Eating, heating or taking the bus? Lived experiences at the intersection of energy and transport poverty

Mari Martiskainen [a,*], Debbie Hopkins [b], Gerardo A. Torres Contreras [a], Kirsten E.H. Jenkins [c], Giulio Mattioli [d,e], Neil Simcock [f], Max Lacey-Barnacle [a]

[a] Science Policy Research Unit (SPRU), University of Sussex Business School, University of Sussex, United Kingdom
[b] Department for Continuing Education and School of Geography and the Environment, University of Oxford, United Kingdom
[c] Science, Technology and Innovation Studies, University of Edinburgh, United Kingdom
[d] Urban Development Research Group, School of Spatial Planning, TU Dortmund University, Germany
[e] School of Earth & Environment, University of Leeds, United Kingdom
[f] School of Biological and Environmental Sciences, Liverpool John Moores University, United Kingdom

ABSTRACT

Experiences of poverty can manifest in multiple aspects of everyday life, often in interlinking ways. One example is 'double energy vulnerability', where a household faces both energy poverty and transport poverty simultaneously. This can result in trade-offs, where prioritising one essential need (e.g., transport) makes accessing another impossible (e.g., heating). Such decisions are not easily made, and they can have distinct spatio-temporal characteristics. They can vary between space and time and across different household members, and result in stark inter- as well as intra-household differences. People with socio-demographic and contextual vulnerabilities are particularly at risk of experiencing double energy vulnerability. Based on 59 household interviews across the four nations of the United Kingdom, we provide novel, multi-nation empirical evidence on the lived experiences of double energy vulnerability, drawing on our themes; 'being locked into infrastructure', 'facing high costs and low incomes', 'choosing between energy and transport', and 'missing out'. A cross-national lived-experiences approach sheds light on double energy vulnerability as a relational, contingent and ongoing phenomena, attending to everyday experiences and capacities. We provide suggestions for further research, such as further study of double energy vulnerability amongst refugees and migrants. We also highlight that the study of lived experiences can aid the recognition of how different forms of poverty intersect and how they need to be taken into account in the design of Net Zero policies.

1. Introduction

Joe[1] is a 52-year-old man living in a rental bedsit in a large city in Scotland. Joe was interviewed for our study and told of his past when he had spent six years living without any income, or state welfare support. This meant that for most of that time, Joe lived in a cold home and had few options for cooking hot meals as the use of the pre-payment electricity meter was too expensive. During tough times, Joe reluctantly accepted outside help, and in his own words, "*I was kept alive by a charity who kept me in sandwiches*" (SCO06). At the time of our interview, Joe was working but had a limited income which meant that he still had to carefully ration his heating, hot water and

electricity use. Joe said that his main mode of transport was walking as, despite living in a city with good public transport links, he could not afford to use the buses or trains. This meant sometimes walking long distances in cold and wet Scottish weather to get basics like food, attend work meetings or catch up with friends. After walking in the cold, John returned to a cold home, to eat a cold meal.

In the vignette above, we introduce Joe who faces the simultaneous impacts of *both* energy poverty and transport poverty; he lives in and out of 'double energy vulnerability'. These overlapping forms of poverty are relevant for the design and development of Net Zero societies, which many countries have pledged to become in order to deal with the climate crisis. Net Zero, i.e. the balancing of greenhouse gas (GHG) emissions

---

produced and the amount removed from the atmosphere, demands a radical transformation of transport and energy systems, along with decarbonisation of whole economies. The United Kingdom (UK) and Great Britain (GB)[2] has aims for a Net Zero society by 2050 (HM Government, 2021), and given their high contribution to national greenhouse gas (GHG) emissions, the transport (27%) and energy (21%) sectors are key in this quest (BEIS, 2021a). Low-carbon technologies such as electric vehicles (EV) and heat pumps are prioritised by the UK's public and private sectors, becoming synonymous with a transition which is expected to increase the intersections between energy and transport due to electrification. Yet such innovations are often out of reach of many, not least due to high upfront costs. People on lower incomes in particular have less chance to benefit from these technologies' reduced running costs, and are forced to use more carbon intensive, inefficient and expensive options (e.g., internal combustion engine vehicles and pre-payment electricity meters). Much research and policy advocacy (e.g., Bickerstaff et al., 2013; Martiskainen et al. 2021a, 2021b; Mullen and Marsden, 2016) has therefore called for a 'just' transition, so that benefits and costs are shared equally across society, and inequality reduced in the Net Zero society (Heffron and McCauley, 2018; also Sovacool et al., 2022).

A consideration of the intersections between Net Zero ambitions, decarbonising energy and transport systems and growing socioeconomic inequalities is timely. A combination of rapidly rising energy bills, growing inflation, increasing taxation, and stagnating salaries has created a 'perfect storm' that has made many UK households vulnerable to both energy and transport poverty. In April 2022, the Office of Gas and Electricity Markets (Ofgem) (2022) lifted an energy price cap (limits to how much utilities can charge in GB markets), meaning a 54% rise and an average annual energy bill increase of £700. The impact of a further increase in October 2022 to an average energy bill £1,600 was temporarily halted by the Energy Price Guarantee, but further increases of the energy price cap in 2023 – to £3,000 (UK Parliament, 2023) – will have widespread effects across the population. At the same time, the Russian war in Ukraine, and resulting economic sanctions, are contributing to energy supply and price volatility.

With UK consumer price inflation at 8.9% in March 2023 (Office for National Statistics, 2023), there is an affordability crisis across the economy. Bus fares in England, for example, have increased above inflation for a long time (Department for Transport, 2021a), and some cities – such a Bristol – are now reporting increases as high as 18% (ITV, 2022). Meanwhile, across the UK rail fares continue to rise (Inews, 2022), with a government 'cap' on rail fare increases of 5.9% (Department for Transport, 2022a) - the largest increase in a decade (inews, 2022) yet described by the UK government as "the biggest government intervention ever" for keeping increases below inflation (Department for Transport, 2022a). Motor fuel prices at the pump also increased rapidly in 2022 and have been at historically high levels in real terms since 2007–2008. While the British government first froze and then cut the motor fuel duty in response to affordability concerns, very little action has been taken for public transport beyond a 3-month (later extended to 6-month) £2 cap on single bus fares introduced on 1 January 2023 for some bus services in some parts of England (Department for Transport, 2022b). Stark pre-existing inequalities in access to and the affordability of energy and transport services are aggravated by these contexts, yet many people impacted by them often remain misrecognised, and misrepresented, in public policy (Mattioli, 2021; Simcock et al., 2021a).

Calls for equitable transitions become even more important in light of research which has suggested that many people, like Joe above, face *double energy vulnerability* (DEV) (Furszyfer Del Rio & Sovacool, 2023; Robinson and Mattioli, 2020; Sareen et al., 2022; Simcock et al., 2021a, 2021b). People particularly at risk of DEV often face both socio-

demographic and contextual vulnerabilities, for example, someone with a disability living on a low-income in a rural inefficient home that is also isolated from public transport links, (Robinson, 2019; Simcock et al., 2021b), whilst they are also at risk of being excluded from the Net Zero transition. Living without sufficient energy *or* transport services has a negative impact on quality of life (Anderson et al., 2012; Liddell and Morris, 2010; Lucas et al., 2016; Martens, 2017; Mattioli et al., 2017), and the combined effect of living without *both* is likely to be even worse (Desjardins and Mettetal, 2012; Ortar 2018). While the inability to keep a home adequately warm and to access work, education and healthcare are often discussed as impacting on life chances (e.g., Bouzarovski and Petrova 2015; Lucas et al., 2016; Mullen et al., 2020; Rozynek et al., 2022; Simcock et al., 2021b), there are a range of more subtle ways that DEV can impact everyday life, from the possibility to cook diasporic foods, take day trips, or provide experiences for children, and it is this which our research aims to uncover. To ensure reduced inequality in the Net Zero society, we argue that it is important to understand the lived experience of those facing DEV, and to hear from people and communities who are often silenced by or ignored in policy making, such as those who have a disability or a chronic illness, or come from refugee and/or migrant backgrounds (see Bouzarovski et al., 2022).

In this paper, we make a new empirical contribution to the study of DEV through interview data collected during 2020–2021 with 59 people across the four UK nations - England, Wales, Northern Ireland and Scotland - in a variety of spatial settings (urban, *peri*-urban and rural locations) and with respondents that include those who are often overlooked, such as the groups mentioned above. By investigating the four UK nations, we (1) respond to a clear research gap, where we overcome England-centric reporting on these issues, reveal insights from often marginalised geographies and contribute to understandings of fuel *and* transport poverty as intersecting issues across various contexts and different socio-demographics, (2) consider cross-cutting, entrenched and systemic inequalities as well as those occurring as sub-national particularities, (3) offer lessons for other, similar contexts, including those with federal and state systems. We address the following research question: *What are the lived experiences of double energy vulnerability in the UK?* In doing so, we make a contribution by providing one of the first papers to examine *both* energy poverty *and* transport poverty simultaneously, within the same households, in the UK context. At the same time we also seek to corroborate, and through a large, multi-nation evidence, *extend* the findings from a handful of studies conducted in other countries on the lived experience of double energy vulnerability (e.g. in France by Ortar (2018), in Norway by Sareen et al. (2022) and in Mexico by Furszyfer Del Rio and Sovacool (2022)).

We make a largely empirical contribution, using the lenses of 'contextual vulnerability' (O'brien et al., 2007; Hopkins, 2015; Okpara et al., 2016; Groves and Henwood, 2021) and 'lived experience' (Eyles, 1981) to guide our analysis. A lived-experiences approach allows DEV to be understood as a relational, contingent and ongoing phenomenon, attending to everyday experiences and capacities (Henwood, et al., 2016). Our findings show that when multiple forms of poverty intersect, and people face DEV, this affects a person's quality of life in several ways, especially regarding: (1) being locked into infrastructure, (2) facing high costs and low incomes, (3) choosing between energy and transport, and (4) missing out on other services and life chances. We argue that the study of lived experience can contribute to more inclusive policy, as those who face vulnerabilities such as social exclusion (which can also then make DEV worse), do not often have a voice in policy making (Bouzarovski et al., 2022; Lister, 2007). The integration of lived experience perspectives can therefore ensure that energy and transport policies and programmes take into account the differing needs of participants, do not increase entrenched inequalities and are equitable (Fell et al., 2022). Moreover, by unpacking the lived experience of DEV, we can show who in particular may be at risk and with what implications. Through this, we seek to provide evidence for Net Zero transitions policy so that intersecting inequalities that can have potentially exclusionary

---

[2] UK includes England, Northern Ireland, Scotland and Wales, whereas Great Britain includes England, Scotland and Wales.

tendencies can be considered at the policy design stage, and thereby avoided.

