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DEPARTMENT OF ENVIRONMENTAL SCIENCES AND ENGINEERING

COMPETING AGENDAS - ENERGY POVERTY AND CARBON NEUTRALITY POLICY PATHWAYS

Katherine Elizabeth Mahoney

Master in Environment and Public Policy

DOCTORATE IN ENVIRONMENT AND SUSTAINABILITY

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Abstract

Current policy pathways to carbon neutrality by 2050 are founded on ideals of a just transition which addresses the inequities inherent to existing energy systems. One such injustice is energy poverty, generally understood as a lack of sufficient access to energy services. Mitigating energy poverty has thus been integrated into broader carbon neutrality goals, where greater energy efficiency and the decarbonisation of the energy supply through the uptake of renewables are essential tools for tackling both energy poverty and for the reduction of greenhouse gas emissions. Despite this, due to instances of extreme energy restriction and shifts in energy needs driven by climate change, uniform decreases in energy consumption are not always synergistic with the mitigation of energy poverty. Thus, synergies and trade-offs arise between the overarching agenda of tackling climate change, one of the central tools employed to mitigate it (the energy transition) and efforts to alleviate energy poverty. Assuming the label "competing agendas", this thesis explores the synergies, trade-offs and dynamic factors at play across the agendas of climate change, the energy transition and energy poverty.

To explore the "competing agendas", two case studies are drawn upon the United Kingdom, which has a significant policy history with "fuel poverty", and Portugal, which presents high rates of renewable energy integration but is in the early phases of political engagement with energy poverty. An analysis of the UK policy context is provided. This policy background reveals the pros and cons of different energy poverty policy strategies in a setting which has been undertaking a tighter integration of energy efficiency and fuel poverty policies for some time. Themes of policy devolution and differences in the definitions and diagnoses of energy poverty are informative for the developing European context, where, ultimately, the policy approach taken affects who benefits and how from mitigatory policies.

The UK policy setting is used as a foreground for a deeper exploration of the Portuguese case. The interlinkages of the three agendas in Portuguese policy are explored through a set of qualitative techniques. These techniques included policy analysis, thematic analysis of qualitative interviews and a Participatory Systems Mapping process. The combined results of these activities highlighted areas of stakeholder agreement and discord, where stakeholders generally felt the agendas should be treated holistically, presented divergent views regarding citizen agency and a lack of consensus on whether energy consumption would need to increase to mitigate energy poverty in Portugal. These areas of stakeholder discord are key future themes for the Portuguese decarbonisation strategy, where greater consensus fosters increased policy acceptance.

The final chapter of the thesis reflects on the interlinkages of the climate change, energy transition and energy poverty agendas explored throughout the thesis, coming to the conclusion that these agendas are inherently connected and should be tackled holistically. This holistic approach must, however, account for the trade-offs occurring across the agendas. To this end, a means of articulating and prioritizing the "agenda conflicts" is presented. The thesis closes with a call for deeper explorations of citizen will and agency and tighter integration of the energy and social policy domains to promote inclusive policy solutions.

Keywords: Energy Poverty, Climate Change, Energy Transition, Just Transition, Participatory Approaches

Resumo

A trajetória até à neutralidade carbónica em 2050 está assente numa "transição justa" que permita reduzir as desigualdades existentes associadas ao sistema energético. A pobreza energética surge como uma destas injustiças, associada à falta de acesso aos serviços essenciais de energia. O combate à pobreza energética integra os objetivos de neutralidade carbónica, já que a eficiência energética e a descarbonização do sistema energético através da integração de energias renováveis são ferramentas essenciais para dar resposta aos desafios simultaneamente da pobreza energética e da redução das emissões de gases de efeito de estufa. Apesar desta clara ligação, as restrições indiferenciadas ao consumo de energia para dar resposta às alterações climáticas, nem sempre são compatíveis com as exigências à redução da pobreza energética. Diferentes sinergias ou *trade-offs* podem emergir entre as agendas políticas das alterações climáticas, uma das ferramentas centrais na sua mitigação (a transição energética) e os esforços para mitigar a pobreza energética.

Esta tese, consideram "agendas competidoras" explora as vantagens, desvantagens e fatores dinâmicos entre as diferentes políticas de combate à alterações climáticas, à pobreza energética e apoio à transição energética. Para analisar as “agendas competidoras" foram usados dois casos de estudo, o Reino Unido, com uma história política substancial no que respeita ao combate à pobreza energética e Portugal, que apresenta elevada integração de fontes de energia renovável, mas que relativamente às políticas de pobreza energética, está ainda numa fase inicial.

O caso estudo do Reino Unido revela as vantagens e desvantagens das políticas da pobreza energética na prática, e em particular de abordagens políticas que cruzam metas da eficiência energética com as da pobreza energética. Diferenças entre definições e diagnósticos da pobreza energética no contexto descentralizado do Reino Unido é informativo para o contexto europeu, onde as políticas da pobreza energética estão numa faze de desenvolvimento. A exploração das políticas no Reino Unido também exemplifica como as políticas podem afetar quem beneficia e como dos esforços mitigatórios.

O contexto do Reino Unido é utilizado como destaque para uma exploração mais profunda do caso português. As conexões das agendas na política portuguesa são exploradas através de vários métodos qualitativos, incluindo análise de políticas, entrevistas qualitativas e mapeamento participado do sistema e das suas relações causais (diagramas causais).

Os resultados das atividades participativas identificaram áreas de acordo e desacordo entre os *stakeholders*. Em particular as partes interessadas sentiram que as agendas deviam ser tratadas de uma forma holística, mas que na generalidade apresentavam perspetivas divergentes sobre a agência dos cidadãos e falta de consenso em relação às necessidades de serviços de energia dos cidadãos e especificamente se o consumo da energia precisa de aumentar para mitigar a pobreza energética em Portugal. A identificação de áreas em que os diferentes *stakeholders* discordam e as que concordam é importante para o desenho de políticas de descarbonização que deem resposta às necessidades das diferentes partes interessadas, promovendo a sua aceitação.

O capítulo final da tese reflete nas interconexões entre as agendas das alterações climáticas, a transição energética e a pobreza energética explorados durante a tese, chegando à conclusão que as agendas têm uma conexão inerente e que devem ser abordadas juntamente. Mesmo assim é de forma mais integrada. Neste sentido as conclusões apresentam um método para articular e priorizar os conflitos entre as agendas. A tese acaba com um convite para uma exploração mais profunda dos níveis de agência e vontade dos cidadãos, e de uma integração mais alinhada das políticas energéticas e sociais para promover soluções inclusivas.

Palavras chaves: Pobreza Energética, Alterações Climáticas, Transição Energética, Transição Justa, Métodos Participativos

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Acronyms

AHC - After Housing Costs

BEIS - Department for Business and Industrial Strategy

BHC - Before Housing Costs

BPIE - Building Performance Institute Europe

BRE - Building Research Establishment

CC - Climate Change

CDD - Cooling Degree Days

CLDs - Causal Loop Diagrams

CO_2 - Carbon Dioxide

COPD - Chronic Obstructive Pulmonary Disease

CSE - Centre for Sustainable Energy

DECC-Department of Energy & Climate Change

DGEG - Direção Geral de Energia e Geologia

DWP - Department for Work and Pensions

EC- European Commission

EEA - European Environment Agency

EP - Energy Poverty

EPAH - Energy Poverty Advisory Hub

EPC - Energy Performance Certificate

ERSE - Entidade Reguladora dos Serviços Energéticos

ET - Energy Transition

EU - European Union

EU SILC - EU Statistics on Income and Living Conditions

EWDs - Excess Winter Deaths

GDP - Gross Domestic Product

GIS - Geographic Information System

Gt - Gigatonne

HDD - Heating Degree Days

HM Gov - Her Majesty's Government

HoC - House of Commons

IEA - International Energy Agency

ILO - International Labour Organization

IPCC - Intergovernmental Panel on Climate Change

IRENA - International Renewable Energy Agency

kWh - Kilowatt-hour

LIHC - Low Income High Costs

LILEE - Low Income Low Energy Efficiency

LPG - Liquefied Petroleum Gas

LSOA - Lower Layer Super Output Area

MS - Member State

Mt - Mega tonne

NDCs - National Determined Contributions

NEA - National Energy Action

NECP - National Energy and Climate Plan

NGO - National Governmental Organization

NHS - National Health Service

NI - Northern Ireland

NIHE - Northern Ireland Housing Executive

NISEP-Northern Ireland Sustainable Energy Programme

NISRA - Northern Ireland Statistics and Research Agency

NUTS-Nomenclature of Territorial Units for Statistics

NZEB - Nearly Zero Energy Buildings

ONLCP-Observatório Nacional Luta Contra a Pobreza

ONS-Office for National Statistics

PSM - Participatory Systems Mapping

PT - Portugal

RCP - Representative Concentration Pathway

RQ - Research Question

RRP - Recovery and Resilience Plan

SDGs - Sustainable Development Goals

SOAs - Super Output Area

UK - United Kingdom

UN - United Nations

UNCTAD - United Nations Conference on Trade and Development

UNEP - United Nations Environment Programme

USA - United States of America

WHO - World Health Organization

Chapter 1 | Introduction

1.1. Decarbonisation and Energy Transitions in The Global Context

Following years of limited progress in the global political response to climate change (Keohane & Oppenheimer, 2016), the 2015 Paris Agreement brokered impressive new targets in the form of National Determined Contributions (NDCs) to limit global temperature increases to a maximum of 2°C and preferably below 1.5°C (Paris Agreement on Climate Change, 2015). Critically, the contemporary pathway of ever-increasing resource consumption and consequent rising global temperatures must be halted to prevent the catastrophic results of climate change, which, despite significant progress in the development of renewable energy technologies in recent years, remains one of the most predominate threats of the Anthropocene era. Specifically, human actions are now known to have led to a global surface temperature increase of 1.1°C in 2011–2020, compared with levels in 1850–1900 (IPCC, 2023). Notably, the consumption patterns causing climate change, like its impacts, are uneven, with a general trend of those who have contributed less typically suffering more (Porter, 2020).

Figure 1.1 shows annual carbon dioxide (CO_2) emissions by world region, highlighting a shift in emissions patterns in recent years, with China overtaking the USA as the biggest emitter and significant increases in emissions in countries such as India, where previously the bulk of emissions originated from the global North (Gardiner, 2011). Analysis of the effects of climate scenario Representative Concentration Pathway (RCP) 4.5 (described as an intermediate climate change scenario in terms of emissions) (IPCC, 2014) on Gross Domestic Product (GDP) losses reveals that South and Central Asia and Sub-Saharan Africa are the regions where predicted risks to GDP losses are highest as a result of physical climate risks, at 15%, 7% and 6% respectively compared to just 1% in Europe in 2050 (S&P Global Ratings, 2022). Due to the lower-income profiles of these countries, their capacity to adapt to these risks is also reduced, an occurrence which can be considered a form of climate injustice (Porter, 2020).

In comparison, Figure 1.2 shows global direct primary energy consumption by fuel type, showing an upswing in energy consumption post-1900 with a sharper peak beginning around 1950. More incremental increases post 1800 are attributable to modernisation during the industrial revolution with later dramatic increases in energy consumption post World War II (labelled the "golden age") occurring in tandem with sustained and rapid growth in Western Europe and North America (Johnstone & McLeish, 2020). The "energy mix" has also changed over time, with greater diversification and integration of renewables detectable in recent years. Crucially, energy consumption increases have been associated with improved quality of life;

there are, however, limits to this relationship, with researchers identifying a so-called "saturation effect", where the value of increased energy consumption plateaus and no longer results in additional well-being benefits (Pesch *et al.,* 2023). Generally, it can be argued that populations in the global North are far closer to reaching this saturation point than those in the global South.

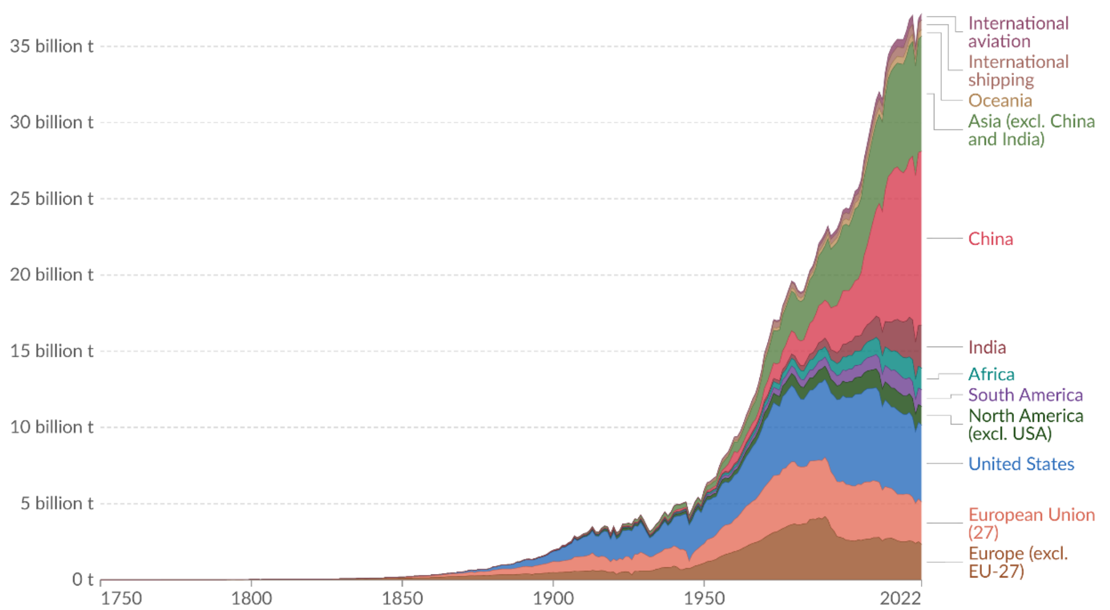

Figure 1.1 CO_2 emissions by world region (Our World in Data, 2024a)

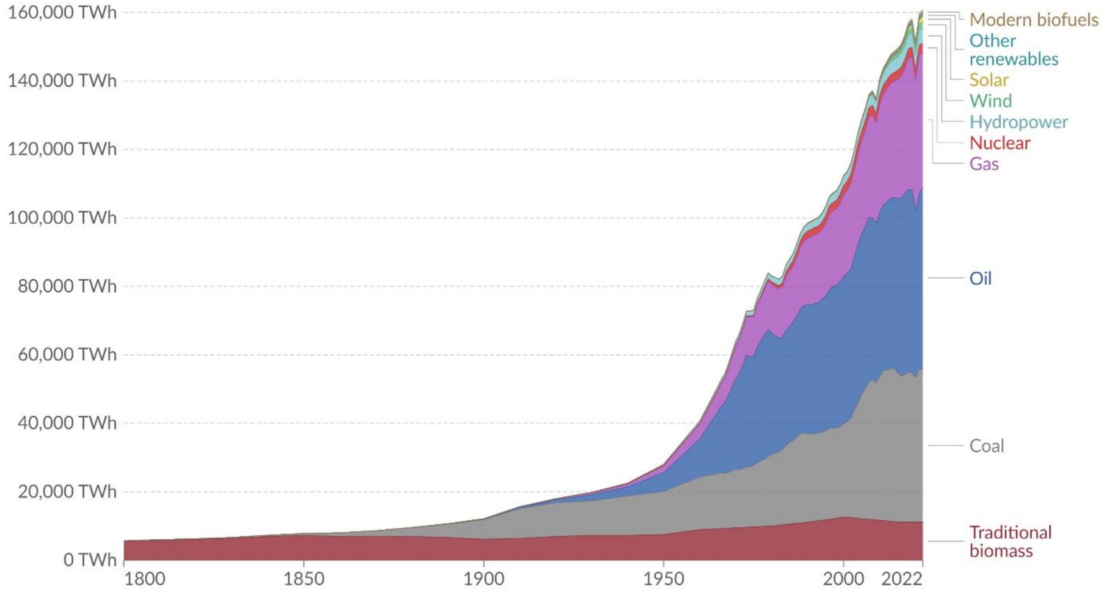

Figure 1.2 Global direct primary energy consumption (Our World in Data, 2024b)

Injustices in consumption profiles are compounded by the energy price crisis arising from the war in Ukraine, resulting, for the first time in many years, in the number of people without access to electricity in 2022 increasing as opposed to falling. In 2022 this figure stood at 774 million, representing an increase of 20 million people from the previous year, with the majority of these reductions occurring in sub–Saharan Africa (IEA, 2022). Sustainable Development Goal 7 focuses on facilitating access to affordable, reliable, sustainable and modern energy for all (UN, 2022), where the lack of access to energy has serious implications for quality of life and is known as energy poverty. Energy poverty also exists in the global North, where it generally refers to a difficulty in affording sufficient energy to achieve an adequate level of services for daily tasks such as heating, cooling, washing etc., (Bouzarovski & Petrova, 2015) as opposed to the lack of connection to an energy source (Guevara *et al.,* 2023).

Recent energy price spikes in Europe due to the Ukrainian war have increased energy prices in Europe even in countries which are generally considered less vulnerable to energy poverty, such as Germany and France (Liadze *et al.,* 2022) and called the perils of fossil fuel inter-dependencies into ever sharper focus. Furthermore, in Europe, links between poor housing quality and adverse social consequences, such as premature mortality, the onset of disability and associated pressures on national health services, have been recognised as a policy priority for some time (The Marmot Review Team, 2011; Lakasing *et al.,* 2019). Within Europe, important divisions exist, with energy poverty generally being more severe in Eastern and Southern European States (Bouzarovski & Tirado Herrero, 2017). Thus, while the manifestation of energy poverty undeniably differs between the global North and the global South, both centre on the provision of sufficient energy to ensure a decent life, which can imply a need to increase energy consumption (Gouveia *et al.,* 2019; Apfel *et al.,* 2021), running contrary to broader emissions targets.

Consequently, efforts to mitigate the impacts of global climate change increasingly seek to employ climate change policies as a tool to redress existing inequalities at the global scale while decarbonising the energy supply (COM/2019/ 640 final; United States Department of State & United States Executive Office of the President, 2021). In other words, there is a need for a global energy transition away from fossil fuels. This need becomes ever more urgent in the times of crisis caused by the war in Ukraine and in the face of a new all-time high in CO_2 emissions, at 36.8 Gt from energy in 2022. This spike follows a post-pandemic emissions rebound in 2021 and suggests a worrying reversal of the decoupling of emissions from economic growth (IEA, 2022).

Under the aforementioned pressures, energy transitions potentially represent the solution to several problems simultaneously. However, many paradoxes and uncertainties remain. For example, significant debate still rages as to how to define what the "right" level of energy consumption (i.e., one that meets consumer needs satisfactorily) is, with agreement going only so far as to recognise that this differs between different countries, cultures and even different households (Day *et al.,* 2016; Hargreaves & Middlemiss, 2020). Energy poverty is a significant detriment to human well-being in the global North and South. Despite the undesirable impacts of energy poverty, in a general discourse of emissions reductions, there is a risk of energy poverty being subsumed in the pressure to decarbonise (Sherriff *et al.,* 2022). This, in turn, suggests limited room for increases in energy consumption. Such increases may be necessary in the context of energy access in the global North and the global South to reduce consumer vulnerability and increase citizen well-being in the extreme temperatures caused by climate change. Thus, the agendas of climate change, energy transitions and energy poverty can be labelled as competing to some degree.

Ultimately, competition between different agendas threatens policy success; as explained above, there are various scales at which this is relevant, i.e., globally, between the global North and the global South and within Europe itself. All contexts are relevant; however, given that Europe has shown considerable initiative in responding to the climate emergency and presents a range of policy settings in varying phases of maturity regarding energy poverty, this seems a natural testbed for exploring the agendas. Specifically, the cases of the UK, which essentially paved the way for energy poverty policy (despite no longer being an EU member), and Portugal, with high rates of energy poverty contrasting with impressive dedication to carbon neutrality, are drawn upon to explore competing agendas in the climate change, energy transition and energy poverty agendas.

1.2. Synergies and Trade-offs: Energy Poverty and Decarbonisation Policy

An important step to understanding to what extent the agendas of climate change, the energy transition and energy poverty compete is to categorise policy synergies and trade-offs across these various agendas. A synopsis of these synergies, trade-offs and their corresponding uncertainties is provided in the following sections.

1.2.1. Synergies

Policy pathways tackling energy poverty within the frame of decarbonisation present important policy synergies which are attractive to policy makers worldwide. On a global scale, jobs from the renewable energy sector increased from 7.3 million jobs in 2012 to 13.7 million in 2022 (IRENA & ILO, 2022); this development of the renewables sector has impacts at different scales. Firstly, renewable energy allows countries to take advantage of their natural resources in new ways. For example, countries which would not have traditionally been considered "resource-rich" in fossil fuel terms may have abundant levels of sun or wind from which they can benefit. Furthermore, new industries in such places create employment and economic benefits that did not previously exist (Deloitte, 2021). Secondly, the creation of new jobs will undoubtedly lift some out of energy poverty in cases where they provide an income that was not previously available. When delving into the distribution of jobs in the renewables sector, there are encouraging signs in terms of the potential to address previously outlined inequities between the global North and the global South, with 62% of all jobs in the renewables energy sector based in Asia in 2022, with the majority of these in China at 5.55 million (IRENA & ILO, 2022). Other regions with impressive renewable energy employment statistics include Brazil, India, the USA and the EU (IRENA & ILO, 2022).

The potential for employment opportunities also applies to the energy efficiency chain, which includes domestic renewable technologies, such as rooftop panels and wind turbines, efficient windows and doors, insulation and heat pumps (amongst others). With a common definition for employment in the energy efficiency sector lacking, it is difficult to precisely characterise the number of people employed in the sector (IEA, 2023). Despite this, it is thought that the number of jobs in energy efficiency projects increased to 10.5 million in 2022, incentivised by high energy prices and political incentives on the one hand and slowed by high interest rates on the other (IEA, 2023). In Europe, political incentives to increase energy efficiency have been observed to encourage employment rates in the sector (Czako, 2020). There is, however, a certain degree of uncertainty around the potential for employment creation depending on the energy efficiency targets applied, with an estimated 2.3 million jobs in the sector in 2030 under a highly ambitious energy efficiency scenario (Næss-Schmidt *et al.,* 2018).

Notably, not all the benefits of carbon neutrality and corresponding energy efficiency measures are quantifiable, with health benefits and increased energy security being less easy to quantify (Cambridge Econometrics, 2015). Public health benefits associated with energy efficiency generally pertain to the links between poor physical health, mortality and poor building quality (Healy, 2003; The Marmot Review Team, 2011; Almendra *et al*., 2016). Greater energy security refers to increases in endogenous supplies at the national or regional level. Significantly, in politically united regions such as the European Union, increasing energy security across the Member States reduces vulnerabilities to price shocks, which can result from dependencies on energy providers outside the EU (COM/2023/ 650 final) whilst allowing intra-state energy provision to mitigate energy vulnerabilities in areas with poor energy infrastructure (COM/2015/ 80 final).

Finally, another important opportunity linked with both energy poverty and broader decarbonisation goals is that of shifting the current power dynamics related to energy provision, where typically a small number of large energy companies are in a position of market dominance and energy consumer choices are limited (Braunholtz-Speight *et al.,* 2018; Wokuri, 2021). Energy transitions offer different ways to change this dynamic, principally in creating "prosumer" energy models where consumers become energy producers and have increased ownership of energy infrastructure. Such models generally do not have the same drive for profit as large energy companies; furthermore, they can involve in situ energy production and consumption (implying less transmission costs), thus reducing energy costs (Šajn, 2016).

1.2.2. Trade-offs

In the first steps towards implementing energy transitions, which can be considered "Just and fair", global political bodies are beginning to concretise exactly what this entails. For example, in Europe in early 2020, the EC proposed “Climate Law 11”, aiming to make the objective of a carbon-neutral society legally binding; the need for a just and socially fair transition was expressed, as was the need for affordable energy, improving resilience and the reduction of climate change vulnerability (Bouzarovski *et al.,* 2020). In 2021, 42% of energy consumed in the EU was used in buildings (EC, 2024). At the global scale, the buildings and construction industry account for 37% of global operational energy and process-related CO_2 emissions (Zhong *et al*., 2021); thus, there is a clear need to reduce energy use in this sector. From this perspective the opportunities provided by improving the energy efficiency of building stock, i.e., simultaneously reducing emissions while improving domestic living conditions, seem clear. In practice, however, several challenges present themselves, complicating this seemingly obvious solution.

In Europe, one such challenge is that of households under-consuming energy to limit expenditure on energy bills, thus obscuring the true level of energy needed for thermal comfort (Bouzarovski & Thomson, 2019). Furthermore, in the global North, authors calculating the so-called "gap" between energy consumed and energy required found that increases in energy consumption would potentially be required to reach the recommended temperature thresholds for heating and cooling (Gouveia *et al.*, 2019; Palma *et al.,* 2019). This has particular relevance for zones suffering from energy poverty in the winter (with additional heating needs) and in the summer (with additional cooling needs) (Gouveia *et al.*, 2019). Added to this are discrepancies across the Member States in terms of building quality, economic conditions and, consequently, levels of energy poverty (OpenEXP, 2019). Thus, complicating understandings of the scale of the problem and where to prioritise interventions. At the citizen level, building efficiency upgrades offer the potential to decrease consumer energy costs and improve building quality; however, in some cases, these improvements have led to a "gentrification" effect where increased desirability drives up rental prices, rendering these buildings unaffordable to lower-income residents (Großmann, 2019).

With Europe having positioned itself as a leader in the move to carbon neutrality since the 1900s (Palinkas, 1998; Oberthür & Dupont, 2021), these challenges serve as important indicators of the types of policy challenges that other global regions may face as they implement their various energy transitions. Additionally, while significant differences exist in the severity of energy (and other types) of deprivation experienced between the global North and the global South, important parallels are already emerging regarding the inequity of policy impacts. Specifically, there are several examples in both cases of decarbonisation policies tending to adversely affect vulnerable population groups. For example, rural dwellings have been observed to have reduced access to diversified (and clean) energy sources in both global North and global South contexts, with corresponding impacts on energy costs in both cases (Roberts *et al.,* 2015; Monyei *et al.*, 2018).

Those with reduced financial means have been observed to benefit less from energy poverty alleviation measures in both sub-Saharan Africa (Alloisio *et al.,* 2017) and European settings (Webber *et al.*, 2015). In both cases, the consideration that economic circumstances generally imply diversified energy demands (Davis, 1998) is also important, where the global South is expected to mirror Europe in trends of increased residential electricity demand due to increased reliance on household appliances and devices (Czako, 2020; Pereira *et al.*, 2023). Currently 70% of the building stock which will exist in Africa in 2040 is yet to be built (UNEP, 2022). Additionally, population growth and increasing wealth is spiking demand for new buildings in Asia, therefore it is key to offer effective and equitable building energy decarbonisation pathways which can be rapidly adopted by the global South as it seeks to reach similar standards of living to those experienced in the global North.

1.3. Uncertainties and Dynamic Factors: A Note on Synergies and Trade-offs

Due to the emergent nature of decarbonisation policies, the synergies and trade-offs identified in the previous sections remain uncertain to a degree, and it is important to reflect the dynamic nature of these policy developments. In other words, these policy agendas are in motion, and their impacts cannot yet be definitively categorised as synergies or trade-offs.

For example, new employment and economic opportunities, particularly in the energy efficiency chain, are difficult to quantify. Simultaneously, such opportunities can benefit some groups while disadvantaging others; for instance, new jobs in the renewable sector are less likely to benefit workers in the fossil fuel industry (SETIS, 2018). Furthermore, without appropriate compensation packages (Gambhir *et al.*, 2018; Hanson, 2023), such opportunities do not benefit those with limitations imposed by poor health, disability or people of retirement age. These disparities also occur between regions, with predictions suggesting net job increases will be concentrated in Asia and the Pacific, the Americas, and Europe. In contrast, net job losses will occur in the Middle East and Africa due to high levels of fossil fuel dependencies (SETIS, 2018). Under the threat of regional differences in job gains and losses within Europe, the European Commission has quickly scoped out appropriate mitigatory strategies, such as mitigatory funding schemes (European Council of the European Union, 2024). Critically, uncertainty about the potential of energy transitions to match job opportunities in the fossil fuel industry has been observed in energy workers themselves; such perceptions have implications for public acceptance of energy transitions (Sicotte *et al.*, 2023).

Similarly, with alternative energy models being at very different stages of development even in the European context, where more established community models exist in countries such as Germany (Hewitt *et al.*, 2019), and Southern Europe has a less developed community energy sector (Caramizaru & Uihlein, 2020) their beneficiary potential in terms of energy poverty remains challenging to assess. For this reason, a focus on the shifting dynamics of these policy agendas is retained.

1.4. Problem Definition

Framing energy poverty within the context of decarbonisation presents a competing agenda from a policy perspective, where policy makers are challenged to simultaneously increase the level of access to energy services without compromising carbon neutrality targets. This is particularly important as the increases in temperature extremes caused by climate change are driving more demand for heating and cooling (Gouveia *et al.,* 2019).

While increased energy efficiency and renewable energy present part of the answer to this problem, the ways in which households use energy are non-uniform, complicating questions of "how much" energy will be required to bridge this gap (Walker *et al.,* 2016). Methods to measure and tackle energy poverty do not point to a "one size fits all" solution rather they reveal numerous contextual specificities and nuances, obscuring the understanding of who suffers and to what extent (Middlemiss & Gillard, 2015; Robinson *et al.,* 2018; Faiella *et al.*, 2021).

Furthermore, as energy transitions unfold in different contexts, it is becoming clear that access to the benefits of these transitions are uneven. Correspondingly, while there are important policy synergies between energy poverty and energy transitions, energy transitions also imply trade-offs of both an environmental and social nature (Chen *et al.,* 2019; Chapman *et al.,* 2021), which in turn link back to the causes and effects energy poverty (e.g., employment opportunities and income) (Stojilovska *et al.,* 2022). Understanding these impacts is vital in efforts to reduce injustices in existing energy systems, which in turn are highly connected with the so-called "energy trilemma", which advocates for the provision of affordable, sustainable and secure energy (McHarg, 2020). An enhanced understanding of this problem is also relevant to the Sustainable Development Goals (SDGs), which are described as “the blueprint to achieve a better and more sustainable future for all” (UN, 2024). By exploring the policy integration of energy poverty in broader decarbonisation targets, this research contributes to goals 1-End all forms of poverty, 7-Access to affordable and clean energy and 13-Take urgent action to tackle climate change and its impacts (UN, 2024).

Given that decarbonisation is at an emergent phase in many contexts (with many NECP plans in Europe coming into operation only in 2021 (COM/2019/ 285 final), there are many unknowns in terms of policy impacts; thus, it is important to establish exactly if and how the agendas of climate change, energy transitions and energy poverty interact and whether these interactions are synergistic or present trade-offs, the nature of who is affected and how by these synergies and trade-offs is another critical focus. Finally, in an evolving policy scenario, identifying the uncertainties or dynamic factors that are currently at play is key for devising successful policies that reduce energy poverty without compromising broader climate change targets.

1.5. Research Questions

The overarching aim of this work is to understand to what extent climate change, energy transitions and energy poverty agendas present competing policy goals and contribute to improved solutions for all three policy agendas. Correspondingly, the main objective of this work is to establish the status quo regarding these agendas and how they have been addressed politically to date, review the links, trade-offs and synergies between them, profile key actors, interests and influences and outline dynamic policy factors which remain uncertain in the agendas.

To achieve this aim, four research questions (RQs) were formulated; the themes of trade-offs and synergies, power dynamics, emergent policy uncertainties and suggestions for more holistic policy approaches are particularly relevant in current policy drives towards the delivery of just, fair and inclusive energy transitions.

RQ 1: What are the benchmarks for addressing energy poverty, and how do they inform future efforts to tackle energy poverty in the frame of decarbonisation policy?

RQ2: What are the links, trade-offs and synergies between the climate change, energy transitions and energy poverty agendas?

RQ 3: Who are the key actors in the agendas, and what are their respective influences and interests? How can these be better aligned for improved outcomes across all three agendas?

RQ 4: What are the dynamic policy uncertainties implied by a holistic approach to the agendas? How can these be managed for maximised policy benefits?

1.6. Methodology and Thesis Outline

The thesis is presented in nine chapters, including the Introduction (Chapter 1) and Conclusions (Chapter 9); four research questions are applied across these different chapters. Section 3 presents the project method schematic indicating which chapters respond to which research questions and summarising the methods applied. This research combined different methods and approaches including policy reviews of both cases, the development of a conceptual framework, stakeholder analysis, qualitative interviews and Participatory Systems Mapping approach, supporting the development of Causal Loop Diagrams (also indicated in Figure 3.1). Two case studies, the UK and Portugal, are used to explore the research theme.

The methodological approach selected to investigate the agendas had to account for two distinct dimensions, the first being policy content, setting the direction of travel towards carbon neutrality by 2050 through a set of rules, objectives and binding targets. The second is that of policy reception and interpretation, which has an elemental influence on how policy is enacted. These two dimensions have a somewhat circular relationship, where public policy attempts to reflect the will of citizens, and citizens and other actors, such as private organizations (made up of individual citizens), are the ultimate receivers and interpreters of policy. Thus, a social constructivist philosophy of science approach is applied, founded on the underlying assumption that social perceptions shape reality (Bryman, 2012). An essential pillar of qualitative research is understanding the social world and its participants (Bryman, 2012), this thesis employs a mixed methods qualitative approach to investigate the "competing agendas" of climate change, energy transitions and energy poverty. A detailed explanation of each method is provided in Chapters 5-8 (which present the research elements of the thesis). An overview of these methods and their links to the research questions is outlined in Chapter 3. A synopsis of the thesis outline is provided below.

Chapter 1 presents the general Introduction, setting the scene of global decarbonisation targets under the threat of climate change, the concept of energy poverty is introduced along with the associated challenge of ensuring a decent standard of life for all whilst cutting GHG emissions. In Chapter 2, a reflection on the state of the art, as well as the justification for the geographical focus of the thesis, is provided through a literature review of the competing agendas upon which the thesis is based (climate change, energy transitions, and energy poverty). Chapter 3 presents the methods applied across the various chapters and the corresponding research questions. In Chapter 4, based on the outputs of the literature review, the cases are introduced with corresponding reviews of policy settings. Chapter 5 focuses specifically on the UK case study, testing the potential for applying a multi-dimensional energy poverty indicator across the four UK countries, a review of policies focused on fuel poverty and the pros and cons of different policies and definitions are presented. Chapter 6 proposes and tests a conceptual framework for assessing competing sustainability agendas. The "competing agendas" of climate change, energy transitions and energy poverty are reviewed. Chapter 7 explores perspectives on the competing agendas in Portugal through qualitative interviews with experts from diverse sectors, using a semi-structured qualitative interview approach. Chapter 8 is based on a Participatory Systems Mapping process, including a collaborative workshop and a final post-produced Causal Loop Diagram that explores the dynamic nature of the energy policy agendas. Chapter 9 presents the conclusions, with insights on the interplay between the different agendas, what competes, what is synergistic and suggestions for improved policy outcomes across all agendas based on the thesis findings.

