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Fuel poverty, uncontrollable heating expenditure, and the consequences of heat cost allocation in a large housing estate of Budapest

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Abstract

Recent initiatives in the European Union aimed at reducing energy consumption in multifamily buildings have centred on implementing heat cost allocation, which facilitates charging for heating services based on consumption. Prior experiences demonstrate that heat cost allocation efficiently decreases energy use by providing prompt feedback regarding energy usage and expense. Nonetheless, its influence on fuel poverty, energy vulnerability, and heating affordability is still inadequately comprehended. The study involved implementing personal surveys and interviews with residents of large housing estates in Budapest to investigate their experiences and coping strategies related to heating expenses, comfort, and ability to influence these aspects. It also analysed how the presence or lack of consumption-based heating service billing influences various factors, including fuel poverty. The findings indicate that heat cost allocation considerably affects energy vulnerability and fuel poverty. In buildings lacking heat cost allocation, resident agency is constrained by fixed heating expenses and the heterogeneity of the residential community, resulting in postponed purchases of essential goods and heightened energy waste. While heat cost allocation reduces consumption and improves financial flexibility, its impact on fuel poverty is ambiguous, as it does not address the broader socioeconomic and energy-efficiency determinants of energy vulnerability and fuel poverty.

Keywords: fuel poverty, heat cost allocation, large housing estate, lived experiences, coping strategies

1 Introduction

In 2020, Space heating accounted for 62.8 per cent of European household energy consumption (Eurostat, 2022). Numerous multi-family housing units in the EU use fixed heating fees based on floor area rather than actual usage, hindering consumption control and contributing to energy inefficiency. Directive 2012/27/EU addresses this issue by advocating the use of individual heat meters or heat cost allocators to accurately measure heating usage and encourage a reduction in consumption (European Parliament, Council of the European Union, Directive 2018/2002).

Twelve years after introducing the Energy Efficiency Directive, Hungary adopted its guidelines on individual metering from 1 January 2024. According to the amendment of Government Decree no. 157/2005 (VIII. 15.) on the implementation of Act XVIII of 2005 on district heating services, and Government Decree no. 676/2023. (XII. 29.) on central heating and hot water service, owners of multifamily building flats are required to install heat meter devices or heat cost allocators. If consumers opt not to install any measurement devices by 1 January 2027, despite the feasibility and cost-effectiveness of such installations, the household's heating-related expenses, determined by the floor area of the flat, will be multiplied by a factor of 2.5.

Currently, 49 per cent of district-heated large housing estate buildings with a one-pipe heating system fail to adhere to the directive due to the absence of heat cost allocation or individual heat metering (BME, 2023). Since 2000, the use of heat cost allocators has been substantially bolstered by a countrywide remodelling campaign called the "Panelprogram." No substantial subsidy scheme comparable to those implemented before 2014 has been put in place to facilitate building-level energy measures (Szabó & Bene, 2019; Ámon et al., 2024). Adherence to the legislative amendment is further obstructed by multiple factors, including the nearly 96 per cent prevalence of individual private ownership (Kovács et al., 2018), significant heterogeneity among homeowners, and the resultant difficulties in building-level decision-making and management (Janky & Kocsis, 2022).

EU policies and academic literature emphasise the positive impact of individual heat meters on energy efficiency, but the challenges regarding heat cost affordability arising from their absence receive less attention (Canale et al., 2019). Addressing this gap, Herrero & Ürge-Vorsatz (2012) highlighted the issues caused by the lack of consumption-dependent heating service billing in large housing estates, noting that uncontrollable heating expenses may lead to fuel poverty.

The research seeks to investigate two principal issues: first, regarding the study by Herrero & Ürge-Vorsatz (2012), to examine the lived experiences, coping strategies, and agency of households that, in the absence of heat cost allocation, cannot mitigate excessive heating expenses, and second, how these factors are affected by the implementation of consumption-based heating service billing. The findings will reflect on the swift and expected further expansion of heat cost allocation in Hungary. The research employs a consensual approach and does not seek to provide an exact quantification of those impacted by fuel poverty; instead, it concentrates on examining the lived experiences related to the difficulties described by Herrero & Ürge-Vorsatz (2012).

In contrast to a substantial portion of the scholarly literature (Canale et al., 2019), this paper primarily examines residential buildings without extensive energy-efficiency modifications. The research does not seek to be statistically representative and lacks the generalisability of quantitative studies. Nonetheless, it indicates that such challenges with unmanageable heating costs are probably widespread in large housing estates in Eastern and Central Europe (Herrero & Ürge-Vorsatz, 2012).

2 Literature review

The Hungarian Statistical Office (KSH) characterises large housing estates as collections of mid-rise and high-rise residential structures, predominantly built with prefabricated technology from the 1960s until the late 1980s (KSH, 2013). Notably, during the initial stages of housing estate construction in Hungary, edifices were constructed using brick (Kovács et al., 2018). Subsequent periods saw the utilisation of monolete concrete technology (Antypenko & Benkő, 2022), although, as indicated by the referenced definition (KSH, 2013), these constitute merely a minor portion of the total housing estate construction from the state socialist era. Considering the article's breadth, it is essential to highlight that although most large housing estates utilise district heating, a significant percentage depend on local central heating boilers (Egedy, 2003; Herrero & Ürge-Vorsatz, 2012).

In Eastern and Central Europe (ECE), prefabricated panel blocks in large housing estates accommodate 34 million individuals, effectively mitigating housing shortages within the framework of state socialist political, economic, and ideological conditions until the 1980s (Szafrańska, 2015; Kocsis, 2012; Kovács & Herfert, 2012). In contrast to large housing estates in Western Europe, those in Eastern and Central Europe have sustained and stable social and real estate conditions due to their socioeconomic heterogeneity (Szafrańska, 2017; Hess et al., 2018).

A key consideration in large housing estate construction during the socialist era was to create the maximum number of buildings in the shortest duration, prioritising quantity over quality (Kocsis, 2012). Energy efficiency was not prioritised, partly due to ongoing fiscal limitations and diminished energy prices (Csizmady, 2003; Kocsis, 2012; Benkő, 2015). Insufficient insulation, substandard windows, and unmanageable heating expenses at the household level have led to considerable energy wastage since the establishment of large housing estates (Csoknyai et al., 2016).

A substantial corpus of literature worldwide examines the management and decision-making obstacles in multifamily buildings that persistently impede building-level refurbishment, particularly in Hungary. The scope of the paper precludes an in-depth examination of the specific legal frameworks governing various multifamily building types in Hungary, including condominiums and housing cooperatives, which are subject to distinct legislation. Furthermore, the impact of these legal structures on the implementation of building-level renovations necessitates additional investigation. Nonetheless, global literature identifies elements that obstruct the execution of renovations, which are similarly widespread in Hungary. This encompasses a significant percentage of homeowners and the considerable social diversity among residents (Matschoss et al., 2013; Janky & Kocsis, 2022). The majority of owners must provide consent for the implementation of improvements, whether in condominiums – where the decision is based on ownership share – or in housing cooperatives, where each flat has one vote, either cast by members (owners) or their representatives. Reaching this degree of consensus can be incredibly challenging when substantial disparities in age or income exist within the residential community, a notable trait in Hungary (Kovács et al., 2018; Janky & Kocsis, 2022).