2. Conceptual approach: The lived experience of double energy vulnerability in the UK context

Our conceptual approach draws from literature on DEV, contextual vulnerability and lived experience to help guide our subsequent analysis. DEV means the simultaneous lack of sufficient energy and transport services, defined by Robinson and Mattioli (2020, p. 1) as *"the increased likelihood of negative impacts upon well-being, owing to the intersection of domestic energy poverty (DEP) and transport energy poverty (TEP)"*. This builds, in part, upon the widely recognised concept of energy poverty, i. e., *"the inability to attain a socially- and materially-necessitated level of domestic energy services"* (Bouzarovski and Petrova 2015, p. 31), often due to a complex mix of affordability, needs, energy infrastructure and housing standards. It also builds, secondly, on transport poverty, which reflects *"the inability to attain a socially- and materially- necessitated level of transport services"* (Simcock et al. 2021b, p. 2), usually resulting from the lack of access to transport, high costs, or the unavailability of transport services (Lucas et al., 2016). We understand energy *services* as the ability to use energy and electricity at home for space and water heating, cooking, lighting and the use of appliances. Transport *services* are more difficult to define, but include the capacity to use transport modes (e.g., car, bike, bus, and walking) whether privately owned, shared or public, in order to access essential services and opportunities. If someone lacks both energy and transport services, it can mean that they cannot, for example, heat their home to a comfortable level and travel to their place of education or employment, which in turn can have implications on health, educational attainment, employment opportunities, income levels and overall life chances.

We approach DEV through a lens of *contextual vulnerability* (O'Brien et al., 2011; Hopkins, 2015; Okpara et al., 2016), which interprets vulnerability not as the result of a (single) external pressure or event, but as an ongoing and complex inability to withstand external stresses (Hopkins, 2015). This approach challenges generalised contextual totalities by situating analysis *in place*, engaging with complexity (rather than predictability) through analysis of the historicity, specificity, and variability of social structures (Tumini and Poletti, 2019; Méndez et al., 2020). Previous use of a contextual vulnerability framing (e.g., O'Brien, 2011; Hopkins, 2015) has shown that it allows the understanding of vulnerability as a relational, contingent and ongoing phenomena, attending to everyday experiences and capacities. Through this, we are able to interrogate already-existing vulnerabilities which intersect with evolving conditions (O'brien et al., 2007), including but not limited to energy price rises, increasing use of home energy and changing travel practices during the pandemic lockdowns, and changes to state welfare allowances (Shirani, 2021). It accounts for the possibilities of change; recognising that impacts are always mutable, with material – and experienced - implications. Of particular relevance is the foregrounding of issues of equity and justice in the contextual vulnerability framing. O'Brien et al. (2007, p. 76), for instance, argue that *"reducing vulnerability involves altering the context in which climate change occurs, so that individuals and groups can better respond to changing conditions"*.

As energy and transport services are experienced differently by different people, due to both variegated socio-demographic characteristics (e.g., income, age, gender and ethnicity) and spatio-material contingencies (e.g., degree of public transport accessibility, heating infrastructure provision, and travel distance to essential services) (Simcock et al., 2021b), a lived experience approach (e.g., Eyles, 1981; Ellis and Flaherty, 1992) offers valuable contributions for the study of DEV. A focus on the lived experience attends to "what *is* rather than what *ought to be*" (Eyles 1981, p. 1371, emphasis added), and investigates the 'conditions and experiences' of social groups. It considers the complex intersections of structure and agency, and the ways in which discursive and policy realities can differ from those experienced

in the everyday and 'personal scale' (Hall, 2019a). This can involve investigating phenomena in-situ, place-ing experiences and acknowledging how those places co-produce everyday lifeworlds. Much work engaging a 'lived experience' perspective leaves it under-theorised; with an assumption that doing empirical research is *de facto* examining lived experience. Yet, as van Lanen (2020) shows, lived experience scholarship can illuminate the diverse everyday experiences of particular policies, in their case, home and housing policy under austerity, as shown also in previous energy poverty research (e.g., Middlemiss and Gillard, 2015; Longhurst and Hargreaves, 2019) and transport poverty (e.g., Horn et al., 2021).

It follows that our approach to examining DEV allows the uncovering of the lived, felt and negotiated legacies of DEV, connecting to different spheres of everyday life, and recognising the intersections of different socio-demographic and spatial characteristics mean experiences can change over time and between people, households and communities (Van Lanen, 2021). This approach shows how DEV manifests through negotiations between energy, transport, infrastructure, and other domains (Hall, 2019b). A review of previous research has shown that a lack of energy and transport services negatively impacts on people's quality of life, health, wellbeing, education and life opportunities, and people experiencing multiple socio-demographic and spatial disadvantages could be at the greatest risk of DEV (Simcock et al., 2021b).

Our research extends the small, yet growing, body of empirical research on lived experiences of DEV in Anglophone academic literature. This work, which has largely been based on qualitative interview methods, has shown the different ways that DEV impacts upon people's daily lives. For instance, Ortar (2018) uncovers the entanglements of household decisions on domestic energy, transport, residential re/location, work participation and childcare. Research has also sought to characterise those at greater risk of experiencing DEV, with Sareen et al. (2022) finding that being unemployed, middle-aged, living in a rented home and not having a car could each contribute to (or potentially exaserbate) energy and transport poverty. For Sovacool and Furszyfer Del Rio (2022) and Furszyfer Del Rio and Sovacool (2023), those (forced) to live on the margins of society or experiencing patterns of social exclusion are at high risk of DEV. An example can come from Gypsies and Travellers in Northern Ireland, where built, social, economic and political factors contribute to their experiences of DEV, for instance with hard to hear homes, and complex transport needs resulting in 50% of their incomes being spent on energy and transport services (Sovacool and Furszyfer Del Rio, 2022). Overall, while a few recent studies have investigated the lived experiences of people affected by both energy and transport poverty, there is still a limited understanding of how households deal with the dynamic interactions between these two issues in their daily life. This paper goes beyond previous studies in that the design and analysis of the qualitative research were aimed at bringing to light the intersections, interactions and trade-offs between energy and transport service use (as we discuss in Section 3).

We recognise that experiences of DEV are shaped by the socio- and spatio-material and political economic realities in which people live. Rather than focusing on specific social groups, we start from the perspective of heterogeneous lived experiences, seeking to show the many ways DEV might sweep in (and out) of everyday life. Our approach therefore offers space to analyse everyday experiences of DEV, avoiding universalising claims of who, and where, might experience vulnerabilities.

2.1. The UK energy and transport poverty context

The UK has a long history of energy (fuel) poverty research and policy measures (e.g., Boardman, 1991). The UK is complex country with a central government in England and devolved governments in Northern Ireland, Scotland and Wales. Ofgem regulates the energy sector in England, Scotland and Wales (i.e., GB), whereas the Utility Regulator operates in Northern Ireland. In GB, electricity generation is

mainly produced by using gas, nuclear power or renewable energy plants. Gas boilers are most commonly used for home heating, with an estimated 86% of GB homes connected to the gas grid, though rural areas often lack connectivity (BEIS, 2021c). In Northern Ireland, approximately 68% of homes use oil boilers for heating (Department for Communities, 2020). In the GB retail supply market, five former monopoly suppliers have nearly 80% of the market (Ofgem, 2022), whereas one incumbent supplier has approximately 54% of the Northern Ireland electricity market (Utility Regulator, 2021). The bankruptcy of many smaller operators during 2021/2, owing to soaring wholesale gas prices (The Energy Shop, 2022), resulted in many households being moved to different suppliers, in many cases on new, higher tarrifs. Decarbonising heating, and doing it affordably, remains a key Net Zero policy challenge (HM Government, 2021), given the UK has one of the oldest, and most inefficient, housing stocks (Piddington et al., 2020).

Public transport also differs between GB and Northern Ireland, with the latter retaining a largely state-owned provision, Translink, which operates rail, buses and coaches. In GB, public transport has been privatised and deregulated to a much greater extent than in other OECD countries (Mees, 2010), resulting in diverse provision and pricing throughout Scotland, Wales and England, while in Greater London, a public agency retains strategic control and operations are tendered. Despite differences, increased prices and reduced services have become common across the nations, with few examples of public transport becoming cheaper. Local bus provision, for example, has deteriorated in terms of affordability, quantity and quality of service outside of London since deregulation (Campaign for Better Transport, 2019; Preston and Almutairi, 2013). For both energy and local public transport, deregulation and privatisation have impacted negatively on the accessibility and affordability of services specifically for low-income households (Bayliss et al., 2021; Crisp et al., 2018).

The UK nations have different official definitions of energy poverty (or fuel poverty as is widely used in UK policy). In England, a household is in energy poverty if their income is less than 60% of median income and their home has an Energy Performance Certificate rating worse than C (NEA, 2021). In Northern Ireland, a household using more than 10% of income on energy costs is in energy poverty (NEA, 2021). The 10% indicator is also used in Scotland and Wales, but they recognise 'extreme', or 'severe', energy poverty (i.e., spending of more than 20%), with Wales also having a definition for 'persistent' and 'at risk' energy poverty (NEA, 2021) (see Appendix A). An estimated 4 million UK households were in energy poverty in 2021, but following the energy price cap lift, this increased to an estimated 6.7 million in October 2022 (NEA, 2022) – nearly a quarter of the UK's 27.8 million households (ONS, 2021a). Multiple policy initiatives across all four UK nations address energy poverty; including but not limited to the GB wide 'Energy Company Obligation' or 'ECO'; the Warm Homes Programme in Wales; the Home Energy Scotland network in Scotland and the Northern Ireland Sustainable Energy Partnership (NISEP) in Northern Ireland (for a summary, see NEA, 2021).

In contrast (and unlike other countries, including France), no UK nation has an official definition of transport poverty and the concept is not used in policymaking (Bogaars, 2020) – although it occurs in government reports (e.g., Lucas et al., 2019; Government Office for Science, 2019; Gates et al., 2019) and empirical indicators have been put forward by researchers and third-sector organisations (e.g., Lovelace and Philips, 2014; Mattioli et al., 2018, 2019; Sustrans, 2012; 2016 2022 – see Appendix A). Limited programmes exist to alleviate transport poverty, although across the UK there are some discounted transport fares for people aged 60 and over (Age UK, nd), 'eligible disabled' (HM Government, nd), (discretionally) for jobseekers in receipt of state welfare, and in Scotland, free transport for ages 5–21. This context across the four UK nations provide varied study locations, given the fragmented definitions and policy support regarding DEV. At the same time, there are overarching similarities resulting from UK government approaches including austerity, resulted in the reduction of state spending on public

services (Hall, 2019a,b).

3. Research design and methods

Our research provides new qualitative empirical data of people facing DEV in the UK, informed by a systematic review on DEV by Simcock et al. (2021b). The review guided our sampling strategy, as we sought to interview people at greater risk of experiencing DEV, i.e. people on low income; people with pre-existing health conditions and/or mobility difficulties; households with children or dependents (especially single-parent households); ethnic minorities; and women (Simcock et al. 2021b, see p. 11). We also recruited participants from across the urban–rural spectrum and in a variety of locations throughout the UK (as discussed below). In doing that, we go beyond previous studies of the lived experience of DEV, which have often focused on specific (and particular) spatial contexts such as affluent Norwegian cities (Sareen et al., 2022) and informal settlements in Mexico City (Furszyfer Del Rio & Sovacool, 2023), and communities (Sovacool & Furszyfer Del Rio, 2022).

