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Bouzarovski, Stefan; Thomson, Harriet

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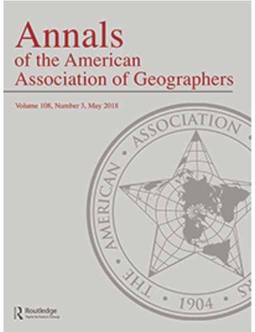

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Energy Vulnerability in the Grain of the City: Toward Neighborhood Typologies of Material Deprivation

Stefan Bouzarovski and Harriet Thomson

Department of Geography, University of Manchester

Geographers are increasingly engaging with the driving forces and implications of energy poverty—a specific but relatively unknown form of material deprivation that emerges at the nexus of sociodemographic inequalities and built formations. In this article, we argue that an improved understanding of the urban embeddedness of energy poverty can provide novel insights into the systemic underpinnings of injustice. We thus develop a conceptual framework focusing on the links between the sociodemographic and housing vulnerabilities to energy poverty on the one hand and wider patterns of urban social inequality on the other. This approach is applied to the study of several postcommunist cities in eastern and central Europe (ECE), where energy poverty has expanded rapidly over the past two decades. Using evidence from extensive custom-built neighborhood surveys, we interrogate the sociodemographic, housing, and infrastructural features of households that experience a lack of adequate domestic energy services. Our results point to the existence of distinct landscapes and typologies of energy vulnerability in the urban fabric. Material deprivation—a phenomenon that has rarely been studied in infrastructural terms—creates new sociospatial inequalities that might supplant patterns and processes of intraurban differentiation. *Key Words: central and eastern Europe, energy justice, energy poverty, housing, segregation.*

地理学者逐渐着手处理能源匮乏的导因及其意涵 —— 这是一种从社会人口不均和建成环境相交的轴线中浮现的特定但却相对而言未被熟知的物质匮乏形式。我们于本文中主张，增进对于能源匮乏的城市镶嵌之理解，能够对于不正义的系统性基础提供崭新的洞见。我们因而一面发展聚焦社会人口与能源匮乏的居住脆弱性之间的连结之概念架构，另一边聚焦城市社会不均的广泛形式。此一方法，运用至东欧与中欧 (ECE) 的若干后社会主义城市研究, 其中能源匮乏在过去二十年来快速扩散。我们运用由客户建立的广泛邻里调查之证据，探讨缺乏充足的家庭能源服务的家户的社会人口、居住与基础建设之特徵。我们的研究结果，指出城市文理中能源脆弱性的清晰地景与地形的存在。物质匮乏 —— 一种鲜少透过基础建设进行研究的现象 —— 创造了新的社会空间不均, 并且可能取代城市内部差异的形式与过程。 *关键词： 中欧与东欧, 能源正义, 能源匮乏, 居住, 隔离。*

Cada vez más los geógrafos se involucran con las fuerzas que controlan la pobreza energética y sus implicaciones—una forma específica, aunque relativamente desconocida, de privación material que surge en el nexo entre las desigualdades sociodemográficas y las formaciones construidas. Sostenemos en este artículo que con el entendimiento mejorado de la pobreza energética incrustada en lo urbano se pueden lograr perspectivas novedosas en los apuntalamientos sistémicos de la injusticia. En ese orden de ideas, desarrollamos un marco conceptual enfocándonos en los vínculos existentes entre las vulnerabilidades sociodemográficas y habitacionales y la pobreza energética, por una parte, y los más amplios patrones de la desigualdad social urbana, por la otra. Este enfoque se aplicó al estudio de varias ciudades poscomunistas de Europa oriental y central (ECE), donde la pobreza energética se ha extendido rápidamente a lo largo de las dos décadas pasadas. Utilizando evidencia de extensos estudios vecinales diseñados a la medida, interrogamos los rasgos sociodemográficos, de vivienda e infraestructura de los hogares que experimentan la falta de servicios domiciliarios energéticos adecuados. Nuestros resultados señalan la existencia de distintos paisajes y tipologías de vulnerabilidad energética en la fábrica urbana. La privación material—un fenómeno que rara vez ha sido estudiado en términos infraestructurales—crea nuevas desigualdades socioespaciales que podrían suplantar los patrones y procesos de diferenciación intraurbana. *Palabras clave: Europa central y oriental, justicia energética, pobreza energética, vivienda, segregación.*

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More than 2 billion households across the world are thought to be incapable of securing a degree of domestic energy services (space heating, cooling, cooking) that would allow them to fully participate in the customs and activities that define membership in society (Bouzarovski and Petrova 2015). Although this enforced lack of basic necessities is particularly pronounced in the Global South, developed-world countries in the Northern Hemisphere are hardly immune to the condition: Vulnerabilities to energy poverty or fuel poverty have been documented across southern and eastern Europe, the British Isles, South Korea, the United States, and even New Zealand (Bouzarovski 2014). From its initial conceptual significance in disciplines such as development studies and welfare economics, the issue is increasingly attracting interest within the emergent domain of energy geographies (Zimmerer 2011; Pasqualetti and Brown 2014; Calvert 2015). This can be attributed to the realization that domestic energy deprivation is an inherently spatial phenomenon: It arises out of the interaction between social inequalities and built formations while extending beyond income poverty (Buzar 2007). Understanding the urban and regional embeddedness of energy poverty, therefore, can allow geographers to make forays into the systemic underpinnings of injustice across different urban environments.

Processes of large-scale sociotechnical change often exacerbate the precarious position of households that cannot afford or access adequate levels of domestic energy. The relationship between dynamics of economic and political restructuring, on the one hand, and the emergence of energy poverty, on the other, is particularly pronounced in the postcommunist states of Eastern and Central Europe (ECE). This part of the world has experienced rapid and substantial restructuring processes during the past twenty-five years, under the influence of policy agendas aimed at establishing a market-based economy (Sýkora and Bouzarovski 2012; Golubchikov, Badyina, and Makhrova 2014). The departure from the communist past has been effected through multiple transformation dynamics of institutional, social, and urban change, which continue to have profound implications for the way urban households live, work, and socialize in the present (Chelcea and Pulay 2015). Neoliberal economic policies guided by the Washington Consensus (and the "Shock Therapy" model) played a key role in influencing the initial course of postcommunist reforms (Åslund 1992; Stiglitz 1994). ECE nations have been subject to economic liberalization and the introduction of private property rights, in conjunction with privatization, fiscal austerity, and the downsizing of state intervention in all aspects of society. In the energy sector, this has involved measures aimed at unbundling formally vertically and horizontally integrated companies and the opening of energy markets to competition (European Bank for Reconstruction and Development 2001). European Union (EU) member states from the ECE region in particular have seen substantial price increases for final consumers due to the dismantling of indirect subsidy schemes inherited from the past (Lampietti, Banerjee, and Branczik 2007).

As a whole, neoliberal energy and economic reforms have helped drive a rapid expansion of energy poverty across the whole ECE region. In addition to social inequality and energy price increases, the rise of this phenomenon can be attributed to the inadequacy of social safety nets, as well as broader policies and transformations in the urban and regional domain: The last twenty-five years have seen increasingly polarized urban districts and growing levels of intra- and interneighborhood segregation. The substantial body of work on urban change and social inequality in postcommunism (e.g., Stenning et al. 2010), however, has generally paid little attention to the additional layers of marginality and exclusion stemming from infrastructural reforms in the energy domain (but see Chelcea and Pulay 2015). The embeddedness of technical and material dimensions in the rise of domestic energy deprivation suggests that this phenomenon can be used to tell a wider story about the patterning of sociospatial inequalities within the urban fabric (Bouzarovski et al. 2015).

In light of such knowledge gaps and opportunities, this article examines the emergence and extent of vulnerabilities to energy poverty within the social and built structure of postcommunist cities. We focus on eight neighborhoods in four ECE cities (Budapest, Hungary; Gdańsk, Poland; Prague, Czech Republic; and Skopje, Macedonia) to examine the neighborhood-level sociodemographic, economic, and spatial formations associated with the lack of adequate energy services in the home. In a broader sense, we are inspired by insights from the literature on material deprivation (Whelan and Maître 2012) and capabilities approaches (Nussbaum 2011) to highlight the systemic circumstances that characterize the vulnerabilities experienced by particular groups and places. The overarching purpose of the article is to enrich existing debates on urban social inequality and segregation (Marcińczak et al. 2015) by emphasizing the importance of sociotechnical and infrastructural factors in driving a hitherto poorly recognized form of deprivation. Part of our analysis is developed in relation to existing scholarship on postcommunist cities, which, we argue, needs to incorporate energy-related sociospatial inequalities in its understanding of processes of intraurban differentiation. Within this broad purpose, the article aims to investigate (1) the relationship between neighborhood trajectories and energy poverty; (2) the energy-related strategies used by affected households; and (3) the social, demographic, and housing characteristics of groups vulnerable to the condition.

The next section of the article critically reviews some of the key debates at the nexus of contemporary energy and urban transformations—especially with reference to postcommunist urban differentiation. We then turn to the specific context of the background research that led to this article, via a description of its methodological approach and case study areas. The three sections that follow then report and discuss the outcomes of our analyses as they relate to aspects identified in the aims of the article: neighborhood typologies, household strategies, and vulnerable groups. The empirical explorations undertaken in these sections are used to draw broader arguments about the nature of energy poverty and vulnerability in the grain of the city. The conclusion of the article synthesizes these arguments into a typology that superimposes energy deprivation onto existing conceptualizations of neighborhood change and urban sociospatial inequality.

Understanding Energy Vulnerability: Social Inequality, Infrastructure, and Residential Transformations in Postcommunism

Domestic energy deprivation across the world has commonly been recognized via terms such as fuel poverty and energy poverty and, to a lesser extent, by cold homes (Boardman 1991), energy precariousness (Dubois and Meier 2014), and energy insecurity (Hernández 2013). Such forms of hardship are generally understood as the inability to secure a socially and materially necessitated level of energy services in the home (Bouzarovski and Petrova 2015). Scholarship on the subject does not treat energy poverty as a subset of income poverty; because incomes are only one of the factors that contribute to energy poverty, households that are nonincome poor might also find themselves facing domestic energy deprivation, and vice versa (Buzar 2007; Boardman 2013). The enforced lack of energy services is central to this condition, thus shifting scientific and policy attention away from the supply of raw fuels onto the end-use benefits (e.g., space heating and cooling, lighting, or information technology) that allow consumers to meet their everyday energy needs (Bazilian et al. 2012). At the same time, the entrance of vulnerability thinking into the theorization of domestic energy deprivation has been motivated by the realization that the lack of energy services is temporally and spatially variable—households might come in and out of energy poverty as their income changes, and the quality of energy services differs from one home to the next due to socioeconomic and technical factors. Energy vulnerability, therefore, serves to highlight the underlying factors that lead to energy poverty, by encapsulating the risk factors that contribute to the precariousness of particular spaces and groups of people (Bouzarovski and Petrova 2015). It foregrounds the existence of systemic inequalities present throughout the energy chain (Chapman 1989) involved in the delivery of energy services to the home, from the policies that govern energy recovery to the framing of vulnerable groups within particular material and institutional settings.