1.7. Scientific Outputs

This thesis produced several scientific outputs, including peer-reviewed papers, presentations at conferences and contributions to book chapters and international reports. These outputs are listed below:

Peer-reviewed papers:

- **Mahoney, K.,** Lopes, R., Gouveia, J, P. "Loops, Triangles and Transitions- Participatory Perspectives on Energy Poverty Policies in Portugal " Manuscript submitted and under review.
- **Mahoney, K.,** Lopes, R., Sareen, S., Gouveia, J, P. (2024). "Perceptions of Competing Agendas in Carbon Neutrality Policies in Portugal: Adverse Impacts on Vulnerable Population Groups" *Energy Research & Social Science.* 112. 103509. https://doi.org/10.1016/j.erss.2024.103509
- Sareen, S., Sorman, A, H., Stock, R., **Mahoney, K.,** Girard, B. (2023). "Solidaric solarities: Governance principles for transforming solar power relations" *Progress in Environmental Geography. 1-2*. https://doi.org/10.1177/27539687231190656
- **Mahoney, K.,** Gouveia, J., P., Lopes, R., Sareen, S. (2022). "Clean, green and the unseen: The CompeSA framework | Assessing Competing Sustainability Agendas in Carbon Neutrality Policy Pathways" *Global Transitions.* 4. pp.45-57; https://doi.org/10.1016/j.glt.2022.10.004
- Stojilovska, A., Guyet, R., **Mahoney, K**., Gouveia, J, P., Castaño-Rosa, R., Živčič, L., Barbosa, R., Tkalec, T. (2022). "Energy poverty and emerging debates: Beyond the traditional triangle of energy poverty drivers" *Energy Policy.* 169. 113181. https://doi.org/10.1016/j.enpol.2022.113181
- Palma, P., Gouveia, J, P. **Mahoney, K.,** Bessa, S. (2022). "It starts at home: Space heating and cooling efficiency for energy poverty and carbon emissions reduction in Portugal." *People, Place and Policy*. pp. 1-20. https://doi.org/10.3351/ppp.2022.5344968696
- **Mahoney, K.,** Gouveia, J.P., Palma, P. (2020). (Dis)United Kingdom? Potential for a Common Approach to Energy Poverty Assessment*. Energy Research & Social Science.* Volume 70, December 2020, 101671; https://doi.org/10.1016/j.erss.2020.101671

National and International Conferences:

- **Mahoney, K**., Gouveia, J, P., Lopes, R. (2023). Energy Economics International Conference (EEIC2023), 7th APEEN Associação Portuguesa de Economia da Energia (APEEN) Annual Conference. "A Problem Shared is a Problem Halved? Exploring Interests, Power, and Responsibility in Portuguese Decarbonisation Policies" 2nd-3rd November 2023. Instituto Superior de Engenharia de Lisboa (ISEL), Lisbon
- **Mahoney, K**., Gouveia, J, P., Lopes, R., Sareen, S. (2023). Global Change and Sustainability Institute Science CHANGing Policy- "Stakeholder Perspectives of Portuguese carbon neutrality and energy poverty policies" 2nd June 2023. Colégio Luís António Verney, University of Évora, Évora
- **Mahoney, K**., Gouveia, J, P., Lopes, R., Sareen, S. (2023). 8th Meeting on Energy and Environmental Economics Energy Poverty- "Exploring Perceptions Of Competing Agendas In Portuguese Carbon Neutrality Policies." 8th May 2023. Departamento de Economia, Gestão, Engenharia Industrial e Turismo (DEGEIT), University of Aveiro, Online Conference
- **Mahoney, K**., Gouveia, J, P., Lopes, R. (2022). SSPCR 4th International Conference on: Smart and Sustainable Planning for Cities and Regions 2022- "Exploring regional injustices in the Portuguese energy transition", 19th-22nd July 2022, EURAC Research, Bolzano/Bolzen Italy
- **Mahoney, K.,** Gouveia, J, P., Lopes, R. (2022). ICEE 5th International Conference on Energy and Environment: Bringing together Engineering and Economics- "Opportunities and obstacles for vulnerable consumers in implementing the Portuguese Carbon Neutrality Strategy – a participatory approach", 3rd-4th June 2022, School of Economics and Management (FEP), University of Porto, Research Center on Economics and Finance (CEF.UP), University of Porto & ALGORITMI Research Center of the School of Engineering, University of Minho, Porto Portugal
- **Mahoney, K**., Gouveia, J, P., Lopes, R., Sareen, S. (2022). Associação Portuguesa de Economia da Energia (APEEN) 6th Annual Conference: Sustainable Energy Challenges- "Clean, Green And The Unseen: The Compesa Framework |Competing Sustainability Agendas In Carbon Neutrality Policy Pathways"- 3rd-4th February 2022, DEGEIT University of Aveiro, Portugal, Online conference
- **Mahoney, K**., Gouveia, J, P., Lopes, R. (2022). International Sustainable Development Research Society Conference "Is energy poverty the missing link? Exploring the realities of intersecting Sustainable Development Goals with qualitative interviews" 13th-15th July 2021, Mid Sweden University, Online Conference
- **Mahoney, K**., Gouveia, J, P., Lopes, R. (2021). Making Decarbonisation Fair ENGAGER COST Conference "Challenges and Opportunities in the Portuguese Energy Transition-The Evidence so far" 1-4th March 2021, Online Conference

- **Mahoney, K.**, Gouveia, J, P., Lopes, R. (2021). APEEN Energy Transition and Sustainability Conference- "Energy poor and powerless? Exploring the use of stakeholder analysis to assess power dynamics in the Portuguese carbon neutrality agenda" 20th-21st January 2021, CENSE, NOVA University Lisbon, Online Conference

Book chapters (including online chapters):

- Gouveia, J, P., **Mahoney, K.** (2021). Cold homes during the winter period in the UK. EP PEDIA. ENGAGER COST ACTION NETWORK. 09.09.2021. Available at: https://www.eppedia.eu/article/cold-homes-during-winter-period-uk
- Gouveia, J, P., **Mahoney, K.** (2021). Perspective on Infrastructure issues - State of energy infrastructure / Access to technology / Smart-metering in the UK. EP PEDIA. ENGAGER COST ACTION NETWORK. 01.09.2021. Available at: https://www.eppedia.eu/article/perspective-infrastructure-issues-state-energy-infrastructure-access-technology-smart
- Consuegra, F., Gouveia, J, P., Palma, P., **Mahoney, K.** (2019). Pobreza energética: experiencias europeas de análisis nacional, regional y urbano. El caso de la Península Ibérica. In Hacia una Arquitectura Sostenible y Resiliente. Biocilmática Sotenible en Europa II. Editor: José Roberto García Chávez. Program Erasmus Plus Jean Monnet. Universidad Autónoma Metropolitana Azcapotzalco

Published reports:

- Gouveia, J, P., Bessa, S., Palma, P., **Mahoney, K.,** Sequeira, M. (2023). Energy Poverty National Indicators: "Energy Poverty National Indicators Uncovering New Possibilities for Expanded Knowledge. European Commission. Energy Poverty Advisory Hub. October 2023. Available at: https://energy-poverty.ec.europa.eu/system/files/2023-10/EPAH2023_2nd%20Indicators%20Report_Final_0.pdf
- Gouveia, J, P., Palma, P., Bessa, S., **Mahoney, K.,** Sequeira, M. (2022). Energy Poverty National Indicators Insights for a More Effective Measuring. Energy Poverty Advisory Hub October 2022. Available at: https://energy-poverty.ec.europa.eu/system/files/2023-01/EPAH_Energy%20Poverty%20National%20Indicators%20Report_0.pdf

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Chapter 2 | Where Are We Now? Literature Review of the Intersecting Climate Change, Energy Transition and Energy Poverty Policy Agendas

The following sections present background and contemporary knowledge on energy poverty and its intersections with climate change and energy transition agendas on the basis that the European setting is insightful for other settings (as explained in earlier sections). These sections are based on the European context.

2.1. Energy Poverty Benchmarks: European Union and the United Kingdom

To understand how to successfully mitigate energy poverty in the context of decarbonisation policy, it is first important to understand the background of the condition and to provide insightful benchmarks. Thus, while energy poverty is a pressing issue in both the global North and global South contexts, the global North presents several comparatively mature policy contexts, including the UK, France and Ireland, which are a useful basis for this study (Sovacool, 2015; Kerr *et al.,* 2019). Additionally, with the global North historically being the most significant contributor to the climate crisis, this implies a responsibility to lead policies which tackle its adverse impacts. We argue that energy poverty, as a consequence of current fossil fuel dependencies and their associated power dynamics (typically dominated by large energy incumbents and implying reduced consumer influence), is one such impact (Walker & Day, 2012). For this reason, the following sections focus on energy poverty in the European Union and the United Kingdom.

The manifestation of energy poverty varies significantly throughout the EU due to different political and social systems, energy infrastructure variations and national economies. There are also variations in the expectations of the citizens of various Member States regarding thermal comfort thresholds (Bouzarovski, 2013). While the majority of energy used in homes (64.4% of final energy consumption in the residential sector) is for heating, the amount of energy used for space heating varies significantly between European countries, with the countries using least energy for space heating identified as Malta (22.5%), Portugal (30.8%) and Cyprus (34.8%), the highest are listed as Luxembourg (80.3%), Slovakia (74.6%), Belgium (74.4%), Estonia (71.1%), Austria (69.6%) and Lithuania (67.9%) (Eurostat, 2023).

The sources used to supply energy for space heating also vary between the Member States. Portugal, Croatia, Bulgaria, Slovenia, Romania and Estonia source over 50% of the energy used to heat their homes from renewables. High natural gas usage for space heating in Italy, the Netherlands and Hungary (accounting for over 50% of energy products used in space heating in each case), as well as the use of petroleum products for space heating in Cyprus, Ireland and Greece (at over 40% in each case), (Eurostat, 2023), represent important areas of focus for future decarbonisation efforts. It is interesting to observe that, while consumption for space heating is lower in warmer Southern European zones, this does not necessarily correspond with a higher level of renewables in the provision of energy for space heating despite considerable solar resources in these areas (Deloitte, 2015; Sareen, 2020).

Directly comparing energy poverty levels between different Member States presents a challenge, with attempts to date hindered by a lack of data availability from some States (OpenEXP, 2019). Some have attempted to overcome this difficulty by using indicators of energy poverty collected as part of standardised EU data collection processes. Examples include the EU Statistics on Income and Living Conditions (EU SILC) and national housing surveys (Bouzarovski & Thomson*,* 2019). A self-reported indicator which received considerable attention was the household´s perceived ability (or inability) to keep warm. In 2022, the five countries reporting the least ability to keep warm were Bulgaria, Cyprus, Greece, Portugal and Lithuania. This indicates areas of particular vulnerability, such as Eastern and some Southern European States. In the case of the Southern European states, this reported inability is surprising due to the milder winter temperatures experienced in these zones. These geographic trends tie into broader social and economic inequalities within the Union (Bouzarovski & Tirado Herrero, 2017), including a poor-quality building stock (Robić & Rogulj, 2014; Ogut *et al*., 2023). Drawing inter-state comparisons is informative for allocating resources and directing policy, particularly in larger institutions such as the EU (Vondung *et al.,* 2019).

2.2. Energy Poverty Measurement and Indicators

The growing impetus to tackle energy poverty in Europe has fuelled discussions regarding the most appropriate means of measuring the condition. The most commonly employed methods of measurement are (Faiella *et al.,* 2021):

1. The use of expenditure data against a relative or absolute threshold

2. Self-reported assessments of housing conditions (otherwise known as "consensual")

3. Direct measures: Comparison of the level of energy services against a specific benchmark

Each assessment method has its associated pros and cons. The advantage of applying relative measures is that they are comparatively easy to understand, facilitating frequent monitoring. Relative measures have been criticised for their dependency on fluctuating energy prices, where the levels of energy poverty tend to fluctuate with these prices (Hills, 2012). Arguably, the most well-known energy poverty measures applied to date have been expenditure-based; these include the Boardman 10% indicator and the Hills Low Income High Cost (LIHC). Due to being the first country to address fuel poverty (as it is called in the UK), both of these more established indicators originated in the UK context. The relative simplicity of Boardman's indicator has been commended, making it broadly understandable to the majority of stakeholders (Castaño-Rosa *et al.,* 2019); however, for some time, the measure has also been labelled outdated given that it emerged in 1991 (Robić & Rogulj, 2014). The LIHC indicator replaced the 10% indicator in England in 2012, seeking to capture both the extent and depth of energy poverty; it also aimed to prioritise resource allocation during a period of austerity (Hills, 2012). The variation in groups identified by the two indicators has been highlighted in academia (Robinson *et al*., 2018).

More recently still, in England, the Low-Income Low Energy Efficiency (LILEE) indicator replaced the Hills indicator; the LILEE indicator is a combination of an absolute measure of energy efficiency and a relative indicator of income (Al Kez *et al*., 2024). Consensual approaches (based on self-reported data at the European scale) are advantageous because data collection is relatively simple. Additionally, interviews with householders can identify the broader social contributors to energy poverty, which are generally omitted from expenditure-based approaches (Thomson *et al.,* 2017).

The direct measures approach is useful because it assesses energy poverty in line with defined thresholds such as indoor temperature; however, this approach has historically not been applied at a European scale, probably due to the practicalities involved with obtaining such measurements (Thomson, 2013). The majority of these approaches were developed in the UK. The potential for their wider application to support EU Member States in quantifying and mitigating energy poverty has subsequently been explored (Rademaekers *et al*., 2016). Research has questioned the relevance of transferring these indexes in regions that differ significantly from the UK in terms of their socio-economic and political structure (Meyer *et al*., 2018). Furthermore, the high-quality, detailed housing surveys available for energy poverty assessment in the UK are not commonplace at the European level. Therefore, these indicators are not always easily replicable (Thomson *et al*., 2017). European approaches based on indicators of energy poverty rather than specifically designed surveys have drawn upon datasets considered illustrative of the condition of energy poverty. These include the inability to keep homes adequately warm, living in a dwelling with a leaking roof or with rot in the windows or doors and arrears on energy utility bills. Trends of vulnerability to these effects have typically been identified in Southern and Eastern European countries (BPIE, 2015), and as outlined in the preceding section, still apply currently (Eurostat, 2023a).

With the advancement of knowledge in the field, there is a growing consensus that energy poverty cannot and should not be captured by a single measure but rather that a combination of different indicators should be used to capture the multi-dimensional nature of energy poverty (Bouzarovski & Thomson, 2019). Energy poverty is multi-dimensional in the sense that it has a wide range of causes (building efficiency, income, employment status) (Gouveia *et al.*, 2019; Stojilovska *et al.,* 2022) and effects (adverse health outcomes, reduced educational attainment) (The Marmot Review Team, 2011; Sovacool & Drupady, 2012) which are interconnected, complicating both the identification of the problem and its resolution.

This has led to the development of composite indexes assessing various vulnerability criteria. This approach does not result in a single figure representing the proportion of energy poor homes. Instead, it provides an overall perspective of relative vulnerability to energy poverty based on a suite of diverse indicators (Thomson *et al.,* 2017). These indexes generally try to reflect the objective measures of energy poverty, such as income and energy expenditure, and explore social aspects, such as mental health or gender (Baker *et al.*, 2018).

At the EU level, data for different energy poverty indicators (such as the inability to keep warm) was originally made available through the Energy Poverty Observatory (EPOV), an EU platform running between 2016 and 2020 (EC, 2024a). Almost in tandem, the Energy Poverty Action: Agenda Co-Creation and Knowledge Innovation (ENGAGER 2017-2021) research network was established and funded under the European Co-operation in Science and Technology (COST) scheme. ENGAGER aimed to develop a community of researchers and practitioners in the energy poverty field and resulted in several important outputs, extending knowledge of energy poverty further in the provision of policy briefs, reports and peer-reviewed publications (ENGAGER, 2024). Since the conclusion of the EPOV project, the Energy Poverty Advisory Hub (EPAH) (essentially EPOV's successor) continues to make indicator data available. It has also promoted the inclusion of additional indicators in response to new policy interests, such as mobility, climate (including heating and cooling degree days) and health indicators (Gouveia *et al.,* 2023). Such developments indicate a commitment on the part of the EU to tackling energy poverty.

Further analysis of literature at the EU level in the previous five years demonstrates that an increasing number of countries are now exploring appropriate methodologies to assess energy poverty in regions where the condition was previously not well recognised. Examples of these efforts consist of a mixture of indicators and indexes, including an absolute expenditure-based approach to energy poverty in Italy (Faiella *et al.*, 2021), the exploration of a multidimensional index in Poland (Karpinska *et al.,* 2021) and the comparison of three different objective measures in France (Charlier *et al.,* 2019). The development of these metrics is encouraging and is shedding light on the condition of energy poverty across European member states. Unfortunately, this research has also demonstrated the complexity of the condition and proved that significant regional disparity occurs both in terms of the manifestation of the condition and the data available to monitor it (Gouveia *et al.,* 2023). Such challenges hinder regional comparisons of the condition between and across Member States. Regional comparisons are valuable as it is believed that the manifestation of energy poverty in similar regions of different countries may be more similar than in different regions of the same country (Bouzarovski & Thomson, 2019).

2.3 Energy Poverty Mitigation Practices

Addressing energy poverty is a complex, long-term process requiring significant investment in building upgrades and more efficient climatization equipment. Securing access to reasonably priced, responsibly sourced and clean energy still requires more investment (Gomes, 2018), and a sustained commitment by political groups over long periods is also required. Research in the field has consistently shown the need for a “deep renovation” of the EU building stock where profound changes to building efficiency are realised to reduce GHG emissions and improve household well-being (BPIE, 2015; BPIE, 2022). Adopting a “one hit” approach to deep renovation is important both in the most effective use of resources and in consumer satisfaction, given that domestic renovation practices are disruptive (Cornelis, 2020).

The first attempts to mitigate energy poverty were made in the UK, where sustained political, academic and non-governmental impetus has retained a focus on the issue since the 1990s (Walker & Day, 2012). Despite this substantial effort, energy poverty remains a persistent problem within the country and understanding the reasons for this persistence could be insightful for policy design further afield. Research has suggested that among the reasons that energy poverty has persisted are the dynamic nature of the condition (Middlemiss & Gillard, 2015) (people move in and out of energy poverty depending on certain conditions, e.g., recession), insufficient understanding of the drivers of the condition (Gillard *et al.*, 2017) and a discrepancy between mitigation efforts and the scale of the problem (Liddell, 2012).

Given the potential for energy efficiency programmes to simultaneously reduce energy poverty and contribute towards climate change mitigation targets, such approaches are strongly attractive for Governments (Gillard *et al.,* 2017). In the UK, there are several examples of such policies, ranging from national to the local level (Mahoney *et al.,* 2020); two well-known examples include the Warm Front Programme (operational from 2003 to 2013) and the Government Green Deal (initiated in 2013). The Warm Front Programme was praised for high customer satisfaction and for reducing GHG emissions and is estimated to have provided the average participating household with an extra £1894.79 per year. Despite these impressive achievements, fuel poverty began to increase in 2004 and continued to rise for the duration of the Programme. Additionally, it is estimated that 75% of participants were not, in fact, fuel-poor; this discrepancy was attributed to the targeting methodology employed (Sefton, 2002). The Green Deal was less positively received, with uptake levels labelled as "disappointing" (Vaughan, 2014). The scheme took an innovative approach to domestic energy efficiency, where theoretically, there were no "up-front" costs for efficiency measures. The finance mechanism worked by participants taking out a loan to fund efficiency costs, which householders often found off-putting. It has been argued that this element of the scheme was particularly unattractive to vulnerable consumers (Marchand *et al*., 2015). Energy efficiency improvements have also been employed in the wider European community as a method of reducing energy poverty.

In Germany, the link between retrofit programmes and drastic rent increases has been high-lighted (Großmann, 2019). Conversely, in Hungary, the development of Net Zero Energy Buildings (NZEB) has resulted in improved housing conditions for low-income households and generated employment in the construction industry (Ürge-Vorsatz, 2020). With the central aim of reducing energy poverty, The Rainha Dona Leonor project in Porto, Portugal, undertook a deep renovation project to improve the quality of severely degraded buildings. Despite CO_2 emission reductions not being a central aim of the project, a reduction of 12.9 tons was made, and yearly primary energy savings of 286.54 kWh/m² were realised. Additionally, residential energy costs decreased by 70%, and there was an increase in rents, but this was considered to be mitigated by the energy-saving costs (Covenant of Mayors, 2016).

A persistent problem regarding energy poverty mitigation projects is insufficient monitoring post intervention, making it difficult to assess their effectiveness (Webber *et al*., 2015; Alabid *et al*., 2022). There is also a problematic lack of evidence regarding the cost/benefit effectiveness of retrofit schemes, which is stymying progress at both the business and householder levels (Bergman & Foxon, 2020). Additional challenges include an undervaluing of the health benefits of retrofit, difficulties in maintaining behaviour change (Palmer *et al.,* 2018) and mistrust of both trades-people and national governments; critically, such barriers, along with financial, technical and awareness barriers (Wheeler *et al.,* 2021) can exclude the energy poor (Alabid *et al.,* 2022).

In summary, assessing energy poverty presents several challenges whereby refined inter-state and sometimes intra-state comparisons cannot be drawn. Even where the debate is most developed, it remains difficult to identify and target vulnerable consumers successfully. Energy poverty is a complex and dynamic problem which is not easily captured by a single measure; this complicates the process of mitigation, which, if improperly targeted, can result in the continued marginalisation of the most vulnerable. In the scope of drives for carbon neutrality by 2050 and the intersection of energy poverty with targets for building efficiency and residential energy consumption, energy poverty is increasingly being framed within carbon neutrality policies, with evidence to date revealing successes and failures associated with this approach.

2.4 Policy Debates Linked to Energy Poverty: Insights for the Interaction of Climate Change, Energy Transition and Energy Poverty Agendas

The previous sections demonstrate that current assessments of energy poverty do not fully capture the condition. There is increasing recognition that energy poverty alleviation requires a reconceptualization of socio-economic systems; traditional research in the field has focused on the income-energy efficiency -energy price triangle (Bouzarovski *et al.,* 2018); emergent research needs to move beyond this traditional perspective of energy poverty to gain new insights and improve mitigation approaches (Stojilovska *et al.,* 2022). To progress in a direction where strategic efforts to mitigate energy poverty are more effective, research has begun to explore a broad range of themes that are linked to or drive energy poverty. These emergent themes are diverse and range from topics such as gender, social relations, household dynamics and emotions (Clancy *et al.,* 2017; Middlemiss *et al.,* 2019; Castaño-Rosa *et al*., 2020; Hargreaves *et al*., 2020). An important contribution from Stojilovska *et al*. (2022) progressed this theme further, scoping out "emerging policy debates" linked to energy poverty in different national contexts.

These debates encompass a wide scope; for this reason, the following section focuses on those that could generally be categorised as causes or effects of energy poverty and which are relevant to the intersections of energy transitions, climate change and energy poverty agendas. In order to frame the various dimensions of these "linked debates", the following sections present them in three major categories: debates of a socioeconomic and structural nature, debates linked to climate change effects and corresponding decarbonisation pathways and miscellaneous debates. While other categorisations of the debates may be equally valid, this framing was chosen for investigating energy poverty in the framing of decarbonisation policy, where the multi-dimensional nature of energy poverty essentially bridges socio-economic and structural issues (which generally tend to vary more between different national contexts) and issues of energy policy (which at present are heavily influenced by European scale decarbonisation initiatives). Thus, this framing facilitated the opportunity to reflect important contextual contrasts and overarching similarities at the interface of these inter-scalar policy debates. Finally, miscellaneous debates were an important category to account for the remaining debates, which are relevant but not easily definable.

The following tables present the "linking debates" with corresponding synopses, it should be noted that while it is informative to review these linking debates, the remainder of the thesis retains a tighter focus on debates linked to vulnerable groups, citizen participation and agency good governance, education, buildings, energy performance certificates (EPCs) and technological uptake and energy justice. This focus was not strictly intentional; instead, it occurred in an inductive nature as the research on the agendas developed. A brief overview of the debates outlined in Tables 2.1-2.3 follows; it is important to reflect that these debates are interrelated and can have compounding effects, where the debates present complex cause/effect relationships with each other and with energy poverty.

Table 2.1 presents debates of a socioeconomic and structural nature, these debates combine factors which can vary at the individual household level i.e., employment or health status and those that are attributable to national or regional characteristics i.e., infrastructure and transport. Relating to debate intersections and compounding effects, significant interrelations occur between these socioeconomic and structural debates. For example, the skills gap identified under the debate on Gross Domestic Product (GDP), Labour markets and Employment (applicable in a context of increasing digitalisation) (Stojilovska *et al.,* 2020) intersects the debate on Education, where educational background essentially acts a precursor to an individual’s possibilities within the employment market.

Additionally, as Table 2.1 shows, there are different dimensions to consider within the debate of Education itself, where educational attainment influences an individual’s employment prospects and, correspondingly, income (a key driver of energy poverty). On the other hand, energy poverty can also affect educational attainment, generally through a lack of appropriate study spaces (The Marmot Review Team, 2011). The impacts of poor-quality school buildings on children's educational awareness is another important concern, both in the developing and the developed context, with examples from the global South (World Bank, 2008) and Southern Europe (Valente & Gouveia). Education is also important in influencing awareness of energy poverty alleviation supports (Gouveia *et al.*, 2019). Later sections of the thesis develop an understanding of the educational policy debate. Health is another debate with different dimensions to consider; on the one hand, existing health conditions can be exacerbated by energy poverty (The Marmot Review Team, 2011; Lakasing *et al.*, 2019). On the other hand, spending time in poor-quality buildings can generate health problems (Loureiro *et al.*, 2015; Almendra *et al.*, 2016; Almendra *et al.*, 2019). The most serious adverse health impact of energy poverty, Excess Winter Deaths (EWDs), are known to be more frequent in Southern European countries with higher winter temperatures than in Northern European zones with far more severe winters (Healy, 2003; Fowler *et al.*, 2014).

Another example of the inter-relational and compounding nature of the debates is illustrated in the connections of the Rural vs. urban Infrastructure debate with the debates on Education, Vulnerable groups (in this case specifically the elderly) and Unemployment, where Horta *et al.* (2019) found that citizens in rural areas are more likely to present these characteristics, all of which are relevant to energy poverty. Similarly, rurality intersects the debate of Transport with rural areas less likely to be well served by transport links and thus to be dependent on car use and, correspondingly, fuel price fluctuations. These trends have been observed in France, where urban sprawl has been encouraged (OpenEXP, 2019).

Table 2.2 provides further evidence of the inter-relations between debates, where Buildings, efficiency, EPC grades & impacts intersect Smart meters. This is justified by the observation that while EPCs are an important source of consistent data in the present scenario (Fabbri & Gaspari, 2021), their accuracy is sometimes problematic, with some authors going so far as to label EPCs as "poor" predictors of actual consumption (Cozza *et al.*, 2020). Smart meters thus present an attractive alternative with the opportunity to collect high-quality individual household level data at regular intervals (Gouveia *et al.*, 2016). Despite this, the uptake of smart meters has been problematic, with bureaucratic (Sareen, 2020) and consumer privacy concerns (Sovacool *et al.*, 2017) as significant barriers to their wider adoption. Furthermore, as a form of technology that has been highly controversial at the level of citizen acceptance, smart meters intersect the debate on technological uptake, energy justice, and notions of a just transition. In this case, citizens can see smart meters as a threat but (in the case of rejection) do not perceive the potential benefits of the technology. Similarly, larger renewable energy installations and exploratory mineral extraction activities can result in adverse local impacts (Silva & Sareen, 2020; Silva & Sareen, 2023), clouding wider benefits resulting from the adoption of renewable energy in Portugal.

Finally, Table 2.3 presents COVID-19 as the only miscellaneous debate; while neither a socio-economic or structural issue nor a climate change effects & corresponding decarbonisation pathways debate, COVID intersected both areas. Critically, in forcing people to remain in their homes, the pandemic disproportionately affected those in poorer-quality housing. COVID brought longer-term shifts to the working pattern with increased home working (Baker *et al.,* 2020; Mantesi, 2022). Given that home working is more available to those with computer-based work, COVID-19 intersects the Labour markets and employment debate with specific relevance to the digital divide. On a more positive note, in the presentation of opportunities to orientate recovery plans towards more ambitious climate targets (Gatto, 2022), which the EU took strong advantage of (EC, 2021), COVID intersects the debate of climate change effects & corresponding decarbonisation pathways.

Overall, the intersections between the linked debates are informative for understanding the interrelationships between the agendas of energy poverty, climate change and energy transitions. This is justified by the multi-dimensional nature of energy poverty, where the linked debates bridge the socio-economic, structural and climate change-related energy policy fields. With a core tenant of this research being to contribute to a carbon neutrality paradigm that does not compromise energy poverty goals, a comprehensive overview of these linked debates is essential. This is particularly key given that contemporary EU policy places energy poverty in the frame of energy policy and specifically on the pathway to carbon neutrality. Yet, differences in opinion as to whether energy poverty belongs in the social or energy policy domain remain (Stojilovska *et al.,* 2023). Thus, the remaining thesis sections will contribute to this ongoing research theme.

Table 2.1 Socioeconomic and structural debates

Debate	Synopsis		References
Gross Domestic Product (GDP), Labour markets and Employment	GDP	• Links between GDP & EP where MSs with lower GDP are behind other countries in the alleviation of EP • Counties with higher GDP at lower risk of inability to afford energy costs • GDP used as proxy for financial development in energy poverty assessment	(OpenEXP, 2019; ul Husnain *et al.*, 2021)
	Labour markets & Employment	• Close link between energy poverty, labour and employment markets, increased remote work & demand for digital skills contributing to a skills gap • Rise of deregulation in the employment sector is driving increased precariousness • Two core problems: 1. Reduction of employment opportunities for some 2. Existing jobs do not guarantee good working conditions or sufficient income for protection from EP	(Stojilovska *et al.*, 2020)
Education	• Identified as a vulnerability factor for EP where not having appropriate spaces to study deepens social inequalities • Can influence access & awareness of energy poverty alleviation measures • Educational attainment affected by access to electricity in homes and schools • Study time lost as a result of time spent collecting fuel • Homes in urban areas led primarily by literate females more likely to have spent more years in education		(World Bank, 2008; The Marmot Review Team, 2011; Sovacool & Drupady, 2012; Gouveia *et al.*, 2019; Oum, 2019)
Health	• High rate of Excess Winter Deaths (EWDs) in Southern European countries with higher winter temperatures has been observed. • High rates of EWDs in Portugal & elevated rates of hospital admissions during summer months • Increased rate of heat waves expected to increase vulnerability to summer energy poverty • Exacerbates respiratory conditions like asthma and chronic obstructive pulmonary disease (COPD) & cardiovascular conditions e.g., coronary heart disease & cerebrovascular disease • Link between EP & health addressed by policy in UK through local schemes, e.g., "Boiler on Prescription" where householders with conditions such as COPD are targeted by health authorities and receive a funded boiler upgrade or installation		(Healy, 2003; The Marmot Review Team, 2011; Fowler *et al.*, 2014; DECC, 2015; Loureiro *et al.* 2015; Almendra *et al.*, 2016; Almendra *et al.*, 2019; Gouveia *et al.*, 2019; Lakasing *et al.*, 2019)
Gender	• EP can be experienced more severely by females where households abide by typical gender roles • Women spending more time at home & responsible for household activities can experience greater exposure to pollutants		

	• Gender gap in the experience of EP has been identified where women are more susceptible to the cold than men • Women tend to participate less in decision making regarding energy and technology, which is typically considered a male domain • Current calls for greater levels of data disaggregation permitting improved insights into the specific EP challenges faced by women	(Clancy *et al.*, 2017; Beshilas, 2019; Hargreaves & Middlemiss, 2020; Sánchez-Guevara *et al.,* 2020; Gouveia *et al.*, 2023)
Vulnerable groups	• EP can disproportionately affect the elderly, who typically spend more time at home & have reduced incomes • EP can adversely affect children & young adults (e.g., university students) & the socially excluded, recipients of social welfare, or those with a disability	(Walker & Day, 2012; Snell *et al.,* 2015; Middlemiss & Gillard, 2017; Stojilovska *et al.,* 2022; Castro & Gouveia, 2023; González-Pijuan *et al.,* 2023)
Human rights	• Emergent area linked to energy poverty is "a right to energy", where energy is a service users cannot simply "opt out" of without severe implications for their well-being & transverses into the area of human rights • Groups such as the Right to Energy Coalition are advocating for a Right to Energy for all Europeans • Themes around the right to decent housing, dignity & quality of life emerging in EU policy approaches to energy poverty	(Jones, 2016 EPSU & EAPN, 2017; Hesselman *et al.*, 2019; Stojilovska *et al.*, 2022; Right to Energy Coalition, 2023)
Citizen participation and agency	• Increasing emphasis on citizens as active agents in energy transitions, with reference to participation in activities such as energy communities • Citizen agency depends on a series of factors, including socioeconomic status, which influence citizen's ability or inability to participate in energy transitions	(Stojilovska *et al.,* 2022; Nouri *et al.*, 2022; EU 2023/1791)
Good governance	• Referring principally to the effectiveness of policies in protecting the energetically vulnerable e.g., bans on disconnection, establishment of a representative body & the role of institutions in consumer protection	(Stojilovska *et al.,* 2022)
Gentrification	• Recognised unintended impact of some domestic retrofit schemes • Potential risk of the EU renovation wave to cause gentrification instead of benefitting the most vulnerable was recognised by EPOV • Renovation activities have the capacity to either lead to the development of inclusive and sustainable cities or bring about displacement & deepen existing inequalities. • Examples observed in Southern European cities such as Lisbon where price levels in 2020 were 356.13% of the national average • In Porto tourist driven gentrification labelled a "double edged sword", with noise pollution, stress & community disruption identified as adverse impacts	(Großmann, 2019; Bouzarovski *et al.,* 2020; Deloitte, 2021; Silva *et al.,* 2023)

Rural vs Urban & Infrastructure	• Rurality can increase vulnerability to energy poverty due to reduced availability of energy infrastructure in rural areas. • In the UK remote areas such as the Scottish Isles are particularly vulnerable to the impacts of EP • Links found between employment in the agricultural sector and energy poverty • In PT increased rural communities exhibit series of socio-demographic characteristics linked to EP	(Changeworks, 2015; Roberts *et al.*,2015; Horta *et al.*, 2019; Cyrek & Cyrek, 2022)
Transport	• Increased interest in links between energy poverty, transport and so called "double energy vulnerability" to energy and transport poverty • Like energy poverty transport poverty difficult to define, however, Mattioli *et al.*, (2017) describe it as "all kinds of inequalities related to transport and access" or "the affordability of transport costs" (pg.95) • Common vulnerabilities include low-income households, households with children, ethnic minority households & people with disabilities and/or health problems.	(Mattioli *et al.,* 2017; Robinson & Mattioli, 2020; Simcock *et al.*, 2020)
Property ownership	• High vulnerability to EP in private rented sector long established in UK • Rates of property ownership differ between European countries • General trend of greater vulnerability & poorer energy efficiency in private rented properties	(RENEW & University of Salford, 2015; Papantonis *et al.*, 2022)

Table 2.2 Debates linked to climate change effects and corresponding decarbonisation pathways

Debate	Synopsis	References
Buildings, efficiency, EPC grades and impacts	• Potential barrier to increased uptake of climatization equipment is increased consumer cost, EPCs important indicators of building quality • EPCs offer a viable & uniform solution to various challenges in data availability • Inconsistencies found between energy use predictions presented in EPCs & actual energy use	(Cozza et al., 2020; Fabbri & Gaspari, 2021; Few *et al.,* 2023).
Smart meters	• Smart meters offer potential to gain greater insights into domestic energy consumption patterns & tailor supply accordingly • Frustrations expressed at level of regulatory processes involved with smart meter roll-out • Level of detailed data collected about individual households is controversial, consumer protection & privacy concerns expressed	(Gouveia *et al.*, 2016; Sovacool *et al.*, 2017; Sareen, 2020).
Technological uptake and energy justice	• Supply of clean, affordable and accessible energy to all increasingly viewed as a matter of justice • Access to new technologies which facilitate the shift to a decarbonised energy supply are not uniformly available to all citizens • Impacts of technological adoption e.g., construction of large renewable energy plants or extraction of minerals for renewable technologies increasingly a point of controversy	(Gillard *et al.*, 2017; Bouzarovski *et al.*, 2018; Silva & Sareen, 2020; UN, 2020; Silva & Sareen, 2023)

Table 2.3 Miscellaneous debates

Debate	Synopsis	References
Covid-19	• Pandemic caused a series of changes in daily behavioural patterns with many confined to their homes for prolonged periods. • Increased consumer energy costs & exposed low efficiency households to adverse effects of inhabiting a poor-quality building for long periods Domestic energy costs rose notably during the pandemic & resulted in longer term changes in the working model • Opportunity to orientate recovery plans towards more ambitious climate targets.	(Baker *et al.,* 2020; EC, 2021), (Mantesi, 2022; Gatto, 2022),

2.5 Policies Tackling Competing Agendas in Europe

In addition to gaining a situated understanding of the policy debates which link to energy poverty, it is also important to chart its emergence as a policy issue in the European context, where political engagement with the issue came significantly later than in the UK.