3.1. Data collection

We conducted 59 semi-structured interviews in October 2020-June 2021. We aimed to examine experiences of DEV in multiple urban, *peri*-urban and rural locations in England, Northern Ireland, Scotland, and Wales. We included all UK nations as they differ in terms of spatial income distribution (ONS 2022), population density (ONS, 2020), housing type (Piddington et al., 2020), rates and definitions of energy poverty (NEA 2021 – see Appendix A) and indications of transport poverty (Lovelace and Philips, 2014; Mattioli et al., 2018; Sustrans, 2012; 2016; 2022 – see Appendix A). By conducting research across the UK, we sought a more diverse understanding of how people experience transport, energy and DEV in particular spatial contexts. We interviewed people in or near to four city locations: Liverpool (England), Belfast (Northern Ireland), Dundee (Scotland) and Swansea (Wales). These were chosen as all have: 1) a sufficiently large population in their respective nation; 2) a mixed level of affluent and deprived areas; and 3) close-by semi-rural areas, leading to the potential inclusion of participants who travel longer distances to essential places like school or work. Second, as unexpected COVID-19 lockdowns meant a lower than anticipated recruitment in these cities, we extended our locations to allow for wider participation.

The interviewee sampling strategy considered socio-demographic and spatial issues such as location, employment, potential pre-existing health conditions, age, income, and housing tenure. Study participants were recruited via two complimentary routes, and a full ethical review was completed at the University of Sussex prior to data collection. At first, as COVID-19 lockdowns prevented face-to-face interviews, we used an *online recruitment tool* "Call for Participants" (https://www.call forparticipants.com), which allows participants to submit interest in taking part in research via a web-based platform. The website link was circulated by our research partners via their networks using email and paper advertisements. Those who submitted interest were then contacted by the research team to check for eligibility and arrange an interview. 20 interviewees were recruited this way (11 in Liverpool, 6 in Swansea, 2 in Dundee and 1 in Belfast). Second, a non-academic *partner organisation* promoted the study via their networks and telephone helplines in all four nations, and collected details of those who showed interest in taking part in the study. These contact details were shared confidentially with members of the research team via a data sharing agreement. The researchers then contacted the participants directly to arrange an interview. 39 interviewees were recruited this way (15 in Northern Ireland, 19 in Scotland and 5 in Wales). It was particularly helpful for recruiting people who may have been unable, for various reasons to access the online route, putting the research team in contact with people from ethnic minorities, with refugee or migrant

backgrounds, single parents, and/or with pre-existing health conditions. All interviewees were provided information about the study and asked for consent before interviews, ensuring anonymity, confidentiality and data protection.

We co-developed interview questions together with the partner organisation to crosscheck suitability and the scope of potentially sensitive questions (such as, welfare benefits, level of income, gender, disability, and marital status), whilst also ensuring the collection of academic and policy relevant data. Questions covered energy and transport service use; provision and expenditure; choice; any trade-offs between different services; and whether services could be improved and by whom. We also asked about people's experience before and during the COVID-19 pandemic (though the focus was not on COVID-19 impacts per se). Participants were also asked to fill in a general socio-demographic background questionnaire covering age, gender, education, income, marital status, number of children, housing tenure, religion, ethnicity, and weekly spend on energy and transport. The questionnaire allowed potentially sensitive topics to be covered in a discrete way. Interviews lasted 10–59 min, with an average time of 30 min. Some interviews were shorter due to interviewee's time availability and response length. Two participants declined to answer the socio-demographic questionnaire. All interviews were digitally recorded, and transcribed by an external transcription company. All participants were also sent a £30 supermarket voucher (of their choice) in recognition of their time and contributions (see, Warnock et al., 2022). To protect anonymity and confidentiality, all interviewees are referred to using randomly generated pseudonyms (see also Table 1 and supplementary data).

3.2. Data analysis

We analysed interview transcripts using a thematic and narrative approach (Braun and Clarke, 2006; Chase, 2005; Hunter, 2010) on QS International NVivo12 software. This analysis was guided by a coding protocol based on the interview questions and conceptual assumptions of DEV. We were particularly interested in energy and transport poverty intersecting, whether people had to make trade-offs between energy and transport services, and what implications this had on quality of life. We conducted coding in two phases, with two people coding a first round, which was then double-checked by two other researchers. Our coding protocol was iterative, so we could add new codes as they emerged. In the end, we had a total of nine 'parent nodes' (agency; aspirations; causes of energy and/or transport poverty; covid19 impacts; home energy experience; impacts of energy and/or transport poverty; neighbourhood; prioritising; and transport experience) and 80 more specific 'child nodes'. In our final analysis, we identified those nodes with evidence of DEV, which led to four main themes guided by contextual vulnerability and lived experience: (1) being locked into infrastructure, (2) facing high costs and low incomes, (3) choosing between energy and transport, and (4) missing out.

3.3. Study limitations

Our study has some limitations. Our initial research design aiming for face-to-face interviews (e.g., at advice centres, food banks and community spaces) had to be redesigned due to COVID-19 lockdowns

and all interviews were conducted online or over the phone. This meant people without phone access could not take part in our study. Similarly, the online recruitment tool would have excluded those without Internet access, although this was mitigated by the partner recruitment. Interviews were conducted in English, which excluded people without the confidence to do so. As English was also not some of our interviewees' first language, they could have had limited opportunity to fully express themselves (the study had no translation resources). We also found that most respondents were facing DEV, but there were some participants that were not explicitly in energy and/or transport poverty even though they may have had some issues with costs or access, for example. Nevertheless, having these interviewees, who turned out to be in comparatively 'better' circumstances, enabled a direct comparison with those participants experiencing severe hardship and exclusion, further highlighting underlying DEV causes. Finally, as we are reporting on qualitative findings, we do not and cannot make any claims of representativeness of the UK population.

4. Results: Lived experiences of double energy vulnerability

Our results are arranged in four narrative themes of DEV: (1) being locked into infrastructure, (2) facing high costs and low incomes, (3) choosing between energy and transport, and (4) missing out. The intersections between energy and transport became evident across these, especially when people traded one service for another (e.g., using a pre-payment meter at home for heating which meant having no money for bus and needing to walk). We present our results by illustrating each section first with a narrative story representative of DEV across our interviewees.

4.1. Being locked into infrastructure

Hasim (SCO12) lives with her three children in a two-bedroom rented council flat in Scotland. The flat has damp and rarely heats up as much as the family would like. This means they need to pay more on the pre-payment meter than they can afford, which eats into the family budget. Hasim describes a cycle of opening and closing windows and turning heating on and off to find a good temperature throughout the year. Hasim walks most of the time, but must sometimes use the bus (for example to get to the city centre) - in these cases, she needs to take two buses due to the fragmented and complex public transport network. When they are travelling as a family, they walk, because the cost of public transport (buses and trains) is too high. Hasim has had to use a credit card in the past, reducing the available money for the next month. As a single mother in part-time employment, Hasim budgets carefully to balance her children's needs in terms of travel, clothes, food and using the meter. Her lack of choice over housing and public transport leaves little money for other things that might be considered 'non-essential'.

Being locked into infrastructure relates to the choice people have for using and accessing energy and transport services, whether it is infrastructure in-house (e.g. energy use at home) or out-house (e.g. public transport use). These lock-ins include issues such as housing quality and transport provision. Our interviewees report living in poor quality homes that are hard to keep warm and have expensive energy technology such as oil-based heating (particularly in Northern Ireland), electric storage heaters, or pre-payment meters which have the most

Table 1
Summary of research participants' location and gender.

Location	England	Northern Ireland	Scotland	Wales	Total
Number of participants	11	16	21	11	59
Gender*	Female: 7	Female: 12	Female: 12	Female: 5	Female: 36
	Male: 4	Male: 4	Male: 9	Male: 6	Male: 23
Anonymised participant identifier	ENG01–ENG11	NI01–NI16	SCO01–SCO21	WAL1–WAL11	

* All participants self-identified as either female or male.

expensive tariffs (Ofgem, 2020). Other issues include faulty housing: broken, draughty windows and doors that let cold air in and leak in the rain, holes in walls causing draughts, doors not closing properly, broken boilers and radiators, water leaks and mould and damp walls – all leading to inefficiencies, and increased expense trying to keep a home warm and dry. These issues are often constrained by tenancy status, and whether landlords (in both private and social housing) are proactive in providing good quality housing. Many renters like Hasim, above, are not allowed to make changes in their homes, having to rely instead on landlords, being on long waiting lists and chasing repairs. Many are afraid to ask for repairs, as Emily (SCO02), a single mother of two children who lives in private rented Scottish home with poor single-glazed windows stated: "*I'm not going to rock that boat, because I'm sure if I asked for double glazing that my cost of my rent would go up, which is just not affordable*". Daina (SCO10), a single mother with two children living in a rented council home in Scotland whose first language is not English, was unable to get help with expensive pre-payment meter either from the social worker who helped her to call the energy utility, or the energy utility themselves. The meter costs are too expensive for Daina who is unemployed. The flat is hard to keep warm, with a heating system that does not work properly, meaning Daina's home is "*very, very cold*", causing her severe stress:

"That meter, since I moved to here, I was so crying. These things make me so sad about the meter. And I complained, I called, but no solution. No solution. If I call for the [energy supplier], for the meter, because my support worker tried to help me to call them. But it's different, different something the [supplier] tell us all the time. At times, they said they did not see the meter reading in their office. And I'm paying, 60, 50 lb every week. It's too much. At times, it's five days. At times, it's seven days. 50 lb finished. And I say why? This thing is too much." Daina (SCO10)

Expensive technologies like pre-payment meters are predominantly offered to households with poor credit ratings or low incomes. In addition to this, household appliances are not always compatible with the household's needs, such as Uzma's (SCO17) fridge which is too small for her and her three children, requiring her to do frequent food shopping trips and thus meaning higher travel costs.

As for transport, many interviewees had issues accessing public transport services, for example, due to a lack of public transport, this emerged particularly for those participants living in Northern Ireland, which has limited train network, or those in rural areas in the other nations. This often resulted in 'forced car ownership' (Mattioli 2017), i. e. having to own an expensive car despite being in material deprivation and/or absolute poverty, or relying on costly taxis. For Julia (NI10), who is retired and lives with her son, the challenge with Northern Ireland is that, due to a lack of a viable public transport network across the country, car ownership is necessary unless a person lives in a city like Belfast or Londonderry: "*a car is totally compulsory and then all the bills that come along with it, you know? There are no other options*". In some cases, forced car ownership is cultural, rather than structural, reflecting how car use is taken for granted. Imran (ENG01) who has access to public transport, feels pressured to own a car, even though he can hardly afford it: "*I've always driven since I passed my driving test. My dad has always had a car. Everyone in my family has had a car. Public transport is not considered normal in my family household. I never questioned that with my dad as well and why public transport is not deemed to be fit*". For those participants with available public transport options, these are often not adequate or trustworthy regarding routes and scheduling, as illustrated by Rehana (ENG11) living in England and who has to commute for work: "*I couldn't catch a bus at all, because they were very unreliable. Like every hour, or miss an hour, or you've just missed one. You're never going to get home*". Or services are limited in terms of price and availability, as Daniel (WAL06) highlights: "*I think they need to reassess how much they should charge. I feel like it is really expensive for bus travel. It is hard to say that they should put on more buses, you know, because they cannot really do*

that, or have more seats available at the moment because of COVID". This locking into infrastructure and poor systems of service provision is compounded with high and rising costs of energy and transport, low incomes and a complex state welfare system that brings hardship to many, as the next subsection shows.