The driving forces of energy vulnerability are region and place specific. In developing countries, energy vulnerability is embedded in the absence of adequate technical infrastructures for the delivery of energy services in line with modern technological and environmental standards. The poor energy efficiency of housing, heating, and appliance stocks is a key factor in developed countries, as it forces households to purchase more expensive final services. Decreasing household incomes and rising energy prices play a role at the global scale, as does the inability of households to access or switch to energy services that are appropriate to their needs. Overall, energy vulnerability can be seen as the outcome of wider dynamics of injustice, encompassing the distribution of economic resources as well as political relations of recognition and procedure (Walker and Day 2012). At the same time, a distinct body of research has connected urban social injustices to the everyday experience and practice of urban infrastructure, initially via work on water and sanitation (Swyngedouw and Heynen 2003; McFarlane and Rutherford 2008) and more recently by focusing on the coconstitution of "city and citizenship through the grid" (Luque-Ayala and Silver 2016, 2). These two bodies of work, however, have rarely communicated with each other, resulting in the relative marginalization of the urban injustices that produce energy poverty. Although the generic features that lead to this condition are well known, the driving forces and patterns that characterize its granularity within particular groups and places—and the broader consequences of resulting spatial variations—have received comparatively little attention beyond the UK, Irish, and French contexts.

Energy-related vulnerabilities and injustices are also present in the ECE region, where they have been shaped by the systemic legacies of communist central planning, as well as the multiple restructuring processes undertaken since the late 1980s and early 1990s. The principal outcome of these reconfigurations has been the upward rebalancing of energy tariffs via significant energy price increases, without corresponding social welfare safety nets or energy-efficiency mechanisms. This gap has been further exacerbated by the predominance of an unsustainable supply mix—fossil fuels have been overrepresented in final demand—and the inflexibilities associated with district heating networks, which are otherwise widespread in the region due to the development policies pursued by communist planners (Ürge-Vorsatz, Miladinova, and Paizs 2006; Bradshaw 2010).

In examining postcommunist energy vulnerability, it is essential to acknowledge the specific sociospatial transformations found in ECE countries, while also recognizing that restructuring dynamics have not been uniform across the region. There is evidence to suggest that the energy-related difficulties experienced by ECE households are embedded in dynamics of urban change and policies in the housing sector. Urban areas have been important centers of economic, social, and political reform during the past twenty-five years, with the physical impacts of neoliberalization discernible in capital cities and other large metropolitan areas in the region. Most notably, the restructuring of state-owned assets in the housing domain has exerted important impacts on city neighborhoods and urban zones (Sýkora and Bouzarovski 2012). Significant changes have occurred to housing allocation as a direct result of policies that aim to introduce conditions for a market-driven housing supply (Sýkora 1999). Market-based housing policies assume that it is natural for housing to be differentiated according to desires, preference, and financial capabilities, resulting in rapidly increasing sociospatial disparities.

The widespread privatization of housing in postcommunist countries led to the dominance of owner occupation, which in turn caused housing to become a costly economic commodity and initiated housing affordability problems (Lux and Sunega 2012). Relevant to privatization is the issue of restitution of private property, whereby nationalized properties are returned to their previous owners or descendants. This has been a highly uneven, controversial, and complex process in postcommunist countries, partly because it raises questions about the extent of national government responsibilities for the actions taken by their predecessors, as well as more generic issues of social justice. Households that benefited from housing privatization in the early 1990s found themselves in a much better position than those that started their careers in later phases of the transition process (Cirman, Mandič, and Zorić 2013). Models of housing privatization have also influenced the postcommunist renovation of inner-city properties, which were in poor condition in the early 1990s due to decades of disinvestment (Sýkora and Bouzarovski 2012).

An inherent feature of communist cities was the lack of urban services and limited commercial spaces, with an emphasis on using land for industrial purposes (Hirt 2008). Postcommunist transformations have resulted in significant changes to land use and a commercialization of the built fabric to accommodate a market-based economy driven by consumerism. Although the adjustment of urban land use patterns is still ongoing, evidence suggests that the replacement of housing by offices and shops has reduced the proportion of less affluent households residing in attractive city locations. Additional land use changes have occurred in the form of periurban growth and suburbanization, in which affluent households relocate from the central city to its suburban periphery in search of a higher quality of life (Stanilov and Sýkora 2014). This represents a significant departure from the communist past, in which cities were more compact than capitalist Western equivalents, with a preference for high-density housing districts.

At the same time, the social vulnerability of citizens in postcommunist countries—that is to say, their (in)ability to respond to multiple external stressors—has increased considerably over the past two decades due to a range of factors. The end of communism initiated rapid and substantial dynamics of economic restructuring, as well as a deep economic recession, creating a loss of real income for many households. Economic changes induced growing wage and income disparities, in line with the neoliberal preference for income differentiation. Although social security systems mitigated some of the subsequent social hardship, they could not prevent the rise of social differentiation among households. Poverty became increasingly visible in ECE cities, with income disparities reflected in the emergence of new enclaves of affluence and exclusion (Kovács 2012), even if socioeconomic segregation has not exhibited dramatic increases (Marcińczak et al. 2015). A further layer of complexity stems from the fact that utility privatization processes and the end of state-regulated prices have also driven social stratification (Sailer-Fliege 1999; Hirt 2008) and subsequent asymmetrical access to resources.

Inequalities in the distribution of urban amenities have combined with socioeconomic disparities to create distinctive geographies of segregation. The spatial evolution of intra- and interurban divides in ECE is relatively well researched, even if much of the scholarship in this domain has been focused on large cities in "fast-reforming" central European and Baltic countries (Sỳkora 2009; Kovács and Hegedűs 2014). Processes unfolding in the former Soviet Union, southeastern Europe, and medium-sized cities across ECE have received comparatively less attention (but see Gentile 2003; Hirt and Stanilov 2007; Pojani 2010; Petrova et al. 2013). Postsocialist segregation scholarship as a whole, though, has been mainly concerned with the historical embeddedness, temporal trajectories, and spatial features of residential variations in the socioeconomic characteristics of urban populations. Although the housing sector has been an important element of this debate, its role in shaping patterns of segregation has rarely been considered beyond issues of privatization and rent. There has been limited discussion of the manner in which differences in access to, and the consumption of, housing resources intersect with the multidimensionalities of human well-being as they relate to patterns and experiences of material deprivation.

To summarize, understanding urban energy vulnerability in ECE requires overcoming the present fragmentation of theoretical insights on processes of energy transformation, social inequality, and spatial differentiation within the grain of the city. These knowledge gaps do not concern only the postcommunist space—as demonstrated by the lack of integrated conceptual and empirical work on the topic—but also extend to wider understandings of the spatial relationship between energy justice and urban sociotechnical networks. There is a need, therefore, to determine how the amalgamation of household characteristics, consumption patterns, and access to networked infrastructure services—factors involved in the production of energy poverty—has produced distinct development trajectories and profiles at the neighborhood scale. In developing a conceptual framework to examine such issues, we take our cue from approaches that have sought to highlight common traits arising from the "bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses" (Galster 2001, 2111). This leads us to emphasize the multidimensional typologies associated with neighborhood change (Holloway, Wright, and Ellis 2012; Hincks 2015) but with an incorporation of energy poverty issues in addition to the socioeconomic and housing features of the population. We see energy-related material deprivation as an integral component of intraurban differences, moving beyond the presently dominant scholarly focus on mental and physical health (a discussion of which would extend beyond the remit of this article, but see Booth, Pinkston, and Poston 2005) to incorporate the material inability to access adequate sociotechnical services in the home.

Methods, Data, and Study Areas

The evidence analyzed in this article is based on a comparative neighborhood-level study based in four cities: Gdańsk (Poland), Prague (Czech Republic), Budapest (Hungary), and Skopje (Macedonia). Our selection of case study cities and countries was motivated, in part, by the state of knowledge on postcommunist urban transformations described in the previous section, particularly the relative marginalization of second-order cities (hence the choice of Gdańsk) and the lack of research beyond central Europe (explaining the selection of Skopje). At the same time, we aimed to compare cities for which recent sociospatial transformations have received limited scholarly attention (i.e., Skopje and Gdańsk) with those that are in the scientific mainstream on the subject (Prague and Budapest). We also wished to ensure a wide geographical spread in terms of building types, urban morphologies, and climatic conditions. In each city, the research focused on two neighborhoods: a historic inner-city district containing relatively dense multistory tenement buildings of different ages, on the one hand, and a less central area with a mix of housing estates built from the 1960s onward (sometimes adjoining individual family homes that generally predate the socialist period), on the other, thus including a variety of building typologies. In the remainder of the article, the case study neighborhoods have been assigned a three-letter code that ends with A if the given district is in the inner city and B if it is more peripheral. The first two letters of the code correspond to the study city: GD for Gdansk, BU for Budapest, PR for Prague, and SK for Skopje (see Figure 1).

The study areas embody a wide range of layers from the medieval kingdoms and empires that dominated this part of the world until the nineteenth century—Austro-Hungarian, German, and Ottoman—and were superseded by built tissues created by independent nation states under capitalist and socialist regimes during the twentieth century. Their host countries are characterized by divergent economic, political, and infrastructural circumstances. Poland has historically had high levels of income poverty and a relatively polarized housing sector, even if it has been a postcommunist forerunner in terms of undertaking neoliberal reforms in the electricity sector. The Czech Republic features comparatively high levels of gross domestic product per capita and low levels of income inequality, although its electricity sector remains monopolized by a large state-owned company (International Energy Agency 2010). Hungary has demonstrated a limited regulatory capacity to support households vulnerable to energy price increases, in addition to recording above-average income poverty rates (Tirado Herrero and Ürge-Vorsatz 2012). Macedonia is still part of the EU accession process, unlike the other three countries, which have part of the EU since 2004, having been generally characterized by a lower level of economic development and a more liberal economic regime during communist central planning. The EU has also influenced regulatory practices in the Czech Republic, Hungary, and Poland, where the process of implementing the basic principles of neoliberal energy restructuring has largely been completed: The electricity and gas sectors of the three countries are institutionally and functionally unbundled, and market competition is present in nearly all aspects of utility operation. The state retains a dominant role in the Czech electricity sector, however, and the Órban government in Hungary has recently taken a series of steps to reverse earlier trends of energy sector privatization. Macedonia is a distinct case in this regard, as it remains only partially in fulfillment of EU regulatory expectations in the energy sector, despite having been one of the first countries of the region to privatize electricity distribution (Energy Community Secretariat 2016).

To capture diverse spatial and social circumstances within the four target countries, we drew data from documentary evidence in the secondary literature, as well as a questionnaire survey that was carried out in the study cities between February and April 2015, involving a total of 521 households in Budapest, 598 in Gdańsk, 620 in Prague, and 598 in Skopje. The implementation of a neighborhood survey was necessitated by the lack of locally specific statistical data on energy-relevant household characteristics. The survey was aimed at establishing the social, spatial, and demographic underpinnings of energy vulnerability, its implications for the conduct of everyday life, and the nature of social attitudes toward energy and housing reforms. It included a wide variety of questions and indicators (see Table 1) that are commonly used in international comparisons on energy poverty (Thomson and Snell 2013; Bouzarovski and Simcock 2017; Thomson, Bouzarovski, and Snell 2017). We also consulted the secondary literature to consider a diverse range of sociodemographic strata and domestic energy circumstances. The surface areas of the case study districts varied from 6.4 to 15.2 km^2, with total population sizes ranging between approximately 10,000 and 20,000 people. Documentary evidence also showed that all case study areas occupied relatively similar positions in local housing markets. At the same time, the survey showed important differences in the dwelling profiles of households in the sample, both within and across sample cities (Table 2). There was notable variation in the proportion of owner occupation, the average size of dwellings, and the proportion of households that have lived in their current home for twenty years or more. Although divergence in the shares of people in full employment was less stark, the percentage of residents with completed higher education ranged from 25 percent in GDA to 70 per cent in SKA.

