University of Salford
MANCHESTER

'The reduction of fuel poverty may be lost in the rush to decarbonise': Six research risks at the intersection of fuel poverty, climate change and decarbonisation

Sherriff, Graeme, Butler, Danielle and Brown, Philip

Title	'The reduction of fuel poverty may be lost in the rush to decarbonise': Six research risks at the intersection of fuel poverty, climate change and decarbonisation
Authors	Sherriff, Graeme, Butler, Danielle and Brown, Philip
Publication title	People, Place and Policy Online
Publisher	
Type	Article
USIR URL	This version is available at: http://usir.salford.ac.uk/id/eprint/63765/
Published Date	2022

Research article

'The reduction of fuel poverty may be lost in the rush to decarbonise': Six research risks at the intersection of fuel poverty, climate change and decarbonisation

Graeme Sherriff[1]*, Danielle Butler[2], Philip Brown[3]
1 University of Salford
2 National Energy Action
3 University of Huddersfield

Abstract

As energy justice research develops and becomes increasingly international in reach and perspective, the climate emergency is an important layer of focus. Fuel poverty alleviation, climate change adaptation and decarbonisation are prominent agendas that are often assumed to be complementary and synergistic. Buildings contribute a substantial share of energy-related greenhouse gas emissions, and their inhabitants will suffer the impacts of extreme temperatures and an unstable climate. How we move towards low-carbon energy sources and technologies in a way that does not leave vulnerable householders behind and does not perpetuate and deepen inequalities is therefore an essential question for those investigating just transitions to a low-carbon future. By means of a Delphi study with a wide range of researchers and stakeholders, primarily in the UK and engaged with energy justice research and policy internationally, we draw on qualitative interviews to distil a set of six risks that inform the development of a research agenda towards a just transition. These risks relate to the prominence of decarbonisation subsuming fuel poverty or detracting from the need for fuel poverty alleviation; the importance of fuel poverty research anticipating climate impacts; the pitfalls for vulnerable people of a transition to electric heating and other technologies; the potential for renewable energy to be costly and excluding; as well as the need to be mindful of existing inequalities and to be sensitive in our treatment of energy practices.

Keywords: Energy justice, energy poverty, climate change, decarbonisation, just transitions.

Introduction

Fuel poverty is a core element of energy research, intersecting with social justice and linking to the built environment, lived experiences and notions of fairness in a consumer economy. Those in fuel poverty, often the most vulnerable in society, are subject to complex interrelated health impacts resulting from living in uncomfortable, cold or hot homes and the financial stress associated with managing them.

At a time of increasing recognition of the climate emergency and of the justice dimensions of moving to a low-carbon society, it is important to place fuel poverty research in this context. How can we ensure that the transition to a low-carbon future is socially just: one in which policies and approaches to reducing the carbon impact of home energy consumption do not add to the financial stress of vulnerable householders? How can we ensure that fuel poverty alleviation is a valued component of decarbonisation whilst not, as our title asks, being subsumed within a focus on carbon?

We build upon recent reviews of energy research (Boardman, 2012; Sovacool, 2014; Ambrose and Marchand, 2017; Van Veelen et al., 2019) to provide an evidence-based agenda to support scholarship into just transitions. We present a set of six risks that have been distilled from interviews conducted as part of a Delphi study:

1. decarbonisation overshadows and detracts from fuel poverty alleviation;
2. fuel poverty research does not take account of adaptation to a changing climate;
3. a transition away from gas results in higher costs and more fuel poverty;
4. the development of renewable energy has limited impact on fuel poverty;
5. approaches to decarbonisation overlook existing inequalities;
6. ignoring energy practices could deepen fuel poverty, but relying on them could disempower householders.

As researchers based in the UK, we understand that, whilst the roots of fuel poverty research are in the UK and Ireland, the field continues to grow rapidly and to encompass more dispersed and diverse geographies. In our Delphi study we sought and received international responses, as well as input from outside of academia, providing a structure through which to systemically capture and consolidate reflections of a range of stakeholders. Whilst we draw upon empirical examples that are primarily in the UK, we place these within the context of climate change and decarbonisation and contribute to the development of the understanding of the relationships between these global agendas and therefore to the conceptual development of notions of energy justice and just transitions internationally.

Energy justice is a planetary consideration, and we recognise that a global, socio-economic, and political energy system exists in a wider context of ongoing impacts on natural ecosystems alongside developments in health and equalities. Studying across cultures, built environments, governance contexts and climate zones facilitates understanding of the structures and conditions that can help (or hinder) the decarbonisation and fuel poverty agendas. In particular, there are opportunities for countries to learn from those already experiencing more extremes of temperatures and to reveal the ways in which people have adapted to specific conditions, whether through technology or social practices (Sherriff et al., 2019a; Winter, 2013). Our intention is that a clearer conceptualisation of the relationship between fuel poverty and decarbonisation will equip those working in research, practice, and policy to make decisions that favour complementary, rather than contradictory, transition pathways.

We recognise that other terms, such as energy poverty and energy vulnerability are in use by particular actors and in different contexts, (Bouzarovski and Petrova, 2015). Whilst acknowledging the importance of this debate, in order to establish a common frame of reference we have chosen to use the familiar term 'fuel poverty'.

In this paper, we begin by providing a context that brings together the fuel poverty, climate change and decarbonisation literatures in a just transitions context. We then present each of the six risks, substantiating them with evidence generated within the study, and consider the implications for scholars working within the broad sphere of energy justice.

The study was supported by UK research funder the Eaga Charitable Trust as part of a project to provide a legacy, at the time of its closure, for its 25-year support of fuel poverty research.

Context

Fuel poverty is a social issue stemming from low incomes, quality of the residential building stock, and energy costs (Boardman, 2012) as well as vulnerabilities connected to physical and mental health (Press, 2003). Although precise definitions and approaches to measurement differ internationally, fuel poverty can be described as a 'specific form of material deprivation that occurs when a person is unable to attain a socially- and materially-required level of energy services in the home' (Simcock et al., 2021: 1). It encompasses a range of challenges in accessing and affording sufficient energy to achieve warmth, comfort, and good health at home. Across the UK it is estimated that more than four million households are affected (National Energy Action, 2021a). In a global context, in which the term 'energy poverty' is more common, it is estimated that more than one billion people across the world experience this situation in diverse ways (Bouzarovski, 2018).

There is a well-established evidence base that connects thermally-inefficient and poor-quality homes with physical and mental health, including respiratory, circulatory and cardiovascular diseases, and extending to conditions such as depression and anxiety (Marmot et al., 2010). Research examining the lived experience of fuel poverty (Middlemiss and Gillard, 2015) has enhanced this understanding, drawing attention to less tangible but critically important impacts upon wellbeing and quality of life connected to, for example, educational attainment and child development, stigma and self-worth, and family and social life. It has also highlighted the commonality and divergence of different groups, including mental health service users (Sherriff, 2016), young adults (Butler and Sherriff, 2017), private rented tenants (Ambrose, 2015) and people in remote and rural locations (Sherriff et al., 2020).