In Europe, pressures from the 2008 economic crisis, liberalizations within the gas and electricity markets and broader climate change policies brought energy poverty to the forefront of the political agenda (Vondung *et al.,* 2019). Energy poverty as a distinct policy issue has been included in European discourse for over ten years (Schliech, 2019). More specifically, the energy chapter in the Lisbon Treaty led to the development of the Third Energy Package. It brought energy poverty to the attention of the European community, resulting in its wider recognition as a prevalent issue within the EU (Bouzarovski & Thomson, 2019). The Third Energy Package stipulated a legal need to protect vulnerable consumers in energy markets; this requirement came into force in 2009 (Bouzarovski, 2018). Following this movement, the measures employed to categorise and target vulnerable consumers were considerably varied. Member States defined vulnerable consumers as those receiving social welfare or as those subject to energy affordability, disability/health vulnerabilities, and a range of other social criteria (Dobbins *et al.,* 2016).

The multidimensional nature of energy poverty has made it difficult for policy makers to place the issue definitively under a specific policy domain (Stojilovska *et al.,* 2023). The policy approach taken is significant as protective actions are designed by the definition chosen, definitions can either be too broad, capturing too many consumers, or too narrow where key groups are missed (Dobbins *et al.,* 2016). In Europe, energy poverty has generally been considered a social or energy policy issue. In social policy cases, this generally implies short-term financial aid allocated through social welfare systems. As part of general welfare payments, under the energy policy domain, financial aids are targeted explicitly towards paying energy or heating costs (Dobbins *et al.,* 2019). There are also examples of financial support being paired with investments in energy efficiency and, in this sense, tackling the underlying problem of energy affordability; such efforts have been observed in the Netherlands, Denmark and more recently in Portugal (Dobbins *et al.*, 2019; Recuperar Portugal, 2023).

The relationship between energy poverty and income poverty is complex, with both forms of poverty sharing causes and effects e.g., unemployment (Stojilovska *et al.,* 2022) and health impacts (Karpinska & Śmiech, 2020), these complexities contribute to the identified difficulty in selecting the appropriate policy domain for energy poverty mitigation. Arguments for the separation of energy poverty from income poverty are based on the role of housing stocks, climatization systems, the implied use of energy equipment and the need for capital investment that separates energy poverty from income poverty (Boardman, 1991: Boardman, 2010), such arguments are illustrated by cases of income poor householders who live in energy efficient properties (Middlemiss, 2017).

2.5.1. The European policy linkages of climate change, energy transition and energy poverty agendas in time

With the concept of sustainable development first surfacing in the late 80s and early attempts to broker global commitments to climate change mitigation in the 1990s (Palinkas, 1998), the scenario has essentially evolved from theory into practice regarding climate change impacts. Thus, early maximums of meeting the needs of current generations without compromising those of future generations have evolved, where living with the impacts of climate change is no longer a concern reserved for future generations but is a contemporary reality. During this evolution, the policy response in the European Union has developed accordingly, starting from an early acknowledgement of the need to provide a clean, affordable energy supply (Palinkas, 1998) to a current attempt to make use of the co-benefits of climate change solutions to mitigate energy poverty.

Significantly, as time has passed, political understandings of what providing clean, affordable energy implies have deepened, and energy poverty has been brought into sharper political focus. Figure 2.1 charts the key points of this evolution, with further detail and corresponding explanations provided in Table 2.4. Notably, while the climate crisis has undoubtedly been an important driver of this evolution, several pivotal trigger points, including economic crises, changes in EU leadership and the pandemic, have further entrenched energy poverty into European decarbonisation policies; these points are presented in Figure 2.1.

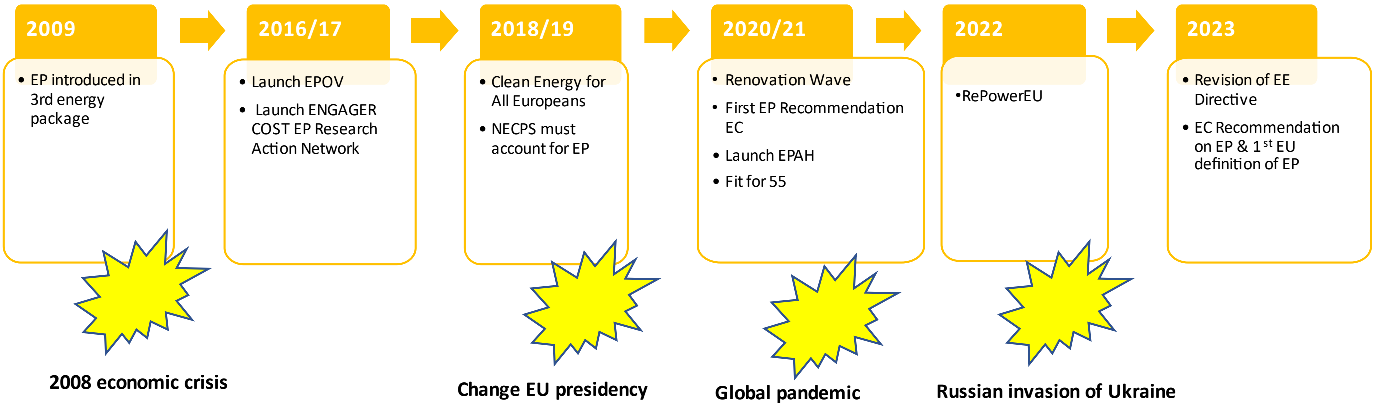

Figure 2.1 Timeline-evolution of energy poverty key activities & corresponding decarbonisation policies in the EU

The successive European-level policy movements outlined in Table 2.4 demonstrate the ever-closer integration of energy poverty into energy policy, which in the current EU context often implies decarbonisation policy. The notion of protecting vulnerable consumers within the energy sector was first reflected in European legislation in 2003, specifically Directives (2003/54/EC) and (2003/55/EC), which required Member States to implement measures for consumer protection in open electricity and gas markets. The transition of energy poverty as a distinct issue into EU policy originated in the Third Energy Package, adopted in 2009, as described in the previous section and shown in Figure 2.1 (Bouzarovski & Thomson, 2019).

This first addressing of energy poverty in EU policy discourse essentially integrates the issue under broader energy policy goals. Critically, the Third Energy Package and the corresponding electricity and gas Directives require Member States to protect vulnerable consumers (Bouzarovski & Thomson, 2019). In addition to important introductions of concepts such as energy-poor consumers and disconnection bans (Bouzarovski & Thomson, 2019), both these Directives indicate linkages of decarbonisation goals with consumer protections.

Specifically, the Electricity Directive (2009/72/EC) identifies that a well-functioning internal market should incentivize consumers to invest in new power generation sources, inclusive of renewable energy, whilst taking energetically isolated areas into account; consumers should also be provided with appropriate conditions to foster efficient usage of energy, which in itself implies a secure energy supply. The gas Directive (2009/73/EC) refers to developing "secure, reliable and efficient non-discriminatory systems that are consumer-oriented". Five years later, the EPOV project was launched as part of Europe's policy approach to tackle energy poverty, contributing significantly to resource collection and knowledge on the topic. The ENGAGER research action network described in previous sections also contributed to this body of knowledge (Bouzarovski *et al.,* 2020; ENGAGER, 2024). Table 2.4 also reveals that despite these integrations of energy poverty into energy policy strategies and links with emissions reductions (through renewable energy and energy efficiency), energy poverty still came partially under the social policy domain in the EU in 2017, with recommendations on the condition in the European Pillar of Social Rights (EC, 2023a).

In 2018-19, the adoption of the Cleaner Energy for All Package embedded energy poverty more deeply into energy policy, integrating energy poverty mitigation methods into policy and legislation; the package consists of eight legislative acts and is strongly focused on energy efficiency, fair treatment of consumers and global leadership in energy transitions. Member States had to account for the degree of energy poverty in their national energy and climate plans (NECPs) and, where necessary, put measures in place to mitigate the condition (Bouzarovski & Thomson, 2019). Where energy poverty is deemed a significant problem, the NECP had to include a timeframe and a specific national objective to mitigate the condition, and policies for energy poverty mitigation also had to be detailed (Bouzarovski *et al.,* 2020). NECPs were due in 2019 (Bouzarovski & Thomson, 2019). More recently updated NECPs had to be submitted in 2023, where energy efficiency was a key dimension for consideration.

In 2019, a Communication on the European Green Deal was announced following Ursula Von de Leyen's assumption of the European Commission presidency, setting out targets to make Europe the first climate-neutral continent by 2050 (European Parliament, 2019). While initially launched in 2019, the Green Deal later tied into European recovery efforts from the global pandemic. Significant intersections of the Green Deal with energy poverty include initiatives such as the Just Transition Mechanism, which directs support towards those most affected by the energy transition and includes funding for activities such as improving the energy efficiency of housing and the mitigation of energy poverty (European Council of the European Union, 2024). The 2021 "Fit for 55" package is another initiative which comes under the European Green Deal, which, in addition to pursuing more ambitious emissions reduction targets for 2050, also presents requirements for the energy performance of buildings (Table 2.4) (European Council of the European Union, 2023).

In 2020, in the throes of the COVID pandemic and also as part of the European Green Deal initiatives, a Communication on a Renovation Wave was released. The Renovation Wave presents a key target of doubling the European renovation rate by 2030; three key focus areas are identified: tackling energy poverty and buildings with poor energy performance, renovating public buildings and decarbonising heating and cooling supplies (COM/2020/ 662 final). The Renovation Wave included a Recommendation on energy poverty, signposting best practices in the field and available funding for vulnerable groups (EU/2020/1563). Crucially, in the face of a global health crisis, the EU strengthened its commitments to decarbonisation despite fears that the climate change agenda would lose ground under these conditions (Elkerbout *et al.,* 2020). Under these significant policy stressors, the EU also saw fit to pursue an increased linkage of critical parts of the energy transition strategy (reducing emissions from the building sector) and addressing energy poverty.

In 2021, in addition to the "Fit for 55" package, the EPAH was launched, focusing specifically on energy poverty eradication at the local level and linking this goal to the realisation of a just transition (EC, 2024b). In 2022, an Energy Poverty and Vulnerable Consumers Coordination Group was created as a platform for information sharing and best energy poverty practices; the group also contributes to the design of programmes and policies related to energy affordability, energy efficiency and renovation measures and national-level financing schemes (EU/ 2022/589). Following another global crisis, this time the invasion of Ukraine by Russia, the REPower EU Plan was released as a tool to help with the price shocks which occurred as a result of the war (COM/2022/ 230 final). REPower EU makes important steps towards reducing the EU's external energy dependencies by increasing the velocity of the European energy transition. Once again, it indicates that in the face of a crisis, the EU maintained commitments to carbon neutrality. REPower EU does not focus strongly on energy poverty but presents a drive for energy savings as part of actions described as complementary to the "Fit for 55" package (COM/2022/ 230 final). REPower EU does, however, refer to vulnerable consumers, recommending Member States take measures against the adverse effects of the energy crisis with specific reference to difficulties in paying energy bills in the face of increased price volatility (COM/2022/ 230 final).

In 2023, the EU Social Climate Fund was established with funding targeted at sufferers of energy and transport poverty, as well as those at risk of being excluded from the transition; the fund can be used to invest in energy efficiency, renovate buildings, implement decarbonised heating and cooling sources and in renewable energy integration (EU/2023/955). Other important policy initiatives shown in Table 2.4 include the Revision of the Energy Efficiency Directive, legally enshrining the energy efficiency first principle, implying energy efficiency should be factored into all relevant policies and significant investment decisions in both energy and non-energy sectors (EU/2023/1791). Finally, in 2023, the EU presented a Recommendation and guidelines on energy poverty, where the first EU-level definition of the condition contributes to improved mitigation, referring to the EPAH as a relevant tool. The Recommendation intersects broader climate and energy transition goals in its focus on renewables and energy efficiency, where efficiency improvements will be targeted at vulnerable groups and where supporting households to switch to lower-cost renewable energy sources is described as a key measure in tackling energy poverty (C/2023/4080).

Overall analysis of Table 2.4 and the corresponding policies demonstrates a clear trend of increased connection between the policy agendas for climate change, energy transitions and energy poverty in Europe. To a certain extent, this integration is a natural one, in the obvious connections between energy poverty, building quality and energy prices; however, despite this policy focus, energy poverty is not entirely separated from social policy at the EU level, with some social policies also addressing the issue.

Table 2.4 Policies intersecting the CC, ET and EP agendas in Europe

Year	Policy initiative/action	Practical implications	References
2009	Introduction of energy poverty concept in Third Energy Package and corresponding electricity and gas Directives (2009/72/EC), Directive 2009/73/EC)	Protection by MSs of final consumers, particularly the vulnerable, may imply energy poor consumers and/or bans on energy disconnections at critical moments.	(Bouzarovski & Thomson, 2019)
2016	Energy Poverty Observatory (EPOV) is launched	40-month project as part of EU policy approach to tackle EP. Particularly important for resource collection & development of national policy indicators.	(EC, 2024a)
2017	The European Pillar of Social Rights-Building a fairer and more inclusive European Union	Sets out 20 principles including principles on housing (related to the Renovation wave for Europe) and access to essential services (related to Commission recommendation on energy poverty)	(EC, 2023a)
	Establishment of ENGAGER 2017-2021, a COST action funded research network	Development of EP research & practitioner community	(ENGAGER, 2024).
2018-2019	Clean energy for all Europeans package is adopted	Consists of eight legislative acts targeting various EP relevant sections. MSs must acknowledge EP in NECPs & where necessary put mitigatory measures in place.	(Bouzarovski & Thomson, 2019)
2019	NECPs require Member States to describe EP policies & measures	NECPs allow EC to assess MSs attempts to meet Energy Union objectives & setting of 2030 targets, ensuring safe, viable & accessible energy. Also facilitate inter-state comparison	(Bouzarovski & Thomson, 2019)
	Communication on the European Green Deal	Aimed to make Europe the first climate neutral Continent by 2050, later became an important part of COVID recovery commitments	(European Parliament, 2019; COM/2019/ 640 final; EC, 2021; European Council of the European Union, 2024).
2020	Communication on a Renovation Wave for Europe released	Aiming to simultaneously contribute to energy gains & economic growth in wake of COVID-19. Strategy focuses on greening buildings, job creation &	(EC, 2020a)

		improving lives. Target to "at least double European renovation rate by 2030"	
	Commission releases Recommendation on energy poverty (EU/2020/1563)	Recommendation issued as part of Renovation Wave strategy providing guidance on suitable indicators, sharing of best practices & highlighted EU funding targeted at vulnerable groups	(EU/2020/1563)
2021	Energy Poverty Advisory Hub is launched	EPOV's successor, focused on EP eradication at the local level in auspices of just energy transition. Acts a central platform for EP expertise in Europe,	(EC, 2024b)
	Fit for 55' package	Revised EU emissions target to reduce GHG emissions 55% by 2030, includes dedicated energy performance requirements for new & renovated buildings, encourages building stock renovation	(European Council of the European Union, 2023)
2022	Establishment of Commission on Energy Poverty and Vulnerable Consumers Coordination Group	Main platform for EC & EU MS's to share best practices and information on EP.	(EU/2022/589)
	REPower EU Plan is launched following invasion of Ukraine	In the face of hardships & market disruption resulting from invasion plan promotes measures to save energy, produce clean energy & diversify energy supplies	COM/2022/ 230 final
2023	Regulation (EU/2023/955) establishes EU Social Climate Fund	Provides Member States with dedicated funding to prevent vulnerable groups including those in energy and transport poverty from being left behind in the transition	(EU/2023/955)
	Revision of Energy Efficiency Directive	Increases ambitions on energy efficiency, giving "efficiency first" principle legal standing. Considers energy efficiency as an energy source in itself	(EU/2023/1791)
	EU Recommendation and guidance on energy poverty	Includes recommendations & policies that can be adopted by MS's to tackle EP. First EU level definition of EP, focus on investment in renewable energy & energy efficiency. Outlines tools for diagnosing EP at the national level (refers to EPAH)	(C/2023/4080)

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Chapter 3 | Applied Methods

The thesis is presented in nine chapters, including the Introduction and Conclusions; four research questions are applied across these different chapters. Figure 3.1 presents the method schematic indicating which chapters respond to which research questions. It is important to note that in some cases the research questions bridge more than one chapter. Chapters 5-8 present the research outputs of the thesis, as highlighted previously the main research aim of the thesis is to deepen understandings of the "competing agendas" which may arise between climate change, energy transition and energy poverty agendas and contribute to synergistic policy solutions. The research questions were developed specifically in response to this aim, in the initial research phases it became clear that to make meaningful policy recommendations a thorough policy benchmarking was essential. For this reason, the background knowledge developed in Chapters 1, 2 and 4 contributes to Research Questions 1-4 (as shown in Figure 3.1). Subsequently the research undertaken in Chapters 5-8 endeavours to contribute new insights to the field. To validate the quality of the works presented in Chapters 5-8 the outputs were disseminated in scientific outlets. The thesis is, therefore, a combination of the review processes in Chapters 1, 2 and 4 and a "compendium of publications" structure in Chapters 5-8. A synopsis of the methods applied is presented below.

3.1. Synopsis of Methods Applied by Chapter

Chapters 1, 2 and 4 are part of the described review processes, with Chapter 1 presenting the general Introduction, setting the scene of global decarbonisation targets under the threat of climate change and introducing the subject of energy poverty. A deeper focus on existing knowledge and research gaps is explored in the literature review in Chapter 2. In Chapter 4 based on the outputs of literature review, the cases are introduced with corresponding reviews of policy settings. These cases present a contrast of one setting where energy poverty has been long established as distinct policy issue and has more recently been incorporated into broader energy efficiency targets (the UK), with a setting where energy poverty is a comparatively recent concept politically, but which has made significant progress in its energy transition in the post Kyoto agreement era (Portugal). In setting out the main policy benchmarks, reviewing the existing knowledge on policy synergies and trade-offs and descriptions of key interests and dynamic factors, Chapters 1-4 lay the foundations of the responses to each research question, supporting deeper explorations in subsequent chapters.

From Chapter 5 onwards the original research contributions of the PhD are presented. Chapter 5 focuses specifically on the UK case study and tests the potential for applying a multidimensional energy poverty indicator across the four UK countries, which currently utilize slightly different definitions of fuel poverty. To conduct this test a review method was applied, this consisted of a comprehensive review of UK fuel poverty policy and available UK databases for input into the indicator, such as housing and budget surveys and deprivation indices. Thus, the research in Chapter 5 consisted of policy and literature review activities (both academic and grey). The nature of these review processes could generally be described as a "scoping review" (Munn *et al.,* 2018) and was guided by the data inputs used in energy poverty indicator and index studies a such as Gouveia *et al.* (2019) and Martín-Consuegra *et al.* (2019). The detailed benchmarking activities undertaken contribute to Research Question 1. Explorations of policy linkages, synergies and trade-offs exposed through the detailed review of the UK case contribute to Research Question 2.

Chapter 6 develops and tests a conceptual framework for assessing competing sustainability agendas. The utility of this framework to the broader context of sustainability, which often presents multiple and competing goals, is presented (Smith *et al.,* 2020; Mastini *et al.,* 2021). The framework consists of three steps, where the first two steps involve policy review activities, including a review of monitoring indicators (Buchmayr *et al*., 2021) and the third step is a desk-based stakeholder analysis Tom *et al.,* (2015). The stakeholder analysis was an important complementary step to the policy analysis as this method is a form of obtaining information about key actors and establishing their corresponding behaviours, interests and influences and their inputs to the processes of decision making (Brugha & Varvasovsky, 2000). The outputs of these steps are combined to reveal the synergies and trade-offs between policies central to the climate change, energy transition and energy poverty agendas in Portugal. The scalar implications of these synergies and trade-offs are discussed and reflections of the associated agenda power dynamics are provided. In this sense Chapter 6 finalises the response to Research Question 2 and contributes to Research Question 3 in its identification of stakeholders and their corresponding interests and influences.

Chapter 7 explores perspectives on the competing agendas in Portugal through qualitative interviews with expert stakeholders from diverse sectors, including Non-Governmental Organizations (NGOs), Energy and Environment Agencies, National Government and the University sector using a semi-structured interview approach, which allows for serendipitous findings (DeJonckheere, 2018). Interview analysis was carried out using the NVivo software tool, specifically the tool was used for the processes of coding and thematic analysis applied to the interview data. The interviews investigated perceptions of current policy approaches to climate change, energy transition and energy poverty agendas in Portugal. Reflections are made on the split of these views by organizational type, and general insights are provided on policy management, efficacy, and uncertainties in the current policy scenario. Thus, in the exploration of the interests and perceptions of different stakeholders (and how these compare) (Reed *et al.,* 2009), Chapter 7 concludes the response to Research Question 3. In discussion of current policy approaches and the existing uncertainties, as well as suggestions for improved policy management Chapter 7 contributes to Research Question 4.

Chapter 8 is based on a Participatory Systems Mapping process, where a collaborative workshop to develop Causal Loop Diagrams was held for thesis research purposes. Chapter 8 advances system dynamics techniques to explore energy poverty, through the collaborative development of a Causal Loop Diagram. This diagram explains the energy poverty system and the main interactions between system variables. Given that this method has not been applied in the context of energy poverty previously, approaches are adapted from other fields such as ecosystem services (Lopes & Videira, 2015; Lopes & Videira, 2017) and sustainable tourism (Tourais & Videira, 2021). Thus Chapter 8 not only provides insights on competing agendas in Portugal but also presents the utility of the Systems Dynamics and specifically the Participatory Systems Mapping process, namely Causal Loop Diagrams, for the exploration of energy poverty. The inter-relations of the different variables relevant to energy poverty expose the dynamic policy factors at play and conclude the response to Research Question 4. In the holistic representation of the energy poverty system and of the relationships between different system variables, the results presented in Chapter 8 are cross-cutting, substantiating and deepening earlier contributions to Research Questions 1-3.

Chapter 9 presents the Conclusions, with insights on the interplay between the different agendas, what competes, what is synergistic and suggestions for improved policy outcomes across all agendas based on the findings of this thesis. In addition to outlining the responses to the research questions, the top ten "agenda conflicts" revealed through the course of the thesis are presented, along with a "priorities pyramid" intended as an aid to policy makers and assessing the pros and cons of various policy approaches. Thus, the Conclusions provide inputs into synergistic policy approaches, acknowledging that there are rarely "win, win" outcomes across the agendas and applying a principle of "causing no significant harm" to realise the best possible outcomes for all.

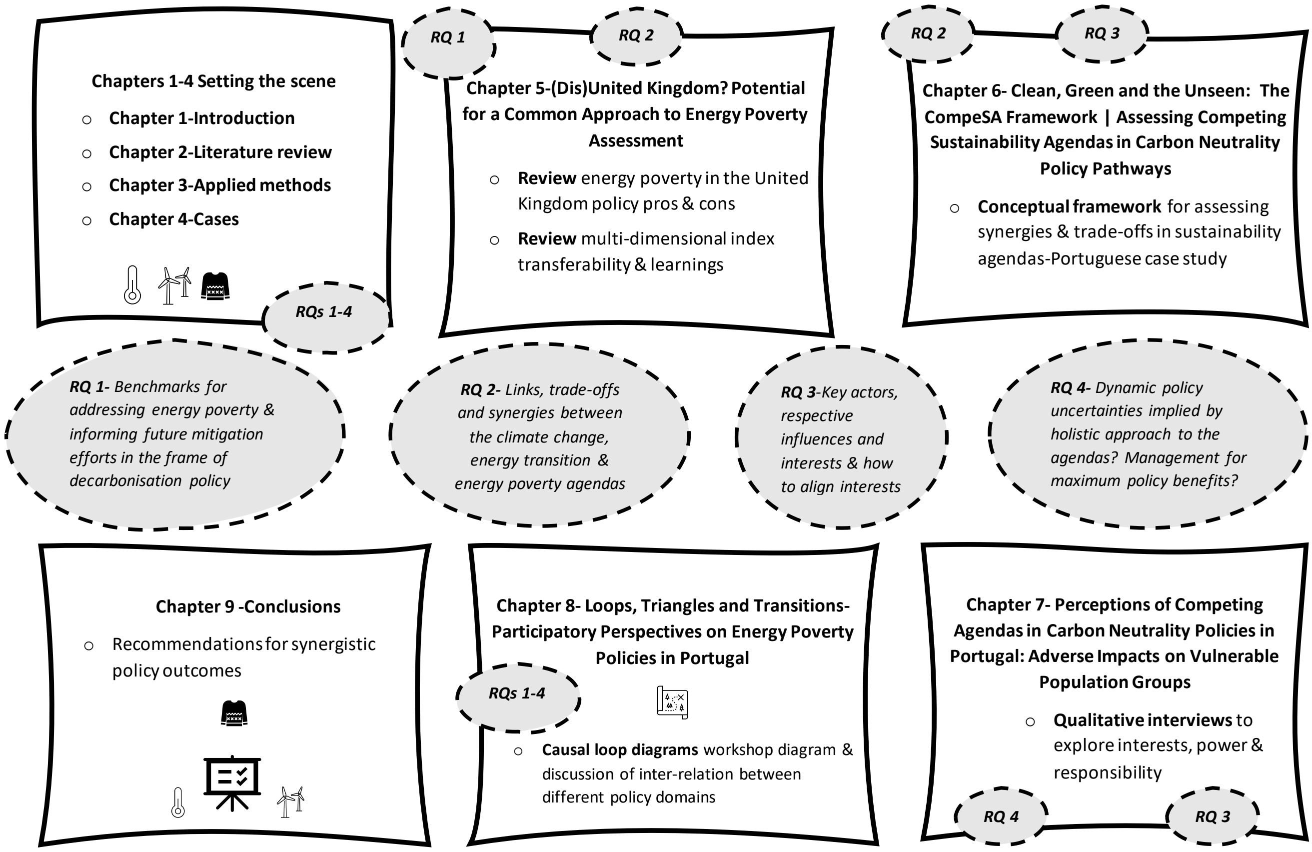

Figure 3.1 Project method schematic

3.2. References

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Chapter 4 | Cases

4.1. The United Kingdom and Portugal

This thesis draws on two case studies, those of the United Kingdom and Portugal, to explore the interactions of climate change, energy poverty and energy transition agendas. Specific details of the relevance and application of each case are provided in the following subsections.

4.1.1. Fuel poverty and links to decarbonisation in the United Kingdom

In the UK, where the term "fuel poverty" was first recognised by the Government in 1997 (Koh *et al.*, 2012), the political response to energy poverty is comparatively mature within the European context (Sovacool, 2015; Robinson *et al.*, 2018). It should be noted that when referring to energy poverty in the UK, due to the common use of the term "fuel poverty" in that context and the more general use of "energy poverty" in a European context, these terms are used interchangeably. Since the 2000s, the UK has been implementing policies with the intent of eradicating energy poverty. However, energy poverty is still a prevalent issue in the country, and this longstanding response has led to a significant amount of research and a deeper understanding of the complexities of the issue. In particular, sustained social and political interest has driven increased awareness of the adverse effects of cold homes, and as a result, temperatures in UK homes have risen (Palmer & Cooper, 2013). The intensity of interest in energy poverty in the UK has also driven changes in social norms in UK society regarding comfort expectations (Palmer & Cooper, 2013).

In the context of commitments to reduce GHG emissions from the building sector over time, the UK policy approach tightened links between energy efficiency and fuel poverty alleviation (Gillard *et al.,* 2017). Intrinsically, there are obvious links between energy poverty and building quality (Rosenow, 2013); therefore, pursuing this approach in the UK (and other) contexts is undeniably valid. Since this closer integration of emissions reduction targets in the UK with the resolution of fuel poverty, however, several authors have evaluated these approaches. Such evaluations deal with the concept of "competing agendas" in different ways and would not necessarily employ the same terminology, but nonetheless, it is possible to find several different studies which deal with this phenomenon in the UK-based literature.

For example, Jenkins *et al.* (2011) explore low carbon and fuel poverty synergies in social housing, finding that the diversity of household types categorised as "fuel poor" presented a risk of under-representing the diversity of responses to fuel poverty by the various tenants, the authors also attest that the variance in household types and behaviours influences how synergistic the combined goals of emissions reductions and fuel poverty alleviation are likely to be. An interesting finding of this work, from the perspective of public policy design, is that lower-income members of society (in this case, social housing tenants) are less able to participate in low-carbon shifts regarding the uptake of more efficient or environmentally friendly technologies, due principally to economic constraints. On the same logic, however, these groups are more responsive to the idea of energy saving as it ties into a greater sense of overall resource conservation guiding their everyday outlooks. This finding also links with themes of responsibility for emissions reductions and who is curbing their energy consumption in what way and with what consequences.

In 2013, Rosenow *et al.* assessed the so-called energy efficiency obligations scheme; initially intended as a carbon-saving measure, supplier obligations were adapted to fund fuel poverty alleviation under a constrained budget context. In their original form, supplier obligations were obliged to deliver domestic energy savings in the provision of subsidies. These subsidies are meant to be used by households to install energy efficiency measures. There are several theoretical policy advantages to supplier obligations, including low delivery costs (Ekins & Lockwood, 2011) and the fact that as the funding source is private, it will not be subject to budget cuts, as a public source would be (Rosenow *et al.,* 2011). A disadvantage of using supplier obligation schemes is that energy suppliers subsequently pass costs on to consumers, thus compromising their integrity as a tool to mitigate fuel poverty. The authors also highlight that energy suppliers delivering the obligation tend to focus on higher income groups as subsidies are means-based, where higher subsidies are due to lower income groups, and the suppliers aim to deliver measures at the lowest cost possible. Finally, lower income groups tend to imply lower carbon savings due to practices such as energy use restrictions and attempts to increase their comfort levels post-intervention. These reflections are insightful for how seemingly obvious synergies between reducing building energy consumption, mitigating fuel poverty and navigating public budget constraints can imply trade-offs for the fuel poor.

The more recent contribution of Abbasi *et al.*, (2022) presents a new indicator labelled the Potential Fuel Poverty Index to assess the likelihood of fuel poverty following future interventions. Part of the rationale for developing the index is that pre-intervention assessments are less socially orientated and generally focus on reducing emissions and costs; the outcome of this is that fuel poverty is a lesser concern in engineering design and decision-making. Of particular relevance is the reference the authors make to the necessity for "multiple and sometimes conflicting objectives to be pursued” (pg. 10) in the scope of just transition delivery.

Similarly, in 2022, Sherriff *et al.* presented six research risks at the intersection of fuel poverty, climate change and decarbonisation with concerns that reducing fuel poverty may be a lesser priority than demanding decarbonisation targets. While this study is not limited to the UK, it is its main focus. The six risks are identified below (pg. 2):

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 a 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.

Notably, one of the risks is the reduced focus in fuel poverty research on a changing climate, which is even more vital in countries with higher average summer temperatures than the UK (Gouveia *et al.*, 2019). Two risks centre on the shift away from fossil fuels and the integration of alternatives as not being financially rewarding for the energy poor. Such findings are significant because they feed into motivations of citizen participation and narratives of elitism, which can fuel far-right arguments and climate change denial (Krange *et al.,* 2021). The last two risks centre on ideas of power (or lack thereof) and inequity, once again feeding into fears that contrary to transition ideals of "leaving no one behind", the move to a decarbonised society will perpetuate existing imbalances.

In the contemporary setting, the UK, like the rest of Europe, has suffered energy price increases in the face of the Ukrainian war; assessments of the effects of the energy crisis on energy poverty in the UK are very concerning, with practices such as energy and hot water rationing and reducing the use of medical equipment reported (NEA, 2022). To make matters worse, the energy crisis was precluded by energy prices which were already inflated due to low wind output, higher than average demand and reductions in other types of energy generation (NEA, 2022). Critically, those on lower incomes living in the least efficient houses are thought to be those suffering the most. With energy prices more than doubling between the winters of 2020-21 and 2021-22, a national energy charity reported an additional 2.7 million UK households suffering from fuel poverty compared to the previous year (NEA, 2022).

Somewhat controversially, in the face of these considerable challenges, the UK has recently shifted its stance on decarbonisation, stating that it will maintain all international commitments while pulling back on emissions targets. Specifically, the UK Government have recently pushed back bans on the sale of petrol and diesel cars to 2035 and moved away from policies focused on improving the energy efficiency of rental properties. Bans on new fossil fuel boilers will be delayed, but increased grants will be available to citizens who wish to transition now. These seemingly contradictory moves are based on the argument that over-delivery of emissions targets allows space for these lightened commitments (UK GOV, 2023). The move is further justified because these reductions will place less pressure on working people (UK GOV, 2023). Given the considerable challenges faced by the most vulnerable members of UK society, (highlighted previously), such discourse indicates the urgent need for policy makers to address the suffering prevalent in its society and presents a cautionary tale for other countries seeking to reduce energy poverty under the umbrella of decarbonisation.

Considering all of the previous information, it is clear that the UK does not present a perfect model for eradicating energy poverty. Instead, it provides essential benchmarks for the synergies and challenges of policies aimed at reducing energy poverty in the scope of decarbonisation and the role of politics, academia and NGOs in progressing the energy poverty agenda. These benchmarks are assessed in this thesis and aim to contribute knowledge to comparatively developmental policy approaches to energy poverty. This benchmarking, along with a proposed common approach to energy assessment for all four UK countries, is provided in Chapter 5; later reflections on the learnings are provided at relevant junctures throughout the thesis and drawn into the Conclusions.