One of our Budapest case study districts was Józsefváros (also known as District VIII and coded as BUA for the purposes of this study), a dense inner-city quarter mostly composed of multifamily residential buildings built before World War II (*bérlakás*), although large postwar socialist prefabricated residential buildings are also present. Despite its complex social structure, Józsefváros has been considered one of the poorest districts, although it also contains some high-income areas currently subject to gentrification. A significant share of the population is Roma. The other Budapest case study area was Kispest (District XIX, coded as BUB), a suburban district at the south edge of the city with good public transport connections. It is almost entirely composed of two building typologies: single-family houses and prefabricated

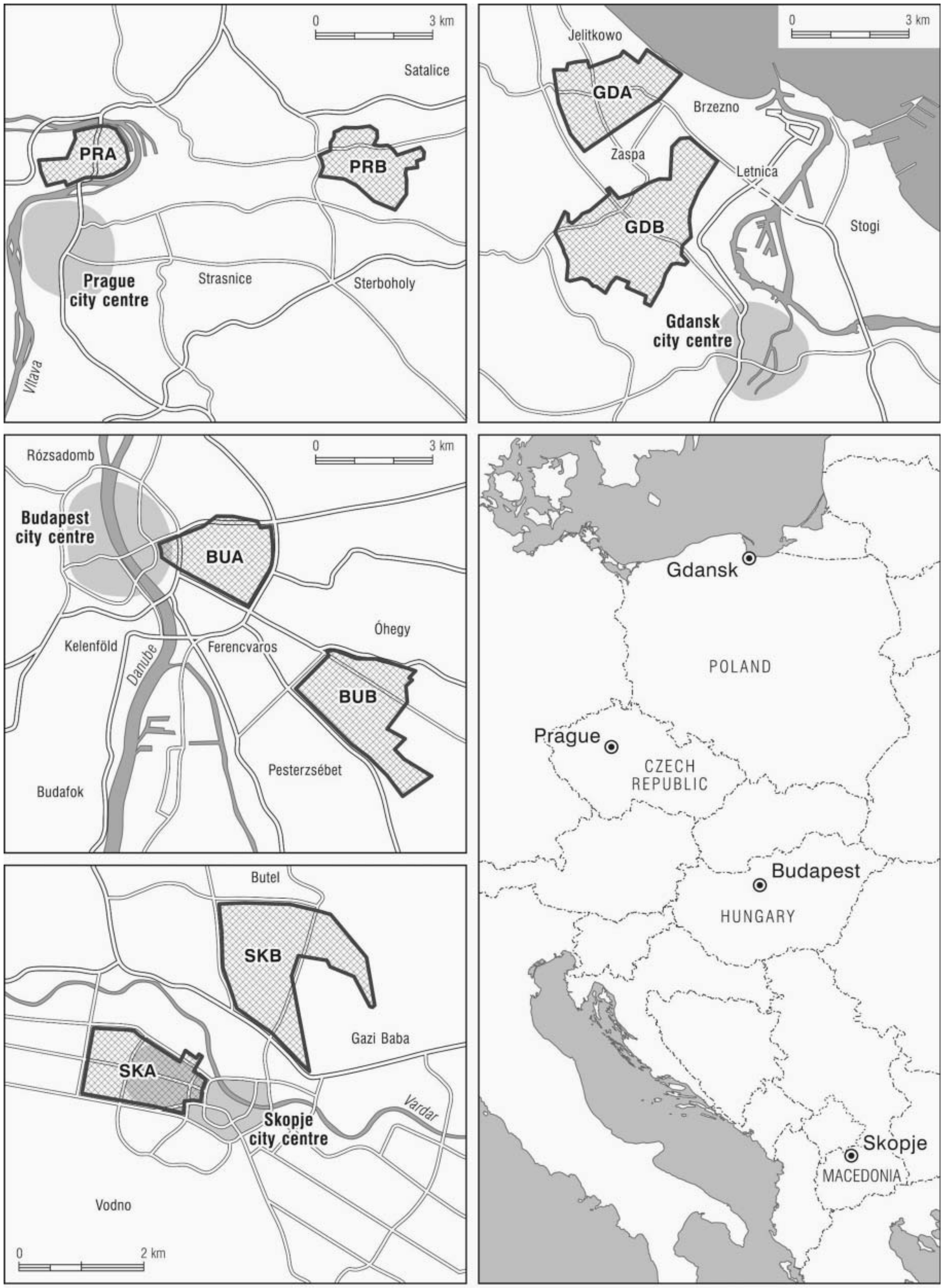

Figure 1. Map indicating the locations of case study cities and areas. BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba.

socialist housing estates from the 1980s. With a total of 12,100 apartments, the Kispest prefabricated housing state (*lakótelep*) is the sixth largest in Budapest (Kovács 2012).

In Gdańsk, our survey was focused on the district of Wrzeszcz (code: GDA). This area lies north of the medieval core of the city and thus contains a mix of housing types, primarily individual family homes and tenement blocks constructed in the second half of the nineteenth century. There are some apartment buildings from the communist era along some of the principal road arteries, in addition to commercial, office, and housing developments constructed after 1990. Having received very little investment during

Table 1. List of indicators that were used in analyses

Indicator category	Name and description	Coding
Expenditure-related indicators	ENER_COSTS: Average monthly share of energy costs (electricity, gas, and heating bills, etc.) in total household income	1 = Less than 10% 2 = 10–20% . . . 6 = More than 50%
	ENERbin20: Household spending 20% or more of income on energy costs	1 = Yes 0 = No
	DH_DISC: Household has been disconnected from the district heating network	1 = Yes 0 = No
	ELEC_DISC: Household has been disconnected from electricity or gas network	1 = Yes 0 = No
	ARREARS: Household not able to pay energy bills on time	1 = Yes 0 = No
	AFFORD: Household cannot afford to keep home adequately warm	1 = Yes 0 = No
	FOOD: Household has cut back on food WATER: Household has cut back on water heating LIGHT: Household has cut back on lighting APPL: Household has cut back on appliance use MEDIC: Household has cut back on other basic expenses (e.g., medicine, clothes)	1 = Yes 0 = No
Self-reported objective housing indicator	COND: Condensation on windows and walls during winter	1 = Yes 0 = No
	DAMP: Dampness on the walls or floors	1 = Yes 0 = No
	MOLD: Mold in home	1 = Yes 0 = No
	LEAK: Home has a leaking roof	1 = Yes 0 = No
Self-reported subjective energy indicators	WARM: Dwelling not comfortably warm during winter	1 = Yes 0 = No
	COOL: Dwelling not comfortably cool during summer	1 = Yes 0 = No
	DAY: Home is generally not heated throughout the day when it is cold outside	1 = Yes 0 = No

(*Continued on next page*)

Table 1. List of indicators that were used in analyses *(Continued)*

Indicator category	Name and description	Coding
Other relevant housing and sociodemographic indicators	OWNER: Own home	1 = Yes
	RENTER: Rent home	0 = No
	MOVE: When household moved in	1 = During the last 5 years 2 = 5–10 years ago 3 = 10–20 years ago 4 = More than 20 years ago
	SQM: Dwelling area of home in square meters	
	ROOMS: Number of rooms in home (excluding bathrooms)	
	SIZE: Number of people in household	
	AGE: Age of respondent in years	
	DHeating: Household uses district heating as main heating method	1 = Yes 0 = No
	EEINDEX: Index of energy efficiency that counts the number of measures installed in the home from the following list: new windows; new heating system; additional insulation; solar thermal panels; energy-efficient appliances.	Possible answers range from 0 (*no measures installed*) through to 5 (*all measures installed*)
	EDUC3: Three-level education variable	1 = Primary 2 = Secondary 3 = Tertiary
	FTWORK: At least one full-time worker in the household	1 = Yes 0 = No
	INC: Net monthly household income	Income bands vary by country according to income trends
	INCbin: Household has above median income	1 = Yes 0 = No
	CHILDHH: Household contains children	1 = Yes
	PENSonly: Pensioner-only household	0 = No
	UNDEROCCUPY: Underoccupancy, measured using standard methodology, where underoccupancy is defined as occurring when rooms = > number of people	1 = Yes 0 = No

communism, the neighborhood has seen intense dynamics of gentrification and residential upgrading during the past twenty years. The other Gdańsk study area was Przymorze, a large housing estate in the northern part of the city (coded as GDB). The area consists entirely of prefabricated panel housing estates constructed between 1960 and 1980, although new housing developments—primarily apartments, even if there have been some houses as well—have also been built during the last twenty years. Although there are several different types of blocks in the area, Przymorze is best known for the *falowiec* buildings, multistory apartment buildings that reach 1 km in length. District heating plays an important role in the local energy mix (Bouzarovski 2015).

In Prague, we focused on Holešovice (also known as Prague 7, code PRA), an inner-city quarter north of the city center, which has historically been considered relatively low income but has experienced revitalization and gentrification in recent years. Increasing rents

Table 2. Principal features of the case study areas as established by the authors' household survey

City	Budapest		Gdańsk		Prague		Skopje	
District	VIII	XIX	Wrzeszcz	Przymorze	7	14	Bunjakovec/ Debar Maalo	Chair, Skopje Sever, Zhelezara
Code used in text	BUA	BUB	GDA	GDB	PRA	PRB	SKA	SKB
Sample size	293	228	298	300	317	303	300	300
Sampling ratio (*n*th term)	148	91	175	159	142	152	128	134
Response rate (%)	21.3	28.5	40.0	40.0	10.5	8.9	54.2	50.8
Average size of dwelling (m^2)	59.5	69.1	52.8	56.0	79.6 (82.9)	79.6 (91.1)	78.3	104.5
Average number of rooms per dwelling	2.3	3.6	2.9	2.9	3.1 (3.1)	3.5 (3.8)	3.5	3.3
Average household size	2.6	2.6	2.5	2.6	2.4 (2.7)	2.6 (3.0)	3.1	4.3
Owner occupancy rate (%)	60.4	82.0	37.7	50.7	45.4 (58.7)	52.8 (64.7)	90.3	95.0
Residency $\leq$ 20 years (%)	71.7	49.1	50.7	53.3	33.1 (47.1)	43.2 (52.6)	45.4	29.4
Residency $\geq$ 20 years (%)	27.3	50.9	48.3	45.0	66.9 (52.9)	56.4 (47.1)	54.3	69.6
Residents with a tertiary education (%)	45.7	43.9	24.6	36.0	51.1 (54.6)	42.3 (49.5)	70.2	40.8
Share of households with at least one resident in full-time employment (%)	58.7	62.7	67.0	64.3	59.0 (79.2)	63.0 (80.6)	71.2	58.9
Heating degree days	2,856		4,004		3,431		2,646	
Cooling degree days	260		12		67		346	

Note: Figures in brackets for Prague refer to post hoc weighted results. BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba. Source for heating and cooling degree data: Boerman and Petersdorf (2007).

in the relatively old housing stock are placing pressure on the aging local population. The neighborhood consists almost entirely of multistory tenement buildings constructed in the late nineteenth and early twentieth centuries. The entire district lies on a bend of the Vltava River, which makes it difficult to reach by foot from the city center; at the same time, the dense concentration of railway infrastructure cuts the district in two and hampers communication links. The second case study area in Prague included the district of Černý Most and parts of Hloubětín (Prague 14, code PRB), two diverse neighborhoods at the eastern edge of the city. The territory primarily consists of housing estates built between the 1960s and 1990s, as well as some new residential developments combined with old rural settlements that were added to Prague. There are many municipal flats in the area. District heating use is widespread, similar to Przymorze. Concentrations of socially excluded or vulnerable populations can be found in the Lehovec housing estate, which, inter alia, contains above-average numbers of Roma (Kostelecký and Vobecká 2017).

