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Energy vulnerability and self-imposed austerity: an ethnographic approach to adaptation strategies to extreme heat among older adults in Madrid

Paloma Yáñez Serrano (a), Daniel Torrego Gómez (b), Zosia Bieńkowska (a)

(a) Institute of Anthropology and Ethnology, Adam Mickiewicz University, Wieniawskiego 1, 61-712 Poznan, Poland

(b) Department of Graphic Expression, Composition and Projects, University of Alicante, Carr. de San Vicente del Raspeig, s/n, 0369 Alicante, Spain

Abstract: This article analyses local practices concerning energy saving in the context of summer heat. It argues that the analysis of people's thermal regulation activities in a situation of energy marginalization is central to understanding the social dynamics of energy vulnerability. The research combines architectural/urban and ethnographic perspectives to investigate the adaptive capacities of users and how external factors and regulations influence local practices concerning energy saving. Older adults are one of the most vulnerable groups to summer heat, as well as most prone to suffering energy vulnerability. The article examines how adults over 65 years of age in Madrid experience heat stress and adapt to extreme temperatures through the analysis of a collaborative documentary film, 'The Wave' (30'), written and designed by research participants to show the ways in which they experience summer heat. It explores older adults' adaptation practices and the various external factors influencing their use of energy dependent adaptation strategies, including climate change (rising temperatures), existing conditions (urban, cultural, and social) and policies/economy (energy prices). The article highlights how these factors govern citizens' energy consumption and how they are negotiated locally through embodied, environmental, and social adjustments.

Keywords: local adaptive adjustments, thermal stress, energy poverty

1. Introduction

The rising temperatures due to climate change and the rising costs of energy prices are forcing vulnerable urban inhabitants to adapt their activities while reducing energy consumption [1,2]. This article explores how the inability to meet adequate temperatures in dwellings to perform "usual social customs and practices" ([3]: 255) may be perceived and understood as energy vulnerability. It does so from an ethnographic perspective, assessing how building conditions, economic vulnerability, and high prices of energy affect the everyday life of older adults, and how they cope and adapt their conditions to attain thermal comfort. The key objective of the article is to identify the embodied, environmental, and socio-cultural adjustments normally summarized as "adaptive activities" in adaptive thermal comfort models

[4]. It does so by analyzing the real-life consequences high temperatures have for urban citizens and how the inability to adapt to these conditions aggravates the mental and physical distress caused by periods of extreme heat.

The ethnographic data was gathered as part of the European project *Embodying Climate Change: Transdisciplinary research on urban overheating (EmCliC)* and this article will focus on the analysis of in-depth conversations and participant observation with adults over 65 years old exposed to the summer heat in Madrid, as well as an ethnofiction documentary called 'The Wave' (30 min), filmed in collaboration with participants. Drawing on the longitudinal participant observation research, we demonstrate how external factors conditioning thermal experience (such as architectural design) are intertwined with people's embodied experiences, daily actions and routines and their energy use. We argue that attention to local adjustments may be helpful to understand how energy vulnerability unfolds adaptive strategies carried out by older adults', engaging with austere living conditions. Furthermore, we suggest that the combination of sensory ethnography of the home and re-enactment of the heatwave experience through an ethnofiction documentary film, can deepen our understanding of the corporeal, emotional and relational experiences of adjusting to extreme heat at different levels of energy vulnerability.

In recent years, there has been growing attention to summer conditions and their relation to energy poverty, due to the increased intensity of extreme heat events. However, information is still scarce and methodologies for its assessment have scope for improvement [5]. In the context of the EU, the different factors that condition the measurement of energy poverty make it difficult to arrange a common international framework [6]. Although it is possible to find recent approaches from the European Institutions for a common definition of energy poverty [7], a specific focus on summer conditions does not exist. This is highly concerning in the context of global warming, which leads to the intensification of heat waves and associated health risks [8–10]. Qualitative methodologies can play a central role in the assessment of adaptive adjustments that are considered in the thermal comfort models used for the evaluation of energy poverty during summer. The adaptive thermal comfort approach is one of the methods used to evaluate summer energy poverty [4]. It considers that building residents are active users in home cooling processes and constantly engage with adaptive adjustments to accommodate the spaces they inhabit, instead of relying solely on energy demand calculations to analyze the performance of buildings [11]. They enable better descriptions of the adaptability of residents and their everyday routines, which can exacerbate or ameliorate their experience of heat.

This paper aims to build an interdisciplinary collaboration between anthropology and architecture, the former working closely with participants to understand their intangible corporeal and sensory experiences of heat, and the latter providing a technical assessment of energy performance in the household and a critical review of users' strategies to cope with extreme heat. Building on adaptive thermal comfort evaluations, we focus on understanding how participants' embodied experiences of heat are expressed and how they are socially articulated. Instead of evaluating threshold temperatures of comfort, we focus on how heat is experienced and adapted to through a combination of adjustments and adaptive strategies. We focus on adjustments to build on the existing framework of the adaptive approach to thermal comfort which classifies adjustments using the following categories: behavioral, environmental, physiological, and psychological adjustments [5]. We have redefined these categories according to the ethnographic testimonies and will be discussing embodied adjustments (including the bodily and mental strategies to adapt to heat, as participants claimed their psychological and physiological adjustments were dependent on each other), environmental adjustments (including the strategies and limitations to control personal microclimates) and social adjustments (including the strategies that become part of the social life of cities to endure the heat as part of cultural tradition or as a reaction to weather anomalies). By doing so, we elaborate on the perceptions and sensations of people who experience energy vulnerability to inform how thermal comfort is inseparable from the habits and norms affecting individuals. We define habits as conscious and unconscious, social practices and

routines derived from personal background and long-term interaction with the heat. We define norms as the set of energy efficiency requirements, thermal regulations for buildings and heatwave alert protocols that govern people's experience of heat. The former shapes and the latter controls older adults embodied, environmental and social adjustments.