Recent years have seen a growing awareness of and focus on a multifaceted international picture, resulting in a growth of terminology, with introduction of new terms such as 'energy poverty', 'energy vulnerability' and 'energy precariousness'. These reflect a move away from 'fuel', a term primarily adopted in the UK context – and one bound up with heating, rather than cooling – as well as a recognition of different challenges surrounding energy use. This broadening of the field highlights both the universality of the challenge of providing energy and comfort, and the specificity of climates, cultures and politics that shape energy supply and demand (Bouzarovski, 2018; Bouzarovski et al., 2012; Howden-Chapman et al., 2012; Castaño-Rosa et al., 2020). The Covid-19 pandemic has had implications for energy availability and costs around the globe (Nagaj and Korpysa, 2020; Mastropietro et al., 2020) and interrupted coping mechanisms through which people find comfortable spaces outside the home (Baker et al., 2020).

Energy justice scholarship recognises that notions of fairness permeate energy policy. Scholars (Hall, 2013; McCauley and Heffron, 2018) have made direct links with environmental justice literature (Walker, 2012; Agyeman, 2013) and Pellegrini-Masini et al. (2020) connect with central concepts of environmental justice: distribution, procedure and recognition. Sovacool and Dworkin, for example, see energy justice to embody 'a global energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial energy decision-making' (2014: 13). They position 'energy poverty' as a subset of this overall picture of energy justice, associating it with intragenerational distribution of access to energy. The justice framing connects with other justice issues such as welfare of energy workers (Henry et al., 2020) and wider impacts of energy systems on, for example, air quality (Jonsson and Hillring, 2006).

There has been increasing recognition that fuel poverty research needs to 'grapple with an increasingly complex research and policy landscape' (Ambrose and Marchand, 2017) in which interrelationships with related agendas such as decarbonisation, economic development, housing provision and welfare are prominent. Climate change brings a temporal dimension to energy justice. The operation of buildings contribute around 32 per cent of final energy use and 19 per cent of energy-related greenhouse gas emissions globally (Lucon, 2014): buildings both contribute towards climate change and, along with their inhabitants, will suffer impacts of extreme temperatures and climatic instabilities. How society prepares for and responds to a changing climate and the extent to which we reduce carbon emissions has profound implications for both inter- and intragenerational justice: not only will the impacts be experienced by future generations, but it is the poorest people, and those in the least developed countries, who will suffer the harshest impacts.

Taking into account this complex relationship, we should be 'fully aware of [fuel poverty's] location within an extended network of social and environmental justice concerns, connecting the local with the global' (Walker and Day, 2012: 74). The notion of just transitions (Henry et al., 2020) brings together energy access and poverty with climate justice goals and is a term that encapsulates the importance of fairness in moving towards a decarbonised society. As Sovacool et al. (2021) note, 'the path towards decarbonization can bring social net benefits, but it can also enhance vulnerabilities'. This observation highlights the importance of understanding fuel poverty within the context of decarbonisation.

Research has begun to explore the implications for fuel poverty of approaches to decarbonisation. Davies and Oreszczyn (2012) identify potential unintended consequences of decarbonising the built environment, noting cost and health impacts. Hannam and Jones (2017) look at low carbon heat in rural areas across Europe and find that a high renewables share in heating does not guarantee lower levels of fuel poverty. Burgess and Whitehead (2020) considered the potential for personal carbon budgets as a decarbonisation tool amongst people in fuel poverty, and Pett (2009) the use of carbon footprinting for fuel poor households.

A particularly challenging part of this agenda is the decarbonisation of heat. In the UK context, National Energy Action (Frerk and MacLean, 2017) have identified some key considerations relating to minimising the impact on fuel poverty. They take into account, for example, the tendency for schemes funded through energy bills to have a greater impact, proportionally, on the bills of low-income households; for those living off the main gas grid to have fewer decarbonisation options available to them; and for costs of installing new technologies or contributing to schemes such as district heating to be high and prohibitive.

The relationship between fuel poverty, climate change, and decarbonisation is complex. Fuel poor households are affected, and likely created, by changes in the climate, which may mean a greater need for heating and/or cooling during some of the year. Additionally, the ways in which we heat and cool homes is such a significant part of carbon emissions, that rapid changes in practices and technologies will be needed and these could, in turn, make heating and cooling homes more difficult and more expensive. People experiencing fuel poverty are therefore impacted not only by changes in climate but also by the approaches deployed to reduce the severity of those changes.

Studies are beginning to explore the ways in which vulnerable households can be helped in preparing for, for example, warmer summers (Schünemann et al., 2020; Pérez-Fargallo et al., 2018; Nicholls et al., 2017). Research therefore needs to take account of the warming climate and the social gradient in the ability to adapt, particularly in the Global South, with '[t]he (misfortunes) of the fuel poor... becoming increasingly folded into a climate justice framing' (Walker and Day, 2012: 74).

Method

Delphi is an established methodology used across a diverse range of disciplines and fields for seeking a convergence of opinion and visioning future developments (Hsu and Sandford, 2007). Delphi is distinguished by an iterative process, comprising two or more rounds with analysis and feedback being applied at the end of each round and informing the design of the subsequent round(s). The first round generally consists of open questions and subsequent stages use closed questions (at least partially) through methods such as surveys, to consolidate the findings, prioritise points, and establish areas of disagreement. This approach affords the study a degree of interaction without the challenges of a conventional workshop, therefore reducing financial and geographical exclusion. Delphi is useful for capturing novel ideas and divergence and allowing parity between new voices and more established commentators. We selected this approach as it enabled us to speak directly to people responsible for research and policy and to blend evidence with strategy.

Our research followed a three-stage process comprising two online surveys and a set of expert interviews. In Stage One, a total of 49 responses to an online survey were collected from a closed list of key actors working on fuel poverty research, practice, and policy. The survey included six open questions with the intention of exploring the views and experiences on definitions, conceptual and theoretical discussions in the field, immediate and short-term research priorities, research impact, and related challenges in the field. In Stage Two, a second online survey was promoted more widely to those working in fuel poverty and related fields and sectors using email lists and social media. The questions were intended to encourage participants to rate and prioritise themes established from the results of Stage One. The open answers from Stage One were synthesised into a list that the researchers judged to be comprehensive in its coverage of the issues raised.

Participants were asked to consider the extent to which each of the themes were well understood by the fuel poverty research community as well as to consider which of them should be prioritised. Participants were given an opportunity to provide more expansive comments to accompany their answers to the closed questions. A summary analysis of the closed questions was completed (Sherriff et al., 2019b). A total of 170 individuals responded to Stage Two, with 68 involved in academic research and teaching; 13 in the energy industry; 34 in health, housing or government; 55 in the NGO or community sector. 19 per cent of Stage Two respondents worked outside of the UK context. Our

approach represents a modified Delphi approach: a larger sample was sought in Stage Two to validate and reflect on findings from Stage One.