As for Skopje, the survey took place in Debar Maalo and Bunjakovec, an inner-city area to the west of the city center (code: SKA). These two quarters primarily consist of individual family housing and small apartment blocks constructed during the first half of the twentieth century and the 1950s, although buildings from the late nineteenth century and several 1960s blocks can also be found here. Having been neglected during communist central planning, the district has recently seen intense dynamics of gentrification and densification. These processes have resulted in the replacement of small-scale historical buildings with large housing developments and apartment blocks. The second Skopje study area encompassed parts of the neighborhoods of Chair, Skopje Sever, and Gazi Baba (code: SKB). Most of the population in the area lives in prefabricated panel housing estates built between the 1970s and 1980s, although there are also some row-house-type family homes constructed largely in an informal manner (and sometimes incorporating elements of built tissues that are several centuries old). There is also some modern individual family housing in the north part of the area. This part of Skopje concentrates above-average shares of low-income and ethnic minority populations (Bouzarovski 2011).

A quasi-random and systematic sample was derived for each case study area. The sampling frames were developed using population registers from local census data, in a two-stage process. We first calculated the sampling ratio, based on the numbers of households in each district and our desired sample sizes (see Table 2); we then divided the case study areas into smaller areas, or stratums, from which random samples were drawn. This method of stratification ensured a good geographical spread and coverage of different housing styles. In Budapest, Gdansk, and Skopje, trained interviewers surveyed respondents aged 18 years old and above using face-to-face methods, resulting in moderate to high response rates (40 percent in Poland, 64 percent in Macedonia, and 35 percent in Hungary). Respondents from each household were selected on the next birthday basis. Pilot and focus group work with local experts prior to the survey indicated that we would face significant nonresponse issues throughout all Prague districts, due to survey fatigue as well as safety fears associated with door-to-door cold calling. To address this, information about the survey was distributed via local media and municipal authorities, in line with methodologies outlined in Buzar et al. (2007). Moreover, we did not include any references to the phrase "energy poverty" in the survey questionnaire, as pilot work indicated that this would have a significant impact on the rate and type of responses.[1] The questionnaire included a total of twenty-eight questions, taking on average fifteen minutes to complete. Most of the questions were derived from existing scientific knowledge on the subject, which meant that they were focused on the indicators and strategies associated with energy poverty (see Table 1).

Due to an initially low response rate to face-to-face surveying in Prague (only ninety-eight collected questionnaires from 2,000 attempts to survey at the doorstep), we relied on the assistance of a professional survey company to conduct computer-assisted telephone interviewing (CATI). Using a database of official landline telephone numbers and mobile numbers for the two neighborhoods, households were contacted using the random-digit dialing method (for landline numbers) and random number selection (from the list of mobile numbers) until the target number of questionnaires was collected, resulting in a response rate of 10 percent across the two neighborhoods in the Czech Republic. The large sample size achieved in Prague during the second round of data collection using CATI prompted us to retain the CATI data for the analyses that follow, even if the results need to be interpreted with caution due to issues surrounding differences in collection methods, low response rates, and potential nonresponse bias (Sivo et al. 2006). To minimize nonresponse error within the Prague sample, we used two post hoc strategies: First, we compared the results of our survey with existing statistics from official surveys and, second, where substantial differences were found, we made weighting adjustments to address the potential bias. Afterward, logistic regression models were employed alongside descriptive statistics to establish some of the key factors that are associated with energy vulnerability and their variation across the case study areas. The choice of predictors was informed by the energy poverty literature.

New Layers of Neighborhood Differentiation: Spatial Variations in Measures of Energy Affordability

A key indicator of energy vulnerability is the ratio of household income to energy costs, also understood as the energy burden or affordability ratio. High energy burdens are thought to signify increased levels of material deprivation in the home, as they point to the prioritization of energy over less essential costs. Households living in postcommunist countries have been experiencing energy burdens well above developed-world averages. Energy-related domestic costs have increased as a result of the systemic processes outlined in the introduction, particularly increases in electricity, gas, and district heating tariffs, in the first decade of movement toward a market economy. Growing income inequalities and rates of poverty per se have also had a powerful effect on the rise of energy burdens. Although there is evidence to suggest that more economically advanced ECE states have managed to stabilize such trends in recent years, the picture is far from uniform: Hungary has recorded dramatic increases in household energy costs and burdens during the past decade, reflecting the broader expansion of energy poverty in the country and resulting in a series of political and infrastructural configurations (Fellegi and Fulop 2012).

The survey results indicated that significant variations in energy burdens exist within and across the case study cities. We developed an approach that analyzes the distribution of energy burdens per net household income group across the eight case study areas, highlighting the proportion of households within each income band with different energy burdens. This provides insights into not only the hardship faced by low-income households but also broader processes of economic and spatial differentiation within the fabric of the city. Thus, it transpired that the majority of households in Budapest (77 percent in BUA, 71 percent in

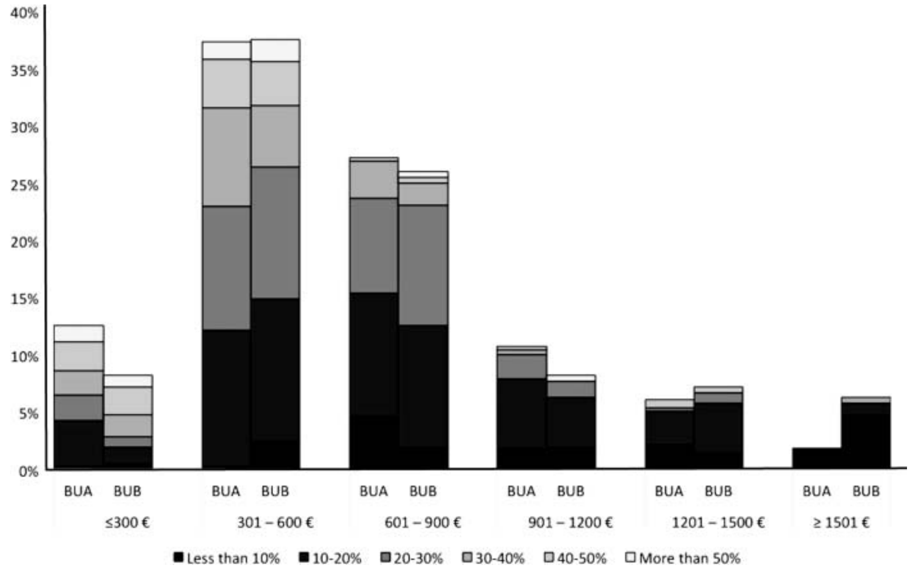

Figure 2. Distribution of energy burdens by income in Budapest (authors' own data). The overall height of each column indicates the proportion of households within the given income band.

BUB) had net monthly incomes below 900 Euro, lower than the mean figure reported by the Organization for Economic Cooperation and Development (OECD 2015), currently at 1,044 Euro (Figure 2). At the same time, although households with the lowest net incomes in both case study areas reported the highest energy burdens, it was notable that households in the BUB case study area with incomes less than 300 Euro were particularly vulnerable to high energy costs. A skewed distribution in favor of high energy burdens could also be seen in higher income households living in this district, possibly due to the existence of the "trapped in the heat" phenomenon described by Tirado-Herrero and Ürge-Vorsatz (2012); district heating coverage is more frequent in BUB compared to BUA.

Examining the distribution of net household incomes in Gdańsk indicated that the overwhelming majority of households have net total monthly incomes between approximately 300 and 1,200 Euro, just below the official OECD (2015) statistic at 1,340 Euro. Compared to GDA, the variation of incomes in GDB was more equalized and somewhat skewed toward the top end of the distribution (see Figure 3). It should be noted that GDA has traditionally

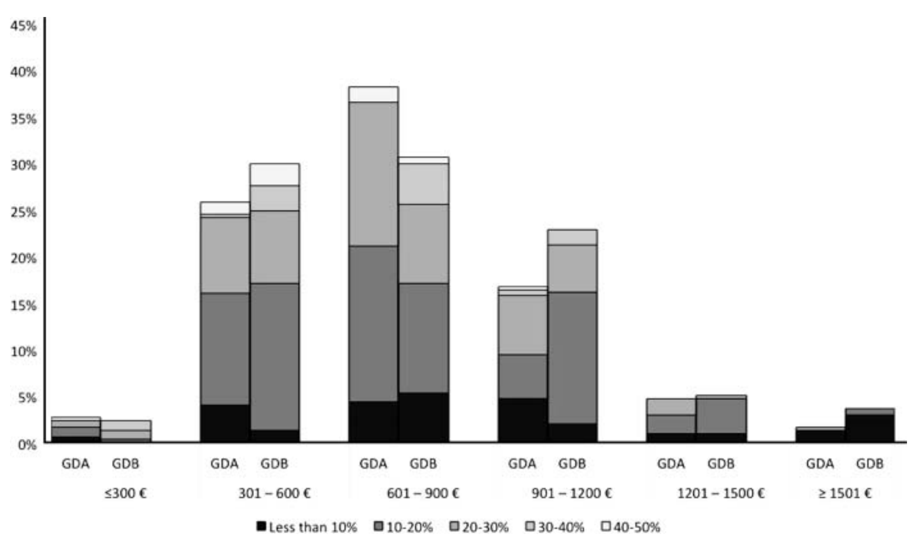

Figure 3. Distribution of energy burdens by income in Gdańsk (authors' own data). The overall height of each column indicates the proportion of households within the given income band. GDA = Wrzeszcz; GDB = Przymorze.

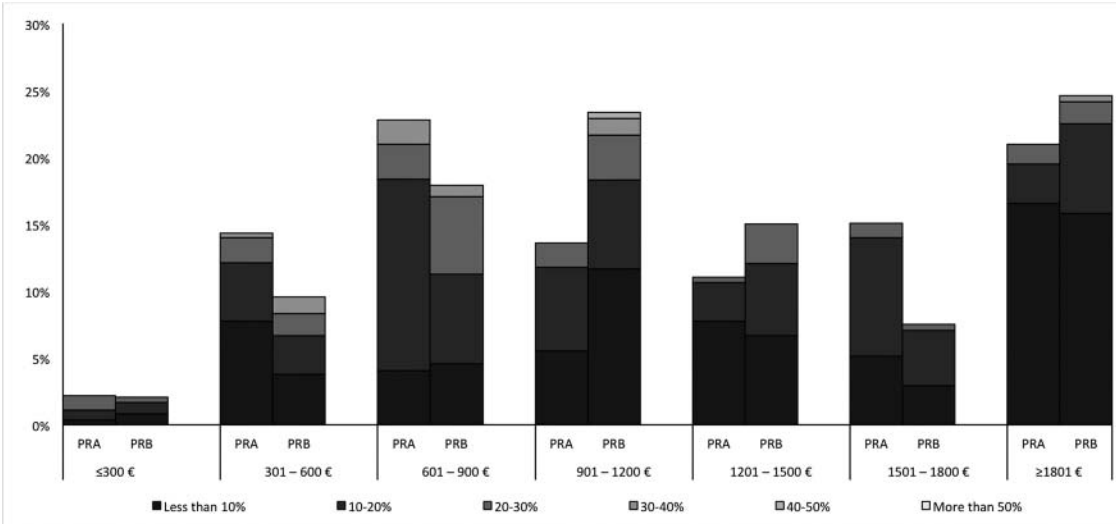

Figure 4. Distribution of energy burdens by income in Prague (authors' own data). The overall height of each column indicates the proportion of households within the given income band. PRA = Hloubětín; PRB = Holešovice.

concentrated lower income groups (particularly pensioners), despite recent processes of gentrification and residential upgrading. Once again, however, GDB households faced somewhat greater energy burdens than those living in GDA, an area where homeownership is more frequent and forms of residential energy supply are more diverse, including a combination of district heating, gas, coal, and oil.