We understand adjustments as everyday adaptation strategies and we use the above categories to highlight the corporeal interactions of participants with environmental conditions over time, and how those experiences become part of the social and cultural life of Madrid. Different strategies are not separated from each other — evapotranspiration and cooling devices take place at the same time and are positively retrofitting. We are trying to highlight different scales of action regarding architecture practice: user, home, and urban, reinterpreting them from the lens of participants' daily actions to cope with the heat. We refer to their bodily experience and how their bodies changes socially and in relation to their environment, framed as embodied, environmental and social adjustments. Our aim with this classification is to bridge disciplines to analyze how the use of participant observation, and collaborative film to represent participants' sensory experience of heat can help inform how we define and measure thermal comfort and energy vulnerability [6]. We pay attention to older adults over 65 years old because they are considered one of the communities' most vulnerable to extreme heat [12], but also because as a group older adults use many strategies to cope with heat. Our ethnography shows that older adults have access to both modern technologies of thermal comfort (A/C, fans and humidifiers) and long term non-energy dependent strategies inherited from their families, some of which are used (such as closing blinds and windows to avoid the heat in the middle of the day, opening the windows to ventilate at night, going to open air spaces to feel the air currents or walking in the shadow) and some which have disappeared (such as playing in the summer around rivers and fields and sitting outside the house with chairs in the evening). These strategies can broaden the spectrum of non-energy-dependent adaptation strategies taken into account in the heatwave adaptation protocol or the indices of energy vulnerability. For this purpose, we concentrate on everyday adjustments and adaptation strategies and how these influence the participants' thermal comfort, drawing on memories, corporeal and sensorial experiences, and their imaginaries and visions of the future.

Section 2 explores the existing literature on the older adults' adaptation to heatwaves, and how it has been framed in thermal comfort research. This section highlights the possibilities of collaboration between anthropology and architecture: qualitative research on energy vulnerability and qualitative research on energy use. In Section 3 we situate the methods and in Section 4 we provide an architecture analysis of the energy vulnerability scenario in Madrid, based on existing regulation. Finally, Section 5 develops the categorization of adjustments illustrated with participants' testimonies, their experiences and contributions to the film.

2. Literature Review

Previous research focusing on older adults' adaptation to heatwaves has highlighted a lack of perception of their vulnerability and lack of identification with heatwave alert recommendations [13], the lack of interference of older adults' social contacts with their heat coping strategies [14] and the benefits of having control of coping mechanisms for older adults wellbeing [15]. It has also pointed to the high cost and user constraints of cooling devices and the social benefit of acknowledging “non-energy-intensive heat-adaptive behaviors (soft adaptation)” ([16]: 4724). Other research has focused on identifying the quantity of coping strategies used, showing their relationship with older adults' perception of risk [17] and the need to target older adults' social practices and beliefs rather than their perception of heat being a problem to foster adaptation strategies [18]. These researches have used structured and semi-structured questionnaires, analyzing their findings through the framework approach [13], thematic codes and statistical analysis [14–17], and the theory of planned behavior [18]. This article contributes to existing research by focusing on the logic behind the use of each adaptation strategy, showing how older adults' lack of perception of risk, can be accompanied by the routinary deployment of a diversity of adaptation

strategies that are part of social practice, through which older adults sometimes consciously and sometimes automatically adapt to the heat.

Summertime cooling needs are marginalized in energy poverty definitions in regulation, which focus largely on wintertime heating needs [19,20]. This is a big concern for cities such as Madrid, where throughout the summer of 2022 there were 61 days on yellow precautionary alert, or red maximum heatwave alerts [21]. Given the current rise in electricity prices, many residents were unable to meet their cooling needs, notably those with low pensions. An understanding of the complexity of adaptation and change for different individuals is needed to inform the wider socio-ecological organization of urban infrastructure and adaptation policies [22,23]. Energy poverty is a dynamic and temporally dependent concept that affects those unable to meet adequate temperatures inside the home [24,25]. Thermal comfort is dependent on the performance of the building, but also on spatial factors (room position, sun radiation, and ventilation control), environmental factors (air temperature and relative humidity), and personal factors (health, age, gender, metabolism, activity, clothing and eating habits, and thermal perception) that influence thermal comfort assessment. Energy poverty assessments are based on the possibility of reaching thermal comfort inside the home according to at least one of the above indicators [24]. Architects use adaptive thermal comfort evaluation approaches to assess periods of overheating inside the dwellings as this method has been suggested as particularly suitable for summer conditions [26]. Alternatively, energy vulnerability has been suggested as the best framework to understand the “driving forces of domestic energy deprivation” ([27]: 10). Energy vulnerability factors have been classified according to access, affordability, flexibility, energy efficiency, needs, and practices [27]. What we argue here is the need to look closely at both thermal comfort and energy vulnerability factors by gathering direct experiences of citizens under heat-stress risk and collecting information on how they cope with extreme heat.

Relevant research in architecture has focused on examining the role of a person’s behavior in household energy performance, analyzing energy usage patterns, the influence of occupants’ lifestyles, and the effectiveness of behavioral interventions in promoting energy-efficient practices in residential settings. To combine technical information on building and energy characteristics with users’ activities, a sociomaterial holistic approach to thermal comfort analysis has been promoted in recent years [28]. According to this perspective, indoor adaptive thermal comfort is a multifaceted concept that requires encompassing architectural and anthropological perspectives. Recent studies have investigated both physical and socio-cultural aspects influencing thermal comfort. In that terms, Chandel et al. [29] conducted a comprehensive review emphasizing the need to consider user perception alongside architectural design elements. Regarding hot climates, numerous case studies demonstrated a wider acceptable range of environmental conditions than those predicted by adaptive comfort standards, highlighting environmental and social factors as determinants [30]. The role of culture and subjectivities was further explored in a cross-culture study by Aljawabra and Nikolopoulou comparing buildings in different parts of the world (Marrakech and Arizona). In that study, the interplay between culture, architectural design, and user behavior is highlighted [31].

The aim to bridge the gap between the material structure of buildings and social practices involves considering buildings as everchanging entities within a socio-material context [32]. In that sense, Strebel [33] and Ingold [34] emphasize the perspective of dwellings as buildings, that become meaningful environments through lived experience. Furthermore, Actor-Network Theory [35] and Schatzki’s [36] conceptualization of practices and arrangements are employed to understand indoor climate control as a nexus of social practices embedded in specific time-space histories [28]. This approach highlights that thermal comfort is a situated practice closely intertwined with various aspects of social life and varies across social-material contexts, even within the same climate zone. What we aim to contribute here is a specific look into summer conditions of vulnerable households, where the thermal response of buildings is less dependent on insulating materials and energy demand, as users’ strategies can in a greater extent counteract discomfort situations.