The analysis presented here draws primarily on data generated as part of the third phase, comprising nine semi-structured interviews with selected Stage Two respondents, as well as some of the qualitative, open answers given in Stage Two. The selection of interviewees was intended to reflect a distribution across academia (5), policy (one non-government and one government) and practice (one housing association and one private sector). One of the academic interviewees was based outside the UK and two of the others worked primarily at an international level. The selection was necessarily limited by time, transcription resources and interviewee availability. With a view to covering a range of expertise and standpoints in relation to fuel poverty, just transitions, decarbonisation, and wider energy research, selection was based on survey responses as well as the researchers' knowledge of interviewee involvement in fuel poverty. Interviewees were invited to talk anonymously about key issues and challenges, drawing on the list generated in Stage One and refined in Stage Two. For each stage, data was coded using QSR NVivo guided by the principles of thematic analysis (Braun and Clarke, 2012). For the closed questions in the first two stages, summary statistics were calculated.

The six risks around which the following section is structured grew from our thematic analysis. This focused on future directions for research, practice and policy and 'risks' was chosen as a structural device that would speak across these audiences.

Findings

In this section we structure the findings from our interviews into six risks, relating to the challenges identified in the discussions. Quotations from the interviews, labelled with the prefix 'I' followed by the interviewee number, are used throughout and folded into a narrative. We also include data taken from the comments provided through the open questions in the survey. These are labelled 'SC' and were selected from the whole sample, i.e. not restricted to the nine interviewees.

Risk 1: Decarbonisation overshadows and detracts from fuel poverty alleviation

Decarbonisation and fuel poverty are important policy agendas, each with a significant social justice dimension. How these two priorities are approached, and how the relationship between them is conceptualised, shaped and nurtured will determine the extent to which policy and research is able to maximise synergy and avoid either agenda being pursued at the expense of the other: *'I think overall, of course everyone wants the same thing, which is lower CO_2 emissions, less energy needing to be used, warmer homes, but I wouldn't want to see more and more people being impacted on now, without there being as really clear, good reason that's been thought through'* (I1).

With growing policy and media interest in decarbonisation, there is a risk that fuel poverty is either sidelined or subsumed within climate change policy. Although there is an opportunity for '*decarbonisation policies [to] fundamentally address equality*' (I8), there is a risk that the people in fuel poverty are left on the periphery and that the issue [is] given less attention:

"The reduction of fuel poverty may be lost in the rush to decarbonise." (SC)

"We've got to be fair to this generation in order to be fair to future generations." (I2)

Commentators observe a tendency for it to be assumed that anything under the banner of decarbonisation will, necessarily, also reduce fuel poverty:

"A low carbon heat source will not, in itself, solve fuel poverty, and I think that's self-evident to folk now working in it day-to-day, but I think it made you sit up and go, "Oh right". I think they just complicate the two things, "Oh yes, we've put low carbon heating in so it must be brilliant"' (I4)

Another reason to be concerned that attention may turn away from fuel poverty is that they tend not to be the households with the highest carbon emissions:

"It's very important that fuel poverty doesn't get side-lined. There's a real risk...it's a replay of a debate that we had probably in about 1980 - along the lines of the most polluting people are the richest people, so they're the ones we should focus on...." (I2)

Whilst energy is arguably invisible at the household level, climate change and moves towards decarbonisation could increasingly make energy, or at least the connected policy areas, more visible. This interviewee, for example, reflects on the tendency for difficulties accessing heating and hot water to make energy considerations very 'visible'. *'It's a very visible impact, no heating or hot water, whereas cost of electricity, it's less visible to the household and potentially also to other agencies who might need to support family members'* (I1). With the current energy crisis, however, price instability and energy unaffordability is more visible as a result of increased media coverage and with such a significant proportion of the UK estimated to be affected. The prevalence of energy-related hardship across the population would likely draw attention to some of the underlying causes of fuel poverty.

Risk 2: Fuel poverty research does not take account of adaptation to a changing climate

Decarbonisation is focused on the *mitigation* of climate change, but policy actors need also to take into account the need for *adaptation* to existing and expected changes in climate. One of the implications for fuel poverty policy is that areas, such as the UK and other northern European countries, where the primary concern to date has been cold homes during winter months, find that overheating (and thus a need for cooling) is, and will be, increasingly problematic: *'We're beginning to talk now about heatwaves'* (I2). This has implications for our understanding of the health impacts of fuel poverty and of our responses.

When thinking about the design of buildings, then, there is a need to better understand how to adapt to a warmer climate*:*

"I've seen virtually nothing that said this is what we should be doing to the homes of the fuel poor to prevent them overheating in future. I don't think I've seen a single paper on that. Do we put grills over the windows? Do we put shutters? How can you do shutters when the windows open the wrong way[?]" (I2)

In a UK and Northern European, context at least, the seasonality of fuel poverty is reconfigured: 'we need to kind of really shift away from just thinking [of] energy poverty as being about cold homes, and it's actually this much broader, all year-round problem'. There is also much that heating-dominated countries can learn from those areas where hot weather is more common. This extends not only to technology and infrastructure but also practices and social networks: 'I think in Arizona they're used to it more so they have infrastructure set in place to help people if they need it, or you know to go check on your grandparents if you need to' (I7).

Risk 3: A transition away from gas results in higher costs and more fuel poverty

An example of a potential tension between decarbonisation and fuel poverty is already evident in the proposed move away from gas as a fuel for home heating: '*we're getting to the stage now where we have to start thinking about phasing out gas from every household*'(I2). Whilst gas, and gas central heating in particular, is familiar to many households, there are longer-term goals to move towards low carbon sources, including renewably generated electricity and biomass. Whilst providing a gas boiler that may be operational for 10-15 years may not be the low-carbon option for decarbonisation in the *long term*, switching to an electric system, such as storage heaters or heat pumps, is not conducive to helping fuel poverty in the *medium term* and may even push up bills in the short term. An interviewee, who worked directly with householders, reflected:

> "We run programmes through the Warm Homes fund which are focused on installing first time central heating into properties and there's been some push back from some local authorities and housing associations about putting gas central heating in, and that's causing tension, as you might expect. The gas distribution network operators and some of the charities involved in that work, because gas central heating is the cheapest or potentially the cheapest way of heating most homes, at least at the moment, gas being a lot cheaper than electricity." (I1)

This challenge has been exacerbated by difficulties experienced in learning to use new technologies: it is not simply the cost of electricity that can cause increasing costs, but also modes of operation. An interviewee recounted their experiences, as a social landlord, with heat pumps, observing that '*low carbon doesn't mean low cost*,' to either resident or housing provider, since when they installed air-source heat pumps '*our tenants were really unsure of them, and we spent a long time and some energy... developing 22 separate bespoke guides for the different developments and the different models*'. People had been '*treating them like boilers and switching them on and off, which they shouldn't be doing, and they weren't changing the filters, which choked them up*' (I4).