Our Prague case study areas exhibited a different picture, particularly in energy burden terms. Expenditure on domestic energy was very low as a proportion of net income (as reflected in the prevalence of dark grays in Figure 4). High energy burdens were relatively evenly distributed across all income bands, although low- and middle-income households still faced the most difficult circumstances. The distribution of incomes was much less polarized compared to the other study cities, particularly in the housing estates encompassed by the PRB case study area. Income levels in PRA indicated a relative absence of middle-income strata: The share of households in the 900 to 1,200 Euro income band was among the smallest within the entire sample (the national average for the Czech Republic is 1,392 Euro; OECD 2015). Reflecting PRA's background as an inner-city district with historically high levels of deprivation, lower income groups were represented to a more significant degree in PRA, whereas PRB had a higher share of middle- and higher income groups.

The proportion of net income dedicated to energy costs in the Skopje case study areas (see Figure 5) was slightly higher than in Gdańsk and Prague, although similarities can be found with the Budapest results. Approximately 36 and 60 percent of households in SKA and SKB, respectively, had total incomes below 600 Euro, against a national mean of 487 Euro per month (Republic of Macedonia State Statistical Office 2015). Although the modal energy burden category in both areas was in the 10 to 20 percent band, a significant proportion of households in both SKA and SKB spent 40 percent or more of their incomes on energy. In SKB, the share of households with high energy burdens was elevated in the group of households with monthly incomes between 600 and 900 Euro, indicating that low-income strata might be underconsuming energy to prioritize other costs. There was a marked contrast in the income distributions of households in the two case study areas, with SKB faring much worse in this regard.

In addition to the affordability ratio, the presence of energy poverty is commonly detected via the self-reported inability to afford adequate levels of warmth in the home (Thomson and Snell 2013). The financially enforced lack of access to necessary levels of domestic heating was particularly pronounced in SKB, affecting nearly two thirds of households in the area (see the *y* axis in Figure 6). SKB was closely followed by SKA and the two Budapest case study districts in this regard, which points to the possible existence of causal links between poor housing and energy conditions, highlighting the role of wider national contexts in determining the driving forces of domestic energy deprivation. A typology of the eight study districts starts to emerge when the affordability metric is compared with

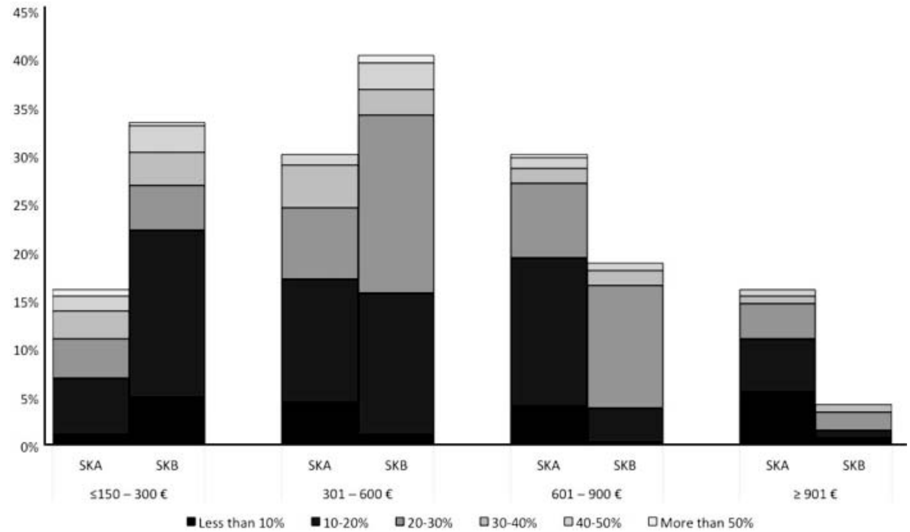

Figure 5. Distribution of energy burdens by income in Skopje (authors' own data). The overall height of each column indicates the proportion of households within the given income band. SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba.

variations in the share of households experiencing disproportionately high energy burdens (Figure 6). The existence of significant differences between SKA and SKB suggests potentially very high intraurban inequalities in that city (further confirmed by Macedonia's Gini coefficient, which is presently among the highest in Europe and has risen at a record pace during the past twenty years; see Hu, Lenthe, and Mackenbach 2015). With the notable exception of Skopje, all of our inner-city case study areas exhibited higher shares of households reporting that they cannot afford to keep the home adequately warm; the same was also true for Budapest and Gdańsk in the case of high energy burdens. At the same time, only 16 and 33 percent of households in SKA and SKB had incomes lower than two thirds of the national mean, indicating that energy poverty could potentially be higher in other parts of the country (the analogous income ratios were much higher in all other case study cities).

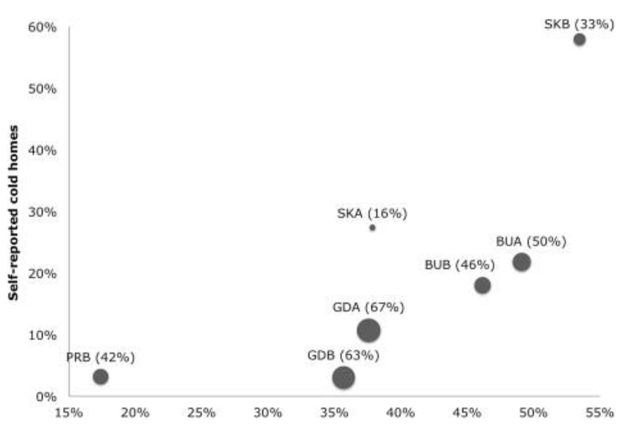

Figure 6. Shares of households that stated that they were unable to keep the home warm versus those with disproportionately high energy burdens (i.e., more than 20 percent of income). Data point diameters are proportional to the share of households with incomes lower than two thirds of the national mean (corresponding figures are indicated in parentheses next to the case study area codes). *Source:* Based on authors' own data and World Bank databases. BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba.

Linking Buildings and People: Energy Vulnerability–Related Symptoms and Practices

The presence of energy poverty and vulnerability can also be determined using self-reported information about the housing circumstances in the home, or the subjective perceptions of achieved levels of thermal comfort. Such consensual measures have now become a common method of capturing the extent of domestic energy deprivation across a variety of contexts. Despite being culturally and socially determined (Healy 2004; Petrova et al. 2013)—which adds a layer of complexity to comparisons between different places and people—these indicators can provide valuable insights into the driving forces and experiences of energy poverty and the strategies that households use to address the condition.

In terms of objective indicators, surveyed households were asked four questions relating to the condition of their home, focusing on the presence of mold

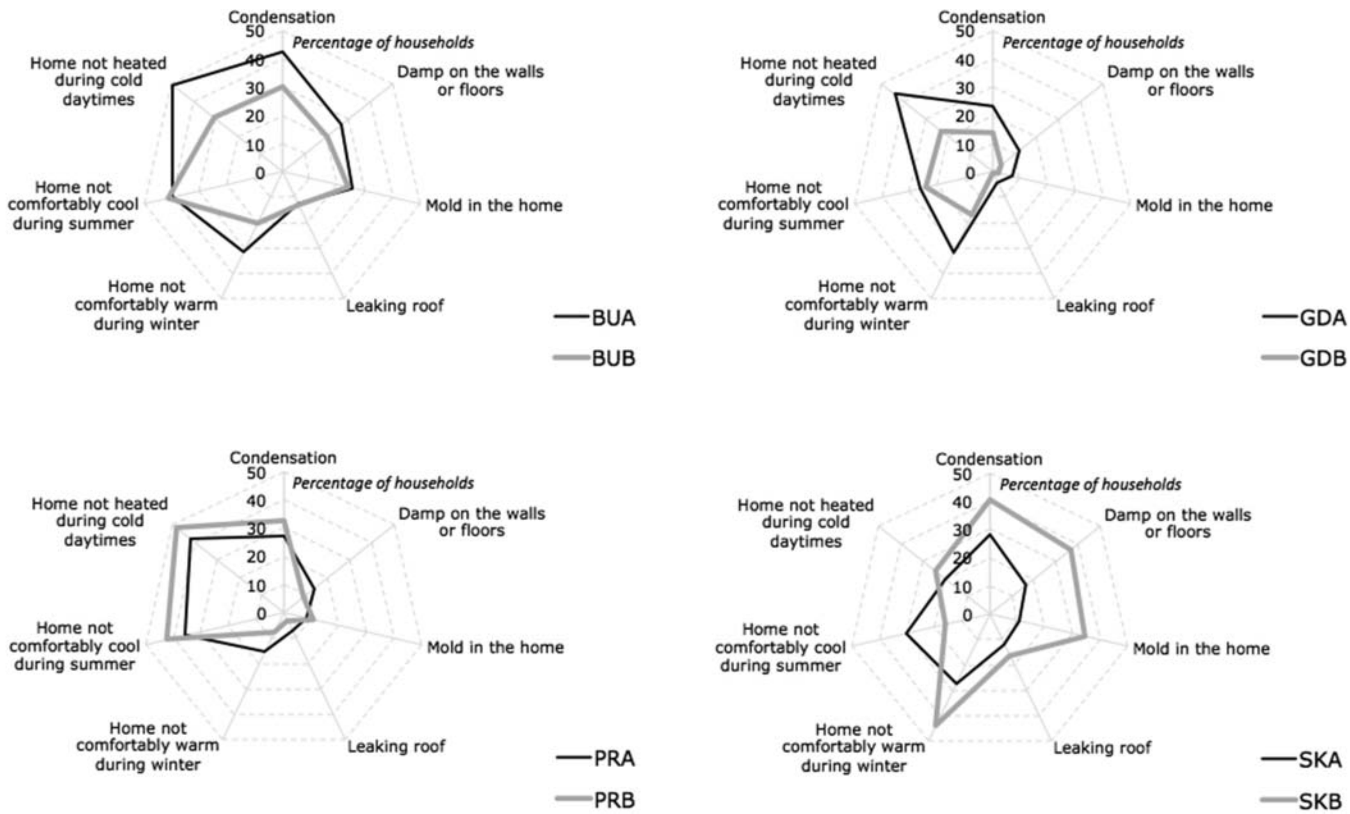

Figure 7. Selected energy poverty–related housing symptoms in the eight study areas, expressed as a percentage of all households in the given area (authors' own data). BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba.

and different forms of moisture. All of these can be seen as indirect proxies of the quality of housing structures and living conditions; for example, condensation on windows is more likely to form if the home is poorly heated, and a leaking roof is a sign of poor thermal insulation (even if the indicators themselves also point to other types of housing deficiencies). In the survey results, condensation on walls and windows emerged as the most reported indicator in all four study cities (Figure 7). Such issues were most prevalent in Budapest and Skopje, with just over 40 percent of households in BUA and SKB reporting condensation problems. Dampness on the walls or floors was the second most frequently reported indicator across all case study areas, with the exception of the panel housing–dominated districts of BUB and PRB, where mold was more common. All four indicators reached high values across the four Budapest and Skopje study areas, which suggests that their residents live in poor housing in addition to facing energy expenditure problems.

Respondents were also asked questions about the extent to which their homes were comfortably warm or cool (Figure 7). Overall, a substantial proportion of households across all case study areas reported thermal comfort issues. The incidence of these difficulties was significantly higher than that of the humidity, dampness, water, and mold-related problems previously described. Somewhat surprising, given the complete lack of research on the subject, the most commonly reported indicator across three of the case study areas was the inability to maintain adequate cooling during the summer, with the highest overall incidence reported in districts dominated by high-rise blocks of apartments (PRB and BUB) regardless of the significant differences in climatic conditions described in Table 1. Across the remaining five case study areas, not heating the home throughout cold days was a common practice in inner-city areas such as BUA and GDA.