Herrero and Ürge-Vorsatz (2012) observed fuel poverty in large housing estates, primarily associating the issue with district heating services and vertically distributed

central heating systems. The cited paper attributes significant importance to the low efficiency and obsolescence of district services in the Central and Eastern European region following the regime changes as contributing to the problem. Regarding vertically allocated central heating systems, the lack of individual meters or heat cost allocators means heating expenses are determined by floor area rather than actual usage, inhibiting residents from reducing costs even as they reduce heating consumption. This leads to superfluous heating services, resulting in energy waste and elevated fixed expenses for residents. This circumstance disproportionately impacts low-income households, necessitating trade-offs between heating costs and fundamental requirements such as transport, sometimes linked to energy poverty (Simcock et al., 2021).

Herrero and Ürge-Vorsatz (2012) designated this form of fuel poverty a 'post-communist type', emphasising its prevalence in large housing estates served by district heating systems, which characterise multifamily buildings in Eastern and Central Europe and the former Soviet Union. Nonetheless, the paper indicates that such difficulties may be pertinent in other settings characterised by the prevalence of energy-inefficient, district heating-serviced buildings. District heating cannot be exclusively linked to post-communist nations or solely to large housing estates. Additionally, the energy efficiency of district heating systems has become a much more nuanced topic than in previous decades (B. Némethi, personal communication, October 6, 2023). Furthermore, it is crucial to recognise that unregulated heating usage and costs are not limited to large housing estates or district heating (Martinopoulos et al., 2018). In light of these considerations, Herrero and Ürge-Vorsatz (2012) pay limited attention to the broader political and socioeconomic factors that could inform the terminology; the designation 'post-communist' may overly simplify the issue. Significantly, between the mid-1960s and the early 1970s, two-pipe heating systems were implemented in large housing estate buildings, enabling the regulation of heating demand via radiators without individual metering or heat cost allocation. However, if these systems have not been updated since their installation, the regulators often become outdated and fail to fulfil their stated purpose of managing consumption. The phenomenon of fuel poverty identified by Herrero and Ürge-Vorsatz (2012) may similarly manifest in these buildings (B. Némethi, personal communication, October 6, 2023).

Herrero and Ürge-Vorsatz (2012) assert that the phenomenon of fuel poverty cannot be appropriately defined by criteria that exclusively focus on a household's capacity to maintain sufficient warmth, such as the indicator 'inability to keep home adequately warm' (Anagnostopoulos & De Groote, 2016, p. 74). Definitions that account for the relative cost of energy (e.g., 'A household is energy poor if / when that household is unable to achieve an adequate [i.e. comfortable and safe] standard of warmth, and supply of energy services at an affordable cost' – Lawlor & Visser, 2022, p. 1) permit the inclusion of households that sustain adequate warmth at a high cost. Consequently, fuel poverty arising from unpredictable heating expenses need not be categorised separately, as it aligns with the commonly referenced contributing factors of fuel poverty, including elevated costs, low incomes, and energy inefficiency (Boardman, 2010).

The framework of 'post-communist fuel poverty' is not entirely incorrect. Still, it should be used contextually to refer to the socioeconomic and political characteristics of post-communist countries that influence fuel poverty in ECE, causing various forms and manifestations of the problem across social and spatial settings (Buzar, 2007; Jiglău et al., 2021). When analysed independently, the factors presented below cannot be considered

characteristics unique to ECE countries. However, when interpreted as a group, their presence is noticeable in the region, influenced by state socialism (Jiglău et al., 2021). As a problem cluster, it significantly impacts the social and territorial manifestations of fuel poverty in the region, as documented by Herrero & Ürge-Vorsatz (2012) and Jiglău et al. (2021). (Figure 1)

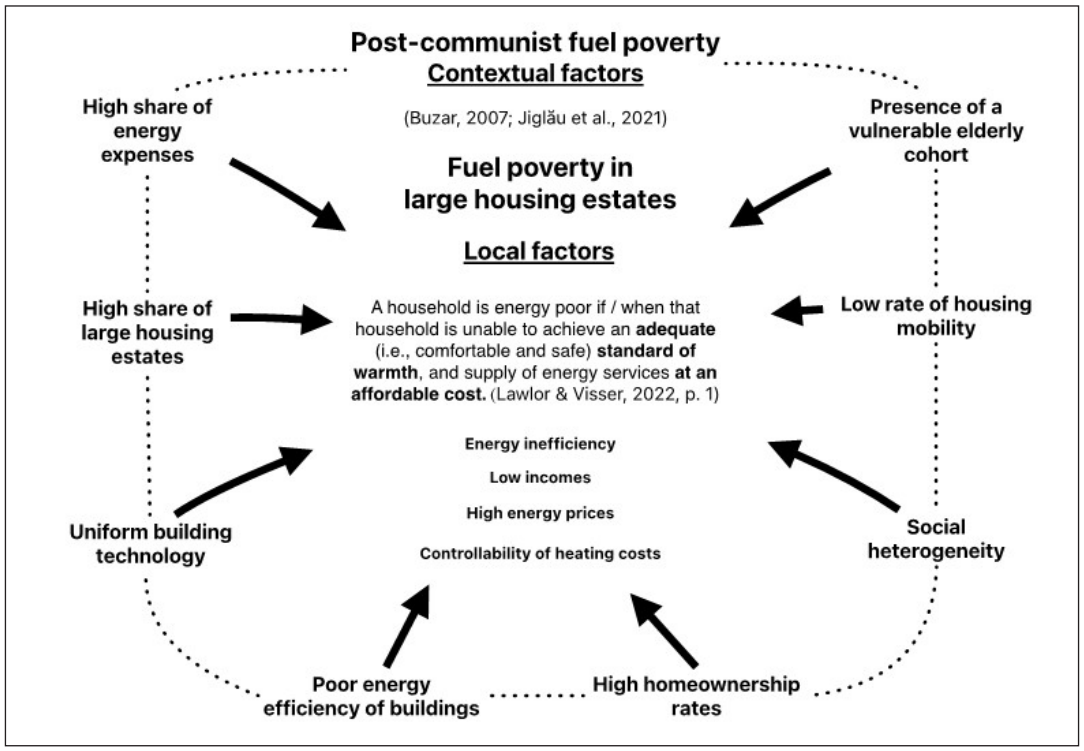

Figure 1 Post-communist fuel poverty

Source: Own editing based on Buzar (2007), Jiglău et al., 2021, and Lawlor & Visser (2022, p. 1)