4.1.2. Energy poverty and decarbonisation in Portugal

Within Southern Europe, one country presents a particularly relevant case for investigating energy poverty within the framing of decarbonisation policy. Portugal is a relatively low-income country in the European context, where in 2022, the median annual disposable income expressed as purchasing power standards was an average of 18 706 PPS per inhabitant; by contrast, PPS per inhabitant in Portugal was 11 500-<13 500 and 13 500-<18 706 in Spain and Italy (Eurostat, 2023a). Demonstrating that incomes are comparatively low in Portugal even in a Southern European setting. Despite this, Portugal has rapidly integrated renewables into its energy sector, considerably out-performing its counterparts (Eurostat, 2023b). Conversely, for some time, Portugal's winter mortality rate has been recognised as unusually high considering the country’s climatic zone (Healy, 2003; Fowler *et al.*, 2014). This worrying occurrence is not systematically recorded or reflected in the public policy response (Almendra *et al.,* 2016). It is also believed that winter energy costs are not fully accounted for in Portugal due to the widespread use of biomass in rural areas; given that this fuel source can be gathered by hand, it is not reflected in official statistics (Antepara *et al.*, 2020). Worrying trends of forced acceptance and coping strategies have also been observed (Horta *et al.*, 2019). Increasingly harsh summer temperatures are intensifying concerns about summer energy poverty and its adverse effects, which range from increased energy consumption due to greater cooling needs (Gouveia *et al.*, 2019) to detrimental mental health effects in the summer months (Almendra *et al.*, 2019).

Linking back to policy integration of carbon neutrality goals with energy poverty, Portugal´s low-income status implies that at the citizen level, the capacity to increase energy expenditure or to invest in more efficient climatization equipment, building renovation, and renewable energy systems is low. In one sense, a reduced capacity to consume energy is positive from the perspective of reducing national emissions; on the other, as shown by the previous arguments, this can and has resulted in detrimental effects on the country's population. This, in turn, connects to questions of energy justice and the distribution of responsibility for emissions reductions (McHarg, 2020; Porter *et al.,* 2020). Furthermore, the lack of capacity to invest is a barrier to adopting more efficient solutions and renewable energies, which are key measures on the path to carbon neutrality.

4.1.2.1. Energy poverty in Portugal-an emerging policy concern

Portugal's engagement with energy poverty as a policy concept is relatively recent, with the explicit reflection of the concept in policy and dedicated research only surfacing towards the end of the 2010s (Sareen *et al.,* 2020); in this sense, additional contributions to this limited body of knowledge are timely. A consequence of this later engagement with energy poverty has been a widespread under-recognition of the problem in society (Horta *et al.,* 2019). In the 2022 Healthy Homes Barometer, Portugal was identified as having 50% of its population exposed to indoor climate hazards; these hazards are damp and mould, excessive noise, cold or lack of daylight (Velux, 2022). In 2019, the source highlighted Portugal as the worst-ranking country in Europe for the proportion of children with an increased risk of developing a health condition as a result of living in a poor-quality building (Velux, 2019).

Another outcome of Portugal’s delayed response to energy poverty has been a prolongation of efforts to define the condition and a dearth of data availability and information useful for diagnosing and mitigating the problem. Such data was generally expressed in percentages at the national scale and often constituted data collected for purposes other than the assessment of energy poverty, such as data from the EU Survey on Income and Living Conditions (SILC) (Sareen *et al.,* 2020). This level of data availability compares starkly with the UK, where dedicated fuel poverty reports are issued comparatively frequently, particularly in England with an Annual Fuel Poverty Statistics Report (Department for Energy Security & Net Zero, 2023). Recently, more data has become available at the regional and urban scales (Sareen *et al.,* 2020); however, disparities in the level of EPC data availability between mainland Portugal and the Azores and a lack of sufficient information for regional governments regarding the potential for building stock renovation are exposed by Palma *et al.* (2021).

The data on the Portuguese building stock is concerning, suggesting a generally low energy performance, with the majority (over 70%) of buildings ranked as grade C or below (ADENE, 2024) and a significant "energy performance gap" in both the summer and winter periods. The "gap" represents the energy which would be required for homes to reach levels of thermal comfort associated with standardized indoor air temperatures as recommended by regulatory bodies (Palma *et al.*, 2019). While researchers, the media and indeed, policymakers in Portugal were already beginning to push the energy poverty agenda forward, it cannot be denied that both the COVID-19 crisis and the War in Ukraine have intensified awareness of living and energy costs in Portugal. The Portuguese Government banned disconnections of water, gas, electricity and electronic communication methods (including internet connections) from December 2021 until March 2022 during the pandemic (LUSA, 2021). In response to inflation caused by the Russian invasion of Ukraine, citizens were supported by the removal of tax costs on essential food items (Alvarez, 2023).

4.1.2.2. Energy poverty in Portugal – pre-implementation of the European requirements in 2030 National Energy and Climate Action Plans

The previous sections explain how European requirements in NECPs advanced political engagement with energy poverty in Member States; prior to this, in Portugal, energy poverty had been mitigated through the social tariff, available to vulnerable consumers in receipt of particular social benefits or those classified as "low-income" households. The tariff is available for electricity and natural gas, but most claims are made for electricity (DGEG, 2023).

While the implementation of the social tariff was an encouraging step forward regarding energy poverty mitigation in Portugal, it is impossible to prove a significant link between the policy's implementation and the improvement of Portugal's performance according to the energy poverty vulnerability indicators. For example, Moreira (2018) argues that the improvement of Portugal's performance in the "inability to keep warm" indicator does not demonstrate an improvement in the householder's ability to heat the house but rather to pay energy bills. For this reason, Moreira (2018) states that energy efficiency schemes have a greater potential to mitigate energy poverty than financial measures. However, Kyprianou *et al.* (2019) present a slightly different view, highlighting Portugal's diverse range of energy-saving measures available to low-income, vulnerable households at the time. Despite this high level of interest in energy savings, the overall quality of the Portuguese building stock remained poor, suggesting that additional financial support for specific periods would have been beneficial. Both sources agree that the Portuguese approach needed more diversification to comprehensively tackle energy poverty. In the initial years of the social tariff, energy price increases and limited eligibility criteria (where householders had to take the initiative to apply for support rather than being targeted) resulted in lower-than-expected uptake (Malheiro, 2018).

The eligibility criteria for the social tariff were subsequently broadened, resulting in substantial increases in the number of benefitting households. The social tariff was praised by some for the increased number of vulnerable consumers it reached since the eligibility criteria were revised; however, it has been argued that the tariff does not promote more efficient energy consumption patterns. Despite this, the high demand for the tariff demonstrated that removing it would be a detrimental step (Observatório da Energia, 2019).

Other associated measures include the "Casa Eficiente 2020", programme designed to support domestic properties to improve energy efficiency (Casa Eficiente, 2020). The programme received 2 million euros of funding and offers financial aid towards building envelope improvements, lighting systems, ventilation, and the installation of energy consumption management systems. Eligible candidates had to be owners, leasers or legally represent the owners of the building (Casa Eficiente, 2018). The programme aimed to benefit both the environment and the economy (Casa Eficiente, 2020). Another important initiative addressing energy poverty during this time was an assessment of energy poverty in Portugal for the energy company EDP, which focused on three indicators: household perception, energy expenditure, and the energy gap. The application of three measures, window caulking, roof insulation and air conditioning, were identified as interventions which could potentially reduce levels of energy poverty in Portugal to approximately 1% by 2040 (Rodrigues *et al.,* 2018).

The "LIGAR - Energy for All" project aimed to reduce energy poverty and to promote an efficient increase in energy consumption; the project focused on ten civil parishes experiencing social or economic disadvantages. The project also aimed to map and characterise energy poverty in vulnerable areas and create teams to interact with consumers needing support (LIGAR, 2020). The STEP project sought to address energy poverty through behavioural change and low-cost energy solutions in groups in or at risk of energy poverty by providing tailored advice. The project worked in some of the European regions most vulnerable to energy poverty, identifying Portugal among these (STEP, 2020).

In Porto, the Porto Energy Hub combines a digital portal with an office space in the Porto municipality offering information services, financial advice and support in the submission of applications for energy efficiency measures. The POWERPOOR project (funded by Horizon 2020) established two designated support offices offering energy advice one in Ermesinde (located near Porto) and the other in Mértola (located in the Alentejo region) (República Portuguesa, 2024). POWERPOOR is mostly focused on "no regret solutions" consisting of low cost and energy efficient measures (POWERPOOR, 2024). The "Transition Point", funded by the Calouste Gulbenkian Foundation is a physical One Stop Shop, offering energy efficiency and bill advice, the project was tested initially in the Setúbal area (a coastal town South of Lisbon) with rollout planned in other areas (as below) (República Portuguesa, 2024).

Further relevant projects are the those benefitting from the EPAH technical assistance supports, where local authorities were invited to apply for support in their approaches to tackle energy poverty. Recipients included The Municipality and the Commission for Coordination and Regional Development of Arganil, receiving support to develop a tool for the mapping and identification of energy poverty, Arganil is in the inland central region of Portugal, is sparsely populated, has an aging population and an aging building stock (EPAH, 2024). Two other beneficiaries of the EPAH technical assistance supports are the "S.ENERGIA" Regional Energy Agency operating across the municipalities of Barreiro, Moita, Montijo, and Alcochete and The Union of Civil Parishes of Baixa da Banheira and Vale da Amoreira, in both instances the municipalities represented are located on the South banks of the Tejo river with close proximity to Lisbon. In Barreiro, Moita, Montijo, and Alcochete the focus is on the replication of the "Transition Point" a One Stop offering energy efficiency and bill advice to local citizens, with the model having proved successful in the surrounding area of Setúbal. In Baixa da Banheira and Vale da Amoreira the focus is on addressing the impact of energy poverty on public health and includes identification of the energy poor through collaboration with local health authorities (EPAH, 2024).

4.1.2.3. Key policies addressing energy poverty and competing agendas in Portugal

Following the EU's policy imposition of Member States accounting for energy poverty in their NECPs and corresponding mitigatory measures, several Portuguese policy initiatives have emerged which tackle energy poverty in carbon neutrality policies. Table 4.1 summarises these policies below, as the table reveals some are directly focused on energy poverty (the dedicated energy poverty strategy). In contrast, others, such as the Carbon Neutrality Roadmap 2050, are more general strategies that intersect with energy poverty but have different general focus.

In Chapters 6 and 7, these policies are assessed and commented upon, with a focus on the trade-offs and synergies across the agendas of climate change, energy transitions and energy poverty these agendas reveal, as well as reflections on how the roles, responsibilities and capabilities of different actors in these agendas (for example local agents, citizens and national governments). Notably, while labelled under the heading "policies", in Portugal, a distinction is made between policies and strategies, where policies are common rules and regulations to guide decision-making and strategies imply directly measurable objectives. The policy names in Table 4.1 allow the identification of the respective policies and strategies.

Table 4.1 Policies relevant to the CC, ET & EP agendas in Portugal

Policy name		Policy summary	References
Carbon Neutrality Roadmap 2050/ Roteiro Para a Neutralidade Carbónica		Presents trajectories for Portugal to meet carbon neutrality by 2050. Identifies buildings as target area for reducing emissions, urban rehabilitation activities and uptake of low carbon & renewable energy sources projects to reduce EP	(APA, 2019a)
National Energy & Climate Action Plan 2030/ Plano Nacional Energia e Clima		Sets out PT's emissions reductions & policy actions for the period 2021-2030. Highlights that EP should be identified and resolved principally through urban rehabilitation, focused on measures such as insulation and the reduction of fossil fuel dependency. EP mitigation is presented in the scope of a just transition	(APA, 2019b)
Long Term Buildings Renovation Strategy 2050/Estratégia de Longo Prazo para a Renovação dos Edifícios de Portugal		Recognises the need for a profound renovation of the existing building stock to meet the requirements of both 2050 and 2030 targets, highlights complementary nature of building renovation with EP mitigation. Highlights that mitigating EP will improve health & thermal comfort of occupants. Building renovation also seen as a means of boosting national economy	(República Portuguesa, 2020)
COVID Recovery and Resilience Plan/ Plano de Recuperação e Resiliência	More Sustainable Buildings II/ Edifícios Mais Sustentáveis II	Energy efficiency funding scheme to improve Portuguese dwellings, provides funding principally for private homeowners for measures such as solar thermal, wall insulation and windows	(Recuperar Portugal, 2023)
	Efficiency Voucher/ Vale Eficiência	Energy efficiency funding scheme to improve Portuguese dwellings directed at energy poor consumers, targeted eligibility criteria e.g., recipients of social or unemployment benefits, recipients of social tariff	(Recuperar Portugal, 2023)
Long-term Strategy for Combating Energy Poverty 2023-2050/ Estratégia de Longo Prazo de Combate à Pobreza Energética 2023-2050		Outlines PT response to EP, main aim to eradicate EP by 2050, protecting vulnerable consumers and integrating them actively in the transition, which strives to be democratic, just and cohesive	(Diário da República, 2024)

A review of the policies in Table 4.1 shows the clear integration of energy poverty into Portuguese decarbonisation policy and more specific targets and policies emerging post-2019. While authors have investigated the social trade-offs associated with the energy transition in Portugal (Silva & Sareen 2020; 2023), have revealed uncertainties about the degree to which alternative (and more just) energy models can penetrate the Portuguese case (Delicado *et al.* 2023) and raised concerns about sufficiently meeting energy needs in the context of decarbonisation (Gouveia *et al.,* 2019), there is a lack of detailed policy analysis which directly assesses the efficacy of tackling energy poverty under decarbonisation policy in the Portuguese setting. This thesis aims to contribute to this research gap.

In very different ways, the UK and Portuguese case studies offer interesting insights into whether the agendas of climate change, energy transitions, and energy poverty are competing. In the UK case, a thorough background of dealing with fuel poverty provides knowledge on which policy efforts have been more and less successful and why; the case also presents a grounding of combining energy efficiency targets with fuel poverty mitigation. In Portugal, a rapid and somewhat unexpected uptake (given its economic constraints) of renewable energy contrasts with undesirable consumer experiences on the ground. Exploring the underlying causes of this occurrence is highly important for informing future approaches to just transition delivery.

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Chapter 5 | (Dis)United Kingdom? Potential for a Common Approach to Energy Poverty Assessment

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Abstract

The UK has an extensive research base in the field of energy poverty, to the extent that other countries have based their policy approaches on the UK model. Despite this, there is no common method for measuring this condition across the UK. Additionally, sustaining meaningful reductions in UK energy poverty remains a challenge. While significant regional differences in UK energy poverty have been identified, it is not possible to draw direct comparisons between devolved countries. This paper explores the causes of these regional differences and contests that a common measurement across the UK countries would be insightful for resource allocation and policy design. The potential for applying a common multidimensional method of energy poverty assessment across the UK countries is investigated, with a strong focus on the value and viability of this process. Findings demonstrate that while there is a high level of data availability for input into a high spatial resolution index, this data is not compatible between countries and would have to undergo a process of data and metrics equivalisation before direct comparisons could be drawn. With increasing interest in the potential of multidimensional indexes to guide EU energy poverty policy, this paper provides useful insights into the practicalities of upscaling indexes between varied socio-political contexts.

Keywords

Fuel Poverty, Energy Vulnerability; Geographic Variation, Multidimensional Energy Poverty Indexes

5.1. Introduction

Awareness of energy poverty and its impacts is increasing throughout the EU. Schliech (2019) identifies that energy poverty has been a prominent issue within the policy arena for approximately 10 years, resulting both from energy price increases and the economic crises. Currently, more than 50 million people are affected by this issue in the EU (Thomson & Bouzarovski, 2018). These groups are typically unable to maintain an adequate temperature in their homes. The World Health Organization recommends a standard of 21°C for living spaces and 18°C for other household spaces to prevent the numerous health conditions linked to cold homes (WHO, 2007).

In contrast to other regions, in the UK an antiquated and inefficient housing stock brought energy poverty to the attention of academic and political circles as early as the 1970s (Koh *et al.*, 2012). The issue has been the subject of academic and policy discourse for a comparatively long period of time, making the UK the country which has made the most intensive efforts to measure and define this condition (Robinson *et al.*, 2018). A range of responsive policy has since emerged, which has contributed to rises in average indoor temperatures across the country (Palmer & Cooper, 2013). The expectations of householders in terms of living standards and thermal comfort have changed, with several previous "norms" (e.g., ice on the inside of windowpanes in winter) now being widely unacceptable (Palmer & Cooper, 2013). These changes have not occurred uniformly across Europe. For instance, in Portugal, the population is still experiencing conditions that were common in the UK during the 1970s (e.g., only heating one room) with low consumption levels both for space heating and cooling (Gouveia *et al.,* 2017) whereas in countries like Bulgaria and Poland, the population still uses coal in inefficient residential space heating appliances with direct negative consequences on indoor air quality (Kisyov, 2014; Sokołowski *et al.,* 2019).

Given the improvements in living standards, the UK has been taken as an example by other nations, leading to the proposed adoption of the English definition of energy poverty at a wider scale (Rademaekers *et al.,* 2016). Despite the valuable experience the UK has gained in mitigating energy poverty, the issue persists, with significant inequalities occurring between devolved UK countries (Liddell *et al.*, 2012). Although these inequalities have been discussed within wider literature, there is a lack of in-depth understanding of these trends, with no attempt to assess energy poverty at a high level of spatial resolution across the UK as a whole.

In Europe, energy poverty indexes are becoming increasingly refined and widespread. For example, the Multidimensional Energy Poverty Index assesses both the scale and incidence of energy poverty in Poland by combining five dimensions of energy deprivation (Sokołowski *et al.*, 2019). The Energy Poverty Vulnerability Index (EPVI) developed by Gouveia *et al.* (2019) in Portugal provides a high spatial scale insight into energy poverty in the country at the civil parish level, assessing the energy performance of buildings (for both heating and cooling), the index also includes socioeconomic indicators. Indexes which facilitate the comparison of energy poverty between EU Member States are now being developed. A composite index using EU SILC indicators has been used to rank the progress of Member States in alleviating both domestic and transport energy poverty (OpenExp, 2019). While these developments are encouraging, the scaling of multidimensional indexes to facilitate regional comparisons between different Member States still presents a significant challenge.

In light of the above, this paper uses the UK as a testbed to explore the potential of scaling a multidimensional index across the four UK countries. It carries out a thorough evaluation of data availability in the UK, in order to assess the current viability and future potential for conducting a comparative analysis on energy poverty by using multidimensional indicators. Theoretical datasets recommended by (amongst others) Morrison & Shortt (2008), Walker *et al.,* (2013), and Gouveia *et al.,* (2019), are a few of the examples used to complete this exercise. The ability to "zoom in" as much as possible in the energy poverty setting enables targeted action and localised policies, therefore the availability of data at high spatial scale is paramount.

The objectives of this paper are: i) to review the status of energy poverty in the UK by country (Scotland, England, Wales and Northern Ireland), in terms of policy, definitions, and indexes, whilst highlighting the differences; ii) identify available data sources and datasets in the devolved countries to assess the potential for a shared UK methodology for energy poverty characterization, iii) to provide input into current energy poverty policy discourse, where debate is rife with regard to the most effective means of measuring, defining and tackling energy poverty. Given that energy poverty is a well-established issue within the UK, a focus has been retained on whether multidimensional index replication would truly add value. Emphasis has also been placed on the "depth" of data attainable by sourcing the highest resolution data possible. This analysis provides useful insights at the European scale, which increasingly values knowledge transfer between Member States (Thomson & Bouzarovski, 2018).

It is worth noting that, while the term "energy poverty" is more widely used in the European context, "fuel poverty" is more often used in the UK, thus both terms have been used within the paper. This paper is organized as follows; Section 5.2 provides a detailed analysis of the UK energy poverty status, including comparative levels, policy approaches and definitions. The Results and Discussion in Section 5.3 presents a synthesis of high-resolution work in the UK by country. Section 5.3 also reviews data availability for characterizing energy poverty at high-resolution scale within the UK, addressing the viability and value of its application. Conclusions and Policy Recommendations are provided in Section 5.4.

5.2. Energy Poverty in the Devolved UK Countries

Energy poverty is still a relevant issue in the UK, despite its comparatively longstanding recognition (Sovacool, 2015). The persistence of energy poverty within the UK is concerning, given the numerous associated negative impacts, felt for instance in the 2003 heat wave, resulting in 2,000 deaths in England and Wales (Kovats *et al.,* 2016). In the winter of 2017-18, a period of severe cold weather (NEA, 2018a) caused significant strain to health services, particularly where infrastructure was poor. Numerous households were without heating in extremely cold conditions due to power failures (NEA, 2018a). Householders were also forced to spend extra funds on making their homes comfortable. There were numerous hospital re-admittances; as patients were released to homes they were unable to heat, putting additional strain on highly taxed health services (British Red Cross, 2018).

In more recent academic discussions, the concept of "energy justice", the right to achieve comfortable conditions in the home has arisen (Walker & Day, 2012) focused on identifying those consumers most vulnerable to energy poverty. Both within the UK and in the EU, debate regarding the most accurate and just methods of defining energy poverty is widespread (Cornelis, 2018), as are the arguments for and against a common EU definition (Thomson & Snell, 2013). It is evident that, although the UK has made significant progress in identifying and designing strategies to tackle energy poverty, it is still a significant problem. This is particularly relevant given that other EU nations have looked to the UK as a leader of energy poverty mitigation. In the following subsections, an overview of energy poverty within the UK is conducted, focusing on the different definitions (subsection 5.2.1), current status according to the existing metrics (subsection 5.2.2), and Policy Framework (subsection 5.2.3).

5.2.1. Definitions

Following Hills (2012), the Low-Income High Costs (LIHC) definition was adopted in England, with variations of Boardman's 10% definition being utilised by the remaining countries (Energy Saving Trust, 2020; Scottish Government, 2018; Department for Communities, 2018). The different approaches have fuelled discussions regarding the definitions of energy poverty, how these affect those identified as energy poor and the design of mitigation policies (Walker *et al.,* 2014). Despite this discord, in the UK the 1991 definition paved the way for the development of fuel poverty policy, resulting in a reduction in fuel poverty (Palmer & Cooper, 2013). Recent research has shown that the lack of a definition can negatively impact mitigation efforts. For example, a recent assessment of energy poverty in Israel and Romania showed that in the case of both countries the lack of a formal definition led to inconsistent data and an inability to identify the energy poor (Teschner *et al.,* 2020). Definitions do therefore, have a role in reducing energy poverty. A description of the definition employed in each UK country follows.

The LIHC (Low Income High Costs) indicator was implemented in England with the objective of assessing both the extent and depth of energy poverty (Hills, 2012). According to this indicator, households with low incomes, high energy needs, and high household costs are considered to be fuel-poor (BEIS, 2018a). Energy costs are modelled through a calculation combining fuel requirements with correspondent fuel prices, accounting for an adequate level of warmth (BEIS, 2018a). Inputs for household details are obtained through the annual English Housing Survey, involving both a physical survey and a qualitative interview (UK GOV, 2012). Energy prices are a synthesis of several sources including the Department of Energy and Climate Change Survey of Domestic Fuels, Office for National Statistics and Sutherland Comparative Domestic Heating Costs Tables (BEIS, 2018a). Critics of the LIHC state that the modelling does not account for low-income homes with a relatively good level of efficiency; this is particularly the case for small houses with lower energy costs (Middlemiss, 2017). It is further argued that the LIHC over-values the impacts of energy efficiency measures (Castaño-Rosa, *et al.*, 2019a).

The adoption of the LIHC indicator in England was undertaken under consensus that the 10% indicator was overly sensitive to price changes, leading to inappropriate categorisation of energy poor households, including large homes with accordingly high spending rates (Hills, 2012). Other authors argue that the 10% method was unsuccessful in preventing energy poverty, while its merits include the calculation of modelled rather than actual energy costs (Koh *et al.,* 2012). The Hills Review was carried out in austerity conditions and argued that accurate resource allocation was of utmost importance (Koh *et al.,* 2012). This justification, however, does not account for the possibility that under austerity, high energy costs would have increased impacts on the population. Both indicators have been criticised for not capturing those households which are energy efficient but in monetary poverty (Castaño-Rosa *et al.,* 2019b).

Following the release of the Fuel Poverty Strategy for Scotland 2018, a revision has been made to the Scottish Fuel Poverty definition (Scottish Government, 2019a). The new definition is shown in Table 5.1. The 10% fuel cost to income ratio will now be calculated on an After Housing Costs (AHC) basis, whereas previously this ratio was calculated Before Housing Costs (BHC). Additionally, there will be an increase in threshold temperatures for householders adversely affected by cold, damp homes (Energy Action Scotland, 2019). The Strategy is described as a "landmark" piece of legislation, noting that Scotland is one of the few countries defining energy poverty (Scottish Government, 2018). Interestingly, the Ministerial Foreword identifies that some elements of energy poverty remain outside the power of the Scottish Government to address; "*there are other drivers of energy poverty we have no control over for example energy prices and polices driven by areas reserved to the UK Government*", poverty (Scottish Government, 2018) pg. 5. This contrasts with the central Government stance, which advocates separated administration of energy poverty (BEIS, 2018a). There are worries regarding the timelines cited, as the document commits to a maximum fuel poverty rate of 5% by 2040, exposing Scottish residents to the impacts of energy poverty for some time (NEA, 2018a).

The Welsh energy poverty definition (Table 5.1) also relies on a 10% indicator, the most recent Welsh Housing Conditions Survey was released in 2018 (Welsh Government, 2018a). Prior to this, the last Welsh Housing Conditions Survey was carried out in 2008. There were concerns about analysis based on 2008 statistics, as a number of energy efficiency projects had since been undertaken (NEA, 2018a). Since 2008 there has been improvement in housing conditions in all tenures, the housing stock in the Welsh private rented sector is both the oldest and the poorest quality. The average energy efficiency band is now Band D, an improvement on the previous Band E (Welsh Government, 2018b).

A 10% indicator is also used in Northern Ireland, a private entity (the Building Research Establishment) was employed to model fuel poverty levels for 2017 and 2018. The 2011 Fuel Poverty Strategy defines three key contributors to the problem: income; fuel price and energy efficiency, demonstrating a consistency with the LIHC indicator, the document identifies four key action areas (Department for Communities, 2011): Targeting of Resources, Improving Energy Efficiency, Achieving Affordable Energy and Building Strong Partnerships.

Table 5.1 Definitions of energy poverty by devolved UK country

Country	Definition of Energy Poverty
England	"Fuel poverty in England is measured using the Low-Income High Costs (LIHC) indicator. Under the LIHC indicator, a household is considered to be fuel poor if: they have required fuel costs that are above average (the national median level) were they to spend that amount, they would be left with a residual income below the official poverty line. There are three important elements in determining whether a household is fuel poor: household income, household energy requirements, fuel prices (BEIS, 2018a)
Wales	In Wales, a household is defined as being in fuel poverty if they would have to spend more than 10% of their income on maintaining a satisfactory heating regime. Any household having to spend more than 20% is defined as being in severe fuel poverty (Welsh Government, 2019a)
Scotland	"The Bill defines a household to be in fuel poverty if more than 10% of its net income (after housing costs) is required to heat the home and pay for other fuel costs – with not enough money left for a decent standard of living. If more than 20% of net income is needed, the household is defined as being in extreme fuel poverty." (Scottish Government, 2019a)
Northern Ireland	A household is said to be in fuel poverty if it needs to spend more than 10 per cent of its income on energy costs (Department for Communities, 2018).

5.2.2. Status

In 2018, in the UK, 18.6% of the population were at risk of poverty or social exclusion (Eurostat, 2020). In 2018, a total of 5.4% had arrears on utility bills; 17.8% were living in dwellings with leaking roofs, damp walls, floors or foundation, or rot in window frames or floors; and 5.4% were unable to keep their homes adequately warm during the winter (Eurostat, 2020). In 2012, 3.3% were living in a dwelling which was not comfortably cool during summertime (Eurostat, 2020). The UK recorded a GINI index of 33.5% in 2018, above the 30.8% for EU28 average (Eurostat, 2020). In the first semester of 2019, electricity and natural gas prices for families, with all taxes included, were respectively 1.2% and 22.0% lower compared to the EU28 average (Eurostat, 2020).

Although the devolved UK countries do not use a common definition for energy poverty, research suggests that rates of energy poverty are highest outside England, as stated by Robinson *et al.,* (2018) pg. 80: "Even within the United Kingdom (UK) there exist significant disparities between the devolved nations (England, NI, Scotland and Wales) with a high prevalence outside England". Comparative levels of energy poverty by UK country are displayed in Table 5.2, confirming this statement. Statistics were available for both the LIHC and 10% indicators for all UK countries apart from Scotland. These figures (Table 5.2) demonstrate an interesting level of variation, showing a significantly lower number of households identified as fuel poor under the LIHC indicator in Wales and Northern Ireland but a slightly elevated number of fuel poor households in England compared with the 10% indicator.

Levels in Northern Ireland were the highest in the UK in 2012, at 42% (McKenzie, 2018). A strong focus on energy efficiency improvements has resulted in significant reductions of this percentage (Mohan, 2018) but has not completely eradicated the issue. Fuel price reductions and income increases were also key contributors to these improvements (NIHE, 2016).

In England, energy poverty levels have fluctuated between 10% and 12% since 2003 (retrospectively applying the LIHC indicator), this limited variation is attributed to the relative nature of the LIHC indicator (BEIS, 2019a). Government literature shows that the fuel poverty gap (i.e., the average reduction in fuel bills necessary to remove a household from fuel poverty) and the percentage of fuel poor households can be negatively correlated, i.e., the gap can increase as the number of fuel poor homes decreases (BEIS, 2019a). Academic sources attribute the stabilisation of energy poverty levels in England to economic austerity, the lack of a "typical" energy poor household and the inadequacy of key policies to address structural energy poverty drivers. Targets for the improvement of private rented stock have also been identified as insufficient (Robinson, 2019a).

Table 5.2 Energy poverty indicators in the devolved UK countries

Country	Number of Fuel Poor Households (10%) indicator	Percentage of Fuel Poor Households (10%) indicator	Number of Fuel Poor Households (LIHC) indicator	Percentage of Fuel Poor Households (LIHC) indicator
England (NEA, 2018b)	2,361,400 (2018)	10.4 (2018)	2,460,000 (2019)	10.9 (2019)
Scotland (NEA, 2018b)	649,000 (2018)	26.5 (2018)	-	-
Wales (Welsh Government, 2019a)	155,000 (2018)	12 (2018)	132,000 (2018)	10 (2018)
Northern Ireland (BRE, 2018)	160,000 (2018)	22 (2018)	55,100 (2016)	7% (2016)

The literature identified a series of inequalities in the manifestation of fuel poverty between the UK countries. Fuel prices are higher in rural areas of the UK, with associated implications for energy poverty (The Marmot Review Team, 2011). Geographically, Wales, Scotland and Northern Ireland are more rural than England with less energy infrastructure and increased reliance on expensive fuels (Roberts *et al.,* 2015). Northerly areas have colder temperatures and increased vulnerability to energy poverty. This has relevance for Scotland (a country with significant rural area), which experienced minimum temperatures of -10°C during the 2017-18 winter (NEA, 2018a).

There are also significant regional differences in energy poverty within the UK countries. The work of Robinson *et al.,* (2018) identifies lower rates of energy poverty in the Southeast region of England and elevated rates in the Northeast and West Midland areas. The Southeast region of England including London and its surrounding economic belt is generally more affluent. In 2019 median weekly pay in London was £699 compared to £531 in the North East (HoC, 2019). Despite this, analysis in 2012 estimated that there were 560,000 fuel poor homes in London with 126,000 of these in severe fuel poverty, principally focused in areas of North and Southeast London (London Assembly, 2012).

In Wales, both older and more recent assessments have demonstrated a particularly high rate of fuel poverty in South Wales, mostly in deprived urban areas including Cardiff. A moderate but widespread concentration has also been observed in North Wales, with lower rates occurring in more affluent rural areas (Gordon & Fahmy, 2008; Kelly, 2016).

In Scotland, a recent assessment showed that higher levels of fuel poverty occurred where homes were not connected to the gas grid, with a prevalence in the Northern Highland area and in several of the Scottish Isles. Furthermore, Morrison & Shortt (2008) identified a possible 3150 fuel poor homes previously considered as "low risk" within Stirling Council. The authors highlighted an increased risk of masking smaller areas susceptible to fuel poverty when data is aggregated across larger spatial units. In Northern Ireland, Walker & Day (2012) found an increased risk of fuel poverty in open countryside areas and in medium sized towns. Lower levels of risk occurred in small towns and cities.

In summary, clear geographical variations in fuel poverty occur within each UK country as well as across them. The way in which these geographical variations occur is, however, different in each country. Therefore, the availability of high spatial scale data is paramount for measuring energy poverty as accurately as possible and in the guidance of targeted policy (McKenzie, 2018).

5.2.3. Policy framework

Policies to tackle energy poverty are administrated separately by the four UK countries (England, Wales, Scotland and Northern Ireland). Policy shortcomings for addressing energy poverty have been identified by the UK Government and by NGOs (HM GOV, 2015; NEA, 2016). In the words of the National Energy Action charity "*one of the challenges to securing and developing lasting co-operation is the lack of a common definition of fuel poverty across the UK*." pg. 32. (NEA, 2016). The same source also referred to differences in support systems between countries, identifying an injustice of energy poverty geographies (NEA, 2017). Recent discourse (both political and academic) has identified the complexity of tackling the issue, suggesting that a wider range of energy poverty drivers need to be identified and assessed for successful mitigation (Gillard *et al.,* 2017). Broader drivers are identified in the work of Castãno-Rosa *et al.* (2020); Hargreaves & Middlemiss, (2020); Middlemiss *et al.* (2019) and Longhurst & Hargreaves (2019). Castãno-Rosa *et al.* (2020) outline the importance of behaviour, household structure and dynamics, finances and social activity on energy use, developing an indicator which accounts for these factors. Hargreaves & Middlemiss (2020) explored the impact of social relations on energy demand, describing the impact of two divergent circumstances on energy use, in both cases social circumstances strongly influenced energy consumption. Middlemiss *et al.* (2019) explore the impact of social relations on capabilities i.e., how one's social relations can impact access to energy services. In a novel approach, Longhurst & Hargreaves (2019) investigate the role of emotions on energy vulnerability, contesting that emotions such as trust can influence willingness to engage with support programmes. However, this broader perspective on the drivers of energy poverty currently exists mostly at the academic level, with policy still tending to be based on standard objective measures. Given the widespread consensus on the traditional drivers of energy poverty, the analysis also sought to identify how these were addressed through policy.

The central UK Government attributes differences in energy poverty governance to the partially devolved nature of the issue (DECC, 2012). The various administrations have separate policy targets, with the power to influence particular policies within the respective countries (e.g., energy efficiency programmes) but not the power to influence other aspects, such as income, the market or energy price variations (BEIS, 2018a). Whilst this justification has some basis, the lack of a common approach across the devolved countries risks fostering inequalities, as evidenced by the fact that England produces an annual report on energy poverty, while in Northern Ireland there is no statutory requirement on fuel poverty (BEIS, 2018a).

