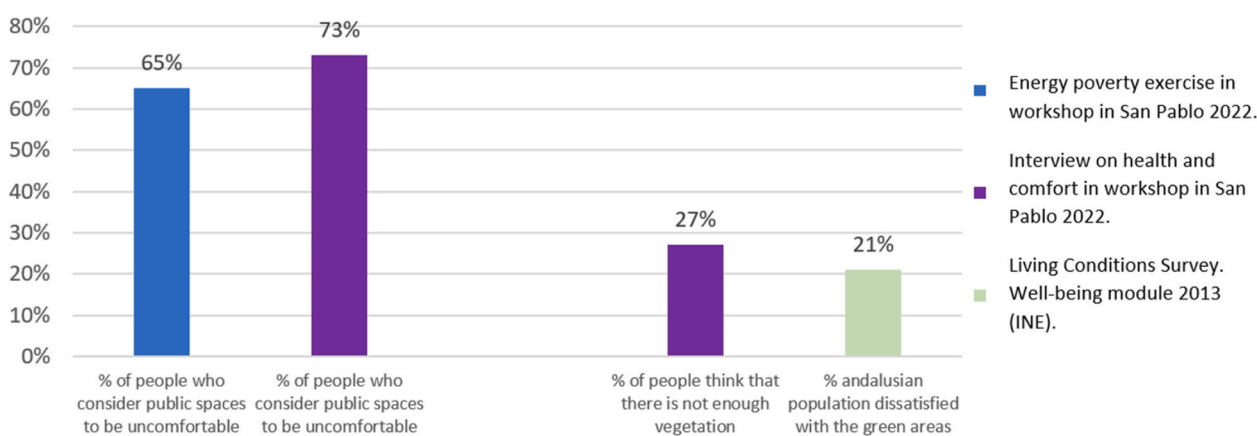


Fig. 11. Results on public space in San Pablo. Source: own elaboration.

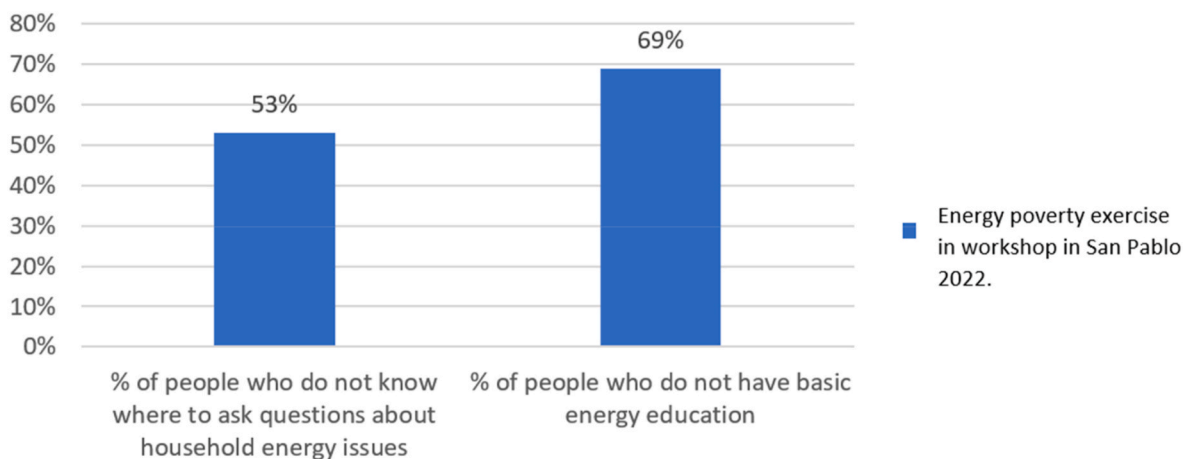


Fig. 12. Results on the energy education of the population of San Pablo. Source: own elaboration.

and comfort of households in the San Pablo neighbourhood is related to the lack of adequate access, as most of the buildings do not have a lift and some of them even have an entrance lower than ground level. It should be noted that the only indicator for which there were two results was the percentage of people with poor or very poor access to their homes. To evaluate both sources of information, the average of the indicator obtained in the energy poverty exercise in the workshop in San Pablo and the result obtained in the interview on health and comfort was calculated.