4.2. Facing high costs and low incomes

Amanda (NI14) and her husband live in a rented house in a town in Northern Ireland. Both have health conditions that prevent them from working. They have oil heating and a pre-payment electricity meter. Heating is important for their health, yet their oil-heated home gets very cold in the winter. Neither Amanda nor her husband drive, so they do not have a car. This has meant Amanda has not been able to buy large quantities of heating oil, but has had to get smaller, more expensive, oil barrels. Their heating bills have been high, and coupled with expensive electricity, Amanda has rationed energy use. As typical for Northern Ireland, Amanda has no public transport options nearby so relies on taxis to go anywhere. Most journeys are for necessities like the weekly shop or health appointments. A few years ago, Amanda's husband's state disability payment was stopped without notice, making it hard to afford energy and transport services for two years. They rationed energy use by turning off heating and all electric appliances, occasionally including the freezer. They borrowed money from their daughter for the limited electricity and heat they needed to get by, and relied on her for journeys. On occasions, they had to cancel health appointments when they had no money for taxis. Amanda's husband's disability payment was restored and their situation is better. They no longer have to think when to put the heating on as they have a credit account with a local oil supplier. However, the lack of public transport makes Amanda feel confined. Their local taxi firm, which did not use to have metered journeys, now has them. This makes budgeting for taxis difficult as the same journey can have a different cost, with most journeys having doubled in price. Being trapped at home due to a lack of transport options means that Amanda's energy use inevitably increases. Amanda is now watching the meter at home for electricity and during their essential journeys also for the taxi fare.

Facing high costs and low incomes is an issue shared amongst many respondents. Unsurprisingly, price rises affect particularly people who have low incomes, limited state welfare payments and/or little financial resources. Many respondents had incomes under £20,000/year, which is below the UK average (median pay was £31,772 in 2021 (ONS, 2021b)), and many more were receiving state welfare payments which are not enough to meet rising costs. As Katie (SWA03), who lives on a tight budget with her partner and one child on the periphery of a city in Wales, highlighted: "*people cannot believe how we are surviving. To be honest, we do not really know how we are surviving but we are*". For Linda (WAL08), an older unemployed woman living in Wales, losing her job after an accident meant changing from a regular energy payment system to an expensive pre-payment meter which then got her into debt because of the increased costs. In Northern Ireland, a single mother of three children, Donna (NI03), described how her energy costs "*have doubled, I would say, over the last two years*", and the limited public transport provision means a reliance on an "*essential*", yet increasingly more expensive, car as "*the kids have to get to school*". Many are subject to what we refer to as 'forced walking', as they cannot afford *any* transport services, even if they have access to them, as Emily (SCO02) showed:

"Walk, walk, walk. I do feel a bit bad on my younger kids, so I have carriers. I have got a pre-school carrier for my five-year-old, and I have got a small carrier for my youngest, so I can just sling them on my back. Some of the places we go, for example, if they were going to their grannies, it would be a short bus trip, but it is £4, but it is an hour walk each way, so I would just walk and just put the kids on my back half-way through." Emily (SCO02)

For Tarek (SCO18), originally from Romania and living with his wife

and two children in temporary accommodation in Scotland, walking and carrying heavy shopping bags contributed to back problems and subsequent medication which then made him tired and affected his ability to look after his children. Other participants were forced to use credit cards or loans to afford their daily expenses. Lauren (ENG06), finds it hard to predict how much money she is spending on petrol monthly. This uncertainty means she relies on credit cards and loans as a backup, ultimately leading to a vicious cycle that does not allow her to escape from debt and anxiety:

> "You need to pay it off [the debt], so you are trying to make all ends meet, so buying the petrol while trying to pay off the card at the same time, you do that at the beginning of the month and then you end up having to re-use the credit card towards the end of the month because you have fallen short of real funds. So yes, it is a catch-22 really horrible cycle, trying to get out of it…until you can, kind of, outdo that, really and be ahead". Lauren (ENG06)

The complexity of the state welfare system for those who depend on it makes high costs worse, and many respondents live on very low incomes and/or receive state benefits such as the Universal Credit or Disability Living Allowance (DLA). The way the welfare system operates, and is organised, brought plight to many, as illustrated by Amanda's husband losing his DLA without any notice at the coldest time of the year:

> "It's an awful process, because when my partner was in receipt of DLA before, and they just stopped it all of a sudden, with no notice. Just said that he wasn't entitled to it anymore. And I mean, the ridiculous thing is, that his condition, it's not going to get any better, it's only going to get worse, or at least stay static, with medication. But I know that there were a lot of people in the same boat, and indeed, there still is today lots of people that are losing benefit. And it's such an unfair system, and it really, really is. But what made it even harder, was getting absolutely no notice at all…. we had a lot of tough weeks here, because it happened in January, the January of that year. I mean, you know, in the middle of winter, when you're using more electric, more oil, everything. And well, we had a very poor couple of years there. We really did. But as I say, just the past six or eight months, things have transformed. I mean like, if… Just knowing that you don't have to fear putting the heating on anymore, you know? Because you can't afford it." Amanda (NI014)

Participants also highlighted how disability benefits are not available in equal measures across the UK. Paul (NI07), who has a disability and lives with his wife and three children in a rented social housing home in Northern Ireland, explained how free bus passes were limited as "*we are the only part of the UK that you have to be registered blind, and blind only, to get free travel on buses and trains. I'm registered partially sighted and people [who] have brain troubles, like epilepsy, they can only get a half-fare bus pass*". This shows the lack of consistency in provision of support across the four nations, which leads to frustration, as Paul continued that both energy and transport costs were going up: "*the electric is through the roof. The electric, it has just gone up and up and up… The energy this day in Northern Ireland. There is a great difference in prices between the energy bills, and as for the Transport Agency, insuring a car, it is £200 or £300 more expensive here in Northern Ireland than it is in [the rest of] the UK. As for fuel, it is a lot more expensive here too.*" These issues can be further exacerbated for undocumented communities or people with No Recourse to Public Funds (NRPF). Manuel (WAL02), a Latin American refugee living in a city in Wales pointed out that: "*many asylum seekers or refugees I know, they avoid to travel by bus because they get lost, and they spend a lot of money. So, here the system is horrible compared to London, and some people told me that Cardiff is better, but I think here it's horrible*". As these quotes show, participants felt that they have no control over the high and rising costs impacting their lives, as these are caused by external conditions beyond their influence. High costs and low incomes mean having tight budgets and taking out loans in order to carefully

monitor expenses to be able to afford essentials such as food, energy and transport services. This means also navigating between welfare benefits, housing markets, health services and debt. And, in many cases, people must choose between different services, especially those of energy and transport, as we elaborate next.

4.3. Choosing between energy and transport

Manuel (WAL02) is a Latin American refugee living in a three-bedroom council flat with his partner and two children in a city in Wales. The apartment is poorly insulated, has damp and feels chilly as there are air leaks in the windows. Manuel struggles to pay the energy bills because he is employed part-time with an income of less than £10,000. Before he came to the UK, Manuel would take multiple showers a day, but now he cannot do that as having showers uses too much water and too much gas for heating it. Manuel has stopped using the bus because the cost is too high, the company is not friendly, and drivers do not stick to the scheduled arrival/departure times. When his family uses the bus, they do not know when to get off because there is too little information for users. While his children and wife continue to use the bus, Manuel uses the bicycle to save money. The whole family used to cycle, but as they now live in a hilly area of a city, it is too hard for his children to do so. This means a big part of their budget goes towards paying for the bus.

Choosing between energy and transport shows how the use of these two services is sometimes carefully negotiated by those at risk of DEV. Many participants prioritised energy over transport to keep their homes warm, especially during COVID-19 lockdowns when they were spending more time at home. In some instances, interviewees could not afford to alter their energy use as much as they hoped for, as they had to ensure a warm home for their children or for health reasons. Amaya (SCO16), a single mother renting a two-bedroom council home in Scotland, only used one room for eating and sleeping because the rest of the flat was cold: "*I am not using all the heating. I am just putting electric heating on in the living room… It costs me a lot and I just make one room warm. The heating boiler is working altogether and it costs me a lot… I just have been sleeping, sitting, eating in the living room, because it was so cold upstairs and I was struggling to pay with paying bills*". For other interviewees, transport was crucial for getting to places of work or study, like for Rehana in England (ENG11), who commutes daily to another city for work. She prioritises transport over home energy, as she needs to get a taxi to the train station and then two trains to the city. As she put it: "*Because I have to work to get some money coming in, I do not have any options about transport. But I can reduce the consumption of my energy. I think not using it. When is broad [day] light, so I am not using as much electricity*".

For some participants, it is difficult to prioritise energy over transport or vice-versa. This forces them to *negotiate* their lived experiences vis-à-vis these two dimensions to, for example provide for relatives, cheer up other people or to stay warm. Manuel's case, for instance, illustrates how he decided to pay for a bus for his family while he cycles every day, despite living on the top of the hill outside of the city centre. He thereby saves this money for other household bills: "*I can afford to pay the bills and some extra costs because I am cycling, so the money I could use to pay for the bus is going to pay bills and to cover other essentials*". Along the same lines, Youcef (SCO14), a retired man living with his wife and three children in a housing association flat in Scotland, found a way to save on bus fares while being able to provide his children the joy of a restaurant meal. Since he cannot afford to pay bus tickets (£8 or £9) for all the family to 'eat in', Youcef goes to the restaurant alone and brings a takeaway back home on the bus. This allows him to: "*buy them something nice to cheer them up. You know, to cheer the kids*". Other participants, on the other hand, negotiated between the use of heating and appliances (e. g. microwave or washing machine). Luca (ENG05), a man living in a listed building in England, recounted how the pandemic lockdown made him cut back electricity use, due to a reduced disposable income: "*that extra £30 or £40 that I am spending on my electricity means I do not do other*

things. I have had to cut maybe a meal out once a month [...] So, I have had to cut down from that".

Some households are unable to *be flexible* on transport or energy costs. These households have tight budgets, often owing to low income, and are therefore very careful with fixed costs. This resonates with Donna (NI03), a single parent with three children. Along with a rise in electricity bills in the last three years, Donna has to drive long distances every day to work and to her children's school. This puts her in a position where she cannot be flexible on energy or transport costs: "*I cannot, obviously, be at home and not cook a meal for my children, so that is priority. I cannot, in the depths of the winter, not turn on the heat*". To not be able to prioritise means that Donna tries to save by reducing the food budget and postponing visits to family or friends. For Ian (WAL07), living in Wales with his wife and son in a house on the edge of a city, both energy and transport are equal priorities and neither are flexible: "*You have to pay it, and you do not have a choice of, "Shall we use it or shall we not use it?" it is got to be, without a car you cannot get to work, so you need a car to get to work to earn money*". Consequently, this means for Ian, and others, that they have to reduce money spent on other issues, meaning ultimately missing out on the 'little extras' as Ian put it: "*it is not something that we do anyways, but those kinds of things you would not be in a position to afford*". We explore this more next.