Analysis of energy poverty policy administration in the UK demonstrates a kind of paradox. Energy poverty is partially attributable to localised characteristics. These include climatic conditions, rurality and particular housing typologies (Roberts *et al.,* 2015). The individual governments and local Councils have a greater insight into these specificities than central Government, thus it is logical to administrate energy poverty locally. Other factors, such as energy price, are the output of wider influences and therefore need to be addressed centrally. This paradox complicates the administration of energy poverty, and the mixed profile of policy approaches fosters inequality, demonstrated by the varying UK energy poverty levels. These frameworks within the UK provide an interesting platform for the EU approach to the issue, highlighting the challenge of sufficiently accounting for regional specifics without creating regional inequalities.

Following the legal commitment to prevent energy poverty in the UK, the Fuel Poverty Strategy (Gordon & Fahmy, 2008) was released in 2001. In response, each country posted interim targets, against the longer-term strategies and targets shown in Figure 5.1. It is interesting to note that, from the outset, there are differences in the targets designed for each country. These differences were attributed to variations in the nature and scale of energy poverty in each country (DECC, 2012). Figure 5.1 demonstrates that previous targets to eradicate energy poverty have been unsuccessful across the UK countries.

Table 5.3 shows the range of UK energy poverty policies in more detail. The number of different policies shows a strong level of political interest in all four devolved countries, this degree of engagement is unique to the UK. However, Table 5.3 also highlights a lack of uniformity in policy instruments between UK countries. These inconsistencies are illuminating in the context of the historic policy approach to UK energy poverty. The degree of political resource dedicated to the issue has been attributed to the efforts of lobbying, NGOs and political figures (Walker & Day, 2012). Analysis of the various policies demonstrates that all three energy poverty drivers – income, energy prices, and energy efficiency- are reflected in the overall policy approach, with each policy targeting at least one of these drivers. With a reduced number of policies targeting income, such schemes include "The Winter Fuel Payment", labelled by some as a blanket payment (Walker & Day, 2012), potentially diverting funds from more targeted policy (Energy Action Scotland, 2019).

Combined energy efficiency and cost agendas proved popular, with policies either combining bill advice with efficiency installations (Warm Wales, 2020a; Welsh Government, 2020a) or emphasising the reduced energy costs associated with improved efficiency (BEIS, 2019b). This popularity extends to the efficiency-based English fuel poverty target, focused on improving energy performance certificates (EPC) ratings rather than fuel poverty percentages (HoC, 2018a). Efficiency policies also reduce greenhouse gas emissions, an obvious attraction for Government (Gillard *et al*., 2017). In the UK housing accounts for 13% of emissions, and the UK's Clean Growth Strategy identifies domestic efficiency upgrades as a target for reducing this figure (HM GOV, 2017). Scottish policy pushed this agenda further, directly referring to renewables and publicly owned energy companies as energy poverty mitigation methods (BEIS, 2019b). Efficiency-based schemes have been both praised and criticised, with positive examples including the reduced levels of energy poverty in Northern Ireland (Mohan *et al.,* 2018) and Warm Front in England (Sovacool, 2015). Critics describe this approach as cost-orientated (Walker & Day, 2012), and as retaining a disproportionate focus on the elderly (Snell *et al*., 2015). The underlying motivations of privately-run schemes have also been questioned, given the desired outcome of efficiency improvements is cost reduction (Rosenow *et al.,* 2013). Significant resource (£640m per annuum) is dedicated this approach through the ECO scheme (BEIS, 2018b). There is a strong focus on energy efficiency, which is particularly evident in English political discourse (HoC, 2018a). Whilst efficiency has a critical role to play in energy poverty mitigation, careful administration of these programmes is necessary in order to avoid a continued marginalisation of the most vulnerable. These groups often do not participate in efficiency schemes to the desired extent and are reluctant to take on debts (as required by the Green Deal) (Middlemiss & Gillard, 2015; Gillard *et al.,* 2017).

Furthermore, there are very few policies targeting energy costs individually. Where not considered a co-benefit of retrofit, energy costs were principally targeted through supported energy supplier switching schemes and the Energy Price Cap (Ofgem, 2019). This reduced focus on energy costs (as a key driver of energy poverty) may partially explain the persistence of the issue, particularly in England where levels have stagnated since 2003 (BEIS, 2019a). Switching schemes rely on users to take the initiative, with evidence showing that many consumers rarely switch more than once if at all (Ofgem, 2019). The Energy Price Cap does not require any action from the consumer but applies only to consumers on prepayment meters, consumers in receipt of the Warm Homes Discount or consumers on a default tariff (Ofgem, 2019).

In summary, the UK demonstrates a range of separate policies dedicated to reducing energy poverty. Within a European context, this level of political engagement is commendable, as many Member State Governments still deny the existence of the problem (EC, 2015). This policy approach is, however, fragmented with different approaches resulting in different levels of support between UK countries. Additionally, the incompatibility of UK energy poverty statistics is problematic for identifying where the problem is most serious. Without a more integrated policy approach the UK risks the persistence of the inequalities between devolved countries.

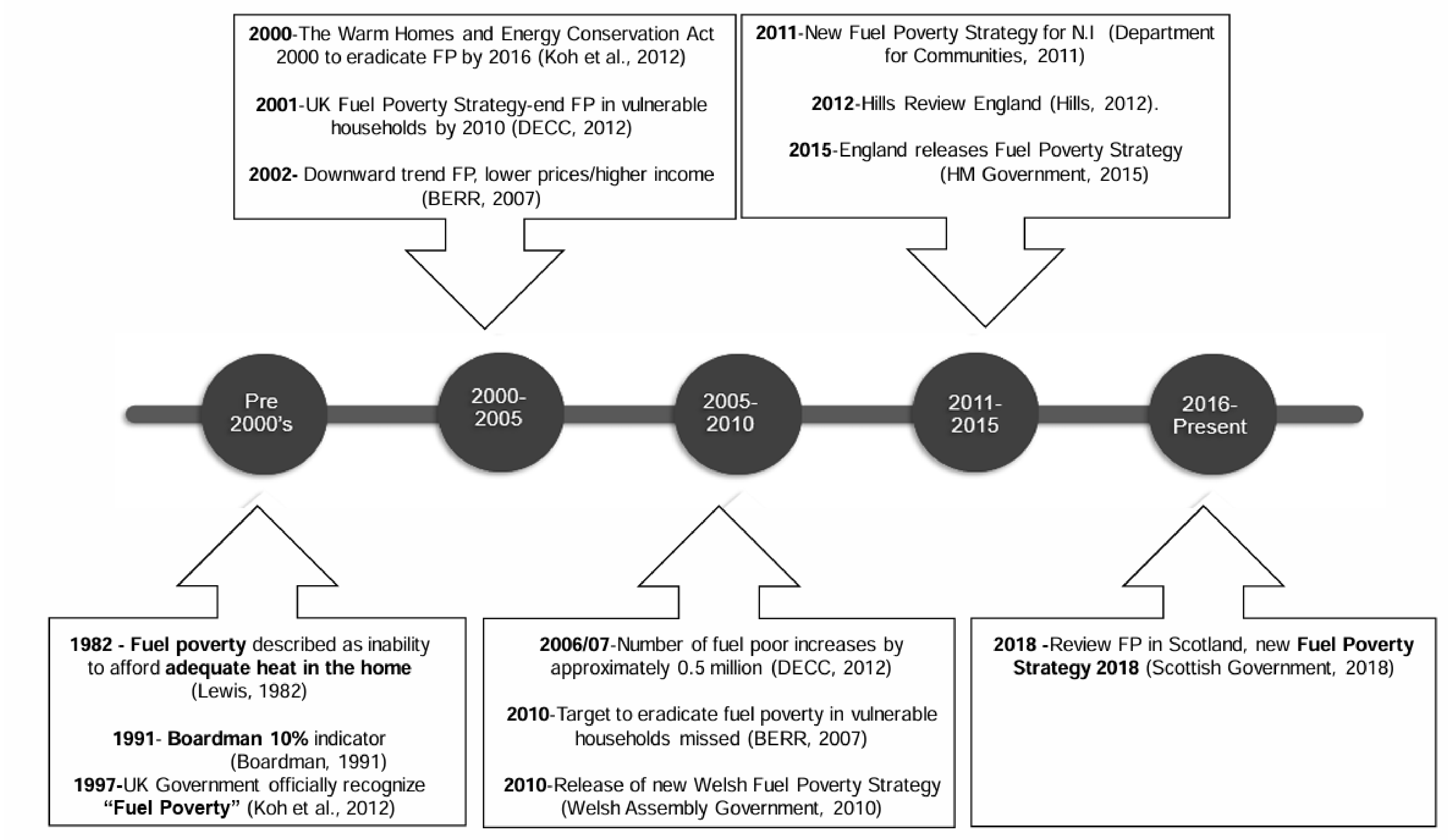

Figure 5.1 UK energy poverty policy timeline

Table 5.3 Key energy poverty policies in UK devolved countries

<table>
<tr><th>Policy name</th><th colspan="2">Country</th><th>Summary</th><th>Driver Targeting</th></tr>
<tr><td>Winter Fuel Payment (UK GOV, 2020a)</td><td colspan="2">U.K.</td><td>Automatic payments between £100-300 if born before Nov 1953</td><td>Income</td></tr>
<tr><td>Cold Weather Payment (UK GOV 2020b)</td><td colspan="2">G.B (equivalent scheme for N.I.)</td><td>Payment if temperature is 0° or less for 7 consecutive days. £25 for each 7-day period between 1 Nov and 31st Mar</td><td>Income</td></tr>
<tr><td>Warm Homes discount (UK GOV, 2020c)</td><td colspan="2">G.B.</td><td>Single payment £140 to energy supplier as a discount to energy bill.</td><td>Income</td></tr>
<tr><td>Green Deal (UK GOV, 2020d)</td><td colspan="2">G.B.</td><td>Household improvements funded by loan paid through energy bills or meter.</td><td>Energy efficiency</td></tr>
<tr><td>Energy Company Obligation (ECO) (BEIS, 2018b)</td><td colspan="2">G.B.</td><td>Energy efficiency improvements in households funded by energy companies. Now "ECO 3" a lower cost version</td><td>Energy efficiency</td></tr>
<tr><td rowspan="2">Warm Homes Programme Nest & Arbed (Warm Wales; 2020a; Welsh Government, 2020a)</td><td rowspan="2">Wales</td><td>Nest</td><td>Energy bill advice and energy efficiency improvements (managed by British Gas)</td><td rowspan="2">Energy efficiency/ Energy costs</td></tr>
<tr><td>Arbed</td><td>Funding energy efficiency measures in deprived communities</td></tr>
<tr><td>The Domestic Private Rented Property Minimum Standard (BEIS, 2019c)</td><td colspan="2">England and Wales</td><td>Minimum efficiency levels for private rented property in England and Wales. Minimum level EPC E grade, if under this band cannot rent to new tenants after April 2018 or continue to rent after April 2020</td><td>Energy efficiency/ Energy costs</td></tr>
<tr><td>Decent Homes Programme (HoC, 2010)</td><td colspan="2">England</td><td>Household improvements including central heating systems</td><td>Energy efficiency/ Energy costs</td></tr>
<tr><td>Fuel Poverty Target- (Based on Fuel Poverty Strategy 2015), (BEIS, 2019a)</td><td colspan="2">England</td><td>"To ensure that as many fuel poor households as reasonably practicable achieve a minimum energy efficiency rating of Band C by 2030, with interim targets of Band E by 2020, and Band D by 2025"</td><td>Energy efficiency/ Energy costs</td></tr>
<tr><td>Scotland's Energy Efficiency Programme (Scottish Government, 2017)</td><td colspan="2">Scotland</td><td>Cut levels of fuel poverty so that no more than 5% of the population are affected by 2040. Includes the Scottish Government Home Energy Efficiency Programme, offering free energy advice</td><td>Energy efficiency/ Energy costs</td></tr>
<tr><td>Warmer Homes Scotland (Energy Saving Trust, 2018a)</td><td colspan="2">Scotland</td><td>Delivered regionally by the Energy Savings Trust. Provide a range of efficiency measures, now including renewables for remoter communities</td><td>Energy efficiency/ Energy costs</td></tr>
</table>

Home Energy Scotland (Energy Saving Trust, 2018b)	Scotland	Managed by Energy Saving Trust, network of local advice centres covering all Scotland. Provides free, impartial advice on improving energy efficiency and reducing costs	Energy efficiency/ Energy costs
Affordable Warmth Scheme (NIHE, 2019)	N.I.	Scheme targeting fuel poverty in the private sector through the installation of energy efficiency measures	Energy efficiency
Welsh Government Housing Quality Standard (Welsh Government, 2020b)	Wales	Requiring all social landlords to improve their housing stock by December 2020	Energy efficiency
The Clean Growth Strategy (HM GOV, 2017)	U.K.	Improving UK homes by focusing on two areas: Improving energy efficiency, Rolling out low carbon heating	Energy efficiency/ Energy costs
Energy Price Caps (Ofgem, 2019)	G.B.	Ensuring fairer energy prices and protecting consumers against overcharging, caps applied to energy supplier on charges per kWh	Energy costs
The UK's Draft Integrated National Energy and Climate Plan (BEIS, 2018b)	U.K.	U.K. (England same target) Upgrade fuel poor homes to an energy performance certificate EPC rating of C or better by 2030 Wales-Wales-Warm Homes programme £104 m further investment Scotland-Public energy company and bioenergy to reduce fuel poverty in Scotland N.I-Affordable Warmth Scheme (as above)	Energy efficiency/ Energy costs

5.3. Results and Discussion

The following sections discuss a range of recent studies and assess the viability and value of conducting a regional high-resolution multidimensional assessment of energy poverty across the UK, where a range of energy poverty indexes and indicators have previously been developed.

5.3.1. Implemented metrics

Despite several sources arguing that the 10% indicator was no longer fit for purpose, the significantly lower number of homes categorised as fuel poor under the LIHC definition in England has proved controversial (Middlemiss, 2017). The difference in groups identified by each UK definition remains divisive (Robinson *et al.*, 2018), and a similar debate is now occurring more widely at an EU level, where a series of indexes and indicators to measure energy poverty are emerging (Castaño-Rosa *et al.*, 2019b). Producing an index that could offer a UK-wide perspective would potentially add a further dimension to the debate which is currently lacking. By exploring the potential for scaling a regional index, this exercise generates insights into both UK specific and wider EU discourse. In this section, a review of recent energy poverty measurement and high spatial resolution work within devolved UK countries is conducted, summarising the methodologies employed and relevant spatial scales. In this context, the advantages and disadvantages, as well as the viability of a multidimensional high-resolution approach for the UK are discussed.

The range of sources shown in Table 5.4 indicate the high profile of energy poverty in the UK. The Table refers to key recent works, presenting several high spatial resolution scale studies for UK countries. Existing high-resolution studies have focused on the individual UK countries, with high spatial scale assessments identifiable for each country. A higher number of these assessments were available for England, this coincided with more regular reporting on the issue of fuel poverty.

The first high spatial scale resolution assessment of energy poverty in the UK was the "Fuel Poverty Indicator", developed by the Centre for Sustainable Energy and The University of Bristol, predicting rates of energy poverty by electoral ward, combining data from the 2001 Census, the 2003 English House Condition Survey and a national property database Residata for England (CSE, 2018). With the increased popularity of geographic information systems (GIS), such approaches have been more widely replicated within the UK, and often feature an energy poverty map. Studies with an accompanying map are identifiable for all four devolved countries (Gordon & Fahmy, 2008; Morrison & Shortt, 2008; Greater London Authority, 2012; Changeworks, 2015; Kelly, 2016; McKenzie, 2018; CSE; 2018, Parallel, 2018; Robinson *et al.,* 2018; Newcastle University, 2019; Robinson, 2019b; Eaga Charitable Trust, 2020; Warm Wales, 2020b). Studies without mapping outputs, were also found (HoC, 2018b). The sources fell into three broad categories, country level assessments of the relevant UK country, adaptable tools which combined national and local datasets and local tools based on local authority data.

Country level assessments provided an overview of energy poverty in the relevant administration (Gordon & Fahmy, 2008; Kelly, 2016; Parallel, 2018; Robinson *et al.,* 2018; Robinson, 2019; Newcastle University, 2019). These studies typically combined Index of Multiple deprivation, Census and EPC data (Gordon & Fahmy, 2008; Newcastle University, 2019; Robinson, 2019), or employed government fuel poverty data to map fuel poverty accordingly (Kelly, 2016; Parallel, 2018; Robinson *et al.,* 2018). An outlier of this group was "The Fuel Poverty Look-up Tool" which allows users to compare rates of fuel poverty in different areas of England at high resolution scale. Although a country level assessment, the tool provides comparative percentages rather than a visual representation of energy poverty. Generally, these assessments provided an instant "snapshot" of energy poverty in each country, where users can make regional comparisons and identify where severity is greatest. These sources have the shared disadvantage of being based on mass data which masks pockets of energy poverty (Morrison & Shortt, 2008). Another disadvantage of these tools is that their integration into policy (either national or local) was not clear.

Adaptable tools had the capacity to be refined through liaison with local authorities, providing data such as SAP values or data on poor housing (CSE, 2018; Warm Wales, 2020b). Interestingly, despite being developed in 2003 the Centre for Sustainable Energy FPI (CSE, 2018) was designed specifically to combine English national statistics with local authority data. More recently, sources which combine country level data with local knowledge are the FRESH vulnerability project (Warm Wales, 2020b), Scottish charity Changeworks (2015) and an Assessment Tool for Low Income High Costs (Eaga Charitable Trust, 2020). FRESH combines English and Welsh income data with local health and housing data. FRESH is clearly linked to policy with maps, used as an evidence base for grant applications and to implement a regional community energy programme (Warm Wales, 2020b). Changeworks produced a fuel poverty map of Scotland, also providing free local "overview" maps on request to local authorities. Detailed maps are chargeable and incorporate local authority databases, to date in depth reports have been developed for City of Edinburgh, Fife, Scottish Borders and Dumfries and Galloway (Changeworks, 2015). The Assessment Tool for Low Income High Costs allows users to apply the LIHC definition in combination with local data on vulnerability and health. The tool developers noted some discrepancies in the English Housing Survey (an LIHC input) which affected the accuracy of fuel cost calculations. The tool is freely accessible on the National Energy Action website, primarily aimed at advice agencies and researchers (Eaga Charitable Trust, 2020). Overall, these tools demonstrated a clear application in fuel poverty policy, however, their capacity to be used in regional comparisons of fuel poverty levels was less evident.

Finally, the local London Fuel Poverty Risk Indicator (Greater London Authority, 2012) combined a series of local vulnerability indicators to guide strategic targeting of high-risk wards. Basing the tool on local data facilitates the pinpointing of fuel poor households. The disadvantage of this approach is once again that comparison with other UK regions is not possible. The key advantage of the tool was its clear utility for local policy, where users could select specific indicators to identify which mitigation measures are likely to be the most impactful in a particular area.

Collectively these sources have the potential to contribute to policy in different ways such as, highlighting regional variations (Gordon & Fahmy, 2008, Kelly, 2016; McKenzie, 2018; Robinson *et al.,* 2018; Newcastle University, 2019) improving monitoring and targeting (Changeworks, 2015; CSE, 2018) or by resource prioritisation (Warm Wales, 2020b). Despite this, their integration into policy is somewhat sporadic, taken up by some local authorities but not others, demonstrating that spatial data is not central to UK fuel poverty policy.

For instance, the English 2015 Fuel Poverty Strategy identifies a policy of helping the "worst first", developing a supporting "non-gas map" and identifying "non-gas" homes as at particular risk of fuel poverty (HM GOV, 2015). Despite this, the main target of the strategy focuses on improving EPC grades, with little evidence of spatial targeting of fuel poverty in subsequent Annual Fuel Poverty Reports. Without a clear focus on spatial targeting in the central government strategy there is a risk that the use of spatial data will be applied inconsistently, depending on the interpretation of the relevant local authority, each with their own political priorities. England, however, is the only country where Governmental sources spatially representing energy poverty are identified (Parallel, 2018).

This wider strategic under-representation of spatial data is reflected in the remaining UK countries. For example, the Scottish 2018 Fuel Poverty Bill recognises increased energy demand and costs in rural areas, yet the strategy does not appear to be guided by spatial data (Scottish Government, 2019a). In Wales a revised fuel poverty strategy is due to be released in 2020, its 2010 predecessor does not draw upon spatial data, despite observing that price variations in oil and LPG prices in rural areas impacted customer vulnerability (Welsh Assembly Government, 2010). The 2011 Fuel Poverty Strategy for Northern Ireland identifies that rural dwellings are more exposed to the weather and face limited fuel choices, yet spatial data is not used to guide the strategy (Department for Communities, 2011). In the case of Wales and Scotland spatial assessments existed at the time of strategy publication (Changeworks, 2015, Gordon & Fahmy, 2008), which could have been drawn upon to support strategy design. While in Northern Ireland there is evidence that reductions in fuel poverty have been achieved as a co-benefit of other schemes such as the NISEP energy efficiency programme (Utility Regulator, 2019), rather than through spatial targeting. In fact, collectively the UK fuel poverty strategies showed a far stronger focus on energy efficiency than on spatial targeting.

Efficiency improvements are undeniably important, however these schemes, involve a trade-off between trying to reach the greatest proportion of fuel poor homes possible, while avoiding the allocation of funds to homes which are not fuel poor. Given the persistence of fuel poverty in the UK, better integration of spatial data into strategic targeting has the potential to mitigate this "coverage vs leakage" effect (Sefton, 2002). Table 5.4 presents a range of high spatial scale work including not only a broader selection of energy poverty drivers, but also showing *where* the most vulnerable are likely to be. Better integration of this data into strategic policy will progress the approach to mitigating fuel poverty (Longhurst & Hargreaves, 2019), adding depth to efficiency-based targets which to date have only gone *so far* in reducing fuel poverty (Baker *et al.,* 2018).

Overall, there are a range of impressive attempts to represent the spatial manifestation of UK energy poverty, with the potential to support fuel poverty policy and improve targeting. However, currently these sources present a "mixed bag" of results which do not allow a direct comparison of energy poverty levels between and sometimes within UK countries. For example, when comparing country scale assessments, the scales measuring the severity of energy poverty differ within and between UK countries. In England the most severe range of energy poverty observed by Robinson *et al.* (2018) was between 22%-56% (10% indicator), compared with 17%-51% (LIHC indicator). In Wales the most severe range measured by Kelly (2016) was 23%-31%, and Gordon and Fahmy (2008) between 32%-43%. The most severe ranges observed in Scotland and Northern Ireland were significantly higher, with a range of 61%-92% in Scotland (Changeworks, 2015) and 75%-95% in Northern Ireland (McKenzie, 2018). In the Scottish case this is consistent with the highest rate of energy poverty observed across the four countries. In Northern Ireland this coincides with the second lowest level of energy poverty. These differences demonstrate the discrepancies which arise from the application of different methodologies to assess energy poverty. While each method will have its benefits and drawbacks, these varied approaches make it difficult to identify where severity is greatest. Gaining a UK wide perspective on energy poverty is therefore important in ensuring that those most in need are identified and targeted.

Recent academic and NGO representations identify clear regional variations in the UK countries respectively (Gordon & Fahmy, 2008; Kelly, 2016; McKenzie, 2018; Robinson *et al.,* 2018). A number of spatial representations of energy poverty in the UK have been undertaken, yet integration of this data into government strategy is limited. Additionally, there is no study assessing energy poverty at high spatial scale resolution across the UK. While some limits occur as a result of variances in statistical data collection methods between different UK countries (e.g. Census data) (ONS, 2018a) and policy devolution (BEIS, 2018a), the sources identified are currently an under-used resource in the UK which should be better integrated into government policy. Building on these sources to create a means of assessing energy poverty at a UK-wide scale would deepen the current understanding of regional inequalities and avoid the limits of either the 10% or the LIHC definitions discussed earlier in this paper.

Table 5.4 Recent energy poverty high resolution projects in devolved UK countries

Source Name	Source type	Relevant country	Summary	Spatial scale
'Getting the measure of fuel poverty': The geography of fuel poverty indicators in England (Robinson *et al.*, 2018).	Academic	England	Aim of study was to determine how the distribution of fuel poverty using the new LIHC indicator compares to the formerly used (in England) 10% indicator	LSOA Lower Layer Super Output Area
FRESH Vulnerability Mapping (Foundation Data for Robust Energy Strategies for Housing) (Warm Wales, 2020b)	Community interest company	Wales	Community interest company which takes big data on poor health and poor income and matches with street level maps of poor housing	Street level
Mapping Fuel Poverty Across Northern Ireland (McKenzie, 2018)	Academic	Northern Ireland	Area based approach based on Census Output Areas, from 2011 Census. Data on housing was extracted from the Land and Property Services. Heating burdens calculated by accounting for winter temperatures and fuel types	Census Output Area
Estimating Percentage of Households in Fuel poverty by Data Zone in Scotland (Changeworks, 2015)	NGO	Scotland	Maps represented either at country or street level to identify areas in fuel poverty. Generated using data from the Scottish House Condition Survey and paired with 2011 Census and Energy Performance Certificate data	Data Zone
Fuel Poverty in Scotland: refining spatial resolution in the Scottish Fuel Poverty Indicator using a GIS based multiple risk index (Morrison & Shortt, 2008)	Academic	Scotland	Uses a GIS framework to integrate census data with georeferenced energy efficiency data on local housing	Census Output and individual dwelling
A Small area fuel poverty indicator for Wales (Gordon & Fahmy, 2008)	Academic	Wales	2008 report estimating number and percentage of households likely to be in fuel poverty, based on 2001 census data	MSOA Middle Lower Layer Super Output Area
Investigating a New Way of Delivery Energy to Tackle Fuel Poverty using Case Studies in Wales and Scotland (Kelly, 2016)	Academic	Wales	A Master's thesis project which uses data supplied by the Welsh Government to map fuel poverty in Wales	LSOA
Fuel Poverty Indicator (CSE, 2018)	Academic	England	Now no longer updated-aimed to efficiently identify fuel poor	English Electoral Ward

			households, designed to help meet the 2016 target	
Parallel (Parallel, 2019)	Governmental	England	Online tool which uses 2016 Government/BEIS data to create interactive fuel poverty map for England	LSOA
Mapping Energy Vulnerability in England (Newcastle University, 2019)	Academic	England	Online look up tool allowing users to look up energy vulnerability categorises four groups which lead to energy poverty, a group is identifiable for each LSOA	LSOA
Energy Poverty and Gender in England: A spatial perspective (Robinson, 2019b)	Academic	England	Academic assessment of energy poverty by gender in England	LSOA
Fuel Poverty Statistics in England – Lookup tool (HoC, 2018b)	Governmental	England	A tool which allows access to data on fuel poverty levels and rates	Constituencies, Local Authorities and Regions
Fuel Poverty Assessment Tool for Low Income High Costs (Eaga Charitable Trust, 2020)	NGO	England	Tool to help energy sector workers (both corporate and governmental) assess whether households are in fuel poverty. Aim to create a free online assessment tool.	LSOA
London Fuel Poverty Risk Indicator (Greater London Authority, 2012)	Governmental	England	Tool to guide strategic targeting of wards at high risk of fuel poverty	Wards

5.3.2. Viability of a common approach

The complex range of drivers that cause energy poverty were discussed previously in this paper. In an attempt to account for these, the works of Gouveia *et al.* (2019), Besagani *et al.* (2019), Pérez-Fargallo *et al.* (2018), and Martín-Consuegra *et al.* (2019) are used to devise a set of criteria and corresponding datasets for analysis. Based on the outputs of this analysis, the viability of assessing energy poverty across the UK is explored, by assessing the availability and variations in national data sources. An inventory of data types, indicators and sources was performed, and data availability is assessed, with a focus on collecting data at the highest spatial scale possible.

Table 5.5 outlines the Data Types and Required Inputs for the criteria identified through the works cited above. A total of 23 Required Inputs were assessed across the 7 Data Types. A full analysis of the availability of data for each criterion is provided in the Annex, Tables A.1 to A.5. Data is not available in standard “UK” datasets, instead several different country groupings are identified. Figure 5.2 shows the number of sources for each data type, date (pre and post-

2016), per country grouping, and per spatial scale. For the purposes of analysis, in Figure 5.2 spatial scales were amalgamated into three categories, small scale data (Household, Lower Layer Super Output Area (LSOA), Data Zones, and Small Areas), medium scale data (Electoral Ward, Local Council, NUTS 3, Council Area and Local Authority) and large-scale data (Regional, Sub-national, Country, National). A summary of the different spatial scales found within the sources is presented in Table 5.6. This analysis highlights that the geographic administration of the UK is complex, which is attributed to two factors, divergent administrative structures between UK countries and the fact that boundaries within hierarchical layers are subject to amends (ONS, 2018a). These complexities filter down to the relevant sources for assessment of data availability.

The majority of sources are available post-2016, with pre-2016 data found only in the Socio-economic sector, primarily Census data (2011), as shown in Table A.5. Less data was available for the G.B and U.K. groups than for the countries individually or the England and Wales group. Not unexpectedly cross referencing with Table 5 shows that a higher number of sources corresponds to those data types with more required inputs. The presence of data sources for one country grouping (i.e., for England and Wales jointly) did not mean that data would not be available for the same country in another grouping (i.e., for England and Wales separately). There is a high level of variation in the spatial scale in which data is collected and presented between devolved countries. When considering the results shown in Figure 5.2 with the Annex A tables, it is evident that most datasets are available at a high scale of spatial resolution. Generally, the most refined data is available by Lower Layer Super Output Area (LSOA) for England and Wales, (ONS, 2012), by Data Zones for Scotland (UK GOV, 2016), and by Small Areas for Northern Ireland (ONS, 2018a). These scales are consistent with those employed by recent high-resolution UK energy poverty assessments (Table 5.4). Data availability by country grouping and spatial scale is shown in Tables A1-A5 (Annex A). These tables demonstrate the differences occurring between the spatial scales at which the data is collected by the different countries.

In general there is a high level of data availability for each criterion assessed. "Energy Consumption" and "Climate Data" are the datasets with the least variation in country grouping. The Annex tables also list datasets for each data type, showing that EPC data, housing surveys and deprivation data are key data sources. The employment of housing surveys is a highly developed tool to collect data for energy poverty studies in the UK. The English Housing Survey has been widely acclaimed, generally being more regularly carried out than the housing surveys of the remaining countries (NEA, 2018a). Surveys from all countries are, however, a highly useful source for many of the criteria assessed. It should be noted that without the 2019 Welsh Housing Condition Data Survey, a number of the sources for Wales would have been outdated (as the previous survey was completed in 2008), compromising the reliability of this data.

Another key data source is the "Indexes of Multiple Deprivation", modelling for the presence of hazards such as excess cold in homes (Annex A). In most instances, these datasets supersede the data from the 2011 Census with more recent data, whilst still maintaining a high level of spatial resolution. Exceptions occur in the "Socioeconomic" sector, where in the case of Northern Ireland, datasets for "Education", "Elderly and Young People", "Housing Tenure" and "Occupancy Rate" are available at Small Area level only from the 2011 Census. This limitation also occurs for the "England and Wales" country grouping- alternative sources are available for England and Wales separately, but only at country level (except income data available at LSOA). For Scotland datasets for "Income", "Elderly" and "Young People" and "Occupancy Rate" are available at Data Zone level. Recent Scottish education data is available only at Council Area level and "Building Conservation Status" and "Tenure" are available only at Local Authority level. Further sources useful for the "Socioeconomic" section (specifically for Education and Income) are available in the U.K. grouping but these were available only at National and NUTS 3 levels.

Two other criteria which presented complications were the "Other Indicators for Benchmarking" and "Building Typology" areas, with particular reference to the sub-criteria of "Construction years" and "Social Housing". In the case of "Construction Years", data is sourced from housing surveys and it is available only at Local Authority level for Scotland, Country level for England and Wales and Council Areas for Northern Ireland. For "Social Housing", data is available at Council Area for Scotland, Local Authority for Wales, and at Country level for England and Northern Ireland. The work of Morrison and Shortt (2008) as well as the Changeworks (2015) and FRESH (Warm Wales, 2020b) projects demonstrate that high resolution data for these criteria can be obtained through liaison with local authorities. However, implementing this kind of liaison across the UK would be very resource intensive and would present challenges in terms of data protection (Martín-Consuegra *et al.,* 2018) as previously identified this would also depend on the willingness and or ability of the relevant local authority to engage. Therefore, a trade-off arises between sustaining a focus on high resolution data and the potential for scaling the index across the UK.

The theoretical datasets assessed in this analysis sought to add to depth to current approaches to energy poverty measurement in the UK. Reference to Table 5.5 and the Annex tables shows a broad range of datasets available at high resolution scale, including some which are not included in current UK energy poverty metrics. Specifically, the analysis showed the availability of data for the "Heating and Cooling" criteria and for "Education". The UK is typically associated with cold winters, however, given current climate change projections it may be prudent to consider including cooling datasets in the development of energy poverty metrics (Kovats *et al.,* 2006; BEIS, 2019b). Education is considered to impact awareness of and access to energy poverty support schemes (Gouveia *et al.,* 2019), the analysis demonstrated a range of educational datasets which could be built into future energy poverty assessments.

To summarise, data is available for each criterion evaluated, although these are not available in a consistent format but in different country groupings depending on the dataset in question. This data is generally available at a high scale of spatial resolution. Exceptions occur in the "Socioeconomic" sector where data at this level was mostly only available from the 2011 Census, raising questions about the representativeness of this data for current analysis. In the other sectors it is possible to supplement data that would otherwise have been available from the Census with Housing Condition or EPC data, with EPC data being particularly valuable given its ability to provide data about individual households. While EPCs are highly valuable sources of data, some concerns have been raised about their accuracy, where discrepancies have occurred in EPCs generated for similar building types. This has been attributed to differences in assessor expertise and the requirements of accreditation body (BEIS & MHCLG, 2018). Supplementing Census data can imply a lower level of spatial resolution.

Finally, a broad range of spatial scales are observed in the datasets investigated, these vary between countries and are not directly comparable, therefore any attempt to generate a UK wide index at high spatial scale resolution would have to develop a method to standardise these datasets. With the datasets in their current format, it would be necessary to carry out separate indexes for each country, or possibly for Scotland, Northern Ireland and then Wales and England jointly. In line with the assertions of Gouveia *et al.* (2019) when referring to the Portuguese case study, this approach would provide a barometer of vulnerability, rather than a strict street level identification of energy poverty.