Most energy vulnerability and energy poverty studies have a quantitative approach [20]. However, engaging ethnographic and multimodal tools with energy studies is already an established practice [37]. Using sensory ethnography, Leder and Pink [38] explored how the home and its aesthetics influence the residents' energy use. Sarah Pink [39] and Annette Henning [40] have also addressed the invisibility of energy as a material resource, as well as the need to engage with participants' sensory experiences to understand their thermal comfort needs and their energy consumption. Our study expands on their research by placing older adults who are energy consumers as the active subjects who are reshaping their home environments in ways aligned with their biographies and needs [37].

Regulations and policies are intermingled with people's socioeconomic conditions, as well as their relations, attachments, and personal background. These influence how energy is consumed in society, shaping our identities, our agency, and our ways of being in the world. Using participant observation to follow participants inside their homes as they engage in everyday activities can be helpful to make sense of the 'entanglements' [41] between urban policies and the participants, as they mediate the devices they use to attain comfort and the strategies they use to control exposure to solar radiation and air flows in their homes. In addition to the use of participant observation, it has also been suggested that re-enactments of everyday activities, through collaborative film methods, such as ethnofiction, "can provide important insights into domestic life, accounting for the kinds of tacit, embodied, experiential and situated knowledge that is difficult to gauge through interview methods alone" ([42]: 172). Scholars point to participatory filmmaking as a way to make visible the unspoken features of how we use and how we are deprived of resources, including energy [43]. Longterm interviewing and diaries are also considered useful tools for observing how individual subjectivities change over time [44].

Furthermore, there is also a growing number of scholars that advocate for the use of multimodal, embodied, and sensory ethnography tools as a means to access individual processes of sense-making. Sarah Pink's [39] work on the multisensory environment of the home has been of extreme importance to understand the flows, entanglements, and affects taking place in people's homes. Additionally, Pink and Leder [38] propose a methodological framework for understanding movement and sensory experience in relation to energy consumption based on multimodal tools, including diaries, following objects in the home, video tours of the home, and re-enactments of everyday life scenes. They argue the combination of these methods allows researchers to focus on human energy expenditure, movement, feelings, and participants' sense of place-making as a means to "arrive at a deeper way of understanding the meanings and practices of domestic energy use" ([45]: 122). They also suggest this approach can help tailor the urban design to actions that allow residents to reduce energy consumption.

Vannini and Taggart [46] go a step further by combining sensuous ethnography and more-than-representational ways of knowing, drawing from ethnographic research conducted in Alberta. Their work describes corporeal involvement in the process of creating indoor warmth when heating with renewable resources. They argue that off-grid indoor warmth is not mediated by temperature but by the atmospheric attunement of peoples' bodies to the environmental conditions. They suggest thermoception is not only a sense through which we gain awareness of a change in environmental conditions, but also an interface, through which we make sense of our feelings and create strategies to cope with distress. In this sense, they view thermoception as a type of affect, which they documented through photography, video, and audio recording. For them, audiovisual tools are "more respectful of 'affective modalities' that are not based in language and allow for a more complete representation of participants' lifeworlds and corporeal experiences" ([46]: 65). They go further by suggesting that "sensuous, affective ethnography also calls for an impressionist strategy of representation that enlivens encounters with the more-than-human world" ([46]: 65). The significance of their work is that it approaches the processes of creating warmth through the understanding of the sensory experience of environmental conditions and their representation. This research also makes a methodological contribution by using long-term participant observation and collaborative film, a combination of methods that allowed the researcher to understand how participants' adjustments changed over-time and

how they justified and approach the heat in different situations. The use of collaborative film shows how the researcher can engage participants with their bodies, accessing their experiential knowledge in non-discursive ways and helping them to reenact how their bodies felt and what they were sensing in the moments of heat that they choose to reproduce in the film.

3. Methods

Building on Pink and Leder's [45] approach to energy research, we explore summer energy vulnerability among older adults through a participatory multimodal design and research process. The study was conducted during two consecutive summers (June–September) of 2021 and 2022 in Madrid, Spain. The researcher engaged in a 2-year relationship with 10 participants above 65 years old. Participants were chosen according to their availability to engage in bi-weekly encounters from May to September of 2021 and 2022, with a non-representational diversity in age, sex, socioeconomic status, proximity to the centers of the urban heat island (UHI), and level of dependency in terms of care. We provided some anonymized details about them in Table 1 below. We got in contact with them through senior centers, neighbourhood associations, social platforms, and personal contacts, especially for those over 90 years old. The process of participating in research was timeconsuming, physically demanding, and emotionally challenging and has prevented the access of certain individuals with disabilities who had initially shown interest in our research. However, for those who were willing to take part, we accommodated research tasks to their need and requirements. We obtained ethical approval from the University and participants provided informed consent to participate in the research, including the film.

We conducted participant observation of their everyday life routines and activities once every two weeks, following their routine habits as well as different objects, such as cooling devices, at participants' homes. We also conducted semi-structured interviews on topics of interest, such as the bodily experience of heat, urban adaptation and coping strategies, and discussed their diaries. Finally, we proposed that participant engaged in the representation of heat by asking them to re-enact their everyday experience of coping with heat during the hottest day of the summer in Madrid, leading to the production of the ethnofiction film 'The Wave'. The film's narrative is composed of a collection of everyday scenes and participants' critical opinions on heatwave adaptation, collected in 2021, that were chosen and re-enacted by participants and filmed and edited during the summer of 2022.

The use of ethnographic methods enables a deep understanding of individual experiences as well as questioning assumptions that have previously been taken for granted, such as how we define and measure adaptive adjustments [46,47]. This is because individuals react differently to different media outlets and information channels, have different interpretations of existing social actors, and have different ways of adapting to extreme weather events depending on their level of vulnerability. Ethnography enables us to systematically collect this information [47], and it helps us understand local uses of energy and how different communities take part in the power dynamics that shape the energy industry and its politics. An ethnographic interest in extreme heat experiences requires attention to the sensorial experience of heat and its representation, the material, cultural and moral conditions that intervene in the satisfaction of people's cooling needs, as well as to the global flows and social and political environments that regulate and set a price on those needs. To this end, in the following sections, we summarize the factors outside the house that contribute to overheating risks and analyze related local policies. We then explore the participants' manifestations of energy vulnerability in their everyday embodied forms, and the local cultural practices people engage with to resist heat through the multimodal approach described above.