- High share of energy expenses: Households in ECE face relatively high energy costs compared to those in other parts of the EU, partly due to the post-privatisation of energy services and a monolithic energy mix (Buzar, 2007; Bouzarovski et al., 2016; Bajomi et al., 2021; Deller, 2018).
- The high share of large housing estates: A substantial portion of the housing in ECE consists of large housing estates with unmodernised heating systems lacking individual controls and consumption-dependent heating service billing (Herrero & Ürge-Vorsatz, 2012; Hess et al., 2018).
- Uniform building technology: Standardised construction methods in large housing estates reduced costs and expedited building to meet housing demand (Kocsis, 2012; Benkő, 2015).
- Poor energy efficiency of buildings: Most buildings have poor energy efficiency, attributable to the quantitative approach that dominated mass housing construction during the state socialist era. In parallel, the low energy cost also contributed

to the marginalisation of energy efficiency considerations, while budgetary constraints hindered building maintenance (Kocsis, 2012). After the regime change, during mass privatisation, former renters of the large housing estate flats became private homeowners. The lack of awareness regarding the upkeep of both private and shared ownership and the management issues caused by the high homeownership rate contributed to the further deterioration of the buildings and their infrastructure, causing considerable energy waste (Matschoss et al., 2013; Benkő, 2015; Janky & Kocsis, 2022; Pirrus & Leetmaa, 2023).

- High homeownership rates: Privatisation led to high homeownership rates in large housing estates, with owners often neglecting common areas of buildings because of low awareness and lack of resources, which also hindered the maintenance and development of their flats (Kovács et al., 2018; Janky & Kocsis, 2022; Pirrus & Leetmaa, 2023). Additionally, homeowners face heating costs as a separate item of expenditure (e.g., not integrated into rent); therefore, there may be a greater interest and awareness in reducing them (Fine & Touchie, 2020).
- Social heterogeneity: The social status and heterogeneity of individual large housing estates varied in the socialist era (Csizmady, 2003). However, since the regime change, the social heterogeneity of the population living in large housing estates has significantly increased, driven by the influx of younger residents (Szafrańska, 2015) and the still-observable prevalence of the 'indigenous' elderly first in-movers (Kovács et al., 2018). Social heterogeneity (alongside the high homeownership rate) complicates collective decision-making related to building refurbishment (Matschoss et al., 2013; Janky & Kocsis, 2022).
- Low housing mobility rate: Low social mobility after regime changes, high homeownership rate, and the unaffordability of new housing limit housing mobility. Relocation is complicated by high utility costs and relatively low real estate market prices compared to the other segments of the housing market (Musterd & van Kempen, 2007; Janky & Kocsis, 2022; Jackson & Evans, 2017; Durst & Huszár, 2022).
- Presence of a vulnerable elderly cohort: There is a high share of vulnerable elderly with low incomes in large housing estates who moved in as young parents in the socialist era (Kovács et al., 2018; Herrero & Ürge-Vorsatz, 2012).

In addition to the previously discussed factors, it is crucial to emphasise other significant aspects that could potentially influence the occurrence of fuel poverty in the region, particularly in Hungary. Climate, a non-socioeconomic or political factor, remains a crucial influencing factor regarding fuel poverty: due to cold winters, heating accounts for a significant share of household energy consumption in ECE (Jiglău et al., 2021). This is partially related to the relatively high heating demand of households in Hungary. Compared to other European countries, the proportion of households heated to indoor temperatures of 22-23℃ or above 24℃ is exceptionally high (Csutora et al., 2021). Fuel poverty is substantially shaped by the 5 per cent VAT rate on district heating services and the state-subsidised energy price regulation program, known as '*rezsicsökkentés*', introduced in 2013. The program applies to electricity, piped gas, and district heating. While this initiative increased residential energy affordability, it has several adverse consequences: it diminishes

household incentives for energy conservation, hinders residential energy-efficiency refurbishments, and leads to declining energy-sector revenues. Consequently, the sector experiences delays in necessary investments, which compromise energy security (Weiner & Szép, 2021).

The concept of post-communist fuel poverty has its limitations. Critics argue that terms such as 'post-communism' and 'post-socialism' negatively frame ECE by focusing on its past (Lánczi, 2007). Also, these terms may not effectively describe whole regions due to their diverse post-communist developments (Armingeon & Careja, 2008). Additionally, over 30 years since the regime changes, the referred-to terms may be obsolete as communist legacies lose relevance. Thus, new theories are being created to describe specific features or differences within and beyond the former Soviet sphere (Müller, 2019). It is essential to note that not all factors are common across all post-socialist countries; for example, Bulgaria has advanced in installing heat cost allocators (MUNEE, n.d.), and the volume and impact of energy price regulations vary across countries (Jiglău et al., 2021).

As with definitions, analytical approaches to fuel poverty often overlook situations in which households face high fixed costs without unhealthily low indoor temperatures, thereby imposing financial burdens (Thomson et al., 2017). Using WHO guidelines, the temperature-based approach is limited by geographical and social factors and is less suitable for assessing fuel poverty caused by fixed tariffs (Thomson et al., 2017). The expenditure-based approach, which defines fuel poverty by the heating expenditure exceeding a threshold percentage of income (utilising Low Income/High Cost, also 2M and M/2 indicators), may identify potential overconsumption but faces limitations in Hungary due to government-regulated energy prices, data biases, and the large share of undeclared incomes (Weiner & Szép, 2021; Fenyvesi & Pintér, 2020).

The consensual approach relies on qualitative methods and self-assessment to identify fuel-poor households based on perceptions, living conditions, and vulnerability. It offers more profound insights into household experiences and challenges than expenditure-based methods (Csizmady et al., 2021). The approach helps detect fuel poverty patterns obscured by limitations in statistical data or by factors outside conventional frameworks (David & Koďousková, 2023). Nevertheless, a frequently cited limitation of the approach is its resource intensity and households' tendency to self-exclude from several problems due to the dominance of self-reports and subjective indicators.

The consensual approach is widely utilised to address lived experiences and coping strategies related to fuel poverty. The former refers to daily challenges, perceptions, and encounters that fuel-poor households face on a daily basis (Willand & Horne, 2018; Ambrose et al., 2021). The theory of coping focuses on daily practices, routines, and habits that the fuel poor implement to tackle challenges and adapt to ensure the best possible quality of life (Anderson et al., 2012; Brunner et al., 2012; Chard & Walker, 2016). With this approach, energy vulnerability may also be captured, a concept that enables researchers to move beyond the binary of fuel poverty and non-fuel poverty (Csizmady et al., 2021) to explore the broader, somewhat hidden aspects of housing deprivation and fuel poverty. Energy vulnerability focuses on specific internal or external factors, harms, and the potential exposure and sensitivity of households to changing circumstances, which could lead to fuel poverty or might be missing from mainstream fuel poverty interpretations

(Middlemiss & Gillard, 2015). The mitigation of the triggering factors and symptoms of fuel poverty and energy vulnerability is strongly connected to the agency of respondents, which can be defined as 'the socio-culturally mediated capacity to act' (Ahearn, 2001, p. 110, cited by Frank [2006]).