It also shows that the temperatures in the dwellings are inadequate, which is consistent with the obsolescence of the building stock in San Pablo (Obra Sindical del Hogar y de Arquitectura, 1966; Navas-Carrillo, 2020). The San Pablo building stock was built between the 1960s and 1970s, when the first basic building regulations introducing minimum energy efficiency criteria, the NBE-CT-79 standard, had not yet been published. As a result, dwellings did not incorporate energy saving and efficiency strategies that would allow households to maintain adequate temperatures without the need for high energy consumption. In

**Table 1**

Main problems identified in the San Pablo neighbourhood that affect health and comfort. Source: own elaboration.

| Sector of action | Problems identified                                      | Indicators  |
|------------------|--|---|
| Households       | Housing without adequate access                          | 48.31% of people with poor or very poor access to their homes <sup>a</sup><br>76.95 % people with households without a lift   |
|                  | Housing with inadequate temperatures                     | 86% people whose homes have extremes of temperature in summer or winter<br>3.85% of people who do not have any devices to combat the heat in summer<br>7.69% of people who do not have any devices to combat the cold in winter<br>Lack of adequate conditioning and temperatures in dwellings<br>9.71% people with unheated households |
| Public space     | Lack of maintenance and cleanliness in the neighbourhood | 65% of people who consider public spaces to be uncomfortable<br>Lack of maintenance and cleanliness of public areas<br>34% of public health complaints in Seville are about bad smells, rubbish and dirt in public spaces   |
|                  | Lack of vegetation in the neighbourhood                  | 26.9 % of people feel that there is not enough vegetation in the neighbourhood<br>Lack of vegetation and natural shade<br>31.40% of the Andalusian population dissatisfied with the green areas in their environment  |
| Energy education | Low level of energy education among citizens             | 53% of people who do not know where to go for advice on household energy issues<br>69% of people do not have basic energy education (knowing what tariff they have contracted, how to read an energy bill, etc.).<br>Much of the population is unaware of the importance of natural ventilation.  |

<sup>a</sup> For the calculation of this indicator, the average of the two calculated data was used: 62% was obtained in the energy poverty exercise in the San Pablo workshop and 34.62% in the interview on health and comfort.

addition, most of the population has medium or low incomes compared to the Seville average, which explains why they have not been able to invest in the refurbishment of their homes.

Regarding public space, the different sources of information agree on the lack of maintenance and cleanliness in the neighbourhood, as well as the need to increase the vegetation in the streets. A careful and maintained greening of the neighbourhood could bring many improvements, such as reducing the high temperatures in summer.

In terms of energy education for citizens, it is worth highlighting the low level of energy literacy among the population. It is necessary to promote energy education, especially among the most vulnerable people, such as the elderly, so that they can make more critical and responsible decisions about their tariffs, learn about energy saving measures and the advantages of energy efficiency measures. Through the activities carried out with the population, the importance of promoting energy education in terms of the proper use of the home and its installations as an energy saving measure has become evident. Natural ventilation or the use of existing solar protection systems depending on external thermal conditions are some measures that can significantly improve the comfort of a home, but some of the public is unaware of these.

## 5. Discussion

This study analyses comfort and health in obsolete neighbourhoods in regions with high rates of energy poverty, choosing the Polígono San Pablo in Seville as a case study. The “Aura Strategy”, on which the research is based, presents four complementary lines of action, one of them focusing on health and the other on energy. In this way, the strategy supports actions aligned with the different dimensions that relate housing and well-being. It is therefore a very useful tool for interdisciplinary studies focused on environmental, economic, and social sustainability. Specifically, this research includes citizen consultation as a key tool for understanding how a heterogeneous problem such as energy poverty affects the well-being of the population. By applying this strategy through a hybrid methodology, valuable results are obtained to improve the comfort and health of citizens in vulnerable neighbourhoods.