Table 1: Overview of study participants

	Alicia	Javier	Rita	Elias	Sandra	Lola	Martín	Antonio
Age	70	64	76	85	70	65	67	85
Sex	F	M	F	M	F	F	M	M

Heigh	1,60	1.82	1.65	1.65	1.64	1.58	1.7	1.64
Weight	50	74	70	73	69	90	77	75
Pension	1400 Eur	Middle Class	2100 Eur	1005 Eur	2100 Eur	Unemploy ed	1400 Eur	1500 Eur
Year of building construction	1983	1960	1968	1968	1934	1990	1960	1968
Floor n°	1	1	1	1	1	2	1	4
Elevator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Uses A/C	No	No	Yes	Yes	Yes	No	Yes	Yes
Uses fans	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Uses blinds	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Living alone	Yes	No	Yes	No	Yes	No	No	No
Dissabilities	No	No	No	No	No	No	No	No

4. External factors conditioning thermal experience: causes of energy vulnerability in Madrid

Here we focus on discussing the external factors that directly influence the thermal performance of buildings, placing residents at the centre of their hygrothermal management and thereby recognizing their ability to control heat and moisture in the domestic space. The rise in electricity prices across Europe, with a 47 % increase in Spain [48] has made visible citizens' struggle to meet their financial saving needs, thermal comfort, and health needs. The authorities and markets promote and assume energy efficiency measures that are managed by individual citizens daily, articulated in part through the management of architectural devices.

The socio-technical assembly that defines and shapes the experiences of heat within buildings is conditioned by internal and external factors. Internal factors are those that alter individuals' thermal needs: metabolic activity, amount of clothing, psychological factors, and age [49,50]. External factors are those that alter thermal comfort parameters, including air temperature, relative humidity, and air speed [51], and can be classified into three main sections: climate, building, and energy. The interaction of climate conditions with building and energy conditions end up externally determining comfort situations. A certain climate, such as Madrid's, causes particular needs for passive insulation, solar capture, and ventilation — that is, without the addition of extra energy. When buildings cannot passively satisfy the demands for thermal comfort, they use external energy (in the form of electricity or gas, for example) to increase or decrease the temperature depending on the time of the year. The greater a building's need for extra energy, the greater its energy demand and the lower its efficiency.

The energy efficiency requirements for buildings in Madrid, introduced in Spain in 1979 are focused on new buildings and major renovations. The law does not require the renovation of existing buildings and insulating façades [52], so practices such as changing the windows depend on the choices and organization of homeowners. In 2015, the first improvement interventions started through municipal energy rehabilitation plans for the most vulnerable areas of the city, promoted by neighbourhood communities and subsidized by public funds [53]. However, there is an alarming deficiency of interventions to improve insulation and windows – which are the most accessible measures of energy rehabilitation – in favour of interventions on accessibility and maintenance of buildings, which are also of great importance to the residents [54]. The lack of energy rehabilitation projects causes an alarming prevalence of old buildings of poor construction quality in which thermal stress is common. This situation is aggravated by the rise in gas and electricity prices in 2021, which makes the inhabitants

reluctant to use active means to improve the indoor temperature of their homes, due to the increased financial toll that this implies [55].

The dominant information policy on heat exposure and adaptation focuses on imposing the responsibility for the maintenance of thermal comfort on citizens. This approach enhances residents' vulnerability by shifting the responsibility and energy costs to individuals, as most of the adaptation practices are being carried out at an individual level. Some recent EU projects are precisely focusing on informing the population about the alarming situation of thermal stress in cities and energy poverty and promoting cost-free modes of cooling down the dwellings. The relevance of this type of initiative has increased over 2021 as many people have been forced to cope with thermal stress situations due to overheating [12].

Many buildings built before the first thermal regulations lack basic insulation conditions and require extra energy during many months of the year to meet their indoor thermal comfort needs [56]. In fact, in the areas with the highest incidence of the UHI effect, only through active acclimatization systems can interior comfort situations be achieved, even in modern buildings. This is because the outdoor temperatures in these places remain too high even during the night, when at other times of the year natural ventilation could be used to cool the interior spaces. Cooling devices, such as air conditioners, are the preferred tools used in overheated dwellings, but in turn, they produce greater external heating, increasing the local heat island effect [12].

The impact of excessive summer heat is exacerbated due to energy vulnerability, which is created by different factors that act on an individual scale (age, physical and mental health, and metabolism), on a socio-economic scale (financial resources, social support, and geographical location), on an architectural scale (the quality of the dwelling), and an urban scale (UHI distribution) [7]. Therefore, thermal stress and thermal comfort are affected by many factors. A large part of the microclimatic management of dwellings lies in their inhabitants' routines and uses. As shown below, the economic and energy context promotes attitudes of energy self-sufficiency carried out by people in situations of vulnerability and heat stress. Such strategies are not sufficiently addressed and valued in energy studies.

5. Coping with energy vulnerability through adaptive thermal strategies

While the previous section focused on the external factors affecting energy vulnerability, this section focuses on the individual and interpersonal characteristics that influence the thermal experience. We differentiate between embodied, environmental and social adjustments to encompass, from ethnographical data, three levels of action of architectural energy-based evaluations (user, building, city). Drawing from Strengers et al. [57], we understand social practice as the everyday activities people engage with their bodies and their material environment leading to different patterns of energy consumption. By studying the social practices that older adults engage with to cope with the heat we can gain insights into how they negotiate their embodied experience with the material condition of their houses, their cooling devices, and their social relations engaging sometimes consciously and other times unconsciously in a degree of austerity that keeps them from attaining thermal comfort. This section explores how participants adjust to such situations of energy vulnerability generating a collection of small-scale adaptation strategies, some reliant on energy-dependent technologies and many of which just require human energy expenditure. First, we analyze embodied and environmental adjustments, including how participants engage in mundane or automatic activities to attain thermal comfort mediated through their sensorial and corporeal experience, their personal background, their building conditions, and their level of financial vulnerability. Second, we analyze how individual adaptation is negotiated socially and the different conscious and unconscious adjustments that emerge from and derive in situations of energy vulnerability. The section will use still photographs from the documentary 'The Wave' (2022), to illustrate the life narratives and personal justifications used by participants when

engaging with adjustments. Participants have consented to publish the film and use the still photos in the article. The full documentary can be watched here: *The Wave* (<https://vimeo.com/842798862?share=copy>)