Table 5.5 Data types and required inputs for an energy poverty vulnerability index

Data Type	Required inputs
1.Climate/region: (Walker & Day, 2012; Walker *et al.,* 2013; Walker *et al.*, 2014; Pérez-Fargallo *et al.,* 2018; Besagani & Borgarello, 2019; Gouveia *et al.*, 2019; Martín-Consuegra *et al.,* 2019)	1.1 Heating degree days
	1.2 Cooling degree days
	1.3 Outdoor temperature
2.Building typology: (Walker *et al.,* 2014; Chard & Walker, 2016; Pérez-Fargallo *et al.*, 2018; Besagani & Borgarello, 2019; Gouveia *et al.,* 2019; Martín-Consuegra *et al.*, 2019; Eaga Charitable Trust, 2020)	2.1. Apartment/house, no of floors
	2.2. Construction years
3.Building characteristics: (Morrison & Shortt, 2008; Hills, 2012; Walker, G., & Day, 2012; Walker *et al.*, 2013; Walker *et al.,* 2014; Chard & Walker, 2016; Pérez-Fargallo *et al.,* 2018; Besagani & Borgarello, 2019; Castaño-Rosa *et al.,* 2019b; Gouveia *et al.,* 2019; Martín-Consuegra *et al.,* 2019;)	3.1. Walls
	3.2. Pavement
	3.3. Ceiling/Roof
	3.4 Glazing
	3.5 Ventilation
4.Other indicators for benchmarking: (Healy & Clinch, 2002; Wang *et al.,* 2015; Thomson *et al.,* 2017; Pérez-Fargallo *et al.,* 2018; Besagani & Borgarello, 2019; Gouveia *et al.,* 2019; Martín-Consuegra *et al.,* 2019)	4.1. Social tariff support
	4.2. EU SILC indicators
	4.3. Social housing
	4.5 Non-conventional dwellings
5.Energy consumption: (Walker *et al.,* 2014; Pérez-Fargallo *et al.*, 2018; Besagani & Borgarello, 2019; Gouveia *et al.,* 2019; Martín-Consuegra *et al.,* 2019)	5.1. Per end use
	5.2. By region
6.Climatisation equipment: (Greater London Authority, 2012; Thomson & Snell, 2013; Middlemiss & Gillard, 2015; Wang *et al.*, 2015; Chard & Walker, 2016; Thomson et al., 2017; Pérez-Fargallo *et al.,* 2018; Besagani & Borgarello, 2019; Gouveia *et al.,* 2019; Martín-Consuegra *et al.,* 2019)	6.1. Levels of ownership
	6.2. Type
	6.3. Efficiency
7.Socio-economic data: (Morrison & Shortt, 2008; Greater London Authority, 2012; Price *et al.,* 2012; Walker, G., & Day, 2012; Walker *et al.,* 2013; Walker *et al.,* 2014, Middlemiss & Gillard, 2015; Chard & Walker, 2016; Pérez-Fargallo *et al.,* 2018; Besagani & Borgarello, 2019; Gouveia *et al.,* 2019; Martín-Consuegra *et al.,* 2019; Eaga Charitable Trust, 2020)	7.1. Educational level
	7.2. Average income
	7.3. Elderly and young people
	7.4. Conservation status of the building
	7.5. Tenure of the house
	7.6 Occupancy rate

Figure 5.2 Number of sources by UK country grouping, data source, spatial scale and date

Table 5.6 Spatial scale definitions UK administrative geographies

Spatial scale	County/ countries applies to	Definition
Household	UK	Data available at individual household level
Lower Layer Super Output Area (LSOA)	Great Britain	The average number of households within LSOAs in England and Wales on 27 March 2011 was 672 (ONS, 2018a)
Data Zone Scotland 2001/2011	Scotland	Data zones are grouped Output Areas with between 500 and 1,000 residents. Defined as the key geography for small area statistics in Scotland (UK GOV, 2016)
Small Area	Northern Ireland	Small areas were introduced after the 2001 Census to produce areas which fit into the SOAs (ONS, 2018a)
Electoral ward	UK	Spatial unit used to elect local Government for statistical purposes all of the UK is considered as having electoral wards. In 2015 the UK had 9,196 (ONS, 2018b)
Local Council	Northern Ireland	11 Local Council areas in Northern Ireland (Nidirect Government Services, 2019)
NUTS 3	All	A European statistical measure used for specific diagnoses, there are 1348 NUTS 3 regions (EC, 2019a)
Council Area	Scotland	Scotland divided into 32 Council Districts (NHS Scotland, 2018)
Local Authority	England and Wales	Local Authority may refer to; a County Council, a District Council, a London Borough Council, the Common Council of the City of London the Council of the Isles of Scilly, a Unitary Authority in Wales (NHS, 2018)
Regional	UK	Used to refer to wide areas within the UK e.g. North West, South East (ONS, 2019a)
Sub-national	England	In the datasets studied sub-national was used to refer to the North, Southeast, Rest of England.
Country	Devolved U.K. administrations	The term “Country was used to refer to datasets available for the Wales, Scotland, Northern Ireland or England separately
National	UK	The term "National" was used to categorise datasets applying to the UK as a whole

5.3.3. Value of application

Considering the preceding analysis collectively, a high spatial scale approach for the UK is broadly feasible, however, this task requires political commitment to agree on a common pathway. This approach would account for a broader range of vulnerability criteria, the need for which is identified in a range of recent sources (George *et al*., 2013; Robinson *et al*., 2018; Middlemiss *et al*., 2019; Castaño-Rosa *et al.,* 2020; Hargreaves & Middlemiss 2020). A common multidimensional approach could offer an innovative insight into the extent and depth of energy poverty across the UK where currently spatial assessments only offer a perspective on the UK countries individually. Section 5.2.1 highlighted an under-use of spatial data in UK energy poverty policy, therefore this approach also has the potential to guide resource allocation and the address of regional inequalities. A balance must be struck between mitigating the impacts of "masking" associated with index scaling (Morrison & Shortt, 2008), and the resource intensity involved with the inclusion of local data (Greater London Authority, 2012, Changeworks, 2015; Warm Wales, 2020b).

There is a growing drive for an EU approach to energy poverty which allows for inter-comparison between Member States (Thomson *et al.,* 2016). Presently, the EU is a long way from understanding the individual national drivers of energy poverty, as inter-State comparison is in its infancy and indexes are based on general, not specific drivers (OpenExp, 2019). The Openexp report identified a need to develop regional work, requiring refinement of current EU statistical collection processes. Furthermore, inconsistencies in the availability of key datasets presented a barrier for index development (OpenExp, 2019). The works of Gouveia *et al*., (2019), Martin-Consuegra *et a*l., (2019) and Besagani *et al.* (2019) at multiple scales represent a comprehensive and innovative progression for inter-country comparison but the scope of what is being addressed also varies (only factoring for the heating dimension of energy poverty, both heating and cooling, or a wider inclusion of energy services). Nevertheless, these assessments are based on centralised political systems (be they at local or national scale) as opposed to the diverse range of political systems which operate within the EU. Clearly facilitating regional inter-state comparisons within countries requires an advancement of data equivalisation methods between divergent political systems. The use of proxies could be applied in order to achieve this equivalisation.

With its devolved political nature, high level of data availability and an extensive research background, the UK could be a useful testbed for developing cohesive European energy poverty assessments. The complexities uncovered within the UK are therefore a useful insight into the transferability of energy poverty index methodologies at a European scale. The outputs of this process would feed into methodologies for scaling up indexes while accounting for a range of vulnerability indicators, facilitating knowledge transfer and policy development. This work identified that a trade-off arose between the availability of recent data and the availability of data at high spatial scale. Access to recent datasets (held by local authorities for instance) is limited by data confidentiality restrictions. While acknowledging the rationale for these restrictions, it is not possible to fully account for data availability without this information. Future work should therefore focus on contacting the relevant bodies in order to overcome this obstacle.

Another limit of this work is related to energy poverty drivers and the data sources included in the analysis. The authors citied several works highlighting the importance of including broader drivers within the assessment of energy poverty, while some of these were included in the index, emergent social drivers such as those explored by Hargreaves & Middlemiss (2020), Middlemiss *et al.* (2019), Longhurst & Hargreaves (2019) and were not. The justification for this is that there is comparatively little evidence of how these drivers influence energy poverty and policy at a greater scale, future work should consider how these drivers could be integrated into a quantitative index.

5.4. Conclusions and Policy Implications

This assessment investigated the potential of producing a multidimensional high-resolution spatial scale energy poverty index for the UK case study. Findings demonstrate that, while from both a perspective of value and viability this approach is broadly feasible, some key datasets were not collected regularly, with implications for the representativeness of the results. In some cases, this data could be supplemented, but this generally implied a reduced level of spatial resolution.

The complexity of the UK administrative system also presented several key challenges. Firstly, the necessary datasets for input into an index are not available at a consistent level of spatial resolution. Secondly, the collection of these datasets is not uniform across the devolved countries, showing variations in the countries which these datasets refer to. These issues, whilst not insurmountable, would have to be carefully considered in the analysis conducted. Perhaps most critically, this analysis demonstrates that although a series of efforts have been made to assess energy poverty within the individual UK countries, these have not been used to gain an overall perspective of UK energy poverty. Although high spatial scale assessment of energy poverty is becoming increasingly refined, in the UK, a country which has made consistent efforts to tackle energy poverty, its potential for supporting policy has not been fully explored.

The value of a high-resolution spatial scale multidimensional approach is the opportunity to apply a common UK standard, highlighting inequalities and introducing consistent monitoring. The current UK policy approach to energy poverty is fragmented, making accurate inter-country comparisons difficult. Decision making is not based on a sound understanding of how energy poverty manifests across the UK but is instead based on how the issue manifests in the separate countries. This inconsistent overview of energy poverty risks decisions being based on information which is misrepresentative. Future UK policy must therefore be informed by measures which are inter-comparable between the devolved countries, highlighting the importance of developing appropriate methodologies, such as the approach discussed in this paper.

Additional research is needed into how UK policy administration and levels of energy poverty are linked. Levels of energy poverty in England are lowest - this coincides with more regular energy poverty reporting. Hence, the English administrative approach may have useful insights for the remaining UK countries. Key UK energy poverty policy recommendations are listed below:

1. Use existing data to guide the "help the worst first strategy". Comparative statistics demonstrated that levels of energy poverty were greatest outside England. Several existing studies identified the areas in each country where energy poverty was most severe, yet there is little evidence of how this data is being applied in UK energy poverty policy.

2. Standardise assessment of energy poverty policy across the UK countries. This would require all four countries to have similar legal obligations in terms of energy poverty and conducting key activities such as Housing Conditions Surveys with the same regularity in each UK country.

3. Increase data availability for energy poverty assessment. Some datasets were not available at the requisite scale for analysis, such data would be held by local Councils, obtaining this data would be resource intensive and potentially limited by data protection. Strategies need to be devised for the release of this data without compromising confidentiality.

4. Reliable and accessible EPC data. Given the importance of EPCs to this kind of analysis, it is critical that EPC data is of a standard high quality.

5. Broaden the range of criteria and scope used to assess energy poverty. Recent academic discourse has highlighted the importance of diversifying the range of indicators used to assess energy poverty and including space cooling vulnerability.

The UK has been at the forefront of addressing energy poverty in the past and remains highly advanced in this field, with a unique range of Governmental policy targeted specifically at this condition. Despite this advanced status of policy response, the impacts of the UK's exit from the European Union present a series of uncertainties for future manifestations of UK energy poverty, some with specific relevance to this evaluation. The identified dataset for "Heating and Cooling Degree Days" was part of an EU database, and several SILC data were unavailable for the UK for 2018, presumably as a result of the UK's impending exit. Furthermore, while EPC data is collected within the UK, the implementation of EPCs was a result of wider EU legislation. Should similar legislation be implemented in the future, the UK will not be a participant and therefore risks stagnation within the field. Finally, the potential for Member State knowledge transfer has been highlighted as critical to the resolution of energy poverty. The upcoming "looser" relationship between the UK and the EU signifies that the UK is less likely to participate in EU wide energy poverty discourse, representing not only a loss to the remaining EU 27, but also to the UK.

Notwithstanding this complication, the UK is a useful case study for the development of energy poverty policy given the comparative maturity of UK policies within a European context. By assessing the viability of a high-resolution multi-dimensional approach to energy poverty in the UK, this analysis proved to be insightful from a more general perspective regarding the transferability of energy poverty assessments. Political unity is necessary in UK energy poverty mitigation for the creation of comparable datasets as well as consistent measures and policies. The root of the current varied status of UK energy poverty lies within the policy response to the issue. Nationally devolved policy has led to the devolution of energy poverty policy, with the result that energy poverty is not measured in a consistent way across the country. While there is a call within European debate to reflect individual national characteristics in the assessment of energy poverty, this analysis raises questions about the extent to which separate policies can impact energy poverty levels.

The outputs of this process show that common approaches will have to be suitably flexible to allow for the specifics of each Member State in order to be both accurate and informative. They will also need to be scalable for comparison purposes. Nations at a developmental stage of energy poverty policy should therefore take care that assessment methods allow for transparent comparisons between different regions of the same country, facilitating the logical distribution of resource. This could be particularly relevant for nations such as Germany where federal states have a high level of authority. Further policy development could then focus on creating common datasets to allow for inter-European comparison, both at the regional and national level. This would allow knowledge transfer and potentially reduce the timeframes involved in mitigating energy poverty. The challenges encountered in this analysis are consistent with the challenges which apply to creating common European methods for assessing energy poverty at a regional scale.

5.5. References

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Chapter 6 | Clean, Green and the Unseen: The CompeSA Framework | Assessing Competing Sustainability Agendas in Carbon Neutrality Policy Pathways

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Abstract

Competing agendas are common within the sustainability field, given its complex and diverse social, economic, and environmental priorities. They can cause less effective policy results, where multiple goals can result in trade-offs and policy compromises. This paper proposes a conceptual framework: CompeSA – Assessing Competing Sustainability Agendas in Carbon Neutrality Policy Pathways. This framework enables the exploration of competing sustainability agendas arising from the simultaneous implementation of climate change, energy transitions, and energy poverty agendas. CompeSA is built on three key steps, 1) The WHAT, aiming to define the scope, 2) The WHERE, to understand the scales at which corresponding policy impacts apply; and 3) the WHO, for deep characterization and analysis of the key stakeholder groups. We base the development and application of the framework in Portugal, a test case strongly engaged with the carbon neutrality agenda, to illustrate important dilemmas over policy mixes and unpack emerging synergies and barriers. Identified synergies include the linked concepts of economic recovery and employment opportunities, mainly through renewable energy expansion, enhanced economic competitiveness, and skilled job creation. Improvements in air quality and the built environment contribute to health benefits. The most significant barriers are inequitable benefit allocation and power imbalances between the energy-poor and agenda-setting actors. Our demonstration shows CompeSA to be a helpful support tool for structured analysis of competing sustainability agendas and pinpoints key critical points that determine the effectiveness of sustainability policies.

Keywords

Just transitions; Climate Mitigation; Inequity; Competing Agendas; Energy Poverty

6.1. Introduction

Following the 2015 Paris Agreement and actions to meet the corresponding climate change targets, global signatories have been challenged to implement a series of policy packages simultaneously. The European Union (EU) positions itself at the "forefront of international efforts to fight climate change" (EC, 2021a), committing to deep decarbonisation targets by 2050 with a net-zero greenhouse gas emissions economy. Critically, decarbonisation requires an energy transition strategy, shifting Member States from fossil fuel to renewable-based economies (EC, 2018). Among the EU's key aims is "making the transition just and inclusive for all" (EC, 2019), yet it is uncertain how energy transitions will impact social justice and equity (Roberts *et al.,* 2020). Central to this debate is energy poverty (EP), a condition where householders are unable to access a level of energy services adequate for basic daily needs such as space heating and cooling and powering appliances (Thomson & Bouzarovski*,* 2018).

Political engagement with energy poverty (or fuel poverty) began in the 1990s in the UK and Ireland (Koh *et al.*, 2012). In European policy, however, acknowledgement of energy poverty has been comparatively recent (Schliech., 2019; Vondung *et al.*, 2019). Mitigating EP is a challenging task, partly because of its multidimensionality (caused and/or exacerbated by numerous factors). These factors were traditionally recognised as a combination of low income, poor energy efficiency, and high energy prices; it is on this basis that Brenda Boardman's first official definition of fuel poverty arose (the 10% indicator) (Boardman, 1991). The debate has since evolved, with numerous sources identifying additional factors contributing to EP. These include long-term illness or disability, unemployment, education, gender, and housing tenure (George *et al.*, 2013; Snell *et al.,* 2015; Clancy *et al.*, 2017; Stojilovska *et al.,* 2022). EP also varies geographically, with different vulnerabilities applying in rural versus urban areas (Roberts *et al.*, 2015; Sanchez-Guevara *et al.*, 2019). These geographical differences also apply at the European scale, with EP generally reduced in Northern and Central states and higher in Southern and Eastern states (Bouzarovski & Tirado Herrero, 2017).

With 6.1% of households in the EU27 having arrears on utility bills and 7.0% unable to keep their homes adequately warm in 2019, the scale of the EP problem is significant (Eurostat, 2021a, b). The alleviation of EP requires access to an adequate level of energy services, implying the need to increase domestic energy use in cases of underconsumption and/or low ownership rates of climatization equipment (Gouveia *et al.*, 2019). In 2019, the EU residential sector accounted for 26.3 % of final energy consumption; at 63.6% of final energy consumption, heating is the primary energy use in the European domestic sector, most of which (32.1 %) is sourced from natural gas (Eurostat, 2021c). European policy thus faces a considerable challenge: implementing climate change and energy transition strategies that do not compromise citizens' ability to access the required level of energy services. With the emergence of the War in Ukraine, additional European and national policy institutions alike are under heightened pressure to deliver affordable energy without reneging on international environmental commitments.

Despite some conflicts of interest, many key measures inherent to the success of energy transitions are also essential in mitigating energy poverty, including improved energy efficiency and the increased uptake of renewables. Thus, the energy transition and energy poverty agendas are strongly interlinked and can neither be labelled fully synergistic nor entirely divergent.

To tackle the complex mix of social, environmental, and economic goals inherent to sustainability agendas (Smith *et al.*, 2020; Mastini *et al.*, 2021) and policy mixes (Lehmann, 2012), previous authors have applied systematic frameworks. Researchers in the field of ecosystem services have demonstrated the utility of frameworks in optimizing community development in protected areas (Zhang *et al.*, 2020) and in elaborating multiple views, diverse system values, and points of controversy (Lopes *et al.,* 2019). Frameworks have also been applied to sustainable construction, where environmental and economic aspects have been the focus at the cost of social considerations, impacting building project legitimacy and future funding opportunities (Fatourehchi *et al.*, 2020).

We argue that these tools are highly beneficial in their capacity to evaluate the diverse goals and wide range of stakeholder values in sustainability agendas but tend to be highly context-specific, resulting in numerous siloed sustainability frameworks that are not easily transferable. We aim to address this gap by developing the CompeSA framework, an analytical tool for the evaluation of complex processes which imply simultaneous delivery of several potentially competing goals and collaboration between a wide range of actors. Thus, CompeSA is a tool aimed at high relevance for policy analysis processes and to shape legislative change. The framework was developed following a review of sustainable energy challenges in the contemporary European context, recognizing the need for tools that evaluate multiple (and sometimes competing) policy agendas. Our deliberate focus on process evaluation in the design of CompeSA makes it a highly adaptive tool for similar instances of competing agendas across the field of sustainability.

We apply our framework to the climate change (CC), energy transition (ET), and energy poverty (EP) agendas in Portugal. Portugal was chosen because it juxtaposes impressive progress with the energy transition against a high incidence of EP (OpenEXP, 2019). Thus, it illustrates that the energy transition is not *prima facie* synonymous with energy poverty alleviation. Our research aim is to assess the interactions of these three policy agendas and, in so doing, to explore key areas of synergy and competition.

We apply this novel conceptual framework to assess competing sustainability agendas by addressing three questions:

i) What topics do the agendas define and address? (Literature review and policy analysis)
ii) Where are these topics managed (nationally, regionally, or locally)? (Policy scale analysis)
iii) Who makes decisions, and who bears their impact across policy topics? (Stakeholder analysis)

This paper is organized as follows: Section 6.2 reviews the interplay between the distinct yet overlapping policy agendas. A European perspective is complemented by a focused appraisal of Southern European energy policies. Section 6.3 outlines the Portuguese case study and methodological approach. The Results and Discussion for each step in the CompeSA framework are provided in Section 6.4, and Section 6.5 concludes.

6.2. Climate change, the Energy Transition and Energy Poverty in Europe

6.2.1. Synergies & trade-offs in sustainability agendas

From large hydroelectric dams driving habitat loss and fragmentation (Moran *et al.*, 2018; Chen *et al.,* 2019) to bioenergy with carbon capture and storage (BECCS) systems causing an increased risk of desertification (Creutzig *et al.,* 2021), many solutions to CC entail trade-offs. In the energy sector, an important trade-off is the solar energy roll-out and competing land uses such as food production (van de Ven *et al.,* 2021), a similar trade-off applies between wind energy and biodiversity concerns (Vasstrøm & Lysgård, 2021). Solar panels and electric vehicles rely on the extraction of minerals, which can cause soil contamination and the displacement of indigenous communities (UNCTAD, 2020). Mineral extraction also requires substantial resources in terms of water and energy input and thus has associated greenhouse gas emissions (Corneau, 2018).

Since the 1990s, the EU has aimed to ensure a secure, competitively priced energy supply without compromising environmental targets (Palinkas, 1998). This has proved challenging, and while efforts to meet emission reduction targets have advanced decarbonisation (EC, 2021b), EU policy has simultaneously recognised several socio-economic issues entrenched in a traditional fossil-fuel-based energy supply. Specifically, EU policy recognises inherent structural inefficiencies where the energy system is based on a centralised supply-side model rather than energy demand management

(COM/2015/ 80 final). There are also numerous barriers within energy markets despite the relatively mature status of liberalization, including a disproportionate competitive advantage for large and established energy companies (Lewis *et al.*, 2021). Uncoordinated national policies are further problematic, resulting in "energy islands" where poor connections of energy infrastructure between neighbouring countries or regions push up energy costs for consumers (COM/2015/ 80 final).

Notably, while many consumers struggle to reach threshold levels of comfort recommended by health bodies (Palma *et al.*, 2019), others are defined as being in "fuel obesity" (Gouveia *et al.*, 2018). Lower levels of economic development correlate with a decreased ability to keep the home adequately warm in the EU member states (Tsemekidi-Tzeiranaki *et al.*, 2018). Furthermore, a recent study highlights that European emissions reductions can be mainly attributed to lower- and middle-income groups (Gore & Alestig, 2020). Oswald *et al.* (2020) call specifically on wealthy consumers to reduce "excess consumption". These findings bring the concepts of "fairness" and "equity" into view, emphasising the question of who should and should not be obligated to reduce domestic energy consumption as well as the structural modalities required to implement such normative goals.

The EU has engaged with this range of challenges when launching several policies, including the Clean Energy for All Europeans Package. These policies feed into and support one another and present an intricate mix of instruments, including Directives, non-legislative Initiatives, and Regulations. This bundle of strategies could, in this sense, be labelled a policy mix (Rogge and Reichardt, 2016). In other words, as Lehmann (2012, pg. 71) puts it with reference to pollution, "Polluting sources may be affected directly or indirectly by several policies addressing the same pollution problem." Thus, the delivery of synergistic CC, ET, and EP strategies is subject to multiple policy influences. While it could be argued that the simultaneous pursuit of these three agendas is a transcendent goal across these various policy initiatives, these multiple influences can (as elaborated above) result in trade-off situations. Given this, a profound understanding of policy interaction is essential to maximise synergies and mitigate trade-offs (Cunningham *et al.*, 2013).

Previous authors have demonstrated the value of frameworks in assessing sustainability challenges, including social sustainability aspects (Fatourehchi *et al.,* 2020), the articulation of stakeholder values with a view to informing decision-making (Lopes *et al.,* 2019), and in the area of policy mixes itself, with Rogge & Reichardt (2016) applying an analytical framework to assess combinations of various policy instruments in sustainability transitions. Building on these resources, we develop a conceptual framework to evaluate the barriers and synergies across different energy policy-related agendas, which have a proclivity to compete but must be synergistic to meet holistic and long-lasting sustainability targets. We develop a framework that is easily adaptable to other instances of competing sustainability agendas, (as existing works tend to be quite context-specific). We also balance qualitative techniques – most appropriate for evaluating the relatively intangible concept of policy interaction – with quantitative techniques, which facilitate a clear and concise overview of stakeholder profiles.

6.2.2. CC, ET, and EP perspectives in Southern Europe

The latest IPCC report highlights that CC-induced changes have increased the likelihood of Southern European wildfires in the last century (IPCC, 2021). This is compounded by the devasting fires of the summer of 2022. Future projections include increased droughts (IPCC, 2021) and heat waves (Parente *et al.,* 2018). CC impacts in European cities may be exacerbated due to the "urban heat island" effect (Oliveira *et al.,* 2022). In the immediate future, heat waves in urban areas of the Mediterranean may increase mortality by 21.8% (Smid *et al.,* 2019).

The above illustrates the urgency of implementing CC mitigation solutions that address the built environment, thermal comfort, and, correspondingly, EP. The specific manifestation of EP varies depending on the national or regional context (Maxim *et al.,* 2017). Supra-national Southern European regions, however, share several characteristics linked with increased vulnerability to EP. These include poor building quality, high energy prices, low incomes, the underconsumption of energy, and low rates of climatization equipment ownership (Antepara *et al.,* 2020). Southern European countries experience comparatively short and mild winters, yet both (Healy, 2003) and (Fowler *et al.,* 2014) demonstrate an elevated rate of Excess Winter Deaths (EWDs) in these regions. Fowler's (2014) more recent analysis shows that Cyprus, Malta, Portugal, and Spain have an EWD rate above the EU average.

A trend of resignation to poor thermal comfort conditions has been observed in Southern European regions, with vulnerable consumers exhibiting limited capacity to improve their circumstances (Horta *et al.,* 2019). This is attested in the work of Santamouris *et al.* (2014), who show a correlation between higher average annual incomes and increased total energy consumption for heating in Athens. Omic *et al.* (2019) highlight the severity of EP in Southern European regions and demonstrate that high rates of EP correlate strongly with increased rates of income poverty, food poverty, and poor health. From an ethical perspective, these issues warrant prompt attention and emphases on equity and justice in CC and ET agendas (e.g., the European Green Deal) and correspondingly increase the pressure for political bodies to address these marked regional vulnerabilities (COM/2019/ 175 final).

The EU addresses these imbalances in customised ET implementation (EC, 2018). Each Member State is responsible for implementing its own ET, implying a series of individual transitions guided by a broader orientation established at the European scale. With considerable renewable resource (mainly solar) capacity installation underway and planned, transitions in Southern Europe offer significant opportunities, including economic development and skilled job creation (Deloitte, 2015; Sareen, 2020). Renewables also provide an alternative path to the traditional link between economic growth and increased CO_2 emissions, which policymakers have long struggled to overcome (Omri *et al.,* 2021), and green growth scholars have termed decoupling.

In practice, transitions imply a series of synergies and trade-offs for Southern European citizens. For instance, in the ET in Greece, expenditure on technical equipment pushed up electricity end-use costs, diminishing public appetite for the process (Nikas *et al.,* 2020). In contrast, in Sardinia, the ET offers regional development, welfare, and employment in a low-income Italian region with high unemployment rates (Osti, 2018). Gaining a situated understanding of the synergies and trade-offs that arise as transitions advance in various contexts is essential to inform national policy and avoid compromising the integrity of European energy transitions while integrating the most vulnerable consumers.

6.3. Case Background and Methodology

This section provides a summary of background details for the case study of CC, ET, and EP agendas targeting a Southwestern EU Country, Portugal. It includes an overview of methods and then presents the conceptual CompeSA framework applied in Section 6.4 (Results and Discussion).

We apply the CompeSA framework to explore the simultaneous implementation of the CC, ET, and EP agendas in the Portuguese case. The framework combines three key steps to evaluate The WHAT (literature review and policy analysis), the WHERE (policy scale analysis), and the WHO (stakeholder analysis). These broadly adaptive steps provide policy insights and valuable feedback on the current Portuguese approach to these agendas (informative for policy design and legislation change). These analytical steps were designed to evaluate policy processes and are thus applicable in similar instances of competing sustainability agendas. Our framework extends the desk-based approach previously applied in policy analysis by Tom *et al.,* (2015) to assess the policy management scale and inform stakeholder analysis. Key materials include national policy documents related to the research questions, collaboration based on complementary expertise amongst authors, and web-based research to develop the stakeholder list (Tsang *et al.,* 2021).

6.3.1. Portugal as a case study

Portugal has engaged strongly with the CC agenda in the release of the 2050 Roadmap for Carbon Neutrality (APA, 2019a) and 2030 National Energy and Climate Plan (APA, 2019b). In fact, Portugal was one of the first countries in the world to set a carbon neutrality goal for 2050 (IEA, 2021). Despite significant economic setbacks resulting from the global Covid-19 pandemic, the country has retained focus on its climate goals and combined efforts for economic recovery with energy transition strategies. Examples include the fast-tracking of permissions for utility-scale solar photovoltaic grid connections and the introduction of financial support for building efficiency measures (IEA, 2021).

Despite these encouraging policies, a closer examination of the Portuguese case reveals a contrast between solid progress in implementing the ET with a somewhat undesirable "lived experience" (Middlemiss *et al*., 2015) for many Portuguese families. Ranking fourth in Europe for the share of electricity generated from renewables (Eurostat, 2020), Portugal has benefited from the ET through both increased employment opportunities (Deloitte, 2019) and greater energy independence (Silva, 2012). Portugal's newfound zeal for CC mitigation, adaptation, and ET agendas marks a turnaround after weak engagement with the Kyoto protocol and a view that renewable energy was a burden for taxpayers (Carvalho *et al*., 2013; Sareen & Wolf, 2021). The timescales of these changes are well illustrated in a snapshot of the Portuguese energy profile over time, where in the year 2000, petrol accounted for 61.4% of total primary energy consumption, coal for 15%, natural gas for 8.1%, renewables for 14.7% and "others" for 0.7%. Comparatively, in 2020 petrol accounted for 40.9% of total primary energy consumption, coal for 2.7%, natural gas for 25%, renewables for 29.9% and "others" for 1.5% (DGEG, 2022).

Conversely, low incomes and a highly inefficient building stock contribute to low rates of climatization equipment ownership and a worrying trend of under consumption (Gouveia *et al.,* 2019). In the first half of 2021, gas prices in Portugal were the 3rd highest in Europe (Eurostat, 2021d), and electricity costs were the 8th highest in Europe; however, the proportion of taxes and levies paid on electricity were the 3rd highest in Europe (Eurostat, 2021e). The juxtaposition of progress with the ET and high energy costs shows a lack of consistency between the strategies for the different agendas and a traditionally greater focus on implementing the ET than mitigating EP, the latter being relatively new on the political agenda.

Historically, vulnerable consumers have been supported through the social tariff, a financial instrument awarded to social benefits recipients or low-income groups (EPOV, 2020). In line with European requirements, Portugal has now begun to address EP, starting with weak references to the topic in its 2050 Roadmap for Carbon Neutrality (APA, 2019a), and offering more detail in its 2030 National Energy and Climate Plan (NECP) 2030, (APA, 2019b). These are supported by mitigation policies elaborated in the Long-Term Strategy for the Renovation of Buildings (República Portuguesa, 2020) and a definitive action plan provided in the draft version of the Long-Term Strategy for Mitigating Energy Poverty (DGEG, 2021).

Aside from touching on the EP agenda, highlights of the 2050 roadmap include plans to source 100% of electricity generation from renewable energy sources by 2050 and the closure of the two existing coal plants by the end of 2021. Emissions from the energy system are projected to decrease by 60% by 2030 and 90% by 2050 against a 2005 baseline (APA, 2019a). Collectively, the 2050 Roadmap and NECP policies present a highly ambitious Portuguese decarbonisation strategy. While policies for tackling EP show strong consistency with instructions from the EU (Neto Bessa, 2021), the timelines for complementary policy action are somewhat latent, with the intensification of the decarbonisation of buildings planned between 2030-2040. This deadline contrasts uneasily with the severity of the Portuguese EP situation.

Key measures elaborated in the Long-Term Strategy for the Renovation of Buildings include major renovation of the building stock and updating domestic appliances to A+++ models. The Long-Term Strategy for Mitigating Energy Poverty is currently awaiting publication after a public consultation period in 2021 (DGEG, 2021). These are the first policy documents to deal specifically with the issue of EP in Portugal and clearly demonstrate intent to address EP in conjunction with CC and ET policies.

The Portuguese approach focuses on the potential of improved building efficiency to simultaneously alleviate EP and reduce emissions from the building sector, complemented by the acceleration of an increasingly decarbonised electricity grid, the emergence of green hydrogen, and decarbonisation of major sectors such as transport. Our focus here is on building energy efficiency and other aspects related to household energy consumption and, thus EP outcomes. Indeed, emerging scholarship highlights access to and affordability of efficiency measures and the need to increase energy consumption among the vulnerable as potential trade-offs in the Portuguese ET (Gouveia *et al.,* 2019). Scholars also emphasise the potential for economic growth, low-carbon jobs, and strengthened public finances (Seixas *et al.,* 2015; Pereira *et al.*, 2016). As we explain next, the CompeSA framework applied in this paper analyses these synergies and trade-offs between the different agendas in Portugal.

6.3.2. The CompeSA Conceptual Framework

To understand the impacts and interconnections of different policies addressing linked but potentially competing agendas, we developed a conceptual framework that integrates three key steps. Figure 6.1 presents the main steps, the questions that the CompeSA framework helps address, and its application to the test case. Step 1 (the literature review and policy analysis) identifies the main topics that affect competing sustainability agendas, where key resources are identified through collaboration within the authors team. Step 2 undertakes a policy scale assessment using a matrix to indicate the scales at which these topics are managed. Step 3 (the stakeholder analysis) complements an iterative approach to stakeholder identification with a quantitative ranking of stakeholder groups to assess the relative interests and influences of these groups. For each of the three steps, the conceptual CompeSA framework suggests different methods, tools, and approaches to implement and their linkages (Figure 6.1). We consider the framework to be a policy-relevant tool, useful for analysts, the provision of policy insights, and the shaping of legislation.

These three steps can be broadly applied to evaluate competing sustainability agendas in multiple instances and at various scales. We show the steps that can be used for sustainability agendas on the left side of Figure 6.1 and show the CompeSA framework as applied to our selected test case on the right. The three steps are explained, subsequently drawing on Portugal's EP, ET, and CC agendas. To undertake this analysis, we conducted a desk-based study of relevant policies as elaborated below, complemented by significant experience with the Portuguese energy policy context within the author team.