In addition to decreasing the heating and cooling of their homes, households employed a variety of practices to maintain the affordability of domestic energy services (Figure 8). This included cutting back on lighting, appliance use, and water heating. More worryingly, numerous households also reported reducing their food consumption and other basic expenses, such as medicines. The vulnerability of Skopje and

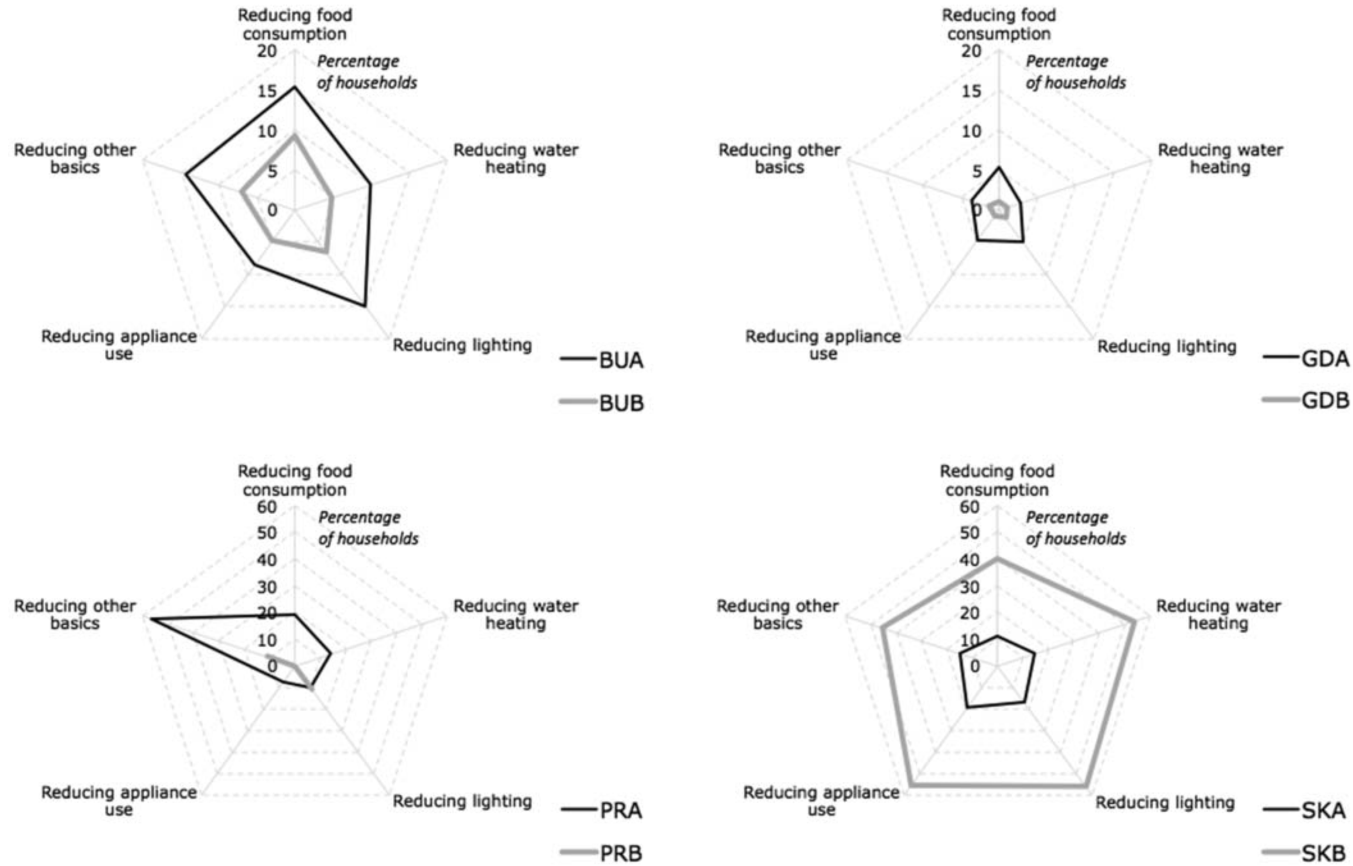

Figure 8. Selected energy vulnerability–related household strategies in the eight study areas, expressed as a percentage of households that stated that they could not afford to keep their home adequately warm in the given area (authors' own data). BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba.

Budapest residents to energy poverty is particularly indicated by the increased incidence of households who cut back energy consumption (Figure 8). It is worth noting that one of the Prague case study areas was not immune to the reduction of basic necessities despite higher income levels.

The comparative distribution of energy poverty impacts and coping strategies in the eight case study areas further elucidates the wider material deprivation patterns associated with this type of infrastructural vulnerability. Inner-city areas in both Budapest and Gdańsk exhibited higher frequencies of energy poverty symptoms, with BUA being particularly hard hit (Figure 7). The greatest share of households experiencing such circumstances was found in SKB; in the previous section, residents of this area were shown to struggle with unaffordable warmth to a much greater extent than any of the other surveyed districts. A common feature of the profiles of neighborhoods with high energy poverty rates was the disproportionately high frequency of housing faults: condensation, dampness, and mold. Heightened everyday household responses to energy poverty were much more common in the two Skopje case study districts (Figure 8), however. In the remaining three cities, nonpayment and reductions in nonenergy consumption were more likely to have been practiced by households living in inner-city areas. The Budapest and Gdańsk profiles look very similar in this regard, even if energy poverty–related circumstances are worse in the former.

Locating Material Deprivation: Vulnerable Groups

Identifying the sociodemographic groups that are vulnerable to energy poverty can provide valuable insights into the systemic forces that drive the condition. As described earlier, we undertook logistic regression modeling to establish the relationship between key energy poverty indicators, on the one hand, and a range of sociodemographic variables (see Table 1 for the coding of the indicators). This form of subgroup analysis can be challenging for detailed, smaller surveys such as ours, resulting in small samples within certain variable categories. Our first regression model (Table 3) focused on the sociodemographic and housing underpinnings of energy poverty via the lens of disproportionately high affordability ratios (i.e., cases where the energy cost burden exceeded a fifth of household income).

In inner-city Budapest (BUA), the significant predictors that increased the odds of having a high energy burden were below median household income (odds of 4.77) and the age of the respondent (for every one unit increase in age in years, the odds of experiencing a high energy burden increases by 1.03). By comparison, the significant predictors that lowered the odds of a high energy burden were being a pensioner-only household (0.33, compared to non-pensioner-only households). In BUB, having below median income statistically increased the odds of reporting a high energy burden (by 3.12 times). Conversely, living in a pensioner-only household lowered the odds of a high energy burden (0.37), as did being a renter (instead of an owner), with lower odds of 0.17. The model results for GDB showed that an increase in the number of rooms in the property and having below median income was statistically associated with higher odds of reporting a high energy burden (with odds of 1.51 and 2.07, respectively). A significant predictor that lowered the odds of high energy expenditure in GDB was having an energy-efficient home (an increase in the number of energy-efficiency measures is associated with decreased odds of 0.68).

An increase in the age of the respondent is linked to higher odds (1.041) of reporting a high energy burden in PRA. By comparison, no significant predictors were found to increase the odds of high energy burdens in PRB, whereas an increase in the number of rooms and using district heating both lowered the odds of reporting high energy burdens (by 0.62 and 0.20, respectively), suggesting that energy vulnerability is not always contingent on the size of the home, with smaller properties also vulnerable to high energy expenditure. In SKA, we saw that a below median income augmented the odds of reporting a higher energy burden by a factor of 2.62. On the other hand, households that were district heating users had lower odds of reporting a high energy burden (0.53). Finally, in SKB, we found slightly unusual results that diverged from those found in GDB, PRB, and SKA, with an increase in energy efficiency linked to increased odds of reporting high energy burdens (1.32), as are district heating users (3.02). Similarly, having below median income was found to decrease the odds of a high energy burden (0.32), whereas in Budapest, GDB, and SKA this predictor increased the odds. These results likely emerge as a consequence of the diverse groups found within the SKB locality, which features a high concentration of ethnic minority households in an area of poor-quality improvised housing, and a contrasting group of families living in higher quality apartment blocks that use district heating and benefit from higher energy efficiency levels. The most vulnerable families in SKB might be choosing to prioritize other essential goods over energy costs, whereas slightly more affluent households in this area are in a position to spend more on energy and thus have higher energy burdens.

We also explored the sociospatial underpinnings of a self-reported subjective indicator of energy vulnerability: dwelling not comfortably warm during winter (see Table 4). This showed that an increase in the number of energy-efficiency measures present in homes across BUA and BUB decreased the odds of self-reported inadequate warmth during winter (odds ratio [OR] = 0.71 and 0.68, respectively). In GDA, an increase in the number of rooms (OR = 1.39), increase in household size (OR = 1.48), and being in a pensioner-only household (OR = 4.05) were significant predictors of self-reported inadequate warmth. Having below median income increased the odds of self-reporting thermal discomfort in GDB (OR = 2.63), whereas being a homeowner and underoccupying the home (where the number of rooms exceeds the number of people, based on official Eurostat methodology) lowered the odds of self-reported inadequate warmth (by 0.12 and 0.25, respectively).

In PRA, an increase in the size of the household and underoccupying the home both emerged as key predictors that substantially increase the odds of self-reported inadequate warmth (OR = 3.11 and 8.34, respectively). Conversely, an increase in energy-efficiency measures (OR = 0.62), an increase in number of rooms (OR = 0.42), and having children in the household (OR = 0.28) all lowered the odds of reporting inadequate warmth. Thus, it emerges that energy vulnerability is not so much contingent on the size of the property but rather on the household structure and occupancy patterns. Finally, in SKB, increases to household size and having below median income both emerged as a significant driver of vulnerability, with households at a higher risk of reporting inadequate warmth (by 1.43 and 2.28, respectively). A wide range of predictors was linked to decreased odds of reporting a dwelling not being comfortable during winter in SKB, including an increase in

Table 3. Final logistic regression model: Energy burdens (Method: Backward likelihood ratio)