5.1 Embodied and environmental adjustments

Antonio (86) lives on the top floor of a working-class building built before the first thermal regulation in Spain, with low-quality materials and no insulation, making his apartment hotter than average. In the summer of 2021, Antonio spent three weeks wishing to turn on the air conditioning, keeping it off even in the moments he felt dizzy during the heatwave. He was physically impaired by the extreme heat conditions, struggling to talk, losing balance, and demonstrating agitation on several occasions. However, he refused to turn on the A/C, he claimed to have lived in more extreme conditions and misery during the 1936–1939 Spanish Civil War when he was a child. “Heat? This is not heat, I have lived everything, heat, cold, hunger” Antonio claimed in every social encounter he had. “Even if it is hot, we can’t compare what we had before with our privileged position now”, he claimed. He also emphasized “The A/C is very expensive and now with COVID, it is dangerous as it spreads the virus”. The double recommendation to stay at home due to COVID and due to extreme heat was “nonsense” for Antonio, who claimed “as older adults we are already isolated. I follow the recommendations, but sometimes this is an oven and I cannot turn on the A/C”. COVID mediated our research, limiting the amounts of participants involved, and our interaction, as we took safety distance and wore face masks. However, for participants like Antonio, COVID was mediating his summer, he claimed “going out with the face mask and the heat is a pain, there is sweat everywhere, but then when I sit at home watching the mass as I started doing during the pandemic, I also sweat and I get bored after a while. I need to go out even if it’s hot”. Drawing from memories of his childhoods, his financial vulnerability, or his current fear of contagion, Antonio convinced himself daily to keep the A/C off and to continue doing his outdoor activities.

To cope with the summer heat conditions, Antonio tends to go on his morning walks at 7 am, sleeps longer during the day, goes to the supermarket to enjoy free air conditioning, and has installed a ceiling fan to obtain a bit of coolness. To attain comfort at home, he routinely lowers the awnings and the blinds when the sun comes up early in the morning, and closes the window in moments of extreme heat. He told us, “my advice is to change spaces, to move around the house, and even to go outside to feel the city’s fresh air”. He argued that the authorities’ recommendations to stay inside during a heatwave did not make sense because by the time the houses start cooling down at night, the sun is already up again, giving no time for indoor spaces to become cooler. For him, the torrid nights were the biggest problem, “I cannot sleep and the morning after I suffer the effects of sleep deprivation. I stay in bed turning from one side to the other until I get up to drink water”. This scene is illustrated in Fig. 1, which was used in the film’s opening scene focusing on Antonio’s insomnia.

One of the strategies Antonio used to avoid the heat was to go out for his morning walk sometimes before the sun was up, “I go out and my body cools down as I walk, and when the heat starts I go back home”. This way, he was able to feel the contrast from his apartment, allowing his entire body to feel a drop in temperature during his walk before the day and the heat started again. He claimed that moment was an essential part of his coping strategy, as it was the only way for him to exit the hotday and hot-night loop of the heatwave and attain some corporeal attunement. However, when selecting the stories to include in our collaborative ethnofiction film, he chose to represent the inability to sleep at night and his privileged position in comparison to the harsh environmental conditions he faced during the Spanish Civil War and postwar when he was just a child. He based his part of the narrative on the idea that his embodied background of austerity is the most important factor influencing his adjustments to the environment during a heatwave period, an idea he makes clear to the cashier in the scene when he goes to buy bread in the film. However, he also wanted to emphasize that despite his experiential knowledge of extreme heat, the consequences of prolonged sleep deprivation are something new to him in the past

few years, sometimes unconsciously affecting him. He claimed “I do the same thing every day, before going out to the street, I automatically close the windows and lower the blinds. For a year it has been enough, but now I feel tired through the day, I forget what I was doing and little things irritate me, I am used to the heat, but not to sleepless nights. I even put the fan to sleep, but it is not enough”. We chose to open the film with Antonio’s insomnia because it shows how his embodied knowledge from years of postwar austerity and his active use of fans to improve his sleep intermingle, and how even when combined they can be insufficient to mitigate the effects of the heat for participants like Antonio.



Figure 1: Antonio drinking water. Still photograph from the documentary ‘The Wave’ (2022).

Within specific local contexts, different forms of adaptation to the environment emerge as means to keep sustaining life. Sometimes these changes take place by changing what we eat, wear, how we move, and how we situate ourselves in a given space; or through interaction with our environment: changing the amount of light, insulation, temperature, and humidity in our surroundings. Most of these activities are relational and experiential, based on a long coexistence between the surrounding environment and our bodies. In this process, there is not a fixed comfort temperature, but a set of adjustments to accommodate the temperature imbalances the body might feel. Antonio’s situation of energy vulnerability is shaped by the high risk of exposure due to the low-quality materials and poor insulation of his building. However, it is also influenced by his lack of awareness of his current sensitivity to heat, based on memories of higher levels of discomfort that keep him from acknowledging the severity of the present impact heat has on his body. This further accentuates his level of vulnerability because it leads him to dismiss heat as a risk and keeps him from reaching out for help.

The second scene of the documentary also builds on the interaction between embodied and environmental adjustments, through the story of Laura (53) and Elias (86) (see above). They live on the first floor of a working-class building, built before the first thermal regulation in Spain. Although it was constructed as a housing cooperative project, with average-quality materials, it has no insulation or, more important, protection against unwanted infiltrations of hot air, making their apartment hotter than average. The family relies on Elias’s pension and has a tight budget at home. While Elias routinely lowered the blinds to prevent solar radiation early in the morning, Laura, his Cuban wife, often waited until he went on his morning walks to open the windows and turn on the fan, this is related to Cuban climate context, where air humidity requires constant ventilation. This is one of the scenes Elias chose

to represent in the film, with Elias arguing in favour of the nonenergy-dependent strategies that his mother and grandmother had taught him, and Laura defending the use of the fan and A/C as she used to do daily in Cuba, before coming to Spain. The couple continuously teased each other, adopting one or the other strategy and they also engaged in daily fights about this topic, especially during the hottest moments of the day, such as siesta time. This is what they tried to represent in the scene illustrated in Fig. 2 above, where Laura wants to turn on the A/C and Elias tries to convince her to wait. He says “It is very expensive, wait a bit longer and then we put it for ten minutes with the fan so the air circulates”. For Elias, it is a question of money, while for Laura who repeats “I cannot take it any longer” it is a question of not being able to withstand the discomfort of heat. Even while filming she used the moments we stopped recording to turn on the fan while we were preparing for the following shoot, because she was really uncomfortable due to the heat.