They ultimately switched away from this technology: 'and then we could see that the maintenance costs of these units were keeping up, so the upshot of that is that when they fail badly now just putting storage heating in instead' (I4). Such issues, the interviewee noted, will not affect all householders: 'the vast majority are tenants that have exhaust air heat pumps in their houses are working away with them fine' (I4). Whilst these unexpected - or difficult to predict - costs, might be an annoyance to affluent households trying out new technology, for people in fuel poverty or energy vulnerable households, for whom energy bills are a greater proportion of their income, they could cause severe financial stress.

In order to avoid expensive bill shocks, there is therefore a need for more information and guidance on how to get the best, and most cost-efficient, performance from heat pumps:

> *"That's going to be a huge behavioural change for them. It's likely that government is going to have to play an important role in not only funding the heating systems, but also managing that behaviour change to make heat pumps normal for people off the gas grids, for example. That's definitely the kind of behavioural side of those heating system changes." (I5)*

Advice and education becomes particularly important when buildings are retrofitted, and new technologies introduced. Where occupants may need to modify their behaviour or learn new ways of managing their heating system, it is important that this handover is effective,

> *"It's no use just sticking in lots of nice blinging technology if we don't bring the tenants along for them to just have a voice and maybe just either leaving folk open to fuel poverty or opening them up to it." (I4)*

As new technologies are rolled out, then, there will need to be a degree of behaviour change in order to get the 'best' out of systems in relation not only to energy performance, and therefore carbon reduction, but also to the impact on the householder.

Understanding these complex interactions between technology, behaviour and vulnerability will be an important focus of social research:

> *"There's a huge agenda here for social scientists because the more technology that comes in around energy efficiency, the more investment there is, the more we're going to see these complex interactions and, indeed, that then creates all kinds of tensions and it works within a political context, so all of these things aren't always very good for low income households." (I8)*

Risk 4: The development of renewable energy has limited impact on fuel poverty

Renewable sources ostensibly provide affordable and low-carbon energy and should therefore be entirely compatible with the fuel poverty agenda, not only providing affordable energy but also reducing the market power of the large energy companies: *'That's where the sustainable energy comes in. Perfect solution internationally as well where people are producing their own energy and they're not dependent on oil companies or waiting to get connected to the grid'* (I3). Renewables could therefore empower communities:

> *"The idea of communities building their own renewables and owning their own renewables and buying energy from each other and reducing their bills, that way, empowering themselves and taking ownership and responsibility away from green energy companies or the government or making a priority for their community together." (I1)*

Our interviewees, however, provide some cause for concern, or at least caution. The first reason is inequality in access. One interviewee referred to *'energy rich folk'*, who had been able to take the opportunity to invest in micro wind or solar PV and perhaps storage and have *'probably wiped their energy costs almost because they're running an electric meter on energy that's been generated and stored'* (I4). In contrast to this group,

the interviewee argued, there are people who cannot afford to *'invest in that sort of renewable revolution'* and therefore to enjoy the benefits in the medium to longer term.

Secondly, and this will depend on energy markets in particular contexts as well as the extent to which on-site renewable technologies are adopted by households, but if many people can afford to take the step of being energy independent and not have to connect to national infrastructure, and therefore not need to pay connection charges the result may be *that 'the fuel poor are going to have to share more and more of the cost between fewer and fewer people'* (I2). This raises the question: *'what is a charging basis and which basis would be fairest to the fuel poor?'* (I2)

A third point relates to the position of renewables in the market and makes a distinction between home renewables that could contribute towards self-sufficiency and renewables at community scale or, in the case of this example, island scale. Simply because the grid is decarbonised, it is not necessarily the case that cost savings are passed onto customers: *'[we are] likely to be able to go only so far to lower energy costs as long as energy supply is in private hands and seeking to pay dividends to shareholders rather than investing in infrastructure and charging fair prices'*. This survey respondent argued that his area had *'already decarbonised, and yet we pay a surcharge for the electricity that heats our homes…'*, and pointed out that *'an island group that can generate 120% of its electricity demand from local renewable resources (in 2016) shouldn't have the highest levels of fuel poverty in the country'* (SC). This a reminder that decarbonisation of supply does not necessarily lead to reduced costs and alleviation of fuel poverty.

These concerns about renewables connect with a broader narrative surrounding access to clean energy and new technologies, especially when access is individualised and requires capital expenditure, with the risk of a *'… sort of increasing gap in access to clean energy. We're seeing that repeated all over the world… the way that policies are designed, mostly requiring a financial impact from households'* (I6). The challenge then becomes how *'we make sure that low income, vulnerable and fuel power households can afford the necessary energy transition that's going to be required to decarbonise heat'* (I5) so that we do not *'end up with middle- and high-income households using very clean energy sources, and then more vulnerable, lower-income households still using very polluting sources and… unable to access that level of technology'* (I6).

In terms of the broader energy market and policy landscape, this implies the need to keep a close eye on the ways in which taxes and subsidies affect less affluent consumers. As this comment highlights, there is therefore a need to carefully design policies with social justice in mind:

> "Questions [in the research] relate to impact in next three years but research is needed now on how to ensure that no one is left behind as the industry transitions to a low carbon future. For example, ensuring that the costs of EV charging and local generation are not disproportionately paid for by fuel poor customers." (SC)

Risk 5: Approaches to decarbonisation overlook existing inequalities

Fuel poverty remains a reflection of social inequalities and any moves to decarbonise will continued to be shaped by those inequalities: *'I would say fuel poverty is a structural thing and it's a structural thing because it's embedded in poor housing, in huge systems of disadvantage and in huge infrastructural inequalities'* (I9). Whilst it is useful to highlight the elements that make fuel poverty distinct, it is critically important to understand its relationship with poverty, as one interviewee noted:

> *"I think that separating fuel poverty from poverty in general is potentially harmful although it might be expedient. It carries the risk of allowing fuel poverty to be characterised apart from the structural factors driving poverty in general and thereby allowing policy makers to forego addressing poverty in favour of energy/fuel specific measures such as smart meter solutions, behaviour change initiatives." (SC)*

It is the close association with housing quality, affordability and tenure that distinguishes fuel poverty from other forms of poverty. The need for capital expenditure to improve homes and the heating and cooling technology within them continues to be important:

> *"The real difference in poverty and fuel poverty is capital expenditure. End of story. That's it. The only way you can cure poverty is extra income. You can get around fuel poverty with extra income but it's not the most sensible approach. You've got to do it through capital expenditure, making peoples' homes more energy efficient, easier to keep warm and better insulated etc." (I2)*

Where decarbonisation and access to clean energy requires capital investment, these barriers will continue to exclude large parts of the population. Those who do not own their homes will also find that they are limited by what landlords – private and social – will allow and/or fund.