4.4. Missing out

Lisa (ENG07) lives with her partner and son in a two-bedroom cottage in England. She is employed full-time and owns her house with a mortgage. Her family went into debt with their previous energy provider without realising, because they were not paying the correct amount per month, as they had not submitted their meter readings. Rising energy bills are a concern to Lisa. Transport costs are variable due to Lisa's mobility impairment, which requires flexibility in decision making based on how much pain Lisa is experiencing, whether the train or car are comfortable, and if there is a delay or too much traffic. This uncertainty makes Lisa more aware of the family's budget. Taking any trip feels like a luxury. In this context, decisions to go and meet up with family or friends are influenced by the cost of travel because Lisa cannot afford to use the train or car unless she really needs to. To save money, the family do not go and see friends so that they can prioritise heating their home. But this decision has consequences: they miss out on being sociable and seeing loved ones, which impacts upon Lisa's mental health.

For many participants, reducing the use of energy or transport services has other impacts, for instance travelling less can mean fewer leisure trips, and less social interaction. But it rarely ends with energy and transport. Many spoke of also reducing the quantity and/or types of food they buy, and not buying any new or second-hand clothing, for example. One of the key issues for the research participants related to missing out on the ability to go out of town to the countryside or to visit family and friends. For example, Christine (NI02), who lives in a small town outside a big city in Northern Ireland, said the lack of reliable public transport in Northern Ireland prevents her from enjoying the countryside: "*if there was transport links there available, I would 100% jump on the train and go up there the day because it is about a two-hour drive. I do not want to drive for two hours, but I will happily sit on a train and relax*". Emma (SCO01), highlights how high train prices in Scotland prevent her from visiting family out of town:

> "I would love to go and visit family out of town on a regular basis, but, for example, say I was going to family that live in Glasgow, it could be £30 return for a train ticket, you know? Well, I would love to do that every week, but £120 a month just would not be viable for paying for transport to do that [...] I love my train trips to family out of town, but it's just not the kind of money that you could shell out every month to commit to." Emma (SCO01)

Living in DEV also entails missing out on issues that contribute to

dimensions of life deemed important to participants. For Daina, in Scotland, being in DEV prevents her from being able to purchase African diaspora food which is more expensive, but also involves a trip beyond the local shops so also has extra transport costs. But being able to cook foods from 'home' is important to her and for teaching her children about their culture and cuisines: "*our African food is too expensive. It is expensive [...] If I want to buy that one, because I said about the meter, is too much for me*". Likewise, as Farhan (ENG09), a married man living in England, put it: "*I would be to spend less on transport and less on energy so that I can spend more on myself and my wife improving quality of life, like going away or trips or going out or eating out, stuff like this, which helps the health and well-being.*" Thus, it is both *physical* and *mental* health which is impacted by DEV.

Living in DEV also implies changing behaviours to be able to afford energy or transport, usually at the expense of something that was important to the respondents. Some can use public transport or energy only for essentials like the weekly shop or keeping the fridge switched on. On these occasions, participants have had to give up something else, like little pleasures (e.g., a takeaway meal). James (SCO11), a single father living with his teenage daughter in Scotland, explains how parents often prioritise children's wellbeing, ensuring they have a warm bedroom, appropriate transport and sufficient food. He recounted how he would keep the heating on in his daughter's room until she goes to bed: "*I always put her as a priority. So, if I need something and she needs it as well -like heating or transport – I think I need to forego mine for her*". As this shows, James has had to limit his expenses to be able to pay for the essentials and priorities for his daughter. Finally, Joe's (SCO06) case also sheds light on changing behaviours at the expense of something else. Joe, as explained in Section 1, lives in a cold home, and for a long time survived because a charity provided him with sandwiches. He had to miss out on things in life that were important for him, but also those that could impact his life chances, like getting a job:

> "Of course, living a normal life with all the normal bills and expenses. I was a smoker. Very rarely drink but I have always been a smoker. So I had to cut down and stop that as well. There are very little pleasures outside of the electric and food. Literally, the parameters of existence were reduced to food and electric. There is literally, nothing else that you can spend your money on because you did not have any… If you are going for a job interview and you have got to walk five miles, you get there all sweaty and uncomfortable. So it has a domino effect on every aspect of your life, whether that be an interview or going for an appointment, or even having a bath, because you have got no electric often." Joe (SCO06).

Missing out is thus not only about getting through the day, but as with the other themes, there are spatio-temporal dimensions too. Life becomes about surviving, removing costs that are not deemed to be 'essential', which differ based on particular social, economic, and spatial contexts. This can take a significant mental and emotional toll (Pellicer-Sifres et al., 2021). Intersecting poverties such as DEV contribute to social exclusion, made worse by inequalities that are linked to inadequate infrastructure, over which people have very little agency. This can, in turn, then reinforce existing deprivation and inequalities.

5. Discussion

Our results show that DEV is caused by multiple factors, with complex impacts on people's quality of life. A major cause of DEV is people's *limited agency* regarding energy and transport services and infrastructures. There are institutional, infrastructural, contextual and spatial conditions that limit available and accessible energy and transport services. For example, the uneven public transport provision across the UK (e.g. lack of buses in rural areas, or trains in Northern Ireland), a lack of adequate transport infrastructure provided with newly-built homes (e.g. few nearby public transport stops and other key services not within easy walking distance – see Transport for New Homes, 2022),

or unreliable and expensive energy infrastructure within homes (e.g. unreliable heaters and costly pre-payment meters). Limited agency to alter these infrastructural circumstances then disadvantages and locks people into situations that cause, and further enforce, DEV, leading to *infrastructural inequalities* (Golubchikov and O'Sullivan, 2020; O'Sullivan et al., 2020). These inequalities then affect the lived experiences of those in DEV, and the ways that people move in, out and through DEV due to constantly negotiating shifting contexts and landscapes of vulnerability (Bouzarovski, 2014). When people are already locked into poor housing and transport infrastructure, low or reduced incomes and high fuel prices mean that they became more susceptible to DEV, and external pressures like climate change can make this worse (e.g., Osberghaus and Abeling, 2022). For many households, DEV is cyclical, affected by seasonal variations and changes in personal circumstances. For those who are on reliant on state welfare for their income, insecurity can occur in multiple ways, including financial payments that can sometimes be stopped abruptly (Middlemiss and Gillard, 2015), but also regarding uncertain help with transport costs and short-term policy changes or actions (such as the 6-month £2 bus far cap, [Department for Transport., 2022a, 2022b]). Where these overlap, they reinforce vulnerability to DEV. Further sudden changes to income and/or state welfare can lead to serious problems for people facing DEV, unable to use *either* energy or transport services.

As a result, DEV *impacts on quality of life* as it requires people to choose between essential energy and transport services, or between these and other basic essentials. By being forced to prioritise in this way, people must make difficult choices over whether to use electricity at home or take a bus, for example. This negotiating and prioritising between different services varies between households and their members. It can mean difficult choices especially for those who are already affected by structural inequalities mentioned above, for example resulting in the use of expensive 'forced' pre-payment meters or car ownership. The latter, in some cases, being reinforced by cultural differences around the impacts of vulnerability (e.g. O'brien et al., 2007) such as the assumption that driving is the "normal thing to do" and that there is a preference to own a car (Urry, 2004; Walker et al., 2022), even at the expense of getting into debt. In other circumstances, DEV-related 'forced walking' can have impacts for those with health conditions and highlights the need for careful planning of low-carbon 'active travel' policies (Middleton, 2022). This constant act of vigilance and prioritisation is ongoing and exhausting, and can degrade a person's mental, emotional and physical health (Pellicer-Sifres et al., 2021), yet it is also unpredictable. For example, daily, weekly or monthly budgets can change depending on the frequency with which bills occur, but also how they may be shared unequally across household members. For some, seeing family and friends is highly valued or culturally expected, but becomes a luxury when the alternative is a cold house or hungry children. The negotiations make life more difficult, and in the current cost-of-living crisis are likely to have already become more frequent. When trade-offs cannot be made, households are often forced into debt by using payday loans and credit cards, which creates future problems when trying to pay off debt as well as cover day-to-day costs.

People in DEV miss out on a variety of activities beyond energy and transport, including leisure activities, certain foods and new clothes, while others must cancel or reschedule hospital appointments as they cannot afford transport. These, in turn, can have additional physical and mental health implications. This missing out is also relational, with many people in DEV unable to visit family and friends as much as they wanted to, notably because of the cost of travel (and regardless of COVID lockdowns). Here our qualitative findings dovetail with previous studies that find energy and transport affordability can harm social relationships and contribute to isolation, with subsequent impacts on well-being and mental health (Middlemiss et al., 2019; Pellicer-Sifres et al., 2021; Prakash et al., 2020; Willand and Horne, 2018). An important finding of our study, which little other research has documented (see Bouzarovski and Cauvain, 2016 for a brief discussion), is that refugees can be

particularly affected by DEV. Those who are undocumented or have No Recourse to Public Funds status, and have usually the lowest incomes, can struggle with issues like not being entitled to state benefits, not having the right to work and not being eligible for free school meals (e.g. Benton et al., 2022; O'Connell and Brannen, 2019), which our research suggests can then increase also their risk of DEV. This is an important avenue for further research.

6. Conclusions: eating, heating or taking the bus

In so-called 'high income' countries around the world, like the UK, there is increasing concern for households facing double energy vulnerability (DEV). As previous research has shown (Simcock et al. 2021b), it is not only household income that marks vulnerability to energy and/or transport poverty, but the cost of services, access and availability of services, payment types, the materiality of the home, the home's location, and also household make up, age, and disabilities, suggesting forms of contextual vulnerability (O'brien et al., 2007).

In this paper, we have sought to provide further evidence to uncover the ways that DEV is lived – and experienced – by 59 diverse participants in a range of urban and rural locations across the four UK nations. We make a contribution by showing that DEV is a contingent and ongoing phenomenon that brings trade-offs between different priorities for households across the UK, forcing households to negotiate the use of energy and/or transport services in order to survive, which often leads to social exclusion. By shedding light on those complex trade-offs and negotiations, we go beyond previous studies where the overlap between energy and transport poverty has sometimes been noted, but rarely investigated in detail as an ongoing, contingent and dynamic process. We find that by examining the lived experience of DEV, we can uncover how the intersection of multiple forms of poverty is underpinned, and further exacerbated, by overlapping and mutually reinforcing structural inequalities (Bouzarovski et al. 2022; Simcock et al., 2021a, 2021b). Here, a pernicious combination of high costs and rising prices, low-incomes, infrastructural inequalities, spatial contingencies and navigating a complex welfare system that is constantly in flux, leads to many individuals and households experiencing forced exclusion from educational and employment opportunities, while having to make difficult trade-offs between essentials such as energy, transport, and food in their everyday lives. This is compounded further by exclusion from vital social and leisure activities that are fundamental to a healthy and fulfilling life. Our findings also show overlaps between the lived experience of DEV and the lived experience of food poverty.

With the benefit of empirical material across the four nations, we show how, within the constraints of local and national political economic conditions, households differentially find ways to negotiate and cope, often foregoing some activities to be able to do others. While this might happen on the household level, it also happens within households. The home then becomes a site of DEV, affording some actions while foreclosing others – not only because of its built capacities, but through connections to local services, energy and transport providers, employment, health services, educational opportunities and more. If the pattern of increasing costs and inflation continues, DEV will only worsen, with more people experiencing these negotiations and trade-offs.