This testimony is relevant because it shows the mechanisms through which older adults budget and place time limits on energy-dependent cooling devices, as well as the interpersonal conflicts derived from negotiating their use at home. A big part of adjusting our bodies and environment depends on the weight we give to our economic vulnerability over our physical ability to stand the heat, as well as that of other members of our household. The arguments Elias and Laura have, reflect the experience of heat in their bodies, the architectural structure of their apartment, the global energy price, and the costly energy bill. Through the way they handle the tension, we can see a diversity in the physical ability to withstand heat and a diversity of worries about energy and economic vulnerabilities, but we also gain knowledge on who has the power over resources within the household and how that mediates couple dynamics.



Figure 2: Laura negotiating with Elias to turn on the A/C. Still photograph from the documentary ‘The Wave’ (2022).

Participants’ energy consumption depended on their everyday rhythms, making use of different devices as needed for each situation. Many of these consumption patterns are mundane intuitive practices that are part of everyday life, such as turning on the radio while cooking, the TV while eating, or opening the window while sleeping. Participants also reported they did not reduce or change their use of heat-generating devices, such as the stove or oven over the summer. They used those devices as they needed them throughout the day, without the same consideration given to the use of A/C, for instance, which was used only in situations of discomfort as if it were secondary to their everyday needs, such as the use

of the fan or the A/C Alicia (71) claimed “I am waiting until I cannot longer breathe in my apartment before I bring the fan up from the basement”. This implies the use of fans or A/C is not normally necessary to make their homes feel right, although several other devices are customarily turned on as part of everyday practices.

The sociotechnical imaginaries of technologies [57] such as A/C's, are not only key in smart home design but as a social adaptation strategy to endure life at home and in indoor spaces under extreme heat. This presupposes particular energy futures where citizens will have the means to power their cooling devices. At the same time, changes in the relative price of energy and political regulation on energy and infrastructure are two of the factors considered to be driving energy vulnerability ([58]: 127). Our study shows that the use of energydependent cooling devices is mediated by the current price of energy, the participants' background of austerity and their embodied and affective relationships with non-energy-dependent strategies, which as Elias claims, “I do them automatically, in the morning I lower the blinds and close the windows, and at night I open them like my mother used to do”. Regardless of the fight and interpersonal conflicts involved, for Elias, as for most participants, the diversity of non-energy-dependent strategies used served to create a sense that even in a situation of energy vulnerability, they were all coping well. With this, we want to highlight there is a double lack of recognition of the risks of heat stress and a combination of small scales adaptation strategies that leads participants such as Antonio and Elias to consider that they are coping well, while in fact their austerity measures are constraining their thermal comfort to the point of having a heat stroke as happened to Antonio in two research visits because as he mumbled, confused, “it is not hot enough to put on the A/C”. Other participants were much more sensitive and rapidly reacted to attain thermal comfort, however this was not so much due to the condition of buildings, but the sense of endurance and self-care of participants, which led many of them to avoid the moments of heat stress participant like Antonio endured. Sandra, for instance, claimed, “what I'm not going to do is have a bad time, I do everything when the heat affects me, I go almost naked, sprinkle water all over my body and put the A/C when I have to. Heat is terrible so you need to do the maximum to maintain a bit the freshness inside the house.

This type of self-imposed reduction of energy consumption due to an embodied sense of austerity as was the case of Antonio, high financial costs, and attachment to non-energy-dependent strategies as what the case of Elias, is not usually measured; still, it is the result of policies that do not take into account the historical struggle to meet basic needs and the existing locally-adapted adjustments to maintain energy efficiency and keep external energy needs at a minimum. As Sahakian et al. ([59]: 423) suggest, “not all bodies and not all parts of bodies in the same space appropriate the indoor microclimate in the same manner, hence different actors may experience the same conditions differently and adjust to them differently”. Consequently, imposed regulations may exacerbate the conditions of austerity older adults engage in to withstand summer energy vulnerability, forcing them to cope with higher levels of heat than what they are used to. Likewise, there are many nonenergy-dependent activities and strategies, such as creating air currents and closing blinds and windows to prevent radiation and maintain a comfortable atmosphere in the home. We claim that these adaptation strategies are an essential part of the embodied and environmental adjustments for energy management at home, with significant impacts on social adaptation to heat. Attention to non-energy-dependent activities and strategies for making one's microclimate feel right is necessary to understand how citizens perceive technology-driven thermal comfort solutions, as well as their agency to manage their thermal comfort otherwise. This section has shown how older adults negotiate their bodily experiences and environment to adapt to conditions, in the next section we will analyze how these experiences are revealed in social practice and how certain social choices are being made to adapt to climate change.

5.2 Social adjustments

Accustomed to keeping her windows closed during hot hours, Rita (79) chose to reduce movement during the heatwave. She did not like being isolated, but in 2022 she had difficulty handling the heat over so many days. She told us, “I’m much hotter than other years, it’s horrible, you can’t do anything outside, I don’t feel like going any close to the front door”. Rita spent most of the heatwave periods in the summer of 2022 at home, sitting on the couch in order not to waste her energy and doing no exercise. During this time, she travelled for some days to France and said the heat was equally intense there, and she also had to spend all of the days on the couch. In July 2022, she told us, “before, I travelled to escape the heat, it was our form of adaptation, everyone travelled outside Madrid, now anywhere you go is equally hot”. When she could not take the heat, she would sprinkle water on her wrists, grab a book and let time pass by.

When deciding on her scene for the film, Rita chose to focus on the troubled sociality during heat periods and her difficulty in meeting friends. She is normally very outgoing, and, despite her mobility problems, she remains positive. However, when she knows meeting her friends will entail further discomfort, she becomes reticent about any social encounter. In the film, she acts out the scene with Sandra (72), a long-term friend who has a different approach to heat and is always ready to go out during hot hours if the plan entails being in a cooler space, like going to the cinema. The scene shows their discussion to agree on a meeting plan and, later, their encounter, where Rita appears horrified by the heat outdoors. Nonetheless, there are several social practices she engages in that improve her experience. First, she avoids further mobility problems by taking a taxi to the cinema; as she arrives, she drinks a cold beer to calm her thirst; and finally, by engaging in a conversation with her friend, she smiles and laughs, dropping (at least temporarily) her negative attitude towards the heat. It is also interesting that in this scene they show that, just as we must adapt to heat, we need to adapt to A/C cultures. As they agree to meet, they also remind each other of the indispensable need to bring a jacket due to the low temperature in the cinema. This is what the two participants are commenting on Fig. 3, where Sandra shows Rita her scarf, and Rita frowns because she forgot hers. Just as there is a consciousness of how heat affects the body, sometimes preventing us from having a proactive attitude, there is also an awareness of the intense use of cooling devices in public spaces and how these can affect us.