3 Research method

One of the main pillars of the research is a personally conducted questionnaire survey utilising both closed-ended and open-ended questions. One hundred and nineteen households from six buildings participated in the survey, with household members serving as the respondents.

To facilitate the identification of individual buildings and the association of specific information with them during the study, the buildings were assigned codes ranging from B1 to B6.

The questionnaire used in the research was partially based on the EU-SILC survey and on questionnaires from European countries on housing and fuel poverty (Thomson et al., 2017). It focused on several key issues across distinct sections: the household's demographic composition, the flat's physical characteristics, the occupants' heating habits, and their lived experiences and coping strategies regarding thermal comfort and affordability. Systematic sampling was not conducted. During the data collection process, all flats with doorbells were approached. If there was no response, a second attempt was made at the next available opportunity on another day and time.

Practical considerations primarily guided the choice to employ a personal questionnaire survey rather than interviews. The residents of the studied housing estate were reserved, distrustful, and unwilling to devote more than minimal time to participation due to other obligations. As a result, conducting one-hour interviews was not feasible. Instead, residents demonstrated greater openness to completing a 15-minute questionnaire, which could be administered conveniently and efficiently in the corridors and doorsteps. Consequently, a substantial proportion of the survey questions were open-ended, which enabled the collection of in-depth qualitative data suitable for examining lived experiences. One of the key advantages of this approach was the ability to reach a relatively large number of residents in a short time: approximately one-third of the 340-360 households in the housing estate were surveyed. Meanwhile, there was an opportunity to collect detailed responses to open-ended questions and conduct personal observations. Applying this practice allowed for the integration of some of the advantages of both quantitative and qualitative approaches. This claim is supported by the fact that responses to some closed-ended questions yielded meaningful results at both the housing estate and building levels. These results are clearly framed by the short comments and additional information from respondents, as well as the feedback associated with the open-ended questions, which provide detailed insight into the quantitative data on lived experiences.

Questionnaire survey results were complemented by semi-structured and spontaneous interviews conducted with residents, janitors living in the buildings as residents, and condominium managers. Interviews, along with some sections of the questionnaire, focused on lived experiences, coping strategies, conflicts, and power relations within the

residential community. Various actors were surveyed during the research, each offering different perspectives. Residents provided valuable information on all aspects as consumers of heating services and housing community members. As daily observers of residential concerns, condominium managers also offered insights into power relations and conflicts as community representatives. Janitors living in the buildings contributed as residents and caretakers of resident complaints, offering more profound insights into building-level issues.

Complementing the data from questionnaires and interviews, exact heating expenditure data could be obtained from condominium managers. Insights were also gathered about the latest renovations, utility metering, and accounting details.

The research adopted the consensual approach to fuel poverty research. Households' difficulty paying heating costs was estimated not based on the share of actual income or expenditure but based on the respondent's self-reporting to avoid the challenges and drawbacks associated with determining exact thresholds. A similar approach was taken regarding respondents' thermal comfort: the precise temperature of flats was not analysed in the survey, as it would not be an accurate indicator of thermal comfort, which is influenced by several other factors. Consequently, the questionnaire asked whether the respondent felt the internal temperature of their home was adequate. The deployment of objective measures and thresholds is somewhat limited to avoid excluding households that fall slightly outside these thresholds as fuel poor.

3.1 Limitations of the research method

Systematic sampling was not used during the implementation of the in-person questionnaire surveys. Despite the relatively high response rate within the housing estate, the conditions for representativeness were not met at either the building or the housing estate level; thus, the generalisability of the findings is low.

Regarding the questionnaire survey results, the article primarily relies on responses to the open-ended questions, with few exceptions. This approach stems from the inherent limitations of the survey employed in the research. While the questionnaire survey reached nearly one-third of households living in the large housing estate, a considerable proportion of responses were strongly influenced by factors that varied at the building level (e.g., social cohesion in the residential community, the size of common areas, and heating costs). As a result, for some closed-ended responses, it was not easy to extract precise housing estate-level findings, limiting the advantages of the quantitative approach that would otherwise have been expected from the questionnaire survey.

Nevertheless, it is essential to note that the depth and detail of responses to the open-ended questions varied significantly. While some respondents were talkative and added informative comments and clarifications even to closed-ended questions, others merely answered the questions and remained brief even in response to open-ended questions.

Regarding the consensual approach to fuel poverty, further research limitations should be noted, which reflect those already mentioned in the previous section. One of the most crucial limitations stems from the fact that the research fundamentally relies on

individual, self-reported, subjective thermal comfort and affordability assessments. This significantly complicates the evaluation of heating affordability and the comparison of households based on objective criteria. As previously noted, self-reports can exclude households from the problem of fuel poverty, or, on the contrary, respondents may exaggerate the severity of their situation. Some elements of the frequently used expenditure-based approach were also utilised, as data offered insights into residents' heating costs provided by condominium managers and residents. However, information about residents' income levels could only be derived through indirect descriptions and personal observation.

4 Study area

The research took place in one of the lowest-status large housing estates of Budapest, located in the centre of the 17th district (Balás et al., 2021), one of the outer districts of the city predominantly characterised by detached houses. The lower status of the area is partially due to its remote location from central Budapest and its densely built, noisy environment, congested with traffic. Monotonous, ten-storey-tall housing estate buildings from the 1970s stand out against the district's suburban character, whose architectural quality and reputation are below average for Budapest.

The six residential buildings involved in the study are located next to each other; their main physical aspects (e.g., number of storeys and flats in the buildings, heating source) are identical, and their overall social status is assumed to be rather similar. In line with the general patterns, the great majority of the residents who participated in the study were private homeowners, thus having a direct influence on refurbishments and building-level decision-making.

Legally, each building functions as an independent condominium. The apartments are individually owned; however, the common areas of the buildings (such as stairwells, corridors, and lifts) are collectively owned. The principal decision-making entity of the communities is the general assembly, consisting of all building owners. Voting rights are commensurate with each owner's property stake, reflecting the size of their flat.

With some exceptions, the general assembly makes its decisions by majority vote, calculated according to the ownership shares of the owners present at the meeting. This includes decisions related to refurbishments as well. The administration of the community is managed by a common representative, who fulfils the functions of a condominium manager, whose role is executive based on the decisions of the general assembly. A sizeable portion of a condominium manager's practical work involves financial and other administrative tasks, communication with residents, organising maintenance work, and, in some cases, fiscal management related to refurbishment projects.

The owners share the monthly expenses of the typical costs based on their ownership proportions. Common costs usually include management fees, cleaning, maintenance of common areas, and other expenses. If a substantial renovation or urgent repair incurs expenditures that surpass the coverage provided by common costs, the additional funds that are required are allocated according to ownership shares.