Perversely, the same combination of factors and structural inequalities that underpin DEV may also contribute towards exclusion from many aspects of the growing Net Zero economy., For example, those experiencing DEV may be excluded from installing electric heat pumps in certain homes, due to a lack of agency, or may not be able to access or own an electric vehicle due to a lack of space or charging infrastructure, or to purchase vegan food products due to associated costs (Barrett et al., 2021).

We also find early indications of regional differences across the UK, for example, with many of our participants discussing the lack of adequate public transport and exhibiting a high reliance on expensive oil heating in Northern Ireland (Sovacool and Furszyfer del Rio, 2022).

This might suggest that Northern Ireland is the constituent nation of the UK where issues of DEV are likely to be most pronounced. This regional pattern of differences and commonalities in the prevalence and lived experiences of DEV requires further investigation.

In addition to further expanding comparative analyses of DEV, we signal a number of future research directions, this includes:

- development of both the conceptualisation of DEV and how DEV may worsen existing issues around access to sufficient energy and transport services, but also how DEV may relate to food poverty. Currently, transport may be a vital consideration left out of the widely acknowledged trade-off between 'heating or eating' (Beatty et al., 2014) in energy and food poverty discourse;
- the need to consider how DEV is conceptualised in relation to infrastructural inequalities, such as poorly insulated homes or inadequate public transport links (and related issues of 'car dependence');
- further interrogation of how the lived experience of DEV can be further elucidated and expanded,such as through development of ideas around 'forced walking';
- more research on and with 'under-researched' groups such as refugees and recent migrants (e.g. Bouzarovski et al., 2022);
- regionally and contextually specific research that considers unique governance and policy frameworks (e.g. in Northern Ireland) for understanding DEV and tailored solutions to DEV.

Methodologically, we find strength in using approaches that capture lived experience and particularly in representing the empirical material via vignettes - such as Joe's words in the Introduction, explaining how he was *kept alive* by a charity when he was experiencing DEV (Van Lanen, 2021; Groves and Henwood, 2021). We argue that such an approach humanises the narratives that are presented in energy and transport research, and offers powerful language to engage with policy makers and the public.

Whilst we welcome further research into policy avenues that tackle DEV and point towards our other work in this area (e.g. Upham et al., 2023; Sovacool et al., 2023; Simcock et al. 2021b), we also offer early reflections here. Our findings highlight how the study of lived experience can inform more inclusive policy making that takes into account the perspectives of those that are affected by diverse vulnerabilities related to different sectors, such as energy *and* transport, at the same time (e.g. Upham et al., 2023; Sovacool et al., 2023). This also means that there is a need for policy makers to (1) recognise the intersections between transport poverty and energy poverty; and (2) seek broader reaching and more systematic accounts of the varying personal circumstances, tensions and trade-offs across energy and transport service availability and use; in order to (3) develop a more integrated approach to mitigate DEV at the policy design stage, and to avoid extending energy or transport poverty by misunderstanding the relational intersections. This may mean, for example, policies to increase the accessibility of public transport, such as expanded networks and lower fares, potentially with additional discounts for those deemed most at risk of DEV. In the energy domain, a national energy advice network (Bouzarovski et al., 2023), funding for energy efficiency improvements, and the implementation of 'social tariffs' in the energy sector (e.g. Sovacool et al., 2023), are potential solutions that warrant further consideration. Despite the diversity of lived experiences of DEV documented above, in combination such systemic interventions would broadly assist many of those most vulnerable to DEV in our analysis. It is also crucial that such policies are *central* to new net zero societies, as they can potential help mitigate against distributional injustices arising from the rapid rollout of new low-carbon technologies. Without decisive action, there is a danger that DEV will become the norm for many more households, particularly amidst rising energy prices and inflation.

CRediT authorship contribution statement

M. Martiskainen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **D. Hopkins:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Funding acquisition. **G.A. Torres Contreras:** Validation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **K. Jenkins:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Funding acquisition. **G. Mattioli:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Funding acquisition. **N. Simcock:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Funding acquisition. **M. Lacey-Barnacle:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Giulio Mattioli reports a relationship with Centre for Research into Energy Demand Solutions that includes: consulting or advisory.

Data availability

The data that has been used is confidential.

Acknowledgements

Appendix A. . Summary of energy poverty and transport poverty context in the UK nations (note: The table uses the term fuel poverty as this is used in official documents)

Nation	Official fuel poverty definition	Incidence of fuel poverty	Energy market provision	Official transport poverty definition	Incidence of transport poverty	Transport provision
United Kingdom	No unified defition for the whole of the UK	Not officially recorded for the	See Great Britain	None	In 2012, 46.5% of households were affected	See below

(continued on next page)

(*continued*)

Nation	Official fuel poverty definition	Incidence of fuel poverty	Energy market provision	Official transport poverty definition	Incidence of transport poverty	Transport provision
	whole of the UK, but National Energy Action estimated in 2021 that over 4 million households were in fuel poverty across the UK.				by at least one of the indicators of transport poverty listed by Lucas et al. (2016 – Fig. 3). In 2012, an estimated 6.7% of households were in 'forced car ownership' (i.e., owned a car despite being in material deprivation) and 10.6% were 'car deprived' (did not own a car because they could not afford it) (Mattioli, 2017). In 2012, 9% of households were in 'car-related economic stress', i.e., they combined low income and high costs for running motor vehicles (Mattioli et al. 2018)	
Great Britain	No unified defition for Great Britain	Not recorded	Liberalised energy market with six main suppliers and several small one (but many have gone into administration in 2020–2022). Ofgem as a regulatory body. Over 80% of households connected to gas heating network	None	See below	Local bus provision follows a model of 'quantity deregulation' outside of London and most operators are private. Railways are privatised. In Greater London a public agency has strategic control of public transport provision, and local bus operations are tendered to private firms.
England	Fuel poverty: Low-Income, Low Energy Efficiency (Household income less than 60% of median income and Energy Performance Certificate rating worse than C)	13.9% of households	See under Great Britain	None	Sustrans (2012) estimates that nearly 1.5 million people live in areas 'at high risk of transport poverty' (defined as areas combining low income, high car availability and low access to essential services by public transport).	See under "Great Britain". In 2015–2016, three companies accounted for more than half of all bus journeys in England (outside of London) (Bayliss et al., 2021). 79% of households have access to at least one car (2020) (Department for Transport, 2021b).
Wales	Fuel poverty: A household needing to pay more than 10% of household income to maintain a satisfactory heating regime Severe fuel poverty: needing to pay more than 20% of household income Persistent fuel poverty: needing to pay more than 10% of household income in two out of three preceding years At risk of fuel poverty: needing to pay more than 8%, but less than 10% of full household income	Fuel poverty: 12% of households Severe fuel poverty: 2% of households	See under Great Britain	None	Sustrans (2022) estimates based on 2012 data that 30% to 60% of households (depending on the area) are in 'transport poverty' (defined as needing to spend 10% or more of their income on the costs of running a car, regardless of whether or not they have one currently).	See under "Great Britain". 79% of individuals have use of a car (2013–2014) (StatsWales, 2014).

(*continued*)

Nation	Official fuel poverty definition	Incidence of fuel poverty	Energy market provision	Official transport poverty definition	Incidence of transport poverty	Transport provision
Scotland	Fuel poverty: Household spending more than 10% of net income, after housing costs, for heating. Also paying for other fuel costs so that not enough money is left for a decent standard of living Extreme fuel poverty: A household spending more than 20% of net income	In 2019, estimated 24.6% of households in fuel poverty, of which 12.4% in extreme fuel poverty	See under Great Britain	No figures available	Sustrans (2016) estimates that 20% of Scottish data zones (corresponding to 466,000 households and 1 million individuals) are 'at high risk of transport poverty' (defined as areas combining low income, high car availability and low access to essential services by public transport).	See under "Great Britain". 72% of households have access to a car (2019). (Scottish Government, 2020).
Northern Ireland	Fuel poverty: A household needing to spend more than 10% of income on energy costs	22% of households	Own Northern Ireland regulatory body for utilities including energy. 68% of homes rely on oil heating.	None	In 2012, 15% of households were in 'car-related economic stress', i. e., they combined low income and high costs for running motor vehicles (Mattioli et al. 2018)	A largely state-owned provision (Translink) operates rail, local buses and coaches. 77% of households have cars or vans available (2011) (NISRA, n.d)

Other sources: Fuel poverty definitions from NEA (2021); fuel poverty statistics in England from BEIS (2021b), in Northern Ireland statistics from Department for Communities (2022), in Wales from Welsh Government (2019), and in Scotland from Scottish Government (2020).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gloenvcha.2023.102728.

References

Age UK. nd. Free bus pass and transport concessions. Online: https://www.ageuk.org.uk/information-advice/money-legal/benefits-entitlements/free-bus-pass-and-transport-concessions/ [Accessed 03.05.2022].

Anderson, W., White, V., Finney, A., 2012. Coping with low incomes and cold homes. Energy Policy 49, 40–52.

Barrett, J., Pye, S., Betts- Davies, S., Eyre, N., Broad, O., Price, J., Norman, J., Anable, J., Bennett, G., Brand, C., Carr-Whitworth, R., Marsden, G., Oreszczyn, T., Giesekam, J., Garvey, A., Ruyssevelt, P., Scott, K., 2021. The role of energy demand reduction in achieving net-zero in the UK. Centre for Research into Energy Demand Solutions, Oxford, UK.

Bayliss, K., Mattioli, G., Steinberger, J., 2021. Inequality, poverty and the privatization of essential services: A "systems of provision" study of water, energy and local buses in the UK. Compet. Chang. 25 (3-4), 478–500.

Beatty, T.K., Blow, L., Crossley, T.F., 2014. Is there a 'heat-or-eat' trade-off in the UK? J. R. Stat. Soc., 177, 281–294.

BEIS. 2021c. Sub-national estimates of properties not connected to the gas network. Department for Business, Energy & Industrial Strategy. Official Statistics. Online: https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network [Accessed 01.03.2022].

BEIS. 2021a. 2019 UK Greenhouse Gas Emissions, Final Figures. 2 February 2021. National Statistics. Department for Business, Energy & Industrial Strategy. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957887/2019_Final_greenhouse_gas_emissions_statistical_release.pdf [Accessed 30.11.2021].

BEIS. 2021b. Annual Fuel Poverty Statistics in England, 2021 (2019 data). March 2021. Department for Business, Energy & Industrial Strategy. National Statistics. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966509/Annual_Fuel_Poverty_Statistics_LILEE_Report_2021_2019_data_.pdf [Accessed 01.02.2022].

Benton, E., Karlsson, J., Pinter, I., Provan, B., Scanlon, K., Whitehead, C.M.E., 2022. Social Cost Benefit Analysis of the no recourse to public funds (NRPF) policy in London. CASEreports (140). Centre for Analysis of Social Exclusion, LSE, London, UK.

Bickerstaff, K., Walker, G., Bulkeley, H. (Eds.). 2013. Energy justice in a changing climate: social equity and low-carbon energy. Zed Books Ltd.

Boardman, B. 1991. Fuel Poverty: From Cold Homes to Affordable Warmth. Belhaven. ISBN 1852931396.