	BUA		BUB		GDA		GDB		PRA		PRB		SKA		SKB	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age of respondent	**1.028***[*]	**1.005, 1.051**	0.989	0.965, 1.013	1.006	0.982, 1.030	1.002	0.997, 1.006	**1.041**[*]	**1.009, 1.075**			1.018	0.995, 1.042	1.024	0.996, 1.053
Energy efficiency index	0.837	0.621, 1.127	0.970	0.737, 1.277	0.904	0.678, 1.206	**0.676**[**]	**0.505, 0.906**	0.966	0.677, 1.378	1.086	0.785, 1.503	1.009	0.794, 1.282	**1.324**[*]	**1.029, 1.705**
Number of rooms	1.231	0.781, 1.941	0.981	0.711, 1.354	0.782	0.572, 1.069	**1.512**[*]	**1.001, 2.286**	0.796	0.452, 1.404	**0.624**[**]	**0.460, 0.845**	1.332	0.934, 1.898	1.229	0.881, 1.713
Household size	1.114	0.781, 1.587	1.001	0.663, 1.510	1.118	0.747, 1.673	0.826	0.552, 1.234	1.376	0.760, 2.490	1.168	0.807, 1.690	1.068	0.701, 1.628	0.896	0.687, 1.168
Below median income	**4.768**[***]	**2.494, 9.113**	**3.115**[**]	**1.499, 6.473**	1.306	0.683, 2.497	**2.074**[*]	**1.122, 3.834**	1.089	0.353, 3.364	1.929	0.604, 6.164	**2.617**[*]	**1.176, 5.821**	**0.318**[***]	**0.161, 0.628**
Households with children	0.733	0.331, 1.623	1.470	0.564, 3.833	0.605	0.263, 1.396	1.109	0.501, 2.453	1.330	0.460, 3.850	0.377	0.139, 1.026	0.976	0.471, 2.022	0.589	0.290, 1.198
Pensioner-only households	**0.330**[*]	**0.120, 0.909**	1.730	0.660, 4.536	**0.365**[*]	**0.146, 0.913**	1.365	0.704, 2.645	1.713	0.444, 6.607	0.533	0.151, 1.889	0.809	0.291, 2.249	1.025	0.254, 4.146
Rented dwelling	0.749	0.093, 6.058	0.552	0.088, 3.480	**0.136**[***]	**0.063, 0.294**	0.307	0.070, 1.349			0.122	0.012, 1.247	0.590	0.078, 4.471	1.194	0.205, 6.953
Owner of dwelling	0.660	0.084, 5.192	0.993	0.207, 4.757			1.075	0.288, 4.006			0.242	0.025, 2.313	0.303	0.049, 1.869		
District heating user	0.843	0.281, 2.530	0.791	0.404, 1.549	0.994	0.553, 1.786	0.626	0.196, 2.004	0.912	0.332, 2.504	**0.196**[***]	**0.090, 0.424**	**0.525**[*]	**0.297, 0.927**	**3.024**[*]	**1.154, 7.927**
Underoccupying home	0.608	0.228, 1.618	0.697	0.235, 2.066	1.495	0.611, 3.656	0.791	0.328, 1.908	1.047	0.283, 3.873			0.579	0.231, 1.449	0.645	0.184, 2.257
Constant	0.167		1.330		1.509		0.634		0.015		9.123		0.351		0.322	
Nagelkerke R^2	0.211		0.121		0.234		0.156		0.109		0.210		0.108		0.272	
Hosmer and Lemeshow Test Sig.	0.486		0.141		0.138		0.497		0.397		0.387		0.604		0.057	

Note: BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba; OR = odds ratio; CI = confidence interval. Values shown in bold indicate statistical significance at the $p \leq 0.05$ level.

*$p < 0.05$.

**$p < 0.01$.

***$p < 0.001$.

Table 4. Final logistic regression model: Dwelling not comfortably warm during winter (Method: Backward likelihood ratio)

	BUA		BUB		GDA		GDB		PRA		PRB		SKA		SKB	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age of respondent	0.985	0.963, 1.008	0.985	0.956, 1.015	0.988	0.965, 1.013	1.000	0.996, 1.004	0.992	0.968, 1.018	1.027	0.993, 1.061	0.989	0.966, 1.013	0.986	0.955, 1.017
Energy efficiency index	**0.714***	**0.521, 0.978**	**0.679***	**0.470, 0.981**	**0.280*****	**0.175, 0.449**	0.732	0.463, 1.157	**0.616****	**0.425, 0.891**	0.813	0.520, 1.270	0.873	0.674, 1.131	**0.397*****	**0.289, 0.546**
Number of rooms	0.784	0.498, 1.235	1.069	0.721, 1.583	**1.394***	**1.072, 1.812**	1.802	0.967, 3.357	**0.419****	**0.225, 0.780**	0.885	0.591, 1.325	1.286	0.905, 1.827	**0.669***	**0.457, 0.980**
Household size	1.369	0.966, 1.939	0.835	0.519, 1.342	**1.483***	**1.050, 2.094**	1.262	0.736, 2.165	**3.113*****	**1.633, 5.935**	1.380	0.687, 2.770	0.954	0.611, 1.491	**1.427***	**1.045, 1.948**
Below median income	1.655	0.881, 3.108	0.731	0.291, 1.835	1.722	0.870, 3.410	**2.628***	**1.137, 6.075**	2.551	0.996, 6.536	1.264	0.334, 4.785	2.110	0.959, 4.644	**2.276***	**1.072, 4.833**
Households with children	0.888	0.392, 2.011	1.090	0.354, 3.359			0.730	0.232, 2.295	**0.279***	**0.105, 0.747**	0.237	0.037, 1.526	0.662	0.304, 1.441	0.476	0.204, 1.110
Pensioner-only households	2.540	0.898, 7.185	1.630	0.474, 5.604	**4.054****	**1.445, 11.376**	2.601	0.873, 7.744	0.748	0.185, 3.017	0.981	0.221, 4.359	1.443	0.502, 4.146	0.630	0.130, 3.064
Rented dwelling	0.809	0.120, 5.451	0.768	0.059, 9.941	**0.328****	**0.156, 0.687**	1.699	0.306, 9.423			0.762	0.044, 13.095	1.219	0.165, 9.032	0.422	0.049, 3.637
Owner of dwelling	0.513	0.077, 3.402	1.621	0.175, 14.977			**0.123***	**0.024, 0.637**			0.328	0.019, 5.585	0.898	0.149, 5.410		
District heating user	0.925	0.271, 3.153	1.867	0.827, 4.219	**0.473***	**0.250, 0.895**	4.546	0.505, 40.936	0.572	0.182, 1.797	0.701	0.272, 1.808	0.855	0.472, 1.550	**0.082*****	**0.023, 0.292**
Underoccupying home	1.248	0.469, 3.322	0.396	0.108, 1.458			**0.245***	**0.062, 0.972**	**8.340*****	**2.439, 28.513**	2.454	0.595, 10.118	0.844	0.327, 2.177	1.644	0.376, 7.182
Constant	1.045		1.210		0.338		0.016		0.166		0.040		0.481		8.117	
Nagelkerke R^2	0.113		0.083		0.311		0.382		0.205		0.108		0.061		0.470	
Hosmer and Lemeshow test sig.	0.178		0.793		0.493		0.491		0.612		0.340		0.147		0.078	

Note: BUA = Budapest; BUB = Kispest; GDA = Wrzeszcz; GDB = Przymorze; PRA = Hloubětín; PRB = Holešovice; SKA = Debar Maalo and Bunjakovec; SKB = Chair, Skopje Sever, and Gazi Baba; OR = odds ratio; CI = confidence interval. Values shown in bold indicate statistical significance at the $p \leq 0.05$ level.

$^{*}p < 0.05$.

$^{**}p < 0.01$.

$^{***}p < 0.001$.

the number of energy-efficiency measures (0.40), an increase in the number of rooms (0.67), and using district heating (0.08). Interestingly, the results for SKB contradict those found in the energy burden model, highlighting the differences in populations picked up by different indicators of energy vulnerability.

It is difficult to formulate an overall typology of vulnerable groups based on these analyses. If anything, they indicate that the sociodemographic, housing, and infrastructural drivers associated with energy poverty are dependent on local circumstances, as well as the types of indicators being studied. When speaking about self-reported thermal comfort during winter, it does seem that factors such as household size and income play a major role throughout the region, and the energy efficiency of the home, the number of rooms in the home, and using district heating tend to decrease the odds of suffering from a cold home. Such conditions are also key in the case of disproportionately high energy burdens, which—somewhat predictably given the nature of the indicator (Bouzarovski et al. 2015)—were influenced by income levels to a greater frequency than affordable warmth patterns, as well as by energy efficiency, but to a lesser degree than self-reported adequate warmth. None of these trends, however, displayed a clear geography, other than the presence of a greater number of vulnerability factors in the central European inner-city study areas and both of the Skopje districts. This points to the multidimensional nature of energy-related material deprivation in urban districts where the phenomenon is pervasive.

Conclusion

This article has sought to explore the manner in which energy vulnerability is nested within the grain of the city, as well as the implications of this phenomenon for the consumption of utility services and the conduct of everyday life more generally. We have highlighted the existence of a specific form of material deprivation that influences the development of wider forms of energy and housing provision embedded in the urban fabric. Returning to the first aim of the article (regarding the relationship between neighborhood trajectories and energy poverty), it transpired that domestic energy deprivation is closely connected to broader utility service affordability trends in the case study countries. Energy burdens were highest in the Skopje and Budapest case study areas, whose host states are characterized by the lowest income levels and overall greatest energy poverty rates within the study sample (Bouzarovski 2014). The presence of self-reported energy hardship across the case study areas brings us to our second aim, focusing on the energy vulnerability–related strategies used by affected households. In this domain, it became clear that the residents of areas with an increased incidence of housing faults were also more likely to report the presence of domestic energy deprivation.

We registered elevated shares of households who reported living in uncomfortably cool dwellings, a dimension that has received almost no academic or policy attention to date, with most energy poverty research and policy being focused on space heating. The entanglement of non-heating-related energy services in the production and articulation of energy vulnerability was also reflected in the cutbacks that households undertook to address the poor affordability of domestic warmth. These practices singled out the residents of historical inner-city districts as more likely to deprive themselves of lighting, appliance use, water heating, and even food and medicines. At the same time, all eight study areas contained households that suffered from energy bill arrears or were disconnected from district heating and electricity grids. Such circumstances were particularly pronounced in the Skopje and Budapest study areas, although the increased rate of heat disconnections in the inner-city Prague case district is also of note. In income terms, we noted the presence of higher earners in inner-city Skopje and Budapest, areas that simultaneously had some of the highest rates of energy vulnerability across the entire empirical corpus. Alongside the presence of households with high energy burdens in the upper income bands across all case study areas (in Figures 2–5), this finding provides further corroboration of the imperfect overlap between incomes and domestic energy deprivation. At the same time, neighborhoods containing housing estates in Poland, the Czech Republic, and Hungary contained a much more equalized distribution of incomes. Their residents were subjectively more satisfied with the level of energy domestic services despite facing high energy costs. Thus, and in response to the third aim of the article (determining the principal sociodemographic and residential circumstances of vulnerable groups), there is evidence to suggest that energy poverty is disproportionately represented in inner-city areas.

Overall, these findings have multiple implications for existing understandings of the geographies of energy, as well as trends of urban differentiation in ECE states and similar spatial settings more widely. We can conclude that energy poverty potentially influences neighborhood profiles and paths via a combination of at least three sets of conditions: (1)

infrastructural service provision (e.g., the presence of district heating or individual coal-fired stoves), (2) relevant housing stock features (especially the ease of installing energy-efficiency measures), and (3) incumbent patterns of socioeconomic inequality. The juxtaposition of such factors creates a clear distinction between quarters predominated by large housing estates and sociotechnical networks for the delivery of heat—where space cooling and higher energy costs are a greater issue for households than domestic energy services—on the one hand, and inner-city neighborhoods featuring a wider range of energy-poverty-related circumstances, on the other. This cleavage, however, only applies to our six Central European study areas, located in "fast reforming" postsocialist countries. The two Skopje case study districts recorded outstandingly high rates of sociospatial inequality, alongside multiple forms of material deprivation associated with a variety of energy services. Their host country has seen a rapid growth of income disparities.

In terms of wider debates in urban and energy geographies, the results of this article suggest that capturing the full extent of urban socioeconomic differentiation requires explicit consideration of the experience and consumption of infrastructure services in the city. The conceptual framework and empirical evidence presented in this article point to the need for incorporating the spatial production, experience, and practice of indoor environments (Biehler and Simon 2010) in understandings of intraurban segregation and inequality. Such an effort can also challenge and enrich the dominant tropes of energy justice scholarship, with its emphasis on the triad of recognition, procedure, and distribution, by introducing a stronger emphasis on the material landscapes of energy deprivation. It foregrounds the multiple spatial injustices involved in the flow and consumption of energy within the urban fabric.

Note

1. The participant information sheet accompanying the questionnaire contained a link to the website of the project that funded the work. This mentions energy poverty and vulnerability explicitly.

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References

Åslund, A. 1992. *Post-communist economic revolutions: How big a bang?* Washington, DC: Centre for Strategic and International Studies.