The buildings employ central gas-heating boilers within a vertically arranged heating system, which is atypical for large housing estates generally supplied by district heating.

This type of heating system provides the community with enhanced autonomy, as the residential collective regulates the boilers' seasonal operation and temperature settings. Nonetheless, the community's obligation to maintain and operate is significantly heightened.

All buildings in the study have been thermally insulated, and most of their windows have been individually replaced by residents. As these measures were implemented years before the study across all buildings, their expenses have already been settled by the condominiums and are hence not included in the common costs. Moreover, the study was unable to investigate the impact of these factors on thermal comfort and the affordability of heating expenses in the buildings.

Two buildings have heat cost allocators and modern individual heat controllers installed on radiators. Unlike individual heat meters, heat cost allocators measure the temperature difference between heat emitters and room air to calculate each unit's share of building-level heating costs. Regardless of the presence of heat cost allocators, households face fixed, flat-rate monthly heating costs determined annually based on the previous year's consumption. Residents pay one-twelfth of the total heating costs of the prior year each month. At year-end, actual consumption is reconciled with estimated costs paid throughout the year. Residents receive compensation if consumption has been lower than estimated, or pay the excess if it is higher.

Building-level heating costs are allocated based on flat sizes in buildings without heat cost allocators. In contrast, buildings with heat cost allocators calculate costs and compensations individually based on household-level consumption.

All the buildings included in the study were equipped with two-pipe heating systems, which allowed for the installation of heating controls on radiators. At the time of the construction, this enabled household-level control over heating consumption. New heating controls were also fitted on all radiators in buildings where heat cost allocators have been installed. In buildings where heat cost allocation has not yet been implemented, some residents have independently replaced their radiators, typically equipping them with new heating controls as well. However, these residents still cannot regulate their heating costs and can only improve their comfort by controlling heating levels. The original heating controls are typically outdated and nonfunctional in households where heat cost allocation has not been introduced, nor have the old radiators been replaced individually.

The end-of-year reconciliation scheme fails to provide immediate feedback on consumption and costs, thereby partially undermining the purpose of cost-sharing. Although the gas service provider offers the option of monthly meter readings and payments, condominiums have opted for flat-rate payments with annual reconciliation. This decision is primarily attributed to the predictability of heating costs: under a flat-rate system, monthly heating expenses are fixed and can be planned for the entire year. Furthermore, the distribution of annual heating costs over twelve months reduces households' financial burden during the winter months of the heating season. From the consumer perspective, despite the scheme's advantages in maintaining predictability, excessive consumption can lead to substantial bills at year-end. Different characteristics of the buildings analysed are presented in Table 1. Further elaboration of the diverse aspects of heating cost variation will be provided in subsequent sections.

Table 1 Characteristics of the buildings analysed regarding heating systems and costs

Building	Heating service billing	Control of heating	Date of last gas boiler replacement	Flat size (m^2)	Common costs/ month (EUR)*	Heating costs/ month (EUR)**	Building level heating costs/ year (EUR)
B1	Consumption-dependent	Available	2020	45	43.24	~20.96	18 519.2
				59	53.54	~27.38	
				63	56.58	~25.97	
B2	Based on floor space, with individual compensation at the end of the year		2010	45	23.88	29.05	26 838.1
				59	23.88	37.86	
				63	31.72	40.48	
B3	Based on floor space	Limited	2020	45	31.23	25.43	23 603.9
				59	37.50	33.41	
				63	36.69	35.72	
B4			2021	45	33.63	32.78	30 464.6
				59	44.32	43.07	
				63	47.32	46.18	
B5			2013	45	32.25	32.92	30 225.6
				59	41.62	42.72	
				63	44.03	45.24	
B6			2012	45	32.20	24.71	22 828.6
				59	42.13	32.20	
				63	48.30	34.43	

Source: Results from data acquired from condominium managers

Note: *Including maintenance and cleaning of common spaces, loan repayment for renovations, and additional target payment obligations.; ** For "B1", the amounts shown are averages based on anonymous data provided by the condominium managers.; *** In these buildings, although manual controls are typically available on the radiators, they are outdated, obsolete, and failing to perform their function due to the lack of renovation.

5 Results

5.1 Lived experiences and coping strategies in buildings where heat cost allocation is not available

In all buildings included in the research, most respondents consider their home temperature to be approximately adequate during the winter months. A tiny proportion of respondents find their home a little colder than necessary. However, more than a quarter of all respondents feel that their flat is slightly or much warmer than they would like (Figure 2).

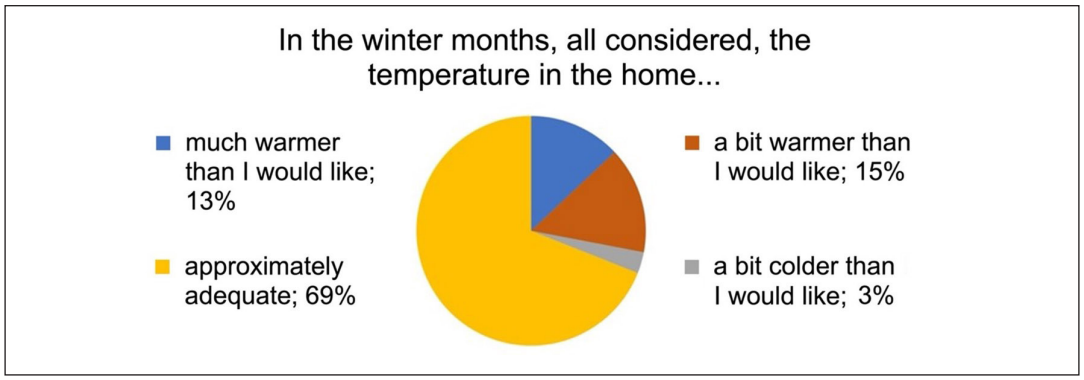

Figure 2 Thermal comfort of surveyed households

Source: Results from a personal questionnaire conducted by the author

Most of these residents live in buildings where heat cost allocation is unavailable. In such buildings, there was rarely criticism of the heating system not providing enough warmth (Table 2). On the contrary, the heating system was criticised for the unnecessarily high temperatures and overheating.