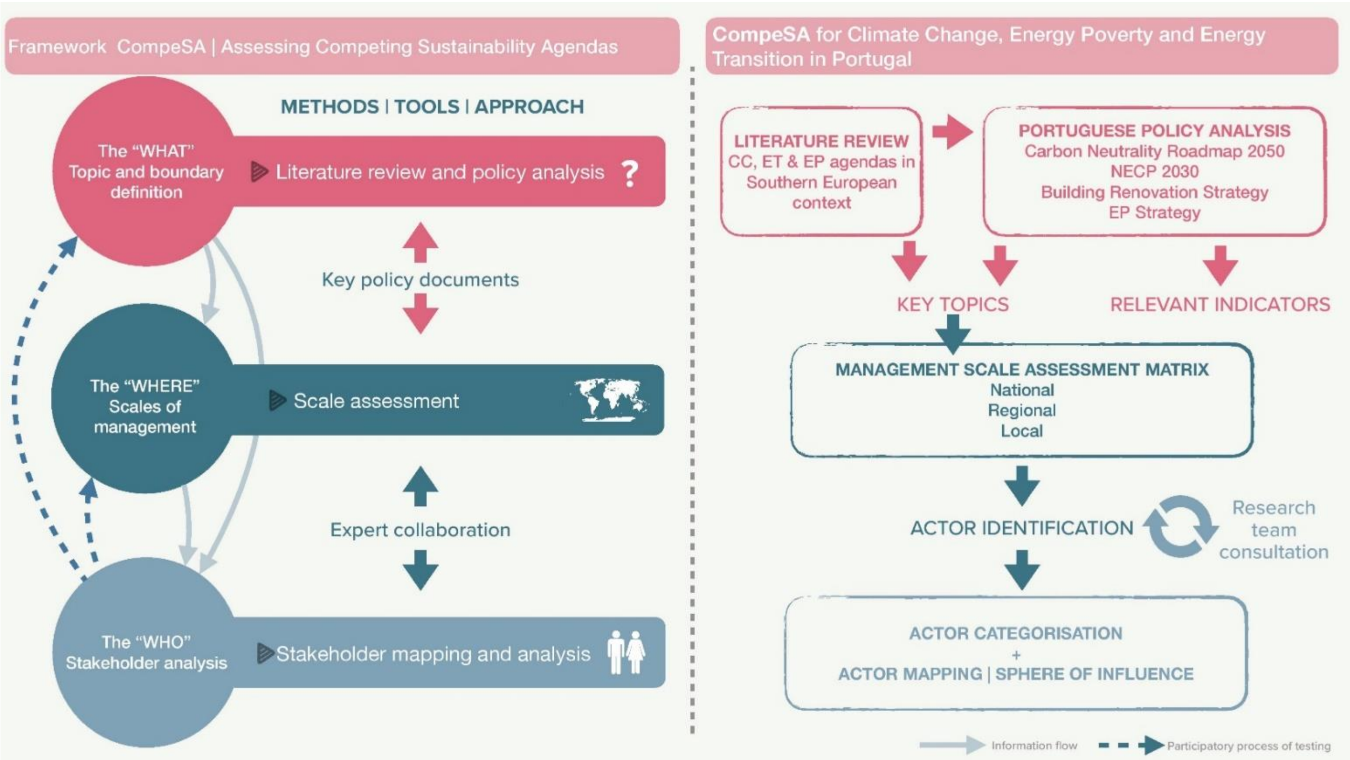

Figure 6.1 CompeSA | Assessing competing sustainability agendas conceptual framework (graphic created by the authors)

Step 1: The 'what' – Topic and boundary definition

Competing sustainability agendas generally have a broad scope that is difficult to refine (Van Bueren *et al.,* 2007). Thus, the process should start by defining boundaries and the main topics of focus for the analysis. Our CompeSA framework refines key topics by combining a literature review and policy analysis. Drawing on the authors' knowledge, we combine key literature on CC and ET strategies with contemporary sources on EP and relevant justice and equity issues. The literature review provides background, context and identifies key policy documents; the second purpose of the policy analysis is to identify monitoring indicators for specific topics presented in the policy documents (Buchmayr *et al.*, 2021).

In the test case, we focus on topics that intersect the CC, ET, and EP agendas. First, the key topics related to the agendas in the Southern European context are identified through the literature review (Araújo *et al.*, 2020; Mengist *et al.*, 2020). The relevance of these topics to the case study is then verified through a policy analysis (Runhaar *et al.,* 2006) of the following Portuguese documents; NECP (APA, 2019b), National Decarbonisation Roadmap 2050 (APA, 2019a), Long Term Strategy for the Renovation of Buildings (República Portuguesa, 2020), and the Public Consultation on the Long-Term Strategy for Mitigating Energy Poverty (DGEG, 2021). This analysis aims to identify the agendas to which each topic is linked from a policy perspective. To conclude this step, we identify monitoring indicators for each topic.

Step 2: The 'where' – Scales of management

After defining the boundaries, an assessment of scale should be conducted to establish if the selected topics in step 1 are managed nationally, regionally, or locally (the management scale). To home in on the policy synergies and barriers between the CC, ET, and EP agendas, only those topics identified across all four policy documents were carried forward to this step. Examples include "Energy efficiency upgrades" and "Just/ Citizen-led transition." Each topic and corresponding indicators were searched in the policy documents. These searches were used to classify the management scale of the topics in the test case (Orenstein *et al.,* 2017). The value of this approach is its capacity to foreground gaps in the policy response, for example, by highlighting the lack of a national management strategy for a topic with national implications. This approach also contributes to the actor identification that feeds into the stakeholder analysis below.

Step 3: The 'who' – Stakeholder analysis

The third step aims to identify and analyse key stakeholders that influence and are affected by the identified topics at different scales. Stakeholder analysis has previously been used to characterize the actors in the energy system (e.g., Avella, 2018), but is an underused resource in the context of EP. A two-stage process is employed to conduct the stakeholder analysis, firstly:

a) **Mapping identification analysis**- Building of a stakeholder list through literature review, web-based research and policy and management scale analysis processes applied in steps 1 and 2. This list is then developed through collaboration within the research team (as in Reed *et al.*, 2009; Videira *et al.,* 2012). Groups for inclusion are those affecting/affected by the EP agenda in the context of the Portuguese energy transition. Stakeholders are categorised according to the type and scale of operations. It should be noted that this is an iterative process which is continually refined throughout the steps described (Reed *et al.*, 2009).

b) **Mapping process-** Use of weighted criteria to rank stakeholders adapted from Carissimi *et al.* (2014); Krupa, (2016); Padur *et al.*, (2017). Categorisation of groups as Core, Direct or Indirect. Stakeholders are ranked according to "traditional pillars" of EP; energy price, energy efficiency and income (Boardman, 1991). An extra point is allocated if a stakeholder influenced another topic(s) linked to EP, as identified in Table 6.1. Only a single point is added in these cases because there is not yet sufficient evidence to establish the relative weight of these topics; furthermore, comparing the relative importance of each topic is outside the scope of this paper. Stakeholders are then mapped using a sphere of influence diagram (Clark *et al.,* 2017). Based on these results, a round of interactions with these identified stakeholders should be conducted to test and validate the obtained outcomes regarding the "what" and the "where" steps.

Table 6.1 Stakeholder scoring system

Score 0-3	Stakeholder Type
1= Influences one pillar or another topic/s	Indirect stakeholder
2= Influences two pillars or one pillar & topic/s	Direct stakeholder
3= Influences three pillars or two pillars & topic/s	Core stakeholder

6.4. Results and Discussion

6.4.1. The What – Links and disassociations between climate change, energy transitions, and energy poverty agendas

The results of the Literature Review and Policy Analysis are presented in Table 6.2 and allow the identification of the topics that bridge social, environmental, and economic sectors, providing a valuable testbed for analysing competing sustainability agendas through the framework (Buchmayr *et al.,* 2021). The review revealed that Portugal shares common Southern European causes and impacts of EP, such as low incomes and poor thermal comfort, yet differs from its Southern European neighbours in its comparatively good performance in implementing the ET (IEA, 2016; IEA, 2021). Currently, Portugal ranks higher than Spain, Italy, Greece, Cyprus, and Malta in both the overall share of final energy from renewables and the share of electricity produced from renewables (Eurostat, 2020).

The topics which were consistently linked to all three agendas across the policy documents were "Building retrofit & Zero Energy Buildings," "Energy efficiency upgrades", and "Uptake of renewables". These three topics were consistently at the centre of the Portuguese strategy to realize the ET and to mitigate EP. "Decentralization/ Renewable energy communities" and "Just/ Citizen-led transition" were also topics that were strongly linked with ET and EP, they were also interlinked with one another, where decentralization was considered synonymous with citizen participation in the ET (APA, 2019b).

"Underconsumption & climatization equipment ownership" was only explicitly referred to in the Long-Term Strategy for the Renovation of Buildings (República Portuguesa, 2020) regarding the potential of Nearly Zero Energy Buildings to facilitate energy consumption increases. Both the Long-Term Strategy for the Renovation of Buildings and the draft version of the EP strategy promote methods such as insulation which increase thermal comfort without increasing energy consumption (República Portuguesa, 2020; DGEG, 2021). Despite the raising of valid concerns in the Long-Term Strategy for the Renovation of Buildings regarding the "rebound effect" (República Portuguesa, 2020), evidence suggests that to bridge the existing buildings energy performance gap and for "under-consumers" to meet recommended temperature thresholds, an 11-fold increase in energy consumption for space heating and a 24-fold increase in consumption for space cooling would be necessary. Based on the current technology portfolio, these increases could represent an extra 8.8 Mt CO_2 for space heating and 1.7 Mt CO_2 for space cooling (Gouveia *et al.*, 2019). This limited accounting for underconsumption, and equipment ownership is reflective of a broader general focus on technology in transitions and a comparatively reduced understanding of the groups who must undergo the transition (Selvakkumaran *et al.*, 2021).

Arguably "climatization equipment ownership" is partially addressed by energy efficiency upgrades and building retrofit targets, for example, in the installation of equipment such as heat pumps (APA, 2019a). Energy efficiency upgrades imply costs that will vary depending on the quality of the building and the requirements of the inhabitants (Middlemiss *et al.,* 2019). Generally, it is likely that the more vulnerable a person is, the more significant their energy requirements are (Roberts *et al.*, 2020). Less affluent groups are more likely to live in degraded buildings and have a higher exposure to environmental risks (Braubach *et al*., 2009). Portuguese policy partially addresses these issues through financial support schemes towards energy efficiency upgrades. Existing and previous schemes require residents to pay for the upgrades upfront and to claim back the costs retrospectively (Casa Eficiente, 2018; Gabinete do Ministro, 2021). These initiatives link clearly with CC and ET objectives and directly tackle energy efficiency targets, but they are unlikely to be accessible to those in energy poverty. More recently, the EP Strategy set the background to address this problem by offering vouchers established in the "Vale Eficiência" program, a potentially positive step towards mitigating EP (DGEG, 2021).

The timelines involved in the implementation of building retrofit and energy efficiency upgrades are somewhat fluid at present (DGEG, 2021). Still, the dimension of the problem is significantly greater than the currently available and foreseen funding (Palma *et al.,* 2021). Given that the Portuguese response to EP is still developmental, this is to be expected to some degree. Going forward, however, it is critical to set clear objectives against measurable timelines. The complex nature of EP means that it can have a dynamic nature, with households moving in and out of the condition as circumstances change (Robinson *et al.,* 2018), making effective targeting of the energy-poor very difficult for policymakers. This has been evident in the UK, where despite early engagement with EP, the condition persists until the present day (NEA, 2020). Nonetheless, the setting of timelines in the UK has allowed EP to be monitored comprehensively, which is helpful information for keeping the issue at the forefront of the political agenda (Walker and Day, 2012; Sovacool, 2015). Drawing on examples such as the UK (where the issue of EP is more established) could be a valuable lesson-learning opportunity in the Portuguese case, providing insights into good practices and avoiding the repetition of mistakes (Thomson & Bouzarovski, 2018; Mahoney *et al*., 2020).

The identified indicators in the policy documents (APA, 2019a, b; República Portuguesa, 2020; DGEG, 2021) ranged from objective indicators such as greenhouse gases (GHG) emissions and energy savings, area (m_2) of buildings retrofitted, to subjective indicators such as reducing reported hours spent in thermal discomfort. The diversity of indicators reflects the multidimensional nature of EP itself (Meyer *et al*., 2018) and demonstrates a clear effort by Portuguese policymakers to track the impact of the measures employed in the CC, ET, and EP agendas. Despite this, the capacity of some indicators to accurately capture policy impacts in terms of EP varies (Sareen *et al*., 2020). For example, while energy costs data is highly relevant, the use of energy bill arrear data can be misrepresentative as in many cases, adaptive coping strategies and underconsumption can “hide” energy poverty or the extensive use of biomass in fireplaces in the country which is not unfolded in energy bills. Palma *et al.*, (2019) suggest that the “heating and cooling gap” may be larger than anticipated in Portugal due to hidden energy poverty. Similarly, although tracking the number of citizens participating in energy communities and the contribution of endogenous sources to the energy profile is informative for the CC and ET agendas, these indicators do not directly measure increases or decreases in EP.

Table 6.2 Key topics and indicators linked to the CC, ET, and EP agendas

List of linked topics	Associated Agendas				Monitoring indicators as identified in policy documents
	RNC 2050	NECP 2030	Building Renovation Strategy	EP Strategy	
Building Quality, Retrofit & Zero Energy Buildings	CC, ET, EP	CC, ET, EP	CC, ET, EP	CC, ET, EP	• Number and percent of buildings retrofitted • Number of EPCs by class • Number of "deep renovations" • Total number and m^2 classified as NZEBs • Number and m^2 of buildings with facades and green covers • Energy consumption in buildings • GHG emissions from buildings
Energy efficiency upgrades	CC, ET, EP	CC, ET, EP	CC, ET, EP	CC, ET, EP	• Number and type of upgrades installed • Government funds directed into energy efficiency measure • Value of taxes directed into energy efficiency measures • Energy consumption in buildings • GHG emissions from buildings
Uptake of renewables	CC, ET, EP	CC, ET, EP	CC, ET, EP	CC, ET, EP	• Contribution renewables to energy profile (by type and geographic distribution) • Energy consumption in buildings • GHG emissions reductions
Decentralization/ Renewable energy communities	CC, ET	CC, ET, EP	CC, ET	CC, ET, EP	• Number of citizens participating in energy communities • Local energy production statistics
Health & well-being (Mental & Physical)	CC, ET	CC, ET, EP	CC, ET, EP	ET, EP	• Costs to health service • Excess Winter and summer deaths
Low income	-	CC, ET, EP	ET, EP	ET, EP	• Income statistics (earnings, pensions, social support)
Thermal comfort	CC, ET	CC, ET, EP	CC, ET, EP	CC, ET, EP	• Thermal comfort index • Percentage reduction in the hours of discomfort in the home reported
Energy Expenditures	-	CC, ET, EP	EP	EP	• Energy costs statistics • Arrears on energy bills
Economic recovery	CC, ET	CC, ET	CC, ET,	CC, ET, EP	• Profitability of renovation measures; current net value, payback period & cost, Investment by annual saving • Job creation
Just/ Citizen-led transition	CC, ET	CC, ET, EP	ET, EP	CC, ET, EP	• Monitor rates of EP • Creation of citizen support network • Promotion of regional carbon neutrality roadmaps
Employment	ET	CC, ET, EP	ET	ET, EP	• Job creation • GDP • Employment in the construction sector

Vulnerable consumers	-	CC, ET, EP	ET, EP	CC, ET, EP	• Number of consumers categorised as vulnerable
Under consumption & climatization equipment ownership	-	-	ET, EP	-	• Programme for the substitution of inefficient equipment • Energy consumption for heating and cooling • Buildings Energy Performance Gap (summer and winter)
Energy Independence	CC, ET	CC, ET	ET	EP	• Contribution of endogenous sources to primary energy consumption • Contribution of endogenous sources to final energy consumption • Financial savings on fossil fuel imports

6.4.2. The Where – comprehensive CC and ET strategies versus fragmented economic and employment policies

Table 6.3 presents the results of the scale assessment, where it should be noted that there is no “right” or “wrong” number or scale of management strategies, as the advisable management strategy will vary between topics. The Table shows that “Building retrofit & Zero Energy Buildings”, “Energy efficiency upgrades”, “Uptake of renewables”, and “Just/ Citizen-led transition” had strategies identifiable at all three scales. “Health & well-being” also had strategies at each scale. National and Regional but not Local strategies were identifiable for “Employment” with only National strategies found for “Economic recovery”. Evaluating the management scale through the assessment matrix gave deeper insights into the various barriers and synergies within the CC, ET, and EP agendas.

Table 6.3 Management scale assessment

List of linked topics	Management Scale		
	National	Regional	Local
Building retrofit & Zero Energy Buildings	X	X	X
Energy efficiency upgrades	X	X	X
Uptake of renewables	X	X	X
Decentralization & Renewable energy communities	X		X
Health & well-being (Mental & Physical)	X	X	X
Thermal comfort	X	X	X
Economic recovery	X		
Just/ Citizen-led transition	X	X	X
Employment	X	X	
Energy Independence	X		X

The potential of the ET to reduce undesirable health impacts of both CC and/or EP is a clear policy synergy in the Portuguese case (APA, 2019a, b). Improved well-being is another desired synergy; however, mental health is underrepresented across the documents. Higher hospital admittance rates for mental health conditions have been shown to correlate with the warmer temperatures experienced during the summer months in Lisbon and other urban zones in Portugal (Loureiro *et al.,* 2015; Almendra *et al.*, 2016; Almendra *et al.,* 2019).

The lack of local management strategies for "Employment" and "Economic recovery" is a potential barrier. Long-term youth unemployment and the emigration of qualified workers are significant challenges faced by Portuguese policy makers (Pacifico *et al.*, 2016). The ET is, therefore, an attractive opportunity to improve working conditions and the economy. The impacts of fossil fuel phase-out on employment are acknowledged in the 2050 Carbon Neutrality Roadmap (APA, 2019a), but the argument put forward in the policy document is that job creation in the renewables sector will outweigh any losses at national scale. However, Alvarenga *et al.* (2017) highlight inconsistencies in the distribution of these jobs, arguing that new jobs will target younger generations and be concentrated in urban centres, reducing benefits for older and rural communities. At

NUTS II level, the Lisbon Metropolitan Area and the North (primarily the Metropolitan Area of Porto) account for 66.2% of Portuguese purchasing power (IEFP, 2017). Purchasing power is reduced in interior sub-regions, particularly in inland areas of the North and Centre regions (IEFP, 2017), which require increased attention regarding the impacts of the ET and EP mitigation.

Gouveia *et al.* (2019) and Palma *et al.* (2019) raise concerns about future CC induced temperature increases driving up energy requirements and increasing vulnerability in these regions. This ties into broader concerns about energy vulnerability in European energy transitions and the distribution of benefits across different groups and regions (Pye *et al.*, 2019). The inequalities between Portuguese regions coincide with higher average maximum air temperatures in the inland areas during the hottest month of the year. For example, in 2020, the average maximum temperature was 32.3°C in the capital Lisbon, 30.3°C in the popular coastal tourist destination Faro and 36.7°C in the inland predominantly agricultural Beja region (PORDATA, 2021).

The matrix also highlighted dynamic elements of the agendas, including balancing citizen participation, decentralization, and centralized energy production strategies. Substituting fossil fuels with renewables in a centralized system sustains the traditional relationship between energy suppliers and consumers; alternatively, decentralization involves consumers becoming producers (Altmann *et al.,* 2010). Both approaches are key in the decarbonisation strategy, yet the extent to which they will play off or feed into one another is unclear. Increasing contributions from the decentralized supply may not be negative from an end-user perspective, as in the Portuguese case, centralized energy production is linked with reduced energy justice (Nordholm *et al.,* 2021). These two elements of Portuguese policy appear at odds, highlighting that increased citizen participation is not universally beneficial for all players in the ET. Byskov Lindberg *et al.* (2021) highlight a split of preferences between centralization and decentralization between actors in the European electricity policy mix, suggesting that this finding is not unique to the Portuguese policy case. Decentralization may, however, present additional challenges in Portugal as the country does not have a history of implementing community-level projects as other central EU countries do.

The Management Scale review revealed multi-scalar policies for several key topics linked to the CC, ET, and EP agendas. While this demonstrated a comprehensive approach to these topics, gaps were identified in important areas such as "Employment" and

"Economic recovery". Our findings show that taking a "top-down" approach to the CC, ET, and EP agendas, initially guided by instruction from the EU and then translated into national policy, does not result in uniform distribution of the intended benefits. This is substantiated by a municipal-level review of CC policies in Portugal, which showed that CC was rarely a priority in local agenda-setting (Campos *et al.,* 2017). Finally, open questions remain regarding balancing the interests of the various energy system stakeholders.

6.4.3. The Who – Balancing power and responsibility

This section presents the stakeholder identification analysis and mapping results. In total, 102 stakeholders were identified. The breakdown of stakeholders by scale and type is shown in Figure 6.2. The majority of these stakeholders (55) were businesses; these comprised a mix of energy companies, suppliers, and installers of energy efficiency equipment, smart home equipment, or micro renewables. *NGOs and associations* was the next largest group (19), followed closely by *Government* (17). The smallest groups were *Research Centre or University* and *Cooperatives*. The low representation of these two groups potentially reflects their limited capacity to influence the traditional pillars of energy poverty.

It should be noted that although not identified as a stakeholder group, Chinese investors have invested significantly in the Portuguese ET. During 2000-2014, China's cumulative investment in Portugal totalled €5.138 billion; the motivation for this investment is thought to be principally economic (Pareja-Alcaraz, 2017). The strategy of owning more than 10% of organizational voting rights and thus securing significant management influence within the company is common practice among Chinese investors in Southern European ETs (Pareja-Alcaraz, 2017). This investment has clear benefits from an economic perspective, providing much-needed funds to progress the ET in the region. However, international investment of this kind tends to favour a centralized approach to the ET, which, as previously highlighted, is not beneficial for all stakeholders.

A significant proportion of the business stakeholders were those involved in retrofit activities. A review of the websites of these groups revealed common engagement with the CC and ET agendas. Still, it did not reveal any engagement with EP or, indeed, with the concept of vulnerable consumers. This suggests that mitigating energy poverty is simply not the *Raison d'être* for these organizations. Yet, in the retrofit activities inherent to the ET, these companies will significantly interact with the energy poor.

The degree of vulnerability within energy-poor households is highly variable (Middlemiss *et al.*, 2015), but in cases of chronic illness or disability, interactions with consumers will generally require sensitive handling and be more time-consuming than usual. These requirements run contrary to traditional time/cost-effective business models. Indeed, research from the UK has shown that installers of energy efficiency measures tend to target the "able to pay" and question the allocation of responsibility for EP (to some extent a social welfare issue) to corporate organizations with a predominately market-based focus (Rosenow *et al.*, 2013). Thus, employment creation in the retrofit sector is synergistic with climate goals and seemingly with EP mitigation through improved energy efficiency. However, a lack of preparation in the sector for dealing with EP households creates a policy barrier. Bad relations with retrofit companies are known to affect consumer trust and can discourage rather than encourage participation in retrofit schemes, which in turn impacts the facilitation of energy transitions (de Wilde, 2019).

6.4.3.1. Stakeholder Mapping- The impacts of power imbalances

Figure 6.3 presents the results of the stakeholder mapping using the sphere of influence (Clark *et al.*, 2017). In the context of the CompeSA framework, the stakeholder analysis is designed as a jumping-off point for identifying actors and for gaining insight into the relative influence of these groups.

Of the 102 stakeholder groups, 27.5% were *Indirect stakeholders*, 36.3% were *Direct stakeholders*, and 36.3% were *Core stakeholders*. *Businesses* made up 78.4% of the Core group, most of these businesses operated at an international or national scale. This finding substantiates the previous gap in local employment and economic opportunities discussed in section 6.4.2. A further split can be drawn within the *Business* group itself, where 67.2% of this category was involved in the domestic energy efficiency/retrofit chain. This essentially presents a privatized model of these activities, which links to concerns that efficiency policies can benefit private economic interests rather than households (Großmann, 2019). Furthermore, energy companies are responsible for social energy tariff payments in Portugal, demonstrating their strong involvement with vulnerable consumers at multiple levels.

The proportion of *Government stakeholders* grew as influence diminished, at 8.1% of the Core stakeholders, 16.2% of the *Direct stakeholders,* and 28.6% of the *Indirect stakeholders*. Local municipalities have been identified as key players in mitigating EP by the Covenant of Mayors (2021) and, more recently at the national level, by the proposed

Portuguese EP strategy (DGEG, 2021). This reduced level of Government influence in the *Core stakeholder* group is thus a factor of concern.

Overall, the stakeholder analysis revealed a skewing of power towards either National or International businesses and a reduced influence of other groups who also had a direct role in mitigating EP, such as *Government* and *Public Institutions.* Despite the active role in disseminating information about EP, participating in international projects, and bringing the issue to the attention of policy makers (Martin, 2020; Brito, 2021; Costa; 2021a; Costa, 2021b), *Cooperatives and Universities* presented a reduced influence. This suggests a trend of reduced power among stakeholders with a strong level of interest in EP and a trend of increased power among stakeholders with interests in the CC and ET agendas but not obviously in the EP agenda. This power imbalance is concerning, given that those with the necessary skill and desire to mitigate EP have limited influence. Further research into the specific interests of smaller groups may expose common goals and opportunities for collaboration which in turn would increase their influence.

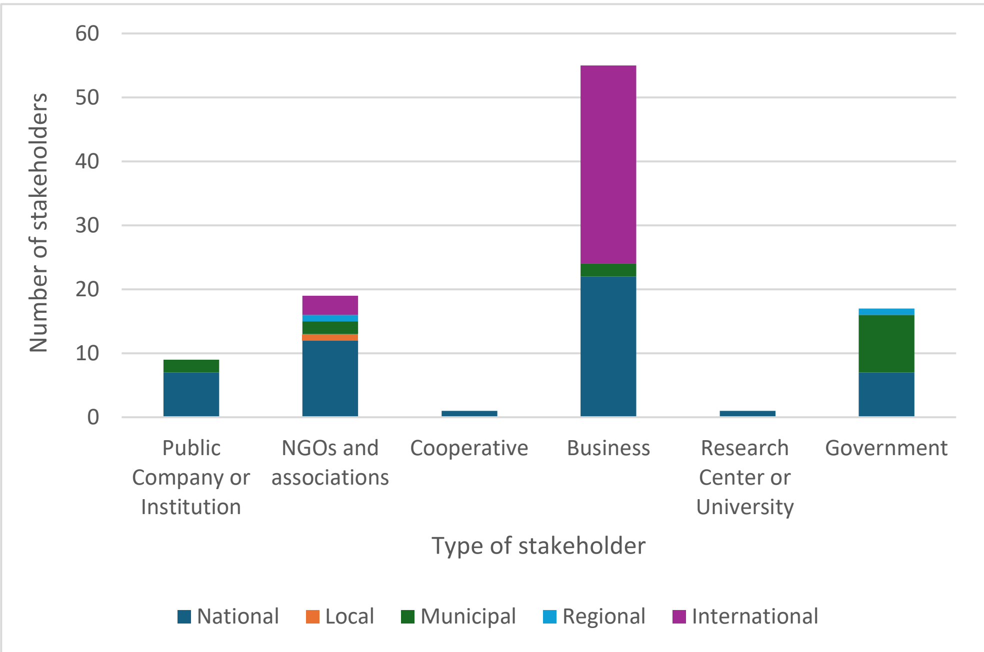

Figure 6.2 Number of stakeholders by type and scale

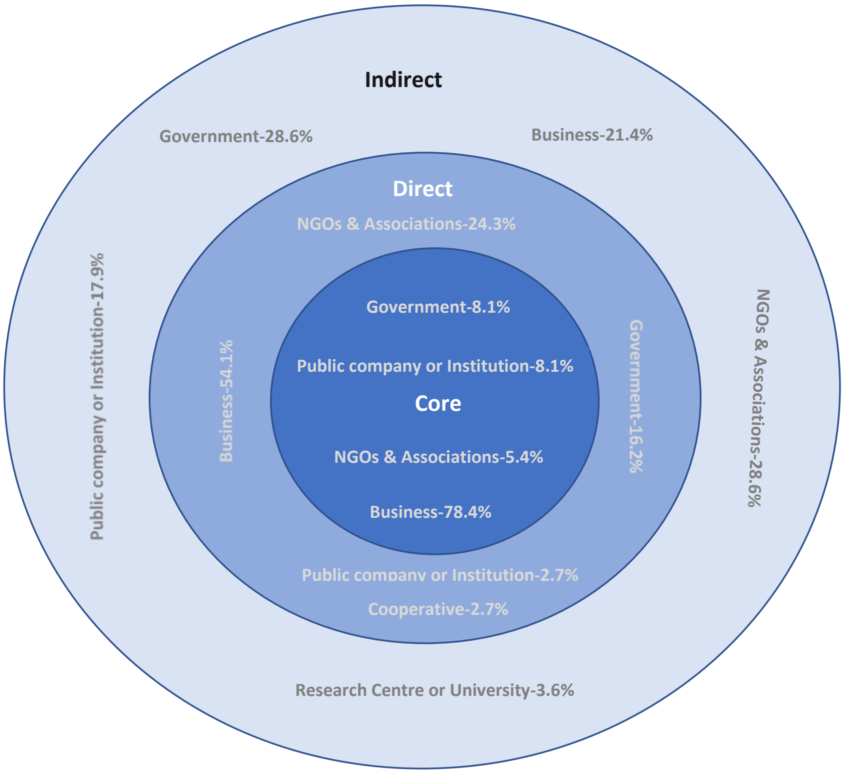

Figure 6.3 Stakeholder sphere of influence

6.4.4. The Unseen

Our review of the CC, ET, and EP agendas framed within the Southern European context and specifically referring to the Portuguese case reveals mixed engagement with these agendas despite a strong impetus from the European Union to engage with all three. Our analysis of the interdependency of these agendas in Portugal revealed several *unseen* elements, compromising the ability of energy transitions to meet climate and social equity targets. Expressly, these were limited accounting for the costs of energy efficiency upgrades, economic and employment strategies that do not comprehensively address local and regional inequalities, and an imbalance in the stakeholder power dynamics in the Portuguese EP agenda.

The Mediterranean region faces unique threats due to CC; thus, we argue that strong engagement with the ET and EP agendas would contribute significantly to mitigating economic and social inequalities and enhancing regional advantages through renewable resource potential. Portugal has shown regional leadership in the CC and ET agendas, mainly in the pursuit of a more resilient economy. High rates of EP are prevalent across the Southern European region, and while Portugal faces several challenges in the mitigation of EP, the highly interlinked nature of the ET and EP agendas suggest that those countries lagging with the ET agenda risk intensifying EP and its adverse effects. Southern Europe presents a range of opportunities in a region that has long suffered more from lower incomes and reduced employment opportunities than their European neighbours (Serapioni *et al.,* 2019). These vulnerabilities have been further exposed by the COVID19 crises, particularly in zones with tourist-based economies (IEFP, 2021).

In the Portuguese case, carbon neutrality is seen as "*the only way for Portugal to leverage its gains and position itself in a highly competitive international economic environment*" (APA, 2019a, pg.98). To this end, Portugal has made good progress in the ET, consistently outperforming its Southern European counterparts (Eurostat, 2020). These achievements are not only economically desirable but contribute to health and well-being improvements through the broader benefits of mitigating climate change such as reducing air pollution and improving ecosystem function (Palinkas, 1998; Jessel *et al.,* 2019). In this sense, the CC and ET agendas can be considered broadly aligned and present several policy synergies, including benefits for health and well-being, economic recovery, and employment opportunities. Furthermore rapid, and effective climate action is increasingly a matter of public will, as demonstrated by the youth-led climate strikes (Vicente, 2021).

This strong appetite for climate action encourages citizen participation, the principal measure by which European and Portuguese ET policies seek to address inequality. Citizen participation promises improved energy efficiency and lower energy bills (EC, 2020a, b). In fact, citizen participation is not only a means of improving conditions for consumers but is essential for decentralization and energy efficiency policies. Successful citizen participation is dependent on making the benefits of ETs clear (Nikas *et al.*, 2020). This is important in Portugal, where 76.4% of the population believe climate change is occurring, but 68.3% are concerned about energy price increases (Magalhães *et al.,* 2018). Notwithstanding these risks, the role of citizen participation demonstrates that public acceptance is highly influential despite a stakeholder group consisting mainly of international corporations.

In recent years and months, EP in Portugal has evolved from a barely recognised phenomenon at the political level to being strongly embedded in the Portuguese ET strategy. Nonetheless, numerous unaccounted for vulnerabilities remain, including gaps in opportunities for local and regional economic development and local employment opportunities. With limited leeway for domestic energy consumption increases, the issue of under consumption was not well accounted for in Portuguese policy. The balance of increasing the contribution of both centralized and decentralized renewables was also not well defined. Finally, the domination of the stakeholder group by larger national or international companies was also a barrier as these groups have strong interests in installing energy efficiency equipment and carrying out retrofit works but not in the mitigation of EP.

These policy gaps raise questions about who pays and who benefits, which are themselves linked to concepts of justice and equity. The aforementioned power imbalances suggest that vulnerable groups will continue to be marginalised due to reduced access to the benefits of the ET. This has implications not only from a moral and ethical standpoint but also for the ET's success. One possible method for mitigating this effect is cooperation between public and private entities, as evidence has shown that when these groups share risks and benefits, carbon neutrality policies are more likely to be successful (Caglar *et al.,* 2021). Furthermore, a deeper understanding and reflection of the synergies and barriers in ET policies would serve to redress power imbalances, promoting a more equitable and just transition.

We argue that our findings have a broader relevance than the Portuguese case alone and provide useful insights for the implementation of ETs in the Southern European zone. This is substantiated by the fact that similar challenges faced in energy efficiency and carbon neutrality endeavours in Mediterranean countries are already leading to cross border collaboration on these issues (Salvia *et al.,* 2021).

Ultimately, the function of the conceptual framework is to structure processes and data collection; the results presented herein will be tested through collaborative mixed-method approaches, combining workshops and qualitative interviews to verify and refine the central findings (Rubin *et al.,* 1995; Bixler, 2013). This is particularly relevant in the case of the stakeholder analysis (Videira *et al.,* 2012) to deepen the understanding of how to support the design of more inclusive and just policies (Sareen, 2018).

The collaborative process to be conducted engaging the "who" will provide insights on perceptions regarding the "where" and the "what", allowing the alignment of the literature and policy findings with the stakeholders´ mental models to be assessed. This is expected to increase understanding regarding the policies and agendas for the stakeholders, and on the other hand, to identify leverage points for action in the system to foster policy alignment, work on power relations and find synergies.

We acknowledge the following limitations, firstly, the framework is a desk-based approach that is advantageous in terms of both time and resources but cannot substitute first-hand knowledge gained through collaborative processes (as identified above). We, therefore, argue that the framework's ideal application is the early stages of a research project as an aid to scope definition. Secondly, the methods applied are mostly qualitative, with the second step of the stakeholder analysis involving an empirical analysis. We took this approach precisely because we are interested in the less tangible elements of these competing agendas, such as the links between the three agendas and the scales at which policies apply. Clearly, however, the framework would not be suitable for users seeking to conduct analysis of an entirely quantitative nature.

Finally, it should be noted that while as thorough an analysis as possible was conducted of the key policy documents, at the time of writing, the Portuguese EP Strategy is under revision following a period of public consultation. The findings of this paper are thus based on the provisional version of this document.

6.5. Conclusions

This paper proposes and applies a conceptual framework adaptable for assessing a wide range of competing sustainability agendas. In so doing, we aim to provide a functional tool that can be applied in cases of competing sustainability agendas to help orientate the research scope, which is often extensive in the sustainability field. We applied the tool in the context of the CC, ET and EP agendas in the Portuguese context to explore policy synergies and barriers specific to the test case. We also employed the knowledge gained in the literature review to draw inferences on the general applicability of these synergies and obstacles in the Southern European context.