Another form of inequality is spatial, and reflected in the differences between urban and rural areas. Any large programme of work, whether motivated by poverty alleviation or decarbonisation, will find that there are additional costs to engaging with people in rural and remote areas, and to carrying out works:

> *"I think they're probably one of the more difficult to address areas, given the kind of dispersion of household and you don't have that same efficiency of work. Yes, for sure it's going to be an important part of decarbonisation and reducing carbon emissions and things." (I6)*

It can be much easier for programmes to rely on economies of scale in urban conurbations than in rural areas:

> *"I do some work with agencies in Cumbria, so I do get a picture of what it takes to drive out to a house in the middle of nowhere, and a house that often has an unusual or unique archetype, as opposed to a street of homes that are mostly the same." (I1)*

Technologies such as EnergieSprong (Brown et al 2019), which offer benefits for energy efficiency and therefore help to tackle fuel poverty and climate emissions, are therefore less economically viable in remote and rural areas:

> *"I think the guy from [the retrofit company] was ready to run out of the room. I said if he came up to Orkney, he would probably have some sort of meltdown when he saw that hardly any houses looked the same here." (I4)*

Interviewees commented on potential inequalities associated with the increasing digitisation of life in general and our interaction with energy markets in particular:

> *"If you've got the current system where you have to apply for benefits online and you can't afford your - you haven't got any electricity. How can you charge your phone or pay for your - have internet if you haven't got electricity?" (I3)*

As smart meters and smart home technologies a rolled out, the digital divide may be a source of exclusion. This is of particular concern given claims made around energy efficiency and low carbon consumption:

> *"From the experience of liberalisation, for instance, it was blatantly obvious that companies were mainly interested in the more affluent, consumers could pay online and by direct debit etc., and I wouldn't be surprised if you'll see the same sort of focus once smart metering starts offering all those. Then it's also all the additional services that are made possible, I guess, the sort of Smart Home etc. Again, it's probably, you can easily envisage, it's going to be the better off that will probably benefit more from that." (I8)*

Risk 6: Ignoring energy practices could deepen fuel poverty, but relying on them could disempower householders

There has been increasing recognition of the value, in initiatives to tackle fuel poverty, of understanding the experiences, behaviours and needs of occupants. Technical improvements to homes and technologies are important but there is a risk that a focus on these could obscure the reality of the experiences of the home. People at the beginning and end of the life course may for example require higher temperatures to be comfortable. Anxiety relating to fuel bills and household financial pressures may result in householders underusing their heating. Medical conditions may mean that householders require warmer temperatures throughout the day or have to wash bedding and clothes more frequently. One important consideration, then, as was recognised in the interviews, is the individual requirements of a householder and how their personal situation may shape their energy demand. An interviewee gave an example relating to disabled people *'if you're someone with a disability and you need to maybe have increased washing loads...the way we measure the problem doesn't take into account any kind of increased costs for people with disabilities' (I6)*.

The notions of behaviour and behavioural change are contested, and this was also reflected in our interviews: one interviewee (I9), for example, asserted a need to be clearer, and more critical, about what is meant when we use the terms. Interviewees were keen to caution against an implication that individual behaviour drives or perpetuates fuel poverty. Whilst there are many things that individuals can do in the home to seek to reduce their energy use, these are likely to be of limited value if the house itself is thermally inefficient and they may indeed result in counterproductive cost cutting. It was stressed that apart from, in some cases, being able to switch suppliers, householders often have little influence over energy markets. Sometimes, in the case of the private rented sector in particular, they have little control over the quality of the building.

An emphasis on behaviour therefore risks a 'faulty consumers' narrative:

> *"When we look at the power dynamics and we look at the broader drivers of energy poverty, it's very clearly beyond the role of the consumer. They don't have power over a lot of those structures, the way that energy pricing works, the way that they can access the schemes, but it seems like it's a very easy topic for people to focus on." (I6)*

Where approaches to decarbonisation rely on appealing to people to change what they do, there is a risk that people in fuel poverty are pressured to make cuts they cannot manage or are otherwise unable to make, whether due to their capital resources, energy requirements stemming from their vulnerability and other personal circumstances, or because they do not have agency over their living environment. Any such messaging can therefore *'...have a victim blaming effect as they can imply that a change in lifestyle could alleviate what is often a grinding lived experience'* (SC).

The act of choosing appliances or making decisions about investments in the home could also be couched as behaviour. Under this understanding of the term, infrequent behaviours, such as choosing an appliance, can have implications for energy use over a number of years. Since decisions now could limit choices, and therefore opportunities to do things differently in the future, by locking households into particular technologies. The ways in which experiences of poverty influence how decisions are made is therefore pertinent:

> *"I'd be interested to see if people could do some more qualitative research on how people in extreme fuel poverty make decisions about energy... Generally, demand-side stuff doesn't seem to talk to fuel poverty literature, but I don't know how much of that makes a difference in fuel poverty." (I7)*

Discussion and implications

Our interviewees and survey respondents highlight that the climate change, decarbonisation and fuel poverty agendas overlap and interact not only in their impacts but also in their potential solutions. Climate change and decarbonisation add a new, and evolving, layer to our understanding of fuel poverty alleviation, but to assume that the two agendas are necessarily, or automatically, synergistic is to risk fully achieving neither. There is therefore a need for a considered and purposive approach to research, maximising connections and minimising contradictions. Genuinely interdisciplinary work, that bridges the divide between social and technical research, is vital. Developing approaches that are fair and inclusive will require in-depth understanding and meaningful responses to lived experience, looking not only at the gaps but also in how existing provision shapes and constrains experiences of health and comfort.

An increasing focus on decarbonisation in policy and the mainstream media provides an opportunity to highlight the social justice issues inherent in our energy system. Energy is so often invisible in everyday life (Hargreaves et al., 2010). It is important that research on decarbonisation takes this into account and is vigilant in avoiding (Risk 1) falling into the trap of assuming *any* decarbonisation policy will aid social inclusion and that decarbonisation is a proxy for action on fuel poverty: simply because decarbonisation is fundamentally about *intergenerational* justice (Walker, 2012), it will not necessarily enhance *intragenerational* justice.

Conversely (Risk 2), energy justice researchers need to take into account the changing climate and its impact on housing (Elsharkawy and Zahiri, 2020; Tettey and Gustavsson, 2020) in both their projections of fuel poverty and their prescriptions for its alleviation. For example, increasing summer temperatures will likely make overheating a more frequent occurrence in northern European countries, such as the UK. Buildings have, however, not been constructed with overheating in mind and as a result occupants may find that existing designs and technologies struggle to provide a comfortable indoor climate (Lomas and Porritt, 2017). This widens the dimensions of fuel poverty, introducing new vulnerabilities and making people newly vulnerable. In countries in which fuel poverty is currently dominated by winter heating challenges, the seasonality of fuel poverty could be reconfigured, becoming an increasingly year-round problem. With

some countries already grappling with overheating issues, there are opportunities for sharing experiences on practices, building techniques, and technologies that can provide affordable ways to maintain comfort in a warming climate (Nicholls et al., 2017).