Figure 3: Rita and Sandra having a drink before their movie session at 4 pm. Still photograph from the documentary ‘The Wave’ (2022).

As the adaptive approach to thermal comfort suggests, urban residents are not passive subjects. They actively engage in restoring their thermal balance as a reflection of their needs, their cultural backgrounds, and their biographies [37,60,61]. Both Rita and Sandra choose to invest their personal energy to change environmental conditions, closing and opening windows and blinds during the day and opening them at night to keep their apartments cool, but they also rely on energypowered technology when they need it. They rely on their experiential knowledge of physics (their perception of how hot it is, as they wake up and open the window in the morning) and their understanding of their physiology and bodily needs (what they consider comfort to be and the level of heat they know they can cope with). Yet, they also interact with others across the urban space in moments of extreme heat, a type of experiential learning that shapes the social practices through which urban residents adapt to the heat.

Rita told us, “I do not like to restrain my movement, I know my hip needs me to go for a walk, but with this heat it is impossible”. The corporeal energy she invested into keeping herself calm and still, together with the mental energy she invested to accept the frustration of feeling isolated due to the heat, allowed her to control her mind and body to maintain comfort. However, even when being outdoors, in a situation she might have perceived as one of discomfort, there are certain social practices, like enjoying a beer with a friend outdoors or watching a film in a cool environment, that allowed her to cope with the heat better than she had expected. This is revealing of how creating our thermal environments influences our patterns of movement and selfcontrol, as well as our patterns of energy use and our experience of heat in the urban space.

Fig. 4 shows Martin (67) and Pedro (69) discussing how the urban structure has affected heat adaption. Martin, told us, “Before we had many strategies, like playing in the street, cooling off in the river and placing chairs right outside the door that are not even possible in the cities today”. Adding to the many traditional practices that have been lost due to the transformation of cities, he explained, “there is resistance to the remaining age-old practices, there is no generational transfer”. Pedro his long-term friend agreed, “My son arrives at a place and he sees that everything is dark, dad, ‘how do you have this?’ Sometimes I say ‘I won’t invite you for lunch if you’ll go around opening the windows or raising the blinds, letting the sun come in, you’re going to make me suffer here every time you come’.” He argues that this makes him suffer every time because his preventive measures to maintain a comfortable temperature are lost. For him and Martin the key lied in the combination of strategies used, including their self-control and endurance, the practices which they inherited from their parents, and modern cooling technologies.

For the film they chose to focus on urban marginalization and the loss of traditional heat adaptation practices because they consider these the most relevant factors leading to summer energy vulnerability. Martin told us “Puente de Vallecas, [where his house is located], is so hot and so packed with buildings that feels like living at the bottom of a hole”. Seeking open-air space, Martin would go from central Vallecas to El Cerro del Tío Pío Park during many summer sunsets to feel the air currents and remember life outside the hole. The buildings and streets blocking the air currents that surround Vallecas create a heat point accentuated by the high population density of the neighbourhood and the absence of urban greenery. For Martin, “this is one of the biggest proofs of the spatial vulnerability of the neighbourhoods, they have blocked all the air currents and due to the high density of the neighbourhood and the noise we can’t even open the windows at night. They are suffocating us”. He explained, “But it is as if the solutions to the problem of heat, would necessarily have to be in the private sphere, inside the house, because the city has neither the means nor the resources. The other day, I was talking to Luis from the neighbours’ association and 700 trees had been cut and not replaced. You realize that the city is not functional for the heat and that it was not thought out for it”.

For Martin, the lack of green spaces and the spatial segregation reveals an active choice to impair the adaptation to the heat of certain neighbourhoods like Vallecas. “We need to publicly discuss these issues

because they lead to the summer energy vulnerability of its residents”. Similarly, Pedro, focusing on the inability to educate his son on the importance of non-energy-dependent strategies, claimed “it’s an education problem, what we had learned from years of living with the heat is now being lost because our children simply choose to turn on the A/C”. For him, not turning on the A/C, involved social adjustments with his family members, but most importantly was a social responsibility derived from his worries of climate change. He told us “Last summer I waited until it got up to 28 °C inside the house to turn on the air conditioning, and this year until 29 °C”. He worked to increase his tolerance to heat exposure because he thinks we need to collectively adapt to increasingly warming temperatures in the summers. Similarly, Alicia and Javier, actively refuse to install an A/C because of the further emissions its use entails.

Those who use technologies that are not automatized invest more corporeal and mental energy to attain a situation of comfort [62]. However, this requires a conscious effort to reduce energy consumption. Unlike the mundane choices made by Antonio and Elias, drawing on their background of austerity to make do with less-than-ideal circumstances, Martin, Pedro, Alicia and Javier choose to test the resistance of their bodies to withstand longer without using energy-dependent devices. While we recognize that in situations where there is no energy or monetary vulnerability, energy-dependent cooling technologies can be considered one of the most efficient ways of reducing heatwave mortality ([20]: 132), their efficiency dissipates as soon as the most vulnerable communities, such as older adults, become unable or unwilling to turn on their devices.



Figure 4: Martin and Pedro discussing the loss of intergenerational knowledge transfer. Still photograph from the documentary ‘The Wave’ (2022).

Furthermore, they choose to actively discuss social marginalization and the loss of intergenerational knowledge transfer, to address the problems that are keeping city residents in a situation of energy vulnerability, despite their efforts to adapt to increased warming. Martin concluded, “We need policies that address people’s problems, the lack of trees, the noise, the pollution, and we need to promote a commitment to the intergenerational knowledge transfer, including the austerity measures and to the cultural norms and customs passed through generations to maintain comfort without the use of fuel-powered energy”. For Martin, social adjustments were those that emerge from long-term experiential knowledge of coping with the environment, but also how people choose to defend or not those strategies as part of social practice. As Groves et al. point out, energy consumption is not simply an instrumental

means to satisfying cooling needs, it is “a constitutive ingredient of valued ways of being in the world, of identities, and forms of agency” ([37]: 72).