Analyses linking energy poverty and health at the European level usually consider variables such as the inability to keep homes warm in cold weather or increased mortality in winter. However, in Mediterranean regions, the impact of extreme summer temperatures, especially in inland areas, is increasingly being analysed as a serious public health issue. This has been addressed by the participants in the interviews and workshops, showing concern for the lack of refrigeration equipment or the restriction of its use due to high energy prices. The lack of maintenance and cleanliness in the neighbourhood was also highlighted, as it is a problem that had not initially been considered in the technical-architectural analysis. Not having a well-kept and healthy environment affects people’s development, for example, by not making use of public space for walking or socialising. It is therefore important to incorporate mechanisms for citizen consultation and participation in interdisciplinary research, as the actions that are built based on these studies will respond better to the needs of the population.

Regarding the results obtained for housing in San Pablo, the different data sources agree that the greatest problems are related to inadequate access to buildings and extreme summer and winter temperatures in homes.

On the one hand, the lack of lifts in buildings (with 77% of the neighbourhood’s population living in buildings without lifts) or the fact that the entrance to buildings is not at ground level (which affects almost 50% of the population) is a major problem for the population, especially in neighbourhoods such as San Pablo with a high proportion of elderly people. Reduced mobility has a direct effect on the health of older people, who spend long days at home, even affecting recovery and rehabilitation after medical interventions. This situation also affects their social relationships and emotional state, as many of these people experience feelings of loneliness.

On the other hand, extreme temperatures inside the home are a serious problem in southern Spanish climates, where extreme temperatures are reached in summer. As shown in Table 1, 86% of the population live in homes with extreme temperatures in summer or winter; and between 4% and 10% do not have any equipment to combat heat or cold. As discussed in the theoretical framework, adults are particularly sensitive to extreme heat spells. Although a small proportion of the population does not have any appliances to combat the heat in summer or the cold in winter, 60% of the population report that they restrict their use of these appliances due to high electricity costs. This can lead to an increase in cases of dehydration due to excessive sweating in summer. This situation is also directly related to energy poverty in this region. The building stock in San Pablo incorporates hardly any energy saving and efficiency measures, which added to the current high price of the different energy sources, makes it difficult to have spaces with adequate temperatures. In 2011, the average final price for the purchase of energy on the electricity market was 60.15 €/MWh (Red Eléctrica de España, 2012). The Price reached 252.21 €/MWh in December 2021 and 180.5 €/MWh in December 2022 (Red Eléctrica de España, 2022). According to the workshop held in the neighbourhood, 77% of the people surveyed



spend a large part of their income on paying energy bills. The price of energy is therefore a determining factor in the situation of energy poverty in Spain.

With regard to public space, the second sector analysed, it is worth highlighting the lack of maintenance, cleanliness, and sufficient vegetation in common spaces. This situation has a negative impact on the population, who cannot even use public roads as a more comfortable alternative to their homes, as 65% consider that public spaces are not comfortable. One aspect to consider urgently is the naturalization of public spaces, because as shown in Table 1, between 27% and 31% of the population considers that there is not enough vegetation in their environment. A commitment to green cities not only has a positive impact on health issues such as improving the purity of the air, but also makes it possible to reduce the heat island of cities and achieve more comfortable temperatures in public spaces.

In contrast to the first two areas analysed, there is a major limitation with respect to public data sources that analyse household energy education. Despite the fact that citizens' knowledge of strategies to improve comfort in their homes or save energy is a fundamental aspect, it is not an area that is usually analysed by public institutions. Through the workshops carried out, it is evident that 69% of the surveyed population does not have a basic energy education, as they do not know how to read an energy bill, do not know their contracted tariff, do not know the importance of natural ventilation, etc. In addition, 53% of the participants do not know where they can make enquiries regarding energy. Social practices shape household energy demands (Pellicer-Sifres, 2018), making energy culture a key factor in addressing energy vulnerability, especially in vulnerable neighbourhoods.

The results obtained show the negative impact of energy poverty on the mental health of the population. The population experiences heavy mental burdens due to having to cope with high energy bills, as well as a feeling of loneliness due to living in inaccessible housing, among other problems. However, continuing research into the field of mental health is considered necessary in order to identify additional aspects that are affecting the citizens of this type of obsolete neighbourhood.