There is an evolving research agenda around questions such as the prevalence and health implications of overheating in heating dominated countries (Thomson et al., 2019) and how to adapt buildings and practices to hotter climates (Tink et al., 2018; Sherriff et al., 2019). Further important questions would relate to how to identify newly vulnerable groups, and the implications of fuel poverty becoming an increasingly year-round issue. This connects with Walker's development of the temporality of energy demand as 'intimately embedded in much of what happens from hour to hour, day to day, season to season and year to year in society' (2014: 50) and it may not only be energy demand that increases throughout the year but also the need for support, whether in the form of advice or money. There is also a broader point relating to the impacts of extreme weather at the intersection of housing and poverty through flooding, storm damage (Lehman and Kinchy, 2021) and displacement, issues that are part of the wider context within which energy justice is understood.

There is concern (Risk 3) that shifting fuel poor homes onto, for example, electric heating could prove an expensive option in the short term (Frerk and MacLean, 2017). This is particularly likely to be the case if effective and appropriate handover and support is not given to occupants to enable them to get the best out of new technologies and avoid expensive price shocks. There is an urgent need to understand how best to manage this process and how best to support vulnerable households in transitioning to decarbonised heating systems (Parrish et al., 2021). Electrification is not the only factor to consider. At the time of writing, gas price rises are being experienced and concerns being expressed about the impact on vulnerable consumers (Simcock, 2022; National Energy Action, 2021b).

This also raises a question of timing. There is an argument for fuel poor households to be prioritised. Installing gas boilers will improve conditions for fuel poor households almost immediately and, in being the most cost-effective way, reach more people. Whilst this contradicts decarbonisation aims, and a need to move away from gas and the use of fossil fuels, there is an argument that in a decade, when those boilers might need replacing, other technologies will be more developed, likely be cheaper, and the research and policy community will have a better understanding of their effective use. Relatedly, it is important to understand the constraints of vulnerable people in terms of accessing and purchasing newer and often more energy efficient appliances: those on severely restricted budgets are unlikely to be able to replace old, inefficient appliances until they break and may then be limited in terms of choice – having to focus on pricing within their available funds rather appliance efficiency, even when the latter could reduce running costs. Simultaneously, there remains a need to better understand the purchasing decisions of people considered not to be vulnerable and not strategically thinking about investing in new, safe, efficient appliances: their decisions could impact their own vulnerability in the medium term, subsequent occupants of their dwelling, and their impact on climate change.

Renewable technologies are attractive given their potential to provide low-cost, clean energy, but access to these sources is uneven as a result of access to capital, space and control of living environments (Risk 4). Even when communities are able to decarbonise, costs may not be lower as a result (Hannam and Jones, 2017). If increasing numbers of more affluent people invest in renewables and are able to move 'off grid', then those remaining may find themselves paying more for connection and services (Nicholls et al., 2017). The issues of who pays, and who can benefit, relates also to other aspects of sustainability transitions, such as electric vehicle charging (Sovacool et al., 2019).

Additionally, a more robust understanding of energy markets is required: how best to inform the development of economic instruments that ensure the costs of transitions do not fall disproportionately on those with low ability to pay.

Inequalities (Risk 5) remain and continue to shape experiences of energy whilst restricting the ability of people to maintain a warm home and invest in cleaner technologies. Fuel poverty scholarship provides a context for understanding the ways in which access to decarbonisation has a social gradient as well as the extent to which changes in housing and energy over coming decades will impact upon those who are most vulnerable. We have seen some groups of consumers will have greater difficulty in adopting new smart home technologies in their current form (Hazas et al., 2019). People have some agency over their homes and practices, but this varies greatly across income, capital availability and tenure. These factors combine to mean not only that people in fuel poverty are likely to find it difficult to engage with decarbonisation but also, and relatedly, that they will also struggle to adapt their homes to the impacts of a changing climate. Climate change will deepen existing inequalities in relation to, for example, race (Wang et al., 2021; Bednar and Reames, 2020), gender (Goodrich et al., 2019; Robinson, 2019), disability (Larrington-Spencer et al., 2021) and age (Haq, 2021).

From this observation, three important implications for research follow. The first is for research on decarbonisation to embrace an energy justice perspective in order better to reflect the differing capacities to benefit from new technologies and approaches. The second is more proactive: identifying and understanding ways in which approaches to decarbonisation can contribute towards reducing inequalities. In relation to the rollout of smart meters, for example, are there opportunities for wider support to be given and, for example, home audits carried out? Thirdly, there is a role for energy advice and support to engage with smart systems and digital skills in order to maximise the benefits of new systems.

Energy practices (Risk 6) is a vital part of energy research (Shove et al., 2015): a poor understanding how people relate to energy in their homes risks policies being ineffective and inequalities being unaddressed. Placing overdue emphasise on practices, however, as a way out of fuel poverty and as a means of decarbonisation can disempower householders who lack agency as a result of structural factors, whether due to insufficient capital, health issues, or restrictions rooted in housing tenure. In discourses around reducing carbon footprints, emphasis is placed on personal choices and practices. As changes in energy will often involve people making decisions about their homes, there is also a need to better understand how people make decisions about retrofit and other energy related issues.

Conclusion

Our discussions with stakeholders in fuel poverty research, policy and practice provide valuable insights at a time when the field of energy justice is rapidly developing and both decarbonisation and the impacts of climate change are increasingly prominent in public discourse. They highlight the importance of understanding these agendas together and of ensuring synergy. There is a risk that a focus on climate change and decarbonisation could be at the expense of action on fuel poverty and that a hotter and less stable climate could not only worsen conditions for those already experiencing fuel poverty but also create new vulnerabilities and intersect with other impacts related to housing, such as flooding, storm damage and displacement. At the same time, policies to decarbonise could themselves create inequalities, with the risk that people without capital to invest, or agency over their homes, will find themselves unable to benefit from new technologies and sources of energy.

In terms of an ongoing research agenda and the knowledge gaps that this paper identifies, it is vital to actively interrogate assumptions that fuel poverty alleviation and decarbonisation are necessarily synergistic. This implies a need for greater awareness of inequality and justice in decarbonisation research and a recognition amongst fuel poverty researchers of the ways in which climate change could impact upon the severity and seasonality of fuel poverty as well as create new forms of vulnerability at the intersection of housing, climate and energy. There is a need for more substantial interdisciplinary cross-fertilisation, reflecting the impact of new technologies and approaches on the most vulnerable householders. An energy justice perspective can facilitate a better understanding of the ways in which capacities to engage with new developments vary, as well as the ways in which new approaches can be utilised to the benefit of the most vulnerable. Fuel poverty researchers can engage with the body of evidence on the impacts of climate change to anticipate and account for the ways in which changes will affect vulnerable people. Those working closely with householders can be realistic about their involvement: engaging with them, whilst accepting that their contribution to, and experiences of, climate change is mediated through layers of inequality.