Unless the radiators and heating systems have undergone renovation, it is improbable that the initially equipped heating controls from the 1970s remain functional. One resident expressed their reluctance to use the controls: *'I'd rather not touch it anymore; I'm afraid it will break apart'.*

Central heating boilers are usually set to an elevated indoor temperature of around 27℃ by *'common agreement'*, predominantly forced by older residents with higher heating demands. As a result of their inability to regulate heating at the household level, many residents are left with only inconvenient and wasteful methods of achieving thermal comfort: *'The elderly lady next door is freezing at 26 degrees, and I sit in my flat all day in underpants with the windows wide open'.* Ventilation for reducing the internal temperature of the flat was sometimes used by residents, but many of them are aware that *'it should not be like this'*; '*it is not good that everyone is heating the street'.* This issue has prompted cunning coping strategies among the most dissatisfied residents, as one of them humorously remarked, *'The other day, we joked with the janitor that we should turn down the central heating boiler without the older residents getting to know [...]. Just 1-2 degrees; maybe they wouldn't notice.*

Table 2 The relationship between the availability of heat cost allocation and modern heating controls and thermal comfort of households surveyed

		In the winter months, all considered, the temperature in the home...				
		a bit cold	**a bit warm**	**absolutely warm**	**adequate**	**Total**
Building	HCA* and modern heating controllers are available	3	2	1	45	51
	HCA and modern heating controllers are not available	1	16	14	37	68
	Total	4	18	15	82	119

Source: Results from a personal questionnaire conducted by the author

Note: *Heat cost allocation

The residents' agency to reduce heating costs at the household level in these buildings is severely constrained. Even if the heating controls were operational and an individual reduced their heating to economise, the resulting cost savings would be distributed across more than 60 households due to the absence of a heat cost allocation system. *'I hardly ever turn off the heating; I pay the same anyway'. 'Why should I turn it down when others always heat?'* Cost reductions could theoretically be achieved through collective action, such as more economical use of the central heating boiler and its regular replacement with a newer and more efficient one. However, heating system renovations are significantly hindered by the varying heating needs of the occupants, their diverse financial situations, and the complicated and slow decision-making in the residential community. Slight dissatisfaction and distrust with the condominium manager can also be observed, as some residents feel that the amount spent on building maintenance is insufficient compared to the common costs they pay.

For older households of lower socioeconomic status, an increase in expenditure of 15 EUR per month for a renovation is a significant burden, whereas higher-status households possess both the need and the financial means to undertake renovations. A resident noted, *'I've been [trying to] convince people to install solar panels for five years at housing meetings, without any progress'.* Difficult building-level decision-making and the unavailability of consumption-dependent heating service billing represent significant barriers to individual initiatives aimed at reducing energy consumption. Residents may desire to contemplate energy efficiency practices at a household level. Yet, they often find themselves questioning the feasibility of such endeavours due to their current circumstances: *'Of course, I would like to consider [using] energy efficiency practices in my home, but what should I do with them? The heating costs won't change anyway. In multifamily buildings, it doesn't make sense to think about such issues'.*

5.2 Recent experiences and consequences of the installation of heat cost allocators

Buildings B1 and B2 are equipped with heat cost allocators and modern heat controllers that provide consumption-based heating service invoicing among the surveyed buildings. In B1, the implementation occurred in 2019, coinciding with the substitution of central heating boilers for more efficient ones. Residents can regulate the temperature in these structures by adjusting controls to maintain satisfactory thermal comfort (Table 2).

In contrast to other residential buildings, where the floor area of each flat determines heating costs, building B1 exhibits significant variability in heating expenses even among flats of identical size.

Table 3 Minimum and maximum heating costs by flat size in the residential building marked with B1

floor space (m^2)	Heating expenses (HUF)		
	min	max	median in buildings without heat cost allocation
45	1 550	24 720	11 495
59	2 090	18 330	15 238
63	2 290	24 150	15 990

Source: Results from a personal questionnaire conducted by the author

Notably, the highest heating cost in building B1 surpasses the maximum heating cost of buildings without heat cost allocators by 27 per cent (Table 1 and Table 3), indicating that the ability to control individually and the installation of heat cost allocators can result in increased consumption and higher expenses. With a few exceptions, it is notable that only buildings B1 and B2 contain residents who assume they may be able to reduce their heating costs significantly if needed.

The financial benefits of modernisation are undeniable at the building level, and they are most striking when looking at the heating costs of building B1. In this case, it is possible to compare heating costs before renovation in 2019 with new heating costs in 2022 based on the data provided by the heat cost allocators. It is essential to point out that after the renovation, the building-level heating costs were 50 per cent lower than before the renovation.

Evidence shows significant variability in household heating expenditure, indicating that retrofitting heating systems and implementing heat cost allocators do not benefit all households financially. In building B1, five out of sixty-four households experienced increased heating costs after the installation of heat cost allocators. Conversely, most households saw their heating expenses decrease by more than half compared to the previous amounts, with some achieving savings of nearly 90 per cent. However, such savings are nuanced if monthly renovation repayments are added to the heating costs. Approximately one-fifth of households faced higher costs, with 70-80 per cent increases due to renovation-related payments. Nevertheless, a quarter achieved reductions exceeding 50 per cent (Figure 3).

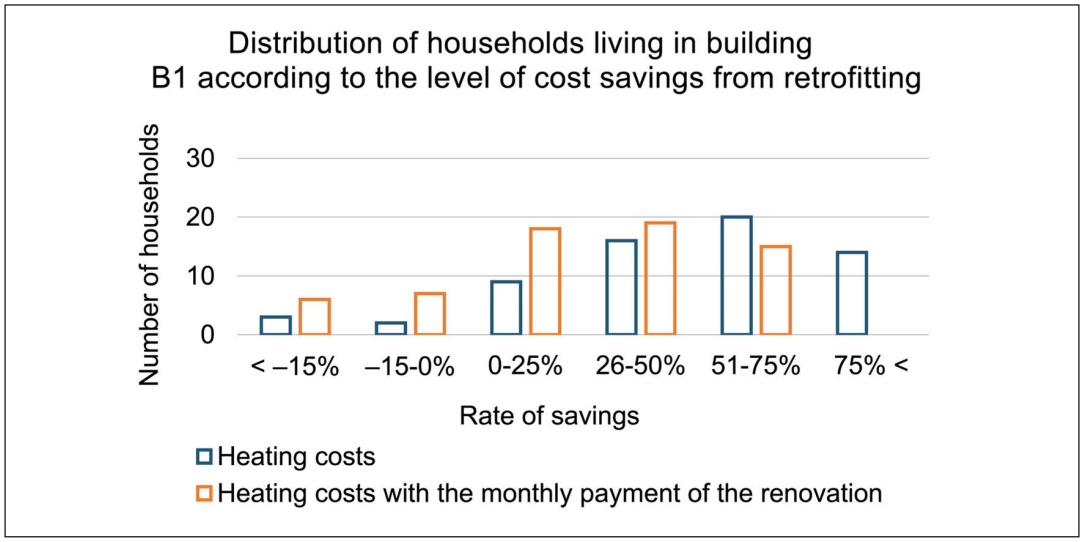

Figure 3 Distribution of people living in building B1 according to the level of cost savings from retrofitting

Source: Data provided by the condominium manager

The installation of modern gas boilers and heat cost allocators has contributed to reducing heating costs at the building level and across most households. The former provided greater efficiency, while the latter enabled residents to adjust their heating levels according to their comfort preferences or financial considerations. Those living in buildings B1 and B2 are the most motivated to save since they can realise rather direct benefits through reducing heating due to the availability of heat cost allocators. However, households living in these buildings also ventilate due to the high indoor temperatures. Nevertheless, according to the janitor of building B1, who has lived in the house since the renovation, there are fewer windows open all the time, and '*the residents are slowly learning to save money by turning off the heating*'. Although the main reason for turning down thermostatic valves (heating controls) was typically limited to achieving comfort in most buildings, saving money was repeatedly mentioned as a motivating factor in Building B1, solely.