Finally, the direct impact that all these issues can have on public health stands out. Health is linked to the environment, which we can modify to improve health and comfort. In particular, research and technical interventions related to architecture, urban planning and design must promote strategies to ensure that citizens have access to affordable, reliable and safe energy services. There is a clear need to intervene and adapt dwellings so that they can evolve along with the needs of the people who live in them.

## 6. Conclusion and policy implications

The relationship between sustainable habitat and health depends on the constructive factors of housing, but also on other dimensions such as public space or the social environment. The obsolete neighbourhoods of the Mediterranean regions are relevant case studies as they are areas with high rates of energy poverty.

In order to address the study of energy poverty and its relationship with the state of health of the population, the application of a hybrid methodology that incorporates technical data sources as well as citizen consultations is proposed. This methodology aims to identify how an obsolete building stock and a lack of access to a basic energy service may be affecting people's health.

For analysis and citizen participation to be effective, there is a need to create decentralised and transdisciplinary studies, especially in technical disciplines related to architecture, design or urban planning. Energy poverty manifests itself in different ways depending on the territory. In order to understand its relationship with health, it is important to consider the different socio-economic, climatic, and cultural factors. In this way, it will be possible to obtain relevant data and information to create more precise strategies for action (Costa-Campi et al., 2019) and thus improve the health of the inhabitants.

These conclusions are linked to some of the new concepts that are being promoted in the European Union, such as the case of "energy citizens". Far from considering the population as mere consumers, this concept advocates that the affected population should become active participants in the energy transition. To this end, engagement actions and participatory policies are promoted (Della Valle and Czako, 2022).

The hybrid methodology applied, which incorporates citizen consultation, yields relevant results for the development of public policy programs and strategies. Specifically, it has become evident how, through citizen consultation, key points not identified through other tools such as public databases or technical studies are perceived. In the current context of climate emergency and energy transition, citizen participation is a key element in the construction of public policies. Moreover, this participation must evolve from consultation to the incorporation of the population as co-designers and co-realizers of energy projects (Haf and Robison, 2020).

In the case study addressed by this research, the neighbourhood of San Pablo in southern Spain, it is hoped that the issues identified will be useful in developing future health programs at the neighbourhood level, such as the Seville Local Health Plan. In particular, it highlights the urgency of having policies that enhance the energy education of the population so that they can apply passive strategies in homes to improve living conditions or so that they can learn about social vouchers and tariffs that are best suited to their conditions.

For future research, it would be interesting to incorporate calculations of actual household consumption into these analyses. Usually, strategies to improve energy efficiency are based on demand and not on consumption, leaving aside the user's behaviour pattern. In contexts such as the Mediterranean area, these issues are of great relevance, as climatic conditions may be favourable for some months and may not require, for example, the use of air-conditioning equipment, which is often incorporated in demand calculations.

## CRediT authorship contribution statement

**Susana Clavijo-Núñez:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gina M. Núñez-Camarena:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Rafael Herrera-Limones:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Conceptualization, Data curation, Formal analysis, Investigation, Methodology. **Miguel Hernández-Valencia:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Antonio Millán-Jiménez:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data from workshop are presented

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approach for the Polígono San Pablo, Seville (as a case study for the extrapolation of results to similar environments, through the implementation of sustainable regeneration in the working class residential area). Part of the information used in the article comes from the development of the project. The project was granted in the resolution of July 28, 2021 by the *Consejería de Fomento, Infraestructuras y Ordenación del Territorio* (Junta de Junta de Andalucía), within the 2020 call for grants for the implementation of research projects in housing, rehabilitation and architecture.

Data used in this research come from the project “Building healthy and sustainable neighbourhoods for children in the face of the impacts of energy poverty: experience in the Polígono San Pablo, Seville”. This project was granted in the resolution of April 5, 2022 by the Development Cooperation Office of the University of Seville, within the Call for Aid for Development Cooperation Activities and Projects (academic year 2021–22).

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.enpol.2024.114177>.

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