Whilst decarbonisation may feel like a medium-term issue when dealing with the day-to-day experience of poverty, the impacts of climate change are increasingly evident and calls for rapid decarbonisation are growing. As policies to electrify heating and introduce new smart technologies are rolled out with enthusiasm, a considered, evidence-based response from the research community can help to bring about a just transition.

Acknowledgements

References

Agyeman, J. (2013) *Introducing just sustainabilities: Policy, planning, and practice.* London: Zed Books Ltd.

Ambrose, A. (2015) Improving energy efficiency in private rented housing: Why don't landlords act? *Indoor and Built Environment*, 24, 7, 913–924.

Ambrose, A. and Marchand, R. (2017) The contemporary landscape of fuel poverty research. *Indoor and Built Environment*, 26, 7, 875–878.

Baker, W., Ambrose, A., Brierley, J., Butler, D., Marchand, R. and Sheriff, G. (2020) Stuck at home in a cold home: the implications of Covid-19 for the fuel poor. *People Place and Policy Online*, 14, 1, 2–5.

Bednar, D. J. and Reames, T. G. (2020) Recognition of and response to energy poverty in the United States. *Nature Energy*, 5, 6, 432-439.

Braun, V., and Clarke, V. (2012) *Thematic analysis*. London: SAGE.

Boardman, B. (2012) Fuel poverty synthesis: Lessons learnt, actions needed. *Energy Policy*, 49, 143–148.

Bouzarovski, S. (2018) *Energy poverty: (dis)assembling Europe's infrastructural divide.* Switzerland: Palgrave Macmillan.

Bouzarovski, S., Petrova, S. and Sarlamanov, R. (2012) Energy poverty policies in the EU: A critical perspective. *Energy Policy*, 49, 76–82.

Bouzarovski, S. and Petrova, S. (2015). A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. Energy Research & Social Science, 10, 31–40. Available at: https://doi.org/10.1016/j.erss.2015.06.007

Brown, D., Kivimaa, P. and Sorrell, S. (2019) An energy leap? Business model innovation and intermediation in the 'Energiesprong' retrofit initiative. *Energy Research & Social Science*, 58, 1253.

Burgess, M. and Whitehead, M. (2020) Just transitions, poverty and energy consumption: Personal carbon accounts and households in poverty. *Energies*, 13, 22, 953.

Butler, D. and Sherriff, G. (2017) "It's normal to have damp": Using a qualitative psychological approach to analyse the lived experience of energy vulnerability among young adult households. *Indoor and Built Environment*, 26, 7, 964–979.

Castaño-Rosa, R., Solís-Guzmán, J. and Marrero, M. (2020) A novel Index of Vulnerable Homes: Findings from application in Spain. *Indoor and Built Environment,* 29, 3, 311–330.

Davies, M. and Oreszczyn, T. (2012) The unintended consequences of decarbonising the built environment: A UK case study. *Energy and Buildings*, 46, 80–85.

Elsharkawy, H. and Zahiri, S. (2020) The significance of occupancy profiles in determining post retrofit indoor thermal comfort, overheating risk and building energy performance. *Building and Environment*, 172, 6676.

Frerk, M. and MacLean, K. (2017) *Heat decarbonisation: potential impacts on social equity and fuel poverty*. UK: National Energy Action. Available at: https://www.nea.org.uk/wp-content/uploads/2020/11/Heat-Decarbonisation-Report-2017.pdf

Goodrich, C. G., Udas, P. B. and Larrington-Spencer, H. (2019) Conceptualizing gendered vulnerability to climate change in the Hindu Kush Himalaya: Contextual conditions and drivers of change. *Environmental Development*, 31, 9–18.

Hall, S. M. (2013) Energy justice and ethical consumption: comparison, synthesis and lesson drawing. *Local Environment*, 18, 4, 422–437.

Hannam, J. and Jones, T. (2017) *Low Carbon Heat and Rural Fuel Poverty: Lessons from across Europe*. UK: Community Energy Plus. Available at: https://www.cep.org.uk/wp-content/uploads/2018/06/Low-Carbon-Heat-and-Rural-Fuel-Poverty-Lessons-from-across-Europe.pdf

Hargreaves, T., Nye, M. and Burgess, J. (2010) Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy*, 38, 10, 6111–6119.

Hazas, M., Strengers, Y., Rinkinen, J., Shove, E., and Torriti, J. (2019) Promoting smart homes. In: *Energy fables: Challenging ideas in the energy sector*. UK: Routledge, pp. 78-87.

Haq, G. (2021) The forgotten generation: Older people and climate change. In: *Diversity and Inclusion in Environmentalism*. Oxon: Routledge, 118–131.

Henry, M. S., Bazilian, M. D. and Markuson, C. (2020) Just transitions: Histories and futures in a post-COVID world. *Energy Research & Social Science*, 68, 1668.

Howden-Chapman, P., Viggers, H., Chapman, R., O'Sullivan, K., Telfar Barnard, L. and Lloyd, B. (2012) Tackling cold housing and fuel poverty in New Zealand: A review of policies, research, and health impacts. *Energy Policy*, 49, 134–142.

Hsu, C.-C. and Sandford, B. A. (2007) The Delphi technique: making sense of consensus. *Practical Assessment, Research, and Evaluation*, 12, 1, 10.

Larrington-Spencer, H., Fenney, D., Middlemiss, L. and Kosanic, A. (2021) Disabled environmentalisms. In: *Diversity and Inclusion in Environmentalism*. Oxon: Routledge, pp. 15–33.

Lehman, J. and Kinchy, A. (2021) Bringing climate politics home: Lived experiences of flooding and housing insecurity in a natural gas boomtown. *Geoforum*, 121, 152–161.

Lomas, K. J. and Porritt, S. M. (2017) Overheating in buildings: lessons from research. *Building Research & Information*, 45, 1-2, 1–18.

Lucon, O., Ürge-Vorsatz, D., Ahmed, A.Z., Akbari, H., Bertoldi, P., Cabeza, L.F., Eyre, N., Gadgil, A., et al. (2014). Chapter 9 - Buildings. In: *Climate Change 2014: Mitigation of Climate Change. IPCC Working Group III Contribution to AR5*. Cambridge University Press.

Jonsson, A. and Hillring, B. (2006) Planning for increased bioenergy use—Evaluating the impact on local air quality. *Biomass and Bioenergy*, 30, 6, 543–554.

Marmot, M., Allen, J., Goldblatt, P., Boyce, T., McNeish, D., Grady, M. and Geddes, I. (2010) *Fair society, Healthy Lives: The Marmot Review*. Available at: https://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review/fair-society-healthy-lives-full-report-pdf.pdf

Mastropietro, P., Rodilla, P. and Batlle, C. (2020) Emergency measures to protect energy consumers during the Covid-19 pandemic: A global review and critical analysis. *Energy Research & Social Science*, 68, 1678.

McCauley, D. and Heffron, R. (2018) Just transition: Integrating climate, energy and environmental justice. *Energy Policy*, 119, 8, 1–7.