Installing heat cost allocators and thermostatic valves eliminates 'artificially' high and low heating costs for some households. After retrofitting, residents start paying prices that reflect their actual consumption, resulting in a range of outcomes, with some households experiencing significant benefits and others experiencing rising costs. Household preferences and the location of the flat within the building both influence expenses. Flats on the corners and edges are typically considered colder, thus exhibiting higher heat demands. Residents who are comfortable in cooler homes and whose neighbours maintain significantly higher heating levels generally have been able to reduce their heating costs by 70-80 per cent. In the process of heat cost allocation, individual households pay their heating costs in proportion to their share of total heat consumption in the building. As a result, the heating consumption of households relative to one another mutually influences each other's heating costs.

Changes in the heating habits of a household's immediate neighbours may lead to an increase in heating costs. Before the installation of heat cost allocators, neighbours had no incentive or ability to influence their heating consumption, and households benefited from heating usage through the shared walls. However, installing heat cost allocators has encouraged neighbours to reduce their heating use, causing households to receive significantly less heat from adjacent flats. High heating costs may thus now be due to the need to compensate for 'cooler walls' through increased consumption, even if only to maintain the same thermal comfort. Consequently, unlike in the past, other residents no longer 'share' the financial burden of maintaining their neighbours' comfort. This scenario exposes older homes, typically characterised by poorer incomes and increased heating requirements, to heightened risk compared to younger households.

The uneven distribution of heating costs arises because nearly 100 per cent are based on heat cost allocator data. In contrast, based on legislation, buildings with district heating must maintain at least 30 per cent of heating costs as fixed, even with heat cost allocators, to ensure an equitable distribution of costs for heating common areas (e.g., staircases) and to reduce cost disparities. Building B1, which uses a privately owned central gas boiler, does not implement this practice because it is not compulsory. The radically altered and divergent heating costs often precipitate conflicts among residents. As the condominium manager of the building noted, *'I used to reassure people that as long as there is no (household-level) metering* (heat cost allocation)*, those who live in a well-located flat will pay much more than is realistic based on the location of the flat. I keep saying (to the resident): Well, you will certainly be paying more in the next thirty years than you have, but you should realise that you haven't been paying what you should have in the last thirty years. It has been paid by those who have paid more than they should have because of the lack of consumption-dependent billing'.*

Residents' reluctance to adopt heat cost allocators that enable individual metering is not solely due to this issue. The unfavourable outcomes of the renovation persist even after completion. Post-renovation, residents have had to adjust their heating settings more frequently, resulting in heightened temperature fluctuations in the heating pipes of the buildings and continuous clicking and crackling noises heard throughout most flats. As stated by the janitor residing in the building: '*We are slowly getting used to it*'.

Despite the refurbishment resulting in a 50 per cent reduction in heating costs and consumption at the building level, this enhancement has led to increased tension among residents and mechanical difficulties. The condominium manager of the buildings deems the installation of heat cost allocators generally advantageous and concurs with their positive impacts. Nevertheless, the manager underscored that heat expense allocation cannot establish a wholly equitable scenario for each household. The manager commented: '*So, that's why I talked them down, the other two buildings…, it would be very nice to have heat cost allocators, but let us not go into that, because they already regretted it* (in building B1)'. This serves as a pertinent example of the influence condominium managers can exert in executing building-level renovations.

5.3 Patterns of fuel poverty and energy vulnerability

Over a third of respondents (44 out of 119 households) reported difficulty in regularly paying their heating bills, 50 per cent of these comprising single pensioners. Among these 44 households, 39 indicated that their indoor temperatures were adequate, slightly warm, or excessively warm. Twenty-five of these households reside in buildings without heat cost allocators, limiting their ability to reduce heating costs. Fourteen live in buildings with consumption-dependent billing, but due to flat-rate billing, savings can be realised at the end of the year.

Fuel poverty can manifest itself in several ways in the large housing estates we analysed. In buildings where heat cost allocation is not available, the phenomenon is associated with significant energy waste. Many of those respondents who live in these buildings are burdened by heating costs, yet they are compelled to keep their windows open and ventilate constantly during winter due to unnecessarily high indoor temperatures.

Meanwhile, many of these households must postpone the purchase of certain goods and services because a disproportionate amount of their income is being allocated to unnecessary heating expenses: As an elderly lady commented, '*Yes, there are occasions when I can't afford a haircut* (…) *I'd rather put on another sweater and turn the heating down if I could'*. To put it into perspective, an elderly, disabled woman who participated in the survey receives a monthly pension of 180 euros, of which she allocates 40 euros to heating and 50 euros to common costs.

Single pensioners face the most significant challenges, with many expressing uncertainty about their future financial stability. Those in better health are currently working to support themselves, but they expressed their concerns about their finances in the event that their health no longer allows them to work. Pensioners living with an elderly spouse typically manage to meet their needs, but they face the potential risk of a sudden income reduction following the death of their spouse. From this viewpoint, elders who reside with an employed adult relative or receive financial support from their family are less vulnerable.

Fixed heating costs, despite being burdensome, ensure a safe indoor temperature, which is crucial for elderly residents. The importance of this leads many to advocate for the early activation and higher temperature setting of the central gas boiler to increase heating and prioritise utility bill payments. '*Every month, the utility bill comes first'*. Only seven respondents out of 119 reported that they were overdue with payments relatively frequently.

Heat cost allocators reduce energy consumption and heating costs by allowing household-level expenditure control and greater financial freedom in allocating expenses. However, the installation of heat cost allocators eliminates a predictable and reliable warm heating service that is available at a set cost. Due to the flat-rate billing system, households only discover at year-end whether they have consumed more than the predetermined flat rate established at the beginning of the year, further exacerbating uncertainty: '*Well, we are heating for now, then we will see the compensation bill at the end of the year*'.

Households occupying flats with higher heat demands and less favourable locations within a building are the most vulnerable. While residents in better-situated flats can reduce their heating consumption, those in less advantageous units have fewer options.

They may resort to reducing their heating, potentially resulting in unhealthily low indoor temperatures. The installation of heat cost allocators may thus push households with the lowest socioeconomic status towards energy vulnerability and fuel poverty, manifesting in low indoor temperatures, high heating costs, and severe unpredictability in heating expenses due to the year-end reconciliation. The monthly repayments for the installation of heat cost allocators may exacerbate the issue.