Bogaars, A., 2020. Fuel poverty and transport poverty in the UK: a critical examination of their future evolution in relation to government policy. University of Greenwich. PhD thesis.

Bouzarovski, S., 2014. Energy poverty in the European Union: landscapes of vulnerability. WIREs Energy Environ. 3 (3), 276–289.

Bouzarovski, S., Petrova, S., 2015. A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. Energy Res. Soc. Sci. 10, 31–40.

Bouzarovski, S., Burbidge, M., Sarpotdar, A., Martiskainen, M., 2022. The diversity penalty: Domestic energy injustice and ethnic minorities in the United Kingdom. Energy Res. Soc. Sci. 91, 102716.

Bouzarovski, S., Cauvain, J., 2016. Spaces of exception: governing fuel poverty in England's multiple occupancy housing sector. Space Polity 20 (3), 310–329.

Bouzarovski, S., Crowther, A., Simcock, N. 2023. The UK needs a national energy advice service. The Conversation. Online: https://theconversation.com/the-uk-needs-a-national-energy-advice-service-197176. [Accessed 30.01.2023].

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101.

Campaign for Better Transport. 2019. The future of the bus. Future funding arrangements. Online: https://bettertransport.org.uk/read-future-bus [Accessed 20.05.2022].

Chase, S.E., 2005. Narrative Inquiry. In: Denzin, N.K., Lincoln, Y.S. (Eds.), The Sage Handbook of Qualitative Research, third ed. Sage Publications, Thousand Oaks, CA, pp. 651–680.

Crisp, R., Ferrari, E., Gore, T., et al., 2018. Tackling transport-related barriers to employment in low-income neighbourhood. Joseph Rowntree Foundation.

Department for Communities. 2020. Northern Ireland Housing Statistics 2019-20. Department for Communities, Northern Ireland Statistics and Research Agency, National Statistics. Online: https://www.communities-ni.gov.uk/system/files/publications/communities/ni-housing-stats-19-20-full-copy.pdf [Accessed 01.03.2022].

Department for Communities. 2022. Fuel poverty. Online: https://www.communities-ni.gov.uk/topics/housing/fuel-poverty#:~:text=The%20rate%20of%20fuel%20poverty,the%20cost%20of%20energy [Accessed 01.02.2022].

Department for Transport. 2021b. National Travel Survey England 2020. Main Results. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1019462/nts-factsheet-2020.pdf [Accessed 25.05.2022].

Department for Transport. 2021a. Quarterly bus statistics: January to March 2021. Department for Transport. National statistics. 16 June 2021. Online: https://www.gov.uk/government/statistics/quarterly-bus-statistics-january-to-march-2021/quarterly-bus-statistics-january-to-march-2021 [Accessed 11.02.2022].

Department for Transport. 2022a. Biggest government intervention ever to keep rail fares down. 22 December 2022. Online: https://www.gov.uk/government/news/biggest-government-intervention-ever-to-keep-rail-fares-down [Accessed 23.01.2023].

Department for Transport. 2022b. £2 Bus Fare Cap. 19 December 2022. Online: https://www.gov.uk/guidance/2-bus-fare-cap. [Accessed 23.01.2022].

Desjardins, X., Mettetal, L., 2012. L'habiter périurbain face à l'enjeu énergétique. Flux 3, 46–57.

Ellis, C., Flaherty, M.G., 1992. Investigating Subjectivity: Research on lived experience. SAGE, London.

Eyles, J., 1981. Why geography cannot be Marxist: Towards an understanding of lived experience. Environ. Plann. A: Econ. Space 13, 1371–1388.

Fell, M.J., Roelich, K., Middlemiss, L., 2022. Realist approaches in energy research to support faster and fairer climate action. Nat. Energy 7 (10), 916–922.

Furszyfer Del Rio, D.D., Sovacool, B.K., 2023. Of cooks, crooks and slum-dwellers: Exploring the lived experience of energy and mobility poverty in Mexico's informal settlements. World Dev. 161, 106093.

Gates, S., Gogescu, F., Grollman, C., Cooper, E., Khambhaita, P., 2019. *Transport and inequality: An evidence review for the Department for Transport*, NatCen Social Research. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843487/Transport_and_inequality_report.pdf [Accessed 20.05.2022].

Golubchikov, O., O'Sullivan, K., 2020. Energy periphery: Uneven development and the precarious geographies of low-carbon transition. Energ. Buildings 211, 109818.

Government Office for Science. 2019. *A time of unprecedented change in the transport System*. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780868/future_of_mobility_final.pdf [Accessed 20.05.2022].

Groves, C. and Henwood, K. (2021) Perspectives on Energy Poverty and Energy Vulnerability in the United Kingdom. ENGAGER Project EP-Pedia, January 22. https://www.eppedia.eu/article/perspectives-energy-poverty-and-energy-vulnerability-united-kingdom [Accessed 17.01.2023].

Hall, S.M., 2019a. A very personal crisis: Family fragilities and everyday conjunctures within lived experiences of austerity. Trans. Inst. Br. Geogr. 44, 479–492.

Hall, S.M., 2019b. Everyday austerity: towards relational geographies of family, friendship and intimacy. Prog. Hum. Geogr. 43 (5), 769–789.

Heffron, R.J., McCauley, D., 2018. What is the 'Just Transition'? Geoforum 88, 74–77.

Henwood, K., Groves, C., Shirani, F., 2016. Relationality, entangled practices, and psychosocial exploration of intergenerational dynamics in sustainable energy studies. Families, Relationships and Societies 5 (3), 393–410.

HM Government. 2021. Net Zero Strategy: Build Back Greener. Presented to Parliament pursuant to Section 14 of the Climate Change Act 2008. October 2021. Hm Government. Department for Business, Energy & Industrial Strategy. Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf [Accessed 18.01.2022].

HM Government. nd. Apply for a disabled person's bus pass. Online: https://www.gov.uk/apply-for-disabled-bus-pass [Accessed 03.05.2022].

Hopkins, D., 2015. Applying a comprehensive contextual climate change vulnerability framework to New Zealand's tourism industry. Ambio 44, 110–120.

Horn, C., Gifford, S.M., Ting, C.Y.P., 2021. Informal, essential and embedded: Transport strategies in remote Sarawak. J. Transp. Geogr. 96, 103181.

Hunter, S.V., 2010. Analysing and representing narrative data: The long and winding road. Curr. Narratives 2, 44–54.

Inews. 2022. Train fare increase 2022: How much the cost of rail travel is rising and why the price hike is happening. 1 March 1 2022. Online: https://inews.co.uk/news/train-fare-increase-2022-how-much-cost-of-rail-travel-rising-price-hike-explained-1491302 [Accessed 03.05.2022].

Liddell, C., Morris, C., 2010. Fuel poverty and human health: a review of recent evidence. Energy Policy 38 (6), 2987–2997.

Lister, R., 2007. From object to subject: including marginalised citizens in policy making. Policy Polit. 35 (2), 437–455.

Longhurst, N., Hargreaves, T., 2019. Emotions and fuel poverty: The lived experience of social housing tenants in the United Kingdom. Energy Res. Soc. Sci. 56, 101207.

Lucas, K., Stokes, G., Bastiaanssen, J., & Burkinshaw, J. (2019). Inequalities in Mobility and Access in the UK Transport System, Future of Mobility: Evidence Review, Foresight, Government Office for Science. Online: https://www.gov.uk/government/publications/future-of-mobility-inequalities-in-mobility-and-access-in-the-uk [Accessed 20.05.2022].

Lucas, K., Mattioli, G., Verlinghieri, E., Guzman, A., 2016. Transport poverty and its adverse social consequences. Proc. Inst. Civil Eng. – Transport 169 (6), 353–365.

Martens, K., 2017. Transport justice: Designing fair transportation systems. Routledge.

Martiskainen, M., Jenkins, K.E., Bouzarovski, S., Hopkins, D., Mattioli, G., Lacey-Barnacle, M., 2021a. A spatial whole systems justice approach to sustainability transitions. Environ. Innov. Soc. Trans. 41, 110–112.

Martiskainen, M., Sovacool, B.K., Lacey-Barnacle, M., Hopkins, D., Jenkins, K.E.H., Simcock, N., Mattioli, G., Bouzarovski, S., 2021b. New dimensions of vulnerability to energy and transport poverty. Joule 5 (1), 3–7.

Mattioli, G., 2021. Transport poverty and car dependence: a European perspective. In: Pereira, R.H., Boisjoly, G. (Eds.), Social Issues in Transport Planning. Elsevier.

Mattioli, G., Lucas, K., Marsden, G., 2017. Transport poverty and fuel poverty in the UK: From analogy to comparison. Transp. Policy 59, 93–105.

Mattioli, G., Wadud, Z., Lucas, K., 2018. Vulnerability to fuel price increases in the UK: A household level analysis. Transp. Res. A Policy Pract. 113, 227–242.

Mattioli, G., Philips, I., Anable, J., Chatterton, T., 2019. Vulnerability to motor fuel price increases: Socio-spatial patterns in England. J. Transp. Geogr. 78, 98–114.

Mees, P., 2010. Transport for Suburbia. Beyond the Automobile Age. Earthscan, London.

Méndez, M., Flores-Haro, G., Zucker, L., 2020. The (in)visible victims of disaster: Understanding the vulnerability of undocumented Latino/a and indigenous immigrants. Geoforum 116, 50–62.

Middlemiss, L., Ambrosio-Albalá, P., Emmel, N., Gillard, R., Gilberton, J., Hargreaves, T., Mullen, C., Ryan, T., Snell, C., Tod, A., 2019. Energy Poverty and Social Relations: A Capabilities Approach. Energy Res. Soc. Sci. 55, 227–235.

Middlemiss, L., Gillard, R., 2015. Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor. Energy Res. Soc. Sci. 6, 146–154.

Middleton, J., 2022. The Walkable City: Dimensions of walking and overlapping walks of life. Routledge, Abingdon.

Mullen, C., Marsden, G., 2016. Mobility justice in low carbon energy transitions. Energy Res. Soc. Sci. 18, 109–117.

Mullen, C., Marsden, G., Philips, I., 2020. Seeking protection from precarity? Relationships between transport needs and insecurity in housing and employment. Geoforum 109, 4–13.

NEA. 2021. Every home should be a warm and safe place. Fuel poverty monitor 2021. National Energy Action. Online: https://www.nea.org.uk/wp-content/uploads/2021/11/0000_NEA_Fuel-Poverty-Report-and-Exec-Summary_v2.pdf [Accessed 01.02.2022].

NEA. 2022. Fuel Poverty Statistics Explainer. November 2022. Online: https://www.nea.org.uk/energy-crisis/fuel-poverty-statistics-explainer/#:~:text=Since%20the%20winter%20period%20of,now%20living%20in%20fuel%20poverty. [Accessed 23.01.2023].

NISRA (n.d.) Car or Van Availability: KS405NI (NRA). Online: https://www.ninis2.nisra.gov.uk/public/PivotGrid.aspx?ds=4044&lh=42&yn=2011&sk=-3&sn=Neighbourhood%20Renewal&yearfilter= [Accessed 25.05.2021].

O'Connell, R., Brannen, J., 2019. In: absolute Poverty in Europe: Interdisciplinary Perspectives on a Hidden Phenomenon Interdisciplinary Perspectives on a Hidden Phenomenon. Policy Press, pp. 159–182.