Middlemiss, L. and Gillard, R. (2015) Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor. *Energy Research & Social Science*, 6, 3, 146–154.

Nagaj, R. and Korpysa, J. (2020) Impact of COVID-19 on the Level of Energy Poverty in Poland. *Energies*, 13, 18, 4977.

National Energy Action (2021a) *Every home should be a warm and safe place: National Energy Action Strategy 2021/2026*. Available at: https://www.nea.org.uk/wp-content/uploads/2021/09/3203_NEA_Strategy_and_annual_review_RL_v5.pdf

National Energy Action (2021b) *Warning comes on Fuel Poverty Awareness Day which highlights the 'cold reality' of millions struggling to pay energy bills*. Available at: https://www.nea.org.uk/news/energy-crisis-will-double-average-heating-bill-from-april/?parent=who-we-are/media-centre [Accessed: 02/02/2022]

Nicholls, D. L., McCann, H., Strengers, D. Y. and Bosomworth, D. K. (2017) *Electricity pricing, heatwaves & household vulnerability in Australia*. Melbourne: Centre for Urban Research (CUR), RMIT University. Available at: file:///C:/Users/dbutler/Downloads/HeatwavesHomesHealthBriefingPaper_RMIT.pdf

Parrish, B., Hielscher, S. and Foxon, T. J. (2021) Consumers or users? The impact of user learning about smart hybrid heat pumps on policy trajectories for heat decarbonisation. *Energy Policy*, 148, 1, 112006.

Pellegrini-Masini, G., Pirni, A. and Maran, S. (2020) Energy justice revisited: A critical review on the philosophical and political origins of equality. *Energy Research & Social Science*, 59, 1, 101310.

Pérez-Fargallo, A., Rubio-Bellido, C., Pulido-Arcas, J. A. and Javier Guevara-García, F. (2018) Fuel Poverty Potential Risk Index in the context of climate change in Chile. *Energy Policy*, 113, 157–170.

Pett, J. (2009) Carbon footprints of low income households; does addressing fuel poverty conflict with carbon saving. In: *Proceedings of the ECEEE*, 1675-1686.

Press, V. (2003) *Fuel poverty and health: A guide for primary care organisations, and public health and primary care professionals.* London: National Heart Forum. Available at: https://www.fuelpovertylibrary.info/content/fuel-poverty-and-health-guide-primary-care-organisations-and-public-health-and-primary-0

Robinson, C. (2019) Energy poverty and gender in England: A spatial perspective. *Geoforum*, 104, 222-233.

Schünemann, C., Olfert, A., Schiela, D., Gruhler, K. and Ortlepp, R. (2020) Mitigation and adaptation in multifamily housing: overheating and climate justice. *Buildings and Cities*, 1, 1, 36–55.

Sherriff, G. (2016) *'I was frightened to put the heating on.' Evaluating the Changes4Warmth approach to cold homes and mental health*. Salford: University of Salford. Available at: https://www.beatcold.org.uk/wp-content/uploads/2018/11/Evaluating-the-approach-to-cold-homes-and-mental-health.pdf

Sherriff, G., Moore, T., Berry, S., Ambrose, A., Goodchild, B. and Maye-Banbury, A. (2019a) Coping with extremes, creating comfort: User experiences of "low-energy" homes in Australia. *Energy Research & Social Science*, 51, 5, 44–54.

Sherriff, G., Brown, P., and Butler, D. (2019b) Future Directions for Fuel Poverty Research A Delphi Study. Salford: University of Salford. Available at: https://www.fuelpovertylibrary.info/content/future-directions-fuel-poverty-research-delphi-study

Sherriff, G., Lawler, C., Martin, P. B., Butler, D., Probin, M. and Brown, P. (2020) *Reshaping health services and fuel poverty in the Outer Hebrides*. Salford: University of Salford. Available at: http://usir.salford.ac.uk/id/eprint/57055/1/Sherriff%202020%20Moving%20Together%20Final%20Report.pdf

Shove, E., Watson, M. and Spurling, N. (2015) Conceptualizing connections: Energy demand, infrastructures and social practices. In: Skillington, T. (ed.) *European Journal of Social Theory*, 18, 3, 274–287.

Simcock, N., Frankowski, J. and Bouzarovski, S. (2021) 'Rendered Invisible: Institutional Misrecognition and the Reproduction of Energy Poverty'. *Geoforum*, 124, 1–9.

Simcock, N. (2022) Why lowering everyone's energy bills is a better solution than targeting only the most vulnerable. *The Conversation* [online] Available at: https://theconversation.com/why-lowering-everyones-energy-bills-is-a-better-solution-than-targeting-only-the-most-vulnerable-174746

Sovacool, B. (2014) What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research & Social Science*, 1, 3, 1–29.

Sovacool, B. and Dworkin, M. (2014) *Global energy justice*. Cambridge: University Press.

Sovacool, B. K., Martiskainen, M., Hook, A. and Baker, L. (2019) Decarbonization and its discontents: a critical energy justice perspective on four low-carbon transitions. *Climatic Change*, 155, 4, 581–619.

Sovacool, B. K., Turnheim, B., Hook, A., Brock, A. and Martiskainen, M. (2021) Dispossessed by decarbonisation: Reducing vulnerability, injustice, and inequality in the lived experience of low-carbon pathways. *World Development*, 137, 1, 105-116.

Tettey, U. Y. A. and Gustavsson, L. (2020) Energy savings and overheating risk of deep energy renovation of a multi-storey residential building in a cold climate under climate change. *Energy*, 202, 7578.

Thomson, H., Simcock, N., Bouzarovski, S. and Petrova, S. (2019) Energy poverty and indoor cooling: An overlooked issue in Europe. *Energy and Buildings*, 196, 8, 21–29.

Tink, V., Porritt, S., Allinson, D. and Loveday, D. (2018) Measuring and mitigating overheating risk in solid wall dwellings retrofitted with internal wall insulation. *Building and Environment*, 141, 8, 247–261.

Van Veelen, B., Pinker, A., Tingey, M., Taylor Aiken, G. and Eadson, W. (2019) What can energy research bring to social science? Reflections on 5 years of Energy Research & Social Science and beyond. *Energy Research & Social Science*, 57, 11, 101240.

Walker, G. (2012) *Environmental justice: concepts, evidence and politics.* Oxon: Routledge.

Walker, G. (2014) The dynamics of energy demand: Change, rhythm and synchronicity. *Energy Research & Social Science,* 1, 3, 49–55.

Walker, G. and Day, R. (2012) Fuel poverty as injustice: Integrating distribution, recognition and procedure in the struggle for affordable warmth. *Energy Policy*, 49, 10, 69–75.

Wang, Q., Kwan, M. P., Fan, J. and Lin, J. (2021). Racial disparities in energy poverty in the United States. *Renewable and Sustainable Energy Reviews*, 137, 110620.

Winter, T. (2013) An uncomfortable truth: air-conditioning and sustainability in Asia. *Environ. Plan. A*, 45, 517–531.