6 Discussion and conclusions

Employing a consensual approach, the paper sheds light on the real-life problems that arise because heating service bills are not based on usage, as discussed by Herrero and Ürge-Vorsatz (2012). The paper contributes to the development of the concept of Herrero & Ürge-Vorsatz (2012) not just empirically, but also theoretically. Herrero & Ürge-Vorsatz (2012) identified a manifestation of fuel poverty characterized by households that, while not experiencing unhealthily low indoor temperatures, must bear significant financial burdens due to uncontrollable heating costs. The phenomenon was referred to as a 'post-communist type' of fuel poverty, with the study primarily associating it with large housing estates served by energy inefficient district heating systems where a substantial share of the ECE population resides (Szafrańska, 2015).

Herrero & Ürge-Vorsatz (2012) argue that following the regime changes around 1989, a lack of investment in district heating systems led to their energy inefficiency and obsolescence in the ECE region. However, the discourse on district heating regarding energy efficiency has recently become much more nuanced (B. Némethi, personal communication, October 6, 2023), and the marginalisation of broader contextual factors that could support the validity of the 'post-communist' label does not provide sufficient justification for its widespread use.

It is crucial to highlight that neither large housing estates nor district heating systems are exclusive to ECE. Additionally, individually uncontrollable, vertically allocated central heating systems were widely installed in multifamily buildings during the twentieth century in other regions worldwide, including North America and Western Europe. Applying the term 'post-communist' may be redundant, as the fuel poverty definition of Lawlor & Visser (2022) already encompasses this specific issue of fuel poverty – the manifestation of inadequate thermal comfort accompanied by burdensome heating costs. Consequently, fuel poverty stemming from uncontrollable heating expenses should not be classified as a distinct 'post-communist' type, as suggested by Herrero and Ürge-Vorsatz (2012). In this paper, this phenomenon is referred to as fuel poverty.

Extending the observations of Herrero and Ürge-Vorsatz (2012) and drawing upon the perspectives of Buzar (2007) and Jiglău et al. (2021), we have identified certain factors that significantly influence the manifestation of fuel poverty in multifamily buildings within ECE countries, emphasizing the role of the state socialist legacy in their persistence. This paper argues for the possible use of the term 'post-communist fuel poverty' contextually, highlighting the interplay of post-communist socioeconomic aspects that influence the manifestation, severity, and volume of the problem, which can be manifest in

any form that causes various symptoms in any social group or space (Buzar, 2007; Jiglău et al., 2021). Within the framework of this research, the issue is primarily relevant to East-Central Europe, but similar studies in the region and Western Europe, as well as in other regions, are crucial to extending knowledge on fuel poverty related to the absence and implementation of consumption-dependent heating system billing.

ECE fuel poverty research typically places significant emphasis on rural areas, highlighting the disadvantageous interplay among large, energy-inefficient buildings, low incomes, and the unaffordability of solid fuels (Jiglău et al., 2021). This paper shifts the focus to urban areas, specifically multifamily buildings, in the Hungarian socioeconomic context. Additionally, the research contributes to the European discourse on heat cost allocation. While much of the related literature primarily addresses the impact of heat cost allocators on energy savings (Canale et al., 2019), this paper places greater emphasis on fuel poverty within the scientific discourse on heat cost allocation, highlighting how the presence or absence of cost allocation influences heating affordability.

Based on the lived experiences of residents living in large housing estate buildings, the availability and lack of consumption-dependent heating service billing persist as significant contributors to fuel poverty and energy vulnerability. Our study confirms that in large housing estate buildings, a lack of heat cost allocation leads to significant energy waste, which is associated with fuel poverty, especially in lower-income households.

Residents in these buildings face uncontrollable heating bills due to excessive energy consumption, forcing lower-status households to sacrifice essential goods and services. The absence of consumption-based billing limits residents' ability to reduce heating costs, thus undermining their energy-saving efforts. Social heterogeneity impedes decision-making about building-level refurbishments and agreements concerning central heating boiler operations, nullifying residents' agency. Indeed, receiving adequate levels of warmth is a markedly different phenomenon from the frequently cited lived experiences of fuel poverty, where unhealthily low indoor temperatures persist as one of the main issues (Middlemiss & Gillard, 2015). Nevertheless, fixed heating costs limit residents' ability to allocate their expenditure efficiently, a phenomenon discussed in studies that highlight the disproportionately high heating costs faced by the fuel poor (Brunner et al., 2012). Uncontrollable heating costs also constrain coping strategies: while fuel-poor households that are experiencing cold home temperatures develop practices to minimally increase thermal comfort (Chard & Walker, 2016), households suffering from uncontrollable heating costs often resort to reducing their consumption of other goods and services, including transportation (Simcock et al., 2021).

Analysing the lived experiences of residents living in buildings lacking heat cost allocation, the paper confirms and extends the observations of Herrero & Ürge-Vorsatz (2012) and Janky & Kocsis (2022) on the situation of being 'trapped in heat' and highlights that the phenomenon is not linked exclusively to district heating, as the paper describes the analysis of buildings served by central gas boilers.

The paper confirms the beneficial energy-efficiency consequences of installing heat cost allocators (Canale et al., 2019), along with providing evidence for emerging disputes among residents over diversified heating costs. Heat cost allocation provides the ability for residents to reduce the heating costs of their household directly, offering increased financial freedom and significantly easing the 'trapped in heat' situation. However, households

residing in flats with an unfavourable location within a building (Canale et al., 2019) often face higher heating costs, a situation further exacerbated by monthly repayments for installing heat cost allocators and heating-related renovations. While the lack of consumption-dependent heating service billing protects elderly households with high heat demand from potentially unhealthy low indoor temperatures, the installation of heat cost allocators introduces uncertainty regarding heating costs and leaves elderly households vulnerable to relatively low indoor temperatures (Boardman, 2010). Platten et al. (2020) have already noted that the installation of heat cost allocators could potentially push vulnerable households towards fuel poverty.

Although we recognize that the widespread implementation of heat cost allocators is a critical measure for reducing emissions from residential building stock, their effectiveness in alleviating fuel poverty remains ambiguous. Broader socioeconomic and energy efficiency factors, such as energy vulnerability (Csizmady et al., 2021), influence this uncertainty, which heat cost allocation alone may not address. The severity of the analysed issue may be significantly influenced by the thermal insulation capabilities of the buildings (B. Némethi, personal communication, October 6, 2023), which could not be addressed in this study due to the specific characteristics of the study area. Given the high share of large housing estate buildings in the ECE building stock and the anticipated increase in heat cost allocators in Hungary in the coming years, these factors could be particularly significant. The paper also highlights the significant role of condominium managers in the residential acceptance of heat cost allocation, suggesting further research on institutional and interest-related barriers to building-level refurbishment.

Given that the research focus on fuel poverty in the ECE has thus far primarily been directed towards rural areas (Jiglău et al., 2021), further studies must provide detailed insight into the nature, characteristics, and severity of fuel poverty in large housing estates.

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