O'brien, Karen, Eriksen, Siri, Nygaard, L.P., Schjolden, ANE, 2007. Why different interpretations of vulnerability matter in climate change discourses. Clim. Pol. 7 (1), 73–88.

Office for National Statistics (2023). Inflation and price indices, release date 19 April 2023. Available at: https://www.ons.gov.uk/economy/inflationandpriceindices [Accessed 25.04.2023].

Ofgem. 2020. Protecting energy consumers with prepayment meters: August 2020 decision. Online: https://www.ofgem.gov.uk/sites/default/files/docs/2020/08/protecting_energy_consumers_with_prepayment_meters_-_august_2020_decision.pdf [Accessed 03.05.2022].

Ofgem 2022. Electricity supply market shares by company, July 2022, Online: www.ofgem.gov.uk/energy-data-and-research/data-portal/all-available-charts?keyword=suppliers&sort=relevance [Accessed 23.01.2023].

Okpara, U.T., Stringer, L.C., Dougill, A.J., 2016. Perspectives on contextual vulnerability in discourses of climate conflict. Earth Syst. Dyn. 7, 89–102.

ONS. 2020. Population estimates for the UK, England and Wales, Scotland and Northern Ireland, provisional: mid-2019. Office for National Statistics. Online: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019 [Accessed 01.02.2022].

ONS. 2021a. Families and households in the UK: 2020. 2 March 2021. Office for National Statistics. Online: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2020 [Accessed 11.02.2022].

ONS 2021b. Employee earnings in the UK: 2021. 26 October 2021. Office for National Statistics. Online: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2021#employee-earnings-and-hours-worked [Accessed 03.05.2022].

ONS. 2022. Income and wealth. UK household income and wealth. Office for National Statistics. Online: https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth [Accessed 01.02.2022].

Ortar, N., 2018. Dealing with energy crises: Working and living arrangements in peri-urban France. Transp. Policy 65, 72–78.

Osberghaus, D., Abeling, T., 2022. Heat vulnerability and adaptation of low-income households in Germany. Glob. Environ. Chang. 72, 102446.

O'Sullivan, K., Golubchikov, O., Mehmood, A., 2020. Uneven energy transitions: Understanding continued energy peripheralization in rural communities. Energy Policy 138, 111288.

Pellicer-Sifres, V., Simcock, N., Boni, A., 2021. Understanding the multiple harms of energy poverty through Nussbaum's theory of central capabilities. Local Environ. 26 (8), 1026–1042.

Piddington, J., Nicol, S., Garrett, H., Custard, M. 2020. The Housing Stock of The United Kingdom. BRE Trust. Online: https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf [Accessed 01.02.2022].

Prakash, K., Awaworyi Churchill, S., Smyth, R., 2020. Petrol prices and subjective wellbeing. Energy Econ. 90, 104867.

Preston, J., Almutairi, T., 2013. Evaluating the long-term impacts of transport policy: An initial assessment of bus deregulation. Res. Transp. Econ. 39 (1), 208–214.

Robinson, C., 2019. Energy poverty and gender in England: A spatial perspective. Geoforum 104, 222–233.

Robinson, C., Mattioli, G., 2020. Double energy vulnerability: Spatial intersections of domestic and transport energy poverty in England. Energy Res. Soc. Sci. 70, 101699.

Rozynek, C., Schwerdtfeger, S., Lanzendorf, M., 2022. The influence of limited financial resources on daily travel practices. A case study of low-income households with children in the Hanover Region (Germany). J. Transp. Geogr. 100, 103329.

Sareen, S., Waage, M., Smirnova, P., Boakye-Botah, J., Loe, M.R., 2022. Double energy vulnerability in the Norwegian low-carbon urban transport transition. People, Place and Policy (Early view, 1-20).

Scottish Government. 2020. Scottish house condition survey: 2019 key findings. Online: https://www.gov.scot/publications/scottish-house-condition-survey-2019-key-findings/pages/6/ [Accessed 26.05.2022].

Shirani, F., Groves, C., Henwood, K., Roberts, E., Thomas, G., Cherry, C., Pidgeon, N., et al., 2021. 'Who cares about Valley people?' - lived experiences of energy vulnerability in the South Wales Valleys. J. Poverty Soc. Justice. 29, 103–120.

Simcock, N., Frankowski, J., Bouzarovski, S., 2021a. Rendered invisible: Institutional misrecognition and the reproduction of energy poverty. Geoforum 124, 1–9.

Simcock, N., Jenkins, K.E.H., Lacey-Barnacle, M., Martiskainen, M., Mattioli, G., Hopkins, D., 2021b. Identifying double energy vulnerability: A systematic and narrative review of groups at-risk of energy and transport poverty in the global north. Energy Res. Soc. Sci. 82, 102351.

Sovacool, B.K., Furszyfer Del Rio, D.D., 2022. "We're not dead yet!": Extreme energy and transport poverty, perpetual peripheralization, and spatial justice among Gypsies and Travellers in Northern Ireland. Renew. Sustain. Energy Rev. 160, 112262.

Sovacool, B.K., Hess, D.J., Cantoni, R., Lee, D., Claire Brisbois, M., Jakob Walnum, H., Freng Dale, R., Johnsen Rygg, B., Korsnes, M., Goswami, A., Kedia, S., Goel, S., 2022. Conflicted transitions: Exploring the actors, tactics, and outcomes of social opposition against energy infrastructure. Glob. Environ. Chang. 73, 102473.

Sovacool, B.K., Upham, P., Martiskainen, M., Jenkins, K.E.H., Torres Contreras, G.A., Simcock, N., 2023. Policy prescriptions to address energy and transport poverty in the United Kingdom. Nat. Energy 8 (3), 273–283.

StatsWales. 2014. National Survey for Wales results, 2013-14: Transport. Online: https://statswales.gov.wales/Catalogue/Transport [Accessed 25.05.2022].

Sustrans. 2022. Making the Connection. Why Wales must act now to tackle transport poverty and ensure access for everyone. Online: https://www.sustrans.org.uk/media/10425/transportpovertypaper-sustrans_eng.pdf [Accessed 20.05.2022].

Sustrans. 2012. Locked Out. Transport Poverty in England. Online: https://www.sustrans.org.uk/media/3706/transport-poverty-england-2012.pdf [Accessed 20.05.2022].

Sustrans. 2016. Transport Poverty in Scotland. Online: https://www.sustrans.org.uk/media/2880/transport_poverty_in_scotland_2016.pdf [Accessed 20.05.2022].

The Energy Shop. 2022. Which energy suppliers have gone bust in 2022. Last updated: 27/01/2022. Online: https://www.theenergyshop.com/guides/which-energy-suppliers-have-gone-bust [Accessed 16.02.2022].

Transport for New Homes. 2022. Building Car Dependency. Transport for New Homes.

Tumini, I., Poletti, A., 2019. Natural disaster and informality (re) production in Chile. City Cult. Soc. 19, 100312.

UK Parliament (2023). Domestic energy prices. 06 January 2023. Available at: https://commonslibrary.parliament.uk/research-briefings/cbp-9491/ [Accessed 23.01.2023].

Upham, P., Simcock, N., Sovacool, B., Torres Contreras, G.A., Jenkins, K., Martiskainen, M., 2023. Public support for decarbonisation policies: Between self-interest and social need for alleviating energy and transport poverty in the United Kingdom. Energy and Climate Change 4, 100099. https://doi.org/10.1016/j.egycc.2023.100099.

Urry, J., 2004. The 'System' of Automobility. Theory Cult. Soc. 21, 25–39.

Utility Regulator. 2021. Quarterly Retail Energy Market Monitoring Report. Quarter 3: July to September 2021. Published: 30 November 2021. Online: https://www.uregni.gov.uk/files/uregni/documents/2021-11/q3-2021-qremm-final-30.11.2021.pdf [Accessed 01.03.2022].

Van Lanen, S., 2020. 'My room is the kitchen': lived experience of home-making, home-unmaking and emerging housing strategies of disadvantaged urban youth in austerity Ireland. Soc. Cult. Geogr. 23, 598–619.

Van Lanen, S., 2021. Imagining a future in the austerity city: anticipated futures and the formation of neoliberal subjectivities of youth in Ireland. Environ. Plann. A: Economy Space 53 (8), 2033–2049.

Walker, I., Tapp, A., Davis, A., 2022. Motornormativity: How Social Norms Hide a Major Public Health Hazard. PsyArXiv.

Warnock, R., MacNeil Taylor, F., Horton, A., 2022. Should we pay research participants? Feminist political economy for ethical practices in precarious times. Area 54, 195–202. https://doi.org/10.1111/area.12790.

Welsh Government. 2019. Fuel poverty estimates for Wales, 2018: revised. 13 December 2019. SB 34/2019(R). Online: https://gov.wales/sites/default/files/statistics-and-research/2019-12/fuel-poverty-estimates-wales-2018.pdf [Accessed 01.02.2022].

Willand, N., Horne, R., 2018. 'They are Grinding us Into the Ground' – The Lived Experience of (in)Energy Justice Amongst Low-Income Older Households. Appl. Energy 226, 61–70.

Further reading

Basu, R., Bazaz, A, D., 2016. Assessing climate change risks and contextual vulnerability in urban areas of semi-arid India: the case of Bangalore. CARIAA-ASSAR Working Paper. International Development Research Centre, Ottawa, Canada and UK Aid, London, United Kingdom.

Citizens Advice Scotland. nd. Help with travel costs if you're older or disabled. Online: https://www.citizensadvice.org.uk/scotland/consumer/holiday-cancellations-and-compensation/help-with-travel-costs-if-youre-older-or-disabled-s/ [Accessed 03.0.5.2022].

Harari, D., Francis-Devine, B., Bolton, P., Keep, M. 2022. Rising cost of living in the UK. Research Briefing. 08 February 2022. House of Commons Library. Online: https://commonslibrary.parliament.uk/research-briefings/cbp-9428/#:~:text=In%20mid%2DDecember%2C%20the%20Bank,to%206%25%20in%20April%202022. [Accessed 11.02.2022].

Li, T., Dodson, J., Sipe, N., 2018. Examining household relocation pressures from rising transport and housing costs–An Australian case study. Transp. Policy 65, 106–113.

Lowans, C., Furszyfer Del Rio, D., Sovacool, B.K., Rooney, D., Foley, M.A., 2021. What is the state of the art in energy and transport poverty metrics? A critical and comprehensive review. Energy Econ. 101, 105360.

Moss, P., Dyck, I. 2003. Embodying social geography, in Anderson, K., Domosh, M., Pile, S. & Thrift, N. [Eds]. Handbook of Cultural Geography, SAGE, London.

ITV News. 2022. First Bus hike prices in Bristol and Somerset - these are the new fares. https://www.itv.com/news/westcountry/2022-01-26/bus-fare-overhaul-in-bristol-and-somerset-sees-some-tickets-cost-almost-20-more [Accessed 12.04.2022].

Scottish Household Survey 2019. 2020. Scottish Household Survey 2019. Supplementary Analysis. Online: https://www.gov.scot/publications/scottish-household-survey-2019-supplementary-analysis/documents/ [Accessed 25.05.2022].