6. Conclusion

Our study relies solely on participants’ testimonies and may be subject to bias or inaccuracies. Additionally, the study only focuses on heat stress in an urban area and may not be applicable to rural areas. These limitations should be acknowledged to provide a clear understanding of the scope and applicability of the study’s findings. Nonetheless, the current study can be used to guide strategies to tackle heat stress for the elderly that seek to account for the dynamic and temporal changes in energy vulnerability. Through the use of collaborative filmmaking we have gained insights into the difference between adjustments, the participants’ trade-offs, negotiations and choices, and the narratives and ideas that they found important to include in the film to account for older adults’ situation of summer energy vulnerability. We worked around the anecdotes and everyday practices the researcher had observed in the summer of 2021, to build a narrative that could be reenacted by the research participants in the summer of 2022. Working with them to define which strategies were meaningful to them, as well as the details of how each strategy was undertaken was important to understand their individual valuing system, as well as how different participants justified their actions and choices when dealing with heat. For participants like Antonio, who often repeated “the heat doesn’t affect me because I have lived worse”, the film process served to situate the actual effect of heat on his body through his insomnia and sleep deprivation, as well as the discursive strategies he uses socially to avoid recognizing that heat poses a problem for him. However, there are also drawbacks when using filmmaking as a method. First, it is time and labour-intensive, which might not be feasible for all research settings. Second, it provides a skewed representation of the ‘real’ based on the relationship, meanings, and arrangements developed between the participants and the researchers. Third, the findings are not linear and are often subjective. This requires researchers to contextualize the film with accompanying texts drawing on participant observation findings to analyze the scenes.

The study participants turned to their past experiences of life without technology, water, or sanitation, and made use of their knowledge to keep energy expenditure to the minimum. While the study supports Wolf et al.’s [63] argument that heat risks are not perceived as personal risks, the participants’ experiences show that the citizens who engage in minimising their energy expenditure over time cope best with situations of austerity. We have understood that the critical agency our participants saw as necessary for adaptation to take place involves a form of energy that is rarely considered in technical–architectural-notions of energy efficiency – personal, bodily, and mental energy [62,64]. Similar to Wright’s [65] results in the case of cold winters, our study suggests that the older generation’s childhood memories of hot summers in homes without energy-dependent cooling devices affect their current use of fans and A/Cs. Yet, they still feel better off having an A/C device at home, because as they have learned through the use of traditional strategies, coping is possible through a combination of strategies. They do not feel comfortable with the A/C on all the time, but it provides an added solution, even if participants tend not to use it. This is done through a strong psychological commitment to maintaining a certain level of energy expenditure, derived from our cultural background and our financial, political, and social constraints.

In this article, we have discussed embodied, environmental and social adjustments, because they show participants reconfigure energy use by modifying their bodily experiences, their dwellings and their social practices. The analysis of adaptive adjustments allows us to consider the modes of local sufficiency and the practices people engage with to accommodate climate changes. Those modes and practices are deeply embedded in local conditions, cultural and social norms, and individual histories. Some strategies might work better than others, but all of them involve a dynamic interaction between the body and surroundings to restore energy balance. The ethnographic testimonies showed that even though, according to thermal comfort models, we would expect that certain conditions (e.g.

architectural) would lead to higher energy use, in some cases they lead to reduced energy use depending on the level of energy vulnerability and the adaptation adjustments the residents engage in. Energy vulnerability undoubtedly sparks creativity, creating personal solutions – like covering our bodies with a wet towel – that reveal numerous possibilities for confronting heat without energydependent devices. Nonetheless, we should remain aware that these strategies are a result of the inability to meet cooling needs among older adults and, while they are extremely valuable for the adaptation of the younger population, they also invisibilize the level of risk and vulnerability to heat experienced by older adults.

The novelty of the study lies in addressing not only the routines of energy use among older adults but also the social and regulatory context in which they are embedded. We intend to draw attention to the thin line that divides conscious austerity and energy poverty, by examining participants' experience of energy vulnerability and their adaptations. This is important because the diversity in the ways of experiencing heat reveals active positions of austerity and self-imposed sufficiency that contrast with current definitions of energy poverty and energy vulnerability, which indirectly imply passive actors. Traditional definitions of energy poverty are linked to the ability to pay bills. However, our study shows people in the situation of deprivation and self-imposed austerity have a range of passive strategies to cope with heat. Furthermore, energy expenditure does not rise during summer, as is usual for winter conditions, so in this case the ability to pay bills wouldn't serve as an appropriate proxy for summer energy poverty. Under conditions of overheating, we can gather a series of evidence that demonstrate the dynamic and temporal characteristics of energy poverty. To transcend definitions of the term, we propose the use of self-imposed austerity, which opens newer recognitions of people's conscious and unconscious choices to survive temporary conditions of energy vulnerability. This notion encompasses two of the forms of hidden energy poverty highlighted by Willand et al., including "disguise by coping mechanisms" and "failure to recognize the health risks of hot homes" ([66]: 5). But also, the justifications based on personal background, social practice or notions of social responsibility, leading participants to make both automatic and conscious choices to engage with austere livelihoods.

This article contributes to energy poverty research by highlighting the dynamic and temporal nature of older adults' situations of summer energy vulnerability and to thermal comfort theory by developing adjustment categories that illustrate the division between individual routinary adaptation strategies and their conscious choices to engage in self-imposed austerity. The article also contributes to methods by proposing interdisciplinary research combining architecture and anthropology and by discussing the benefits and drawback of collaborative filmmaking for energy vulnerability research, especially regarding the representation of the sensory experience of heat. It also makes a wider contribution to society by placing older adults and their vulnerability at the core of adaptation research, seeking a wider focus on the specific conditions of vulnerable groups and addressing the marginalization of summer energy vulnerability that exists in the literature. We suggest further research is needed to reflect on how the experience of heat changes people's body rhythms, such as the sleep cycle, and how it affects interpersonal relationships, as well as how it affects people's social life and shapes their critical interpretation of urban development. We need to fully understand the adaptation strategies people use, the social reasoning behind them and how these allow people to cope, to be able to measure energy vulnerability accounting for people's temporal and dynamic changes. Populations adapt to the climate they live in as they redefine the meanings of extreme temperature, adaptation, and energy vulnerability. As such, we must begin to take into account citizens' energy attitudes, differentiating between conscious and unconscious choices, to understand how and why people engage in processes of energy austerity.

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Data availability

The data that has been used is confidential.

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