Bazilian, M., P. Nussbaumer, C. Eibs-Singer, A. Brew-Hammond, V. Modi, B. Sovacool, V. Ramana, and P.-K. Aqrawi. 2012. Improving access to modern energy services: Insights from case studies. *The Electricity Journal* 25:93–114.

Biehler, D. D., and G. L. Simon. 2010. The great indoors: Research frontiers on indoor environments as active political-ecological spaces. *Progress in Human Geography* 35:172–92.

Boardman, B. 1991. *Fuel poverty: From cold homes to affordable warmth*. London: Bellhaven.

———. 2013. *Fixing fuel poverty: Challenges and solutions*. London and New York: Routledge.

Boermans, T., and C. Petersdorf. 2007. *U-values for better energy performance of buildings*. Cologne: Ecofys.

Booth, K. M., M. M. Pinkston, and W. S. C. Poston. 2005. Obesity and the built environment. *Journal of the American Dietetic Association* 105:110–17.

Bouzarovski, S. 2011. Skopje. *Cities* 28:265–77.

———. 2014. Energy poverty in the European Union: Landscapes of vulnerability. *Wiley Interdisciplinary Reviews: Energy and Environment* 3:276–89.

———. 2015. *Retrofitting the city: Residential flexibility, resilience and the built environment*. London: IB Tauris.

Bouzarovski, S., and S. Petrova. 2015. A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. *Energy Research & Social Science* 10:31–40.

Bouzarovski, S., and N. Simcock. 2017. Spatializing energy justice. *Energy Policy*. Accessed May 15, 2017. http://www.sciencedirect.com/science/article/pii/S0301421517302185.

Bouzarovski, S., S. Tirado Herrero, S. Petrova, and D. Ürge-Vorsatz. 2015. Unpacking the spaces and politics of energy poverty: Path-dependencies, deprivation and fuel switching in post-communist Hungary. *Local Environment* 21:1151–70.

Bradshaw, M. 2010. Global energy dilemmas: A geographical perspective. *The Geographical Journal* 176: 275–90.

Buzar, S. 2007. *Energy poverty in Eastern Europe: Hidden geographies of deprivation*. Aldershot, UK: Ashgate.

Buzar, S., P. E. Ogden, R. Hall, A. Haase, S. Kabisch, and A. Steinführer. 2007. Splintering urban populations: Emergent landscapes of reurbanisation in four European cities. *Urban Studies* 44:651–77.

Calvert, K. 2015. From "energy geography" to "energy geographies" Perspectives on a fertile academic borderland. *Progress in Human Geography* 40:105–25.

Chapman, J. D. 1989. *Geography and energy: Commercial energy systems and national policy*. Harlow, UK: Longman.

Chelcea, L., and G. Pulay. 2015. Networked infrastructures and the "local": Flows and connectivity in a postsocialist city. *City* 19:344–55.

Cirman, A., S. Mandič, and J. Zorić. 2013. Decisions to renovate: Identifying key determinants in central and Eastern European post-socialist Countries. *Urban Studies* 50:3378–93.

Dubois, U., and H. Meier. 2014. *Households facing constraints: Fuel poverty put into context*. Cologne, Germany: Institute of Energy Economics at the University of Cologne.

Energy Community Secretariat. 2016. *Annual implementation report*. Vienna, Austria: Energy Community Secretariat.

European Bank for Reconstruction and Development. 2001. *Transition report 2001: Energy in transition*. London: European Bank for Reconstruction and Development.

Fellegi, D., and O. Fulop. 2012. *Poverty or fuel poverty? Defining fuel poverty in Europe and Hungary*. Budapest, Hungary: Energia Klub.

Galster, G. 2001. On the nature of neighbourhood. *Urban Studies* 38:2111–24.

Gentile, M. 2003. Residential segregation in a medium-sized post-Soviet city: Ust'-Kamenogorsk, Kazakhstan. *Tijdschrift voor Economische en Sociale Geografie* 94:589–605.

Golubchikov, O., A. Badyina, and A. Makhrova. 2014. The hybrid spatialities of transition: Capitalism, legacy and uneven urban economic restructuring. *Urban Studies* 51:617–33.

Healy, J. D. 2004. *Housing, fuel poverty and health: A pan-European analysis*. Aldershot, UK: Ashgate.

Hernández, D. 2013. Energy insecurity: A framework for understanding energy, the built environment, and health among vulnerable populations in the context of climate change. *American Journal of Public Health* 103: e32–e34.

Hincks, S. 2015. Deprived neighbourhoods in transition: Divergent pathways of change in the Greater Manchester city-region. *Urban Studies* 54 (4):1038–61.

Hirt, S. 2008. Landscapes of postmodernity: Changes in the built fabric of Belgrade and Sofia since the end of socialism. *Urban Geography* 29:785–810.

Hirt, S., and K. Stanilov. 2007. The perils of post-Socialist transformation: Residential development in Sofia. In *The post-socialist city: Urban form and space transformations in central and Eastern Europe*, ed. K. Stanilov, 215–44. Dordrecht, The Netherlands: Springer.

Holloway, S. R., R. Wright, and M. Ellis. 2012. The racially fragmented city? Neighborhood racial segregation and diversity jointly considered. *The Professional Geographer* 64:63–82.

Hu, Y., F. J. Lenthe, and J. P. Mackenbach. 2015. Income inequality, life expectancy and cause-specific mortality in 43 European countries, 1987–2008: A fixed effects study. *European Journal of Epidemiology* 30:615–25.

International Energy Agency. 2010. *Energy policies of IEA countries: The Czech Republic*. Paris: International Energy Agency.

Kostelecký, T., and J. Vobecká. 2017. Socio-spatial inequalities in the Czech metropolitan areas: The case of Prague Metro. In *Inequality and governance in the metropolis: Comparative territorial politics*, ed. J. M. Sellers, M. Arretche, D. Kübler, and E. Razin, 221–36. London: Palgrave Macmillan.

Kovács, Z. 2012. Residential segregation in Budapest before and after transition. In *Residential segregation in comparative perspective: Making sense of contextual diversity*, ed. T. Maloutas and K. Fujita, 197–216. London and New York: Routledge.

Kovács, Z., and G. Hegedűs. 2014. Gated communities as new forms of segregation in post-socialist Budapest. *Cities* 36:200–209.

Lampietti, J. A., S. G. Banerjee, and A. Branczik. 2007. *People and power: Electricity sector reforms and the poor in Europe and Central Asia*. Washington, DC: World Bank.

Luque-Ayala, A., and J. Silver. 2016. Introduction. In *Energy, power and protest on the urban grid: Geographies of the electric city*, ed. A. Luque-Ayala and J. Silver, 1–18. London and New York: Routledge.

Lux, M., and P. Sunega. 2012. New social housing strategies in post-socialist countries: Effectiveness, efficiency and sustainability. In *Social housing in transition countries*, ed. J. Hegedus, N. Teller, and M. Lux, 307–30. London and New York: Routledge.

Marcińczak, S., T. Tammaru, J. Novák, M. Gentile, Z. Kovács, J. Temelová, V. Valatka, A. Kährik, and B. Szabó. 2015. Patterns of socioeconomic segregation in the capital cities of fast-track reforming postsocialist countries. *Annals of the Association of American Geographers* 105:183–202.

McFarlane, C., and J. Rutherford. 2008. Political infrastructures: Governing and experiencing the fabric of the city. *International Journal of Urban and Regional Research* 32:363–74.

Nussbaum, M. C. 2011. *Creating capabilities*. Cambridge, MA: Harvard University Press.

Organization for Economic Cooperation and Development (OECD). 2015. OECD Better Life Index. Accessed September 15 2017. http://www.oecdbetterlifeindex.org/#/11111111111.

Pasqualetti, M. J., and M. A. Brown. 2014. Ancient discipline, modern concern: Geographers in the field of energy and society. *Energy Research & Social Science* 1:122–33.

Petrova, S., M. Gentile, I. H. Makinen, and S. Bouzarovski. 2013. Perceptions of thermal comfort and housing quality: Exploring the microgeographies of energy poverty in Stakhanov, Ukraine. *Environment and Planning A* 45:1240–57.

Pojani, D. 2010. Tirana. *Cities* 27 (6):483–95.

Republic of Macedonia State Statistical Office. 2015. Standard of living. Accessed September 14, 2017. http://www.stat.gov.mk/OblastOpsto_en.aspx?id=13.

Sailer-Fliege, U. 1999. Characteristics of post-socialist urban transformation in East Central Europe. *GeoJournal* 49:7–16.

Sivo, S. A., C. Saunders, Q. Chang, and J. J. Jiang. 2006. How low should you go? Low response rates and the validity of inference in IS questionnaire research. *Journal of the Association for Information Systems* 7:351–414.

Stanilov, K., and L. Sýkora. 2014. *Confronting suburbanization: Urban decentralization in postsocialist Central and Eastern Europe*. Chichester, UK: Wiley.

Stenning, A., A. Smith, A. Rochovská, and D. Świątek. 2010. *Domesticating neo-liberalism: Spaces of economic practice and social reproduction in post-socialist cities*. Malden, MA: Wiley-Blackwell.

Stiglitz, J. E. 1994. *Whither socialism?* Cambridge, MA: MIT Press.

Swyngedouw, E., and N. C. Heynen. 2003. Urban political ecology, justice and the politics of scale. *Antipode* 35:898–918.

Sýkora, L. 1999. Processes of socio-spatial differentiation in post-communist Prague. *Housing Studies* 14:677–99.

———. 2009. New socio-spatial formations: Places of residential segregation and separation in Czechia. *Tijdschrift voor Economische en Sociale Geografie* 100: 417–35.

Sýkora, L., and S. Bouzarovski. 2012. Multiple transformations: Conceptualising the post-communist urban transition. *Urban Studies* 49:43–60.

Thomson, H., S. Bouzarovski, and C. Snell. 2017. Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data. *Indoor and Built Environment* 26 (7):879–901.

Thomson, H., and C. Snell. 2013. Quantifying the prevalence of fuel poverty across the European Union. *Energy Policy* 52:563–72.

Tirado Herrero, S., and D. Ürge-Vorsatz. 2012. Trapped in the heat: A post-communist type of fuel poverty. *Energy Policy* 49:60–68.

Ürge-Vorsatz, D., G. Miladinova, and R. Paizs. 2006. Energy in transition: From the iron curtain to the European Union. *Energy Policy* 27:2279–97.

Walker, G., and R. Day. 2012. Fuel poverty as injustice: Integrating distribution, recognition and procedure in the struggle for affordable warmth. *Energy Policy* 49: 69–75.

Whelan, C. T., and B. Maître. 2012. Understanding material deprivation: A comparative European analysis. *Research in Social Stratification and Mobility* 30:489–503.

Zimmerer, K. S. 2011. New geographies of energy: Introduction to the special issue. *Annals of the Association of American Geographers* 10:705–11.

STEFAN BOUZAROVSKI is a Professor of Geography at the Department of Geography, University of Manchester, Manchester M13 9PL, UK. E-mail: stefan.bouzarovski@manchester.ac.uk. He is also Director of the Collaboratory for Urban Resilience and Energy within the Manchester Urban Institute and holds Visiting Professorships at the Universities of Bergen (Norway) and Gdansk (Poland), while chairing the European Energy Poverty Observatory. His research focuses on questions of justice and inequality as they relate to the urban energy nexus.

HARRIET THOMSON is a Postdoctoral Research Associate in the Department of Geography, University of Manchester, Manchester M13 9PL, UK. E-mail: harriet.thomson@manchester.ac.uk. Her research interests include domestic energy deprivation, comparative analysis, the European Union polity, and climate change.