Overall, we found the CompeSA framework an effective method to explore the agendas in more depth. Such an approach can be adapted to competing sustainability agendas outside the energy field and to other locations. This is attested to by the fact that the CompeSA framework steps were designed to assess competing policy agendas and, in this case, have also been applied to the broader CC agenda as well as the ET and EP agendas. Furthermore, many of the methods applied in the steps were adapted from other fields of sustainability, including water resource management (Rodina, 2019; Tom & Munemo, 2015) and wildlife conservation (Tsang *et al.,* 2021).

As discussed, sustainability agendas often comprise a diverse mix of overlapping and divergent social, economic, and environmental criteria (Smith *et al.,* 2020). These criteria are often extensive, making it challenging to identify and retain focus on the central research topics. The CompeSA framework has proved to help narrow down the central topics, management strategies, and key stakeholders in the policy agendas selected herein. Applying the three steps of the CompeSA framework enables a more profound exploration of policy synergies and barriers. This examination, in turn, revealed missing links between the different agendas and how more cohesive management strategies can contribute to a more equitable energy transition and the common and divergent interests of the key stakeholder groups. These findings are ultimately useful for policy development and directing legislative change; they may also be informative for key stakeholders who wish to resolve competing interests. In this sense, we believe the CompeSA framework presents a method with low resource intensity to define and orientate the initial phases of policy design focused on competing sustainability agendas.

6.6. References

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Chapter 7 | Perceptions of Competing Agendas in Carbon Neutrality Policies in Portugal: Adverse Impacts on Vulnerable Population Groups

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Abstract

The links between the political agendas of climate change, the energy transition, and energy poverty are multiple, complex, and overlapping. In line with European Union policy demands, Member States are implementing the various policies necessary to address these agendas, with an emergent focus on their synergistic potential. Successful implementation requires cooperation between multiple actors, yet little research exists on how diverse actors view the agendas. This limits the ability to account for diverse perspectives in carbon neutrality policy and related insights on trade-offs and competition points between the climate change, energy transition, and energy poverty agendas. We analyse perspectives on agenda interactions based on 39 expert interviews on Portuguese carbon neutrality agendas. Our case study results suggest strong agreement regarding theoretical linkages of the agendas but mixed views on whether this transpires in practice. These perceived inconsistencies reveal several unresolved competing agendas in Portuguese carbon neutrality policies. We also reveal important influences on citizen agency in the decarbonisation agendas. We argue these insights are valuable for current policy approaches, which promote decarbonisation policies that incorporate energy poverty and rely strongly on citizen participation.

Keywords

Carbon-neutrality, Just Transition, Energy Poverty, Climate Change Mitigation

7.1. Introduction: Carbon Neutrality and Competing Agendas

When implementing energy transitions at the supra-national scale through time-bound targets for carbon- and climate-neutrality, international political institutions such as the European Union (EU) have emphasised addressing issues of equity and justice in conjunction with climate change mitigation goals. A core injustice identified is the multidimensional issue of energy poverty, defined as an inadequate level of access to energy services (Bouzarovski & Petrova, 2015). Energy poverty has been limited to the social policy domain in some national contexts (von Platten, 2021); however, in the context of the modern-day climate and energy crises, we argue that the political scope of energy poverty extends beyond the social policy domain. Indeed, multifaceted and complex interlinkages bridge these three agendas, which we refer to collectively under the umbrella of a carbon neutrality agenda in this article.

By "carbon neutrality agenda", we refer specifically to the global drive towards net zero greenhouse gas emissions by 2050 as per the 2015 Paris Agreement and the inherent energy transition required to facilitate the shift from finite fossil fuels. The energy transition itself intersects energy poverty at the level of domestic energy consumption. It is at this intersection of the climate change, energy transition and energy poverty policies that we base our study.

Notably, while European political bodies generally focus strongly on the synergies between energy and climate policies for energy poverty alleviation (EC, 2019), European Commission initiatives such as the Just Transition Mechanism focus on providing support to those regions most affected by the transition away from fossil fuels, demonstrating increasing concern regarding the trade-offs between various policy initiatives (EC, 2023). Similarly, scholars have shown that what is beneficial for one policy agenda may come at the cost of realising goals associated with another agenda for example lower income households presenting reduced energy savings post retrofit (McCoy & Kotsch, 2020), or climate change induced temperature extremes worsening energy poverty (Sherriff *et al.,* 2022) and point out the need for careful evaluation of these policies to monitor progress and impacts in different domains. Additionally, movements such as the Right to Energy Coalition combine the interests of NGOs, health organizations, energy co-operatives and other groups to promote a Right to Energy for all Europeans (Right to Energy Coalition, 2023). Thus, various organizational types have indicated a preoccupation with these policy trade-offs. What is less clear is how convergent the views of the various organizations are.

Simultaneously, there is widespread consensus that successful implementation of the energy transition relies upon the interaction and cooperation of numerous actors with varying interests (Fernandez *et al.,* 2021). Transition processes also inherently imply disruption for traditional energy sector players. Based on the premise that carbon neutrality policies provide insightful examples of these competing agendas in practice, we undertake a thematic analysis of 39 expert interviews in our selected case of Portugal to assess perceptions of areas of competition and synergy in carbon neutrality policies. Our assumption is well-founded in the sense that Portugal has made rapid progress in implementing its energy transition, where installed power for electricity production increased by 3.5 GW during 2020-2021, mainly through electricity production from renewable resources (DGEG, 2023). Simultaneously, Portugal presents a significant vulnerability to energy poverty across different population groups (Gouveia *et al.,* 2019), with 75% of energy performance certified buildings not meeting thermal comfort requirements (IEA, 2021). Therefore, this case study offers an opportunity to investigate synergies, trade-offs, and uncertainties between the agendas of climate change, the energy transition and energy poverty, to understand how they compete with or complement each other, and to pave the way for convergence.

7.2. Case study: Carbon Neutrality Policies in Portugal

Situated on the western extreme of the Iberian Peninsula, Portugal falls into the "energy periphery" (Bouzarovski & Tirado Herrero, 2015), with a high prevalence of low incomes, poor building quality, low ownership rates of climatization equipment such as air conditioners and central heating, and high energy costs. Portugal's geographic position renders it especially vulnerable to the effects of climate change and increasing temperature extremes, meaning that both summer and winter energy poverty are significant problems (Gouveia *et al.*, 2019; Horta *et al.,* 2019). Portugal's policy response to the agendas of climate change (CC), the energy transition (ET), and energy poverty (EP) is poised at an interesting juncture. Energy poverty is addressed in key climate policy documents, including the Carbon Neutrality Roadmap (APA, 2019a) and the National Energy and Climate Action Plan (NECP) (APA, 2019b). Moreover, the Portuguese NECP is also due for renewal. Additionally, energy poverty is well addressed in Portugal's Long-Term Strategy for the Renovation of Buildings (República Portuguesa, 2020). However, a dedicated national energy poverty policy was published in early January following two public consultation periods in May 2021 and March 2023. At the time the interviews were undertaken this document was in draft format and thus comments on this document refer to the draft rather than the official version.

Notwithstanding the considerable climatic and economic challenges, the country has faced in recent years, Portugal has emerged as a frontrunner in the implementation of the energy transition. It boasts impressive rates of renewable energy integration both in terms of the shares in gross electricity consumption and gross final energy consumption (Eurostat, 2022). Given the stark contrast between the vulnerabilities (struggles with both winter and summer energy poverty, low incomes and generally poor building quality) mentioned above and strong progress with the implementation of the energy transition, Portugal presents an ideal scenario in which to study the interaction of climate change, energy transition, and energy poverty agendas, i.e., the policy coherence challenge of a holistic carbon neutrality agenda.

Previous authors have applied policy mix analysis to assess progress against multiple policy objectives (Rosenow *et al.,* 2016), providing valuable insights into policy impacts before and after implementation, for example, Rosenow *et al.* (2016) find that energy efficiency obligations overlap with public finance mechanisms for energy efficiency, suggesting that applying these measures in tandem may not be the optimal approach. Kyprianou *et al.* (2019) evaluate the effectiveness of energy poverty policies by reviewing the history and evolution of these policies at multiple scales. Stojilovska *et al.* (2022) explore the impact of policy debates linked to energy poverty, such as welfare and housing efficiency policies. To deepen our understanding of how related policy areas interact, we map out how different groups perceive these synergies and trade-offs. Given the similarity of Portugal with other Southern European zones, we argue that our findings have broader implications beyond the case study. Furthermore, as stipulated by Kleanthis *et al.* (2022), understanding diverse actors' perspectives fosters cooperation, ultimately contributing to maximised policy benefits.

Thus, we aim to build on the knowledge of experts involved in the agendas by eliciting and analysing key insights on synergies and trade-offs between these agendas to inform future policy development and implementation for convergence.

The paper is structured as follows: Section 7.3 presents our Methodology, Section 7.4 consists of the Results and discussion, and Section 7.5 comprises the Conclusions and Policy implications.

7.3. Methodology

The following sections outline the research methodology and the specific methods used, this includes a description of interview protocols, reflections on the validity of the data and a description of the data treatment and analysis. The key thematic areas explored in the interviews are also introduced, along with an overview of the research areas these thematic areas contribute to. Finally, the interview method schematic (Figure 7.3) presents the interview method, explaining how the interview subthemes were derived. The thematic areas chosen allow a cross-comparison of the three agendas explored and thus are insightful for deeper understandings of areas of policy synergy and or conflict between them.

7.3.1. Interview protocols

Interview candidates were identified through the process shown in Figure 7.1 to generate a list of stakeholders affecting/affected by the energy poverty agenda in the Portuguese energy transition. In Figure 7.1 the direction of the arrows indicates the sequence of steps followed to identify interviewees. This process combined a review of groups allocated with responsibility for the climate change, energy transition and energy poverty agendas in key policy documents (e.g., PT draft EP strategy and building renovation strategy) with expertise from the research team guiding a stakeholder analysis elaborated in Mahoney *et al.* (2022), a precursory step to the research presented in this paper. This analysis generated a list of stakeholders affecting/affected by the energy poverty agenda in the Portuguese energy transition.

This stakeholder analysis was used to gain insights into the respective roles, responsibilities and influences of these groups and, along with the results of the previous steps, research team contacts and the snowball effect (Bryman, 2012) led to identifying agents with expertise in the climate change, energy transition and energy poverty agendas for interviews, as per Figure 7.1.

7.3.2. Notes on data validity

While acknowledging potential pitfalls of the 'experience of the researcher' approach as per Galvin (2015), we find this approach appropriate in our case (as stipulated above) to contribute to the selection of interview candidates. We emphasize that our sample size (n=39) is not definitive of the "correct" number of interviews to conduct with regard to our research subject.

Numerical values expressed in the following sections should not be interpreted as generalizable across the organizational sectors in our interview sample in Portugal or any other context; instead, our results intend to provide insights into which types of issues are considered significant by which types of actors within our study sample. Further comments on the utility of our findings are provided in Section 7.4.

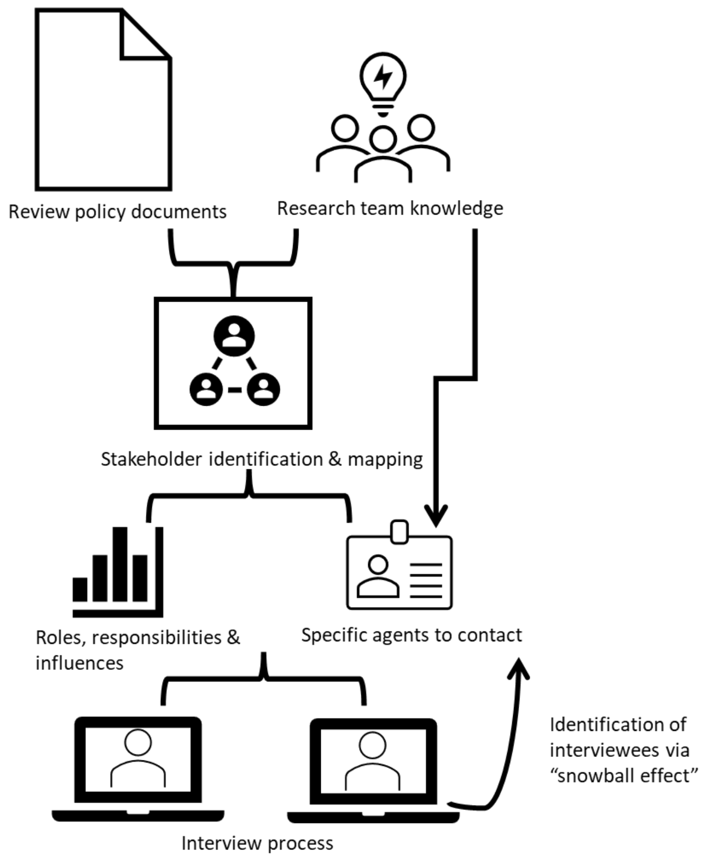

Figure 7.1 Process for identification of actors for the interview process

7.3.3. Data treatment and analysis

Following the interview guide provided in Annex B, 39 interviews were conducted, applying an exploratory semi-structured qualitative interview approach, where a pre-set list of questions was designed by the research team (Annex B), but which also left room to explore individual areas of expertise of the interviewees. This flexible approach is recommended when the topic of investigation remains relatively uncharted (Bryman, 2012) and intentionally allows for serendipitous insights into competition points between the agendas (DeJonckheere, 2018).

Thirty-eight interviews were held via Zoom, with one respondent sending written answers. Figure 7.2 shows the interviewee profile, comprising a range of organizational types. While a more even spread across interviewees per participant type would have been ideal, overall, this interviewee profile represents a broad spread of interests across the climate change, energy transition and energy poverty agendas in Portugal. We do not specify key interests more granularly to ensure anonymised treatment. On a related note, while some interviewees did not want the views expressed to be considered representative of the organization for which they worked, these views have been categorised as representative of perspectives of their respective organizational sectors, with the rationale that the interviewees' professional experience shaped perspectives expressed during interviews. That said, every effort has been made to retain the anonymity of the interviewees, and we abide by specific requests for the non-inclusion of interview content.

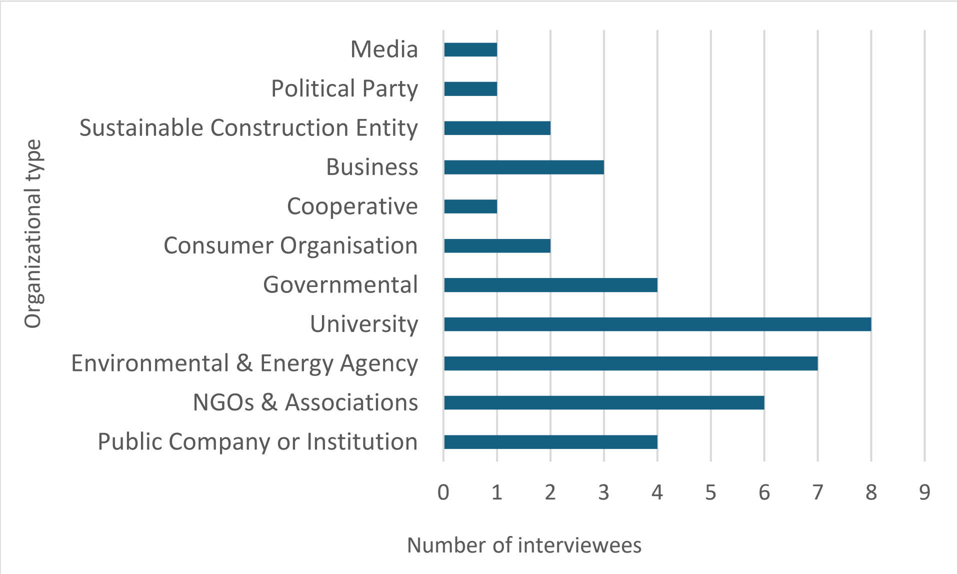

Figure 7.2 Interviewee profile (number and organization)

The interviews were held in English or Portuguese, recorded and subsequently transcribed with the participant's consent. The transcriptions were realised by the interviewer, which has the advantage of the researcher becoming thoroughly familiar with the data (Frost, 1992; Bazeley, 2007). Interviews lasted between 40-60 minutes, representing approximately 900 minutes (15 hours) of total interview time. From this extensive material, we draw on policy-related sections of the interviews to focus the empirical analysis for this paper.

The NVivo[1] software tool was used to code and analyse the interview responses, using a deductive approach where responses were coded under corresponding thematic headings, as per Table 7.1. The questions in the policy section of the interviews focused on the perceived interactions of the agendas. Our focus on perceptions is based on a constructivist approach, with the argument that perceptions have a bearing on reality (Ritchie *et al.,* 2003). Following a thorough review of this content and to contribute to

[1] https://lumivero.com/products/nvivo/

research gaps relevant to the case, we opted to investigate the four thematic areas presented in Table 7.1 which explains the relevance of these areas to the Portuguese case or more broadly where applicable. The thematic areas were based on the interview questions (outlined in Annex B). It is important to note that areas 3 and 4 are merged in the Results and Discussion Section. The research gaps and supporting resources highlighted in the table guided our deductive approach.

Table 7.1 Thematic areas explored in interviews with corresponding contributions and references

Thematic area	Research contribution	Supporting references
1. Perceptions of the CC, ET and EP agendas in Portugal	Links imposed at EU & PT policy level; insights needed into benefits & trade-offs at the practical level	(Rosenow *et al.*, 2016; Mahoney *et al.*, 2022; Sherriff, *et al.*, 2022)
2. Perceptions of policies central to the CC, ET and EP agendas in Portugal	Policies are early attempts to mitigate EP under umbrella of carbon neutrality, important juncture for evaluation of effectiveness	(Stojilovska *et al.*, 2022)
3. Views on public awareness of and capacity to participate in the CC and ET agendas	Citizen participation key tenet of carbon neutrality agenda, contributes to knowledge on the challenge of reduced participatory culture in Southern Europe	(Delicado *et al.*, 2023; Escario *et al.*, 2023)
4. Views on public awareness of EP and ability to mitigate	EP recent concept in PT, evidence suggests resignation to condition, more evidence needed on who is affected & how	(Horta *et al.*, 2019)

Figure 7.3 presents the interview analysis method, where relevant responses were categorised under each thematic heading. These themes then underwent several phases of analysis for the eventual development of subthemes. It should be noted that a single interviewee may be categorised as having more than one viewpoint (or as having identified more than one subtheme), having given a range of views in response to the same question. While what constitutes a thematic analysis is debatable (Bryman, 2012), we apply an adapted version of the framework approach (Ritchie *et al.,* 2003) to thematic analysis. Here, themes are based on the questions posed to interviewees, and a coding framework is built using functionalities in NVivo.

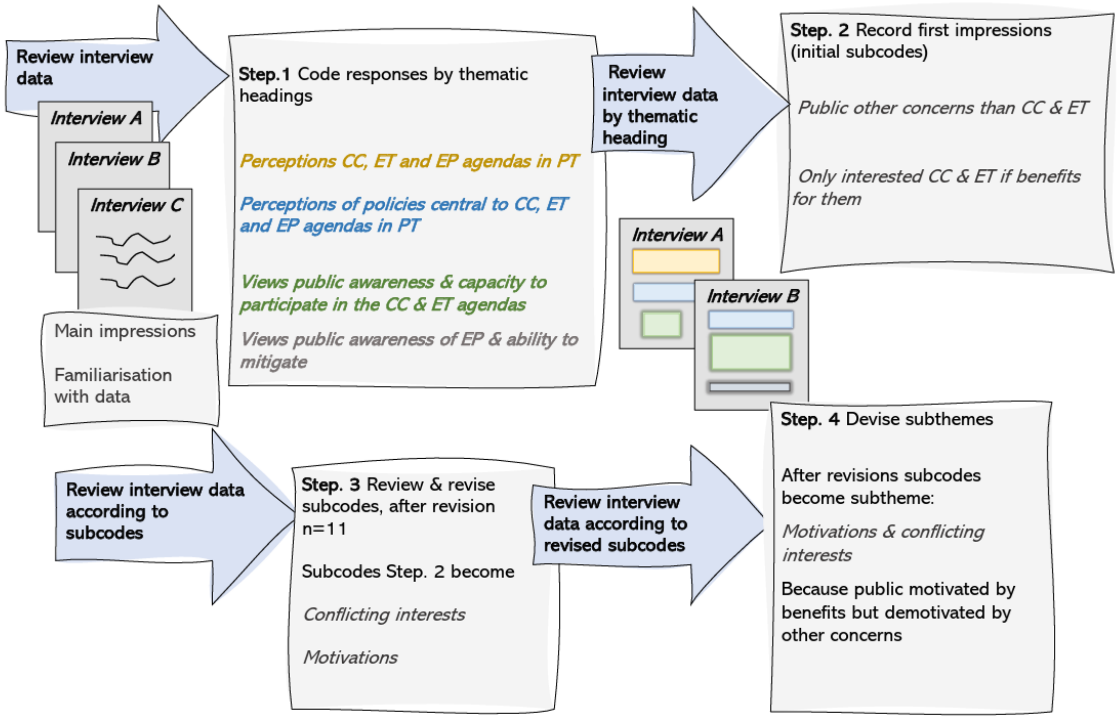

Figure 7.3 Interview method schematic

We thus analysed key trends in the subthemes derived for each interview question. Considering which subthemes were identified by which organizational types yielded insights into how actors from different sectors viewed the various topics broached. We interpreted these results to derive conclusions about the perceived synergies and competing agendas in climate change, energy transition and energy poverty policies and their practical implications.

7.4. Results and Discussion

The following section presents our analysis and discussion, focusing on how interviewees perceived the interactions of the climate change, energy transition and energy poverty agendas.

Subsections 7.4.1-7.4.3 explore responses under the thematic headings set out in Subsection 7.3 and outlined in Annex B. In each subsection, we comment on policy synergies and competing policy agendas in the context of the subthemes identified, where the quotes present responses to questions outlined in Annex B (where sections 7.4.1 and 7.4.3 present responses to questions 1,2, and 3 in Part 2 of the Annex and 7.4.2

presents responses to the questions in part 4 of Annex B). In the later subsections, we reflect on issues of participation in decarbonisation agendas through what we label factors of awareness and capacity, and compounding effects. We include relevant quotes to validate our arguments throughout.

Sections 7.4.1-7.4.3 feature charts linking the number of interviewees by organizational type to subthemes, where we found it valuable to explore what is considered important by whom within our interviewee profile. As explained previously, not all interview participants answered the same questions, and the number of interviewees by organizational type varies; hence, these values represent the number of interviewees who identified each subtheme, which does not constitute the same set of interviewees across all subthemes.

Furthermore, our findings do not attempt to fully represent the range of themes and perceptions encompassed within the Portuguese climate change, energy transition and energy poverty agendas. Results that present the comparative frequency with which a subtheme is identified should be considered as only strictly relevant within our interviewee profile. We do, however, draw on relevant findings from broader literature to support our Results and Discussion. Critically, our primary purpose in presenting comparative empirical weightings between subthemes is to compare organizational views rather than attributing significance to comparative values. Finally, described trends by organizational type can, once again, only be attributed to the representatives of these various organizational types within our interviewee profile, not across Portugal as a whole.

7.4.1. Perceptions of the climate change, energy transition and energy poverty agendas in Portugal

Interviewees were asked if they perceived the agendas of climate change, the energy transition and energy poverty as linked or separated. The purpose of these questions was to explore to what extent our interviewees perceived the agendas as synergistic and contribute to broader assessments of the policy approaches in Portugal and Europe (where energy poverty is incorporated into wider decarbonisation policy). We categorised responses to this question according to whether an interviewee identified the agendas as linked, separated, or expressed mixed views. These results are presented in Figure 7.4, which outlines the spread of views by organizational type and the number of interviewees who mentioned the relevant subtheme.

7.4.1.1. "Separated" views

Overall, Figure 7.4 shows that overall, a minority of interviewees identified the agendas as spilt. The remaining organizational types either perceived the agendas to be linked or presented mixed views. Notably, only interviewees from the Political Party and Consumer Organizations wholly viewed the agendas as linked.

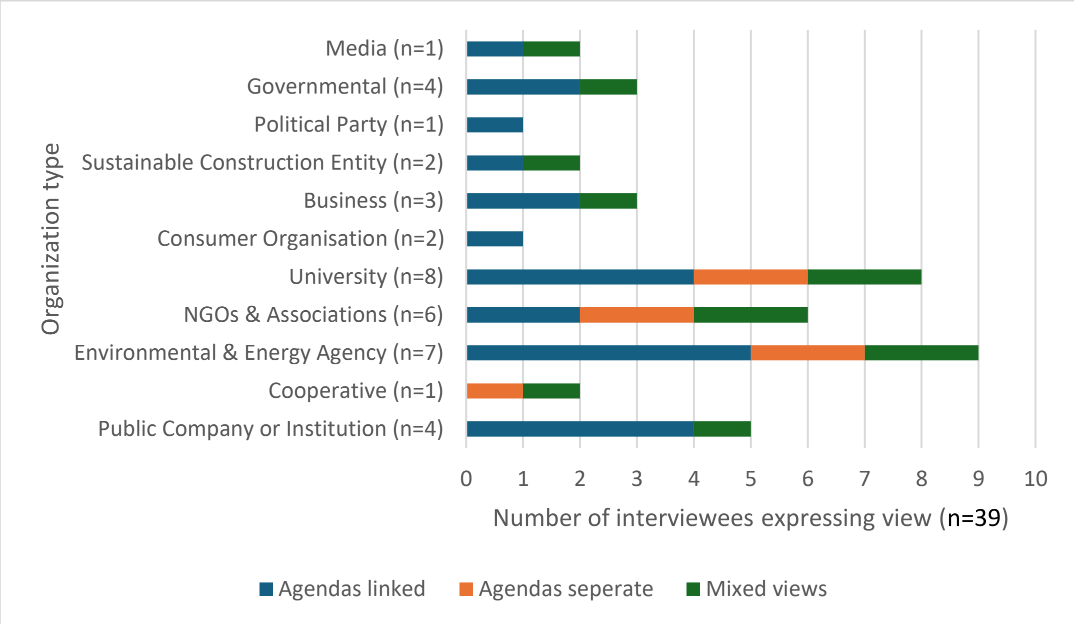

Figure 7.4 Views on whether CC, ET, and EP agendas are linked or separate (n=39)

7.4.1.2. Linked views

In cases expressing linked views, several interviewees highlighted that energy poverty should be integrated into the climate change and energy transition agendas for a just transition. They associated the lack of a holistic view with the potentially negative consequences of viewing the agendas separately- *"Looking at them as if they were different things, this can bring unexpected consequences which could even be prejudicial for other sectors"* (interviewee PT027).

In linked cases, participants often connected building quality issues with the challenges of meeting the energy needs of the energy poor while reducing energy consumption. Viewing the agendas as linked or presenting a mixed view commonly coincided with references to energy transition and energy poverty solutions, such as renewable energy, electrification, sustainable transport and the social electricity tariff currently in place to mitigate energy poverty in Portugal. Interestingly, interviewees viewed emergent (in the Portuguese context) energy transition tools with mitigatory capacity for energy poverty (such as energy communities) as more efficient than the existing social electricity tariff. Here, a competing agenda arises, where Portuguese policy documents emphasize the potential of "prosumer" energy models (APA, 2019b). Yet, the current political approach in Portugal (as well as Italy and Spain) generally favours the development of renewables by large utility companies, with a potentially limited space for alternative actors (Delicado *et al.,* 2023). A reduced ability of community energy projects to engage with vulnerable energy consumers has been observed in other contexts (Hanke *et al.,* 2021). Below the typical demographic of energy transition and energy co-operative participants in Portugal, according to interviewee PT002 from an energy co-operative is outlined:

"But let's be frank…this transition, the members of the parties involved in the transition are normally middle-class citizens, upper middle class… Incidentally, the members of co-operatives, also the managers, are normally middle-class citizens, upper middle class, white and over 40."

These assertions are important considerations for the Portuguese context and questions of who is included or excluded from energy transition activities, which are often considered to have co-benefits for energy poverty.

7.4.1.3. Mixed Views

Mixed views related to the broader political framings of the agendas, both in the Portuguese and EU contexts, where energy poverty was perceived to be a sub-agenda subsumed under the broader energy transition agenda. Recognising the gap between the theoretical linking of the agendas at the political level and the actual degree to which this occurred at the practical level was common among interviewees who expressed mixed views and identified the agendas as separated. As interviewee PT031 stated:

"It's like this at this moment; you notice some preoccupation with already having the programmes which tackle energy poverty. Meanwhile, to me, it seems that things are still disconnected; they are still two worlds, two different worlds, two different worries, despite the connection being obvious. But it doesn't seem there is a guide to incorporate energy poverty, taking into account the energy transition."

This reference to the current disconnection at the policy *level "despite the connection being obvious"* is symbolic of a trend wherein interviewees rarely advocated for the agendas to be viewed separately. Instead, interviewees generally believed that the agendas should be linked while highlighting failings in the current policies to facilitate this integration.

7.4.1.4. Synergies and competing agendas

Consensus on the value of agenda linkage is encouraging from the perspective of creating policy synergies. However, conflicting views on electrification unearth a competing agenda where efforts to decarbonise the energy supply may deepen existing levels of energy poverty through potential price increases. Navarro-Espinosa & Thomas-Galán (2023) report price increases following the replacement of firewood with electricity to supply heating in Chile. Several interviewees expressed concerns about the costs of electrification being passed on to the consumer in the Portuguese context, where 25% of households use fuelwood (Stojilovska *et al.,* 2023), electricity prices were the eighth highest within Europe in 2019, including taxes and levies (COM/2020/ 951 final), and where 22.4% of the population was at risk of poverty or social exclusion in 2021 (ONLCP, 2023).

Notably, the organizations that explicitly identified separation in the agendas were primarily those with a high level of consumer contact or those with analytical roles in policy evaluation rather than those designing policy. Finally, while not explicitly mentioned in response to this question, an interviewee from a Sustainable Construction Entity noted that using unsustainable construction materials in the supply chain is common, mainly due to being the less costly alternative.

7.4.2. Perceptions of policies central to the climate change, energy transition and energy poverty agendas in Portugal

Following our assessment of how the agendas were perceived at the policy implementation level, we now present our interviewees' perceptions of specific Portuguese policies. The interviewees were asked if they were familiar with key policies and related funding schemes intersecting the Portuguese climate change, energy transition and energy poverty agendas. These consist of national climate policies, the Roadmap for Carbon Neutrality, RCN 2050 (APA, 2019a) and the National Energy and Climate Action Plan (NECP 2030) (APA, 2019b). These also include the Long-Term Strategy for the Renovation of Buildings (LTRS) (República Portuguesa, 2020) and the draft Energy Poverty Strategy (DGEG, 2022). Strategies differ from policies in that policies consist of a set of shared rules and regulations to guide decision-making. In contrast, strategies are plans dedicated to attaining measurable objectives, hence more targeted in this sense.

The Portuguese RRP (Recovery and Resilience Plan) is the national COVID recovery plan following the attribution of funding from the EU. The More Sustainable Buildings II and the Efficiency Voucher are dedicated energy efficiency funding schemes to improve Portuguese dwellings under the umbrella of the RRP (Recuperar Portugal, 2023). Figure 7.5 shows the degree of familiarity with the respective policies expressed by the interviewees.

Overall, the interviewees showed a comprehensive knowledge of the various policies, with the majority being familiar with all policies. More Sustainable Buildings II was the only policy with which all interviewees expressed a thorough knowledge. This policy was a national energy efficiency improvement scheme with a high adhesion level, particularly when compared with its “sister” programme, the Efficiency Voucher, which targeted energy efficiency measures at energy-poor consumers. The More Sustainable Buildings II scheme ran between June 2021 and May 2022. Due to high interest, the scheme's duration was increased past the original deadline of December 2021, and an extra several million euros were directed into the programme for a total of almost 123M€. In November 2021, the programme reported 46000 applications (Fundo Ambiental, 2021); by the end, the programme registered 70511 successful applications from 106131 applications (Gabinete do Ministro, 2021).

In contrast, the Efficiency Voucher was launched in September 2021, and the first phase aimed to deliver 20000 vouchers. The first deadline for vouchers application submission was the 31st of December 2021, or until all vouchers were spent (Fundo Ambiental, 2021). In June 2023, with the submissions closed, only 11300 vouchers were given.

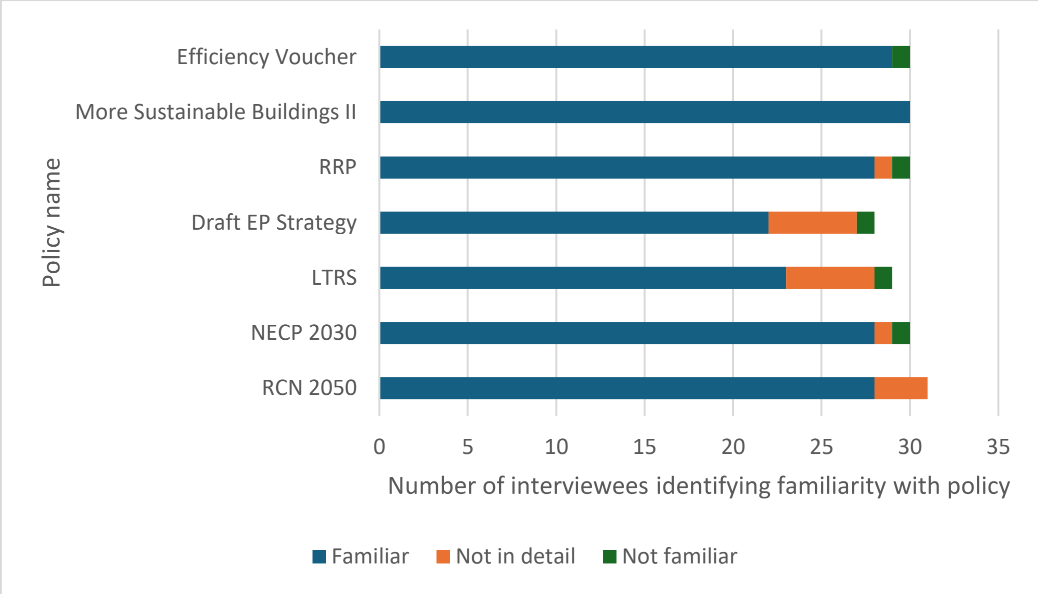

Figure 7.5 Awareness of policies central to the CC, ET and EP agendas (n=39)

7.4.2.1. Policy successes and failures-feedback for the path ahead

Many interviewees commented on the divergent levels of success between the two programmes and criticised the design of the Efficiency Voucher programme. Specifically, they identified that the values attributed through the programme were insufficient (€1300 + VAT), perhaps facilitating the purchase of climatization equipment or minor efficiency improvements but not sufficient to implement passive measures such as wall and roof insulation, which were generally viewed as the most impactful. On occasion, the Efficiency Voucher elicited strong views from participants, being described on separate occasions as a "*flop*" and as an "*insult*" to vulnerable consumers. These views reflected a frustration that the programme did not go far enough to help those most in need. The programme's eligibility criteria, which combined requirements for applicants to be homeowners and in receipt of the social tariff (DGEG, 2022), were also criticised, with the argument that those in energy poverty rarely united these requisites.

These comments fed into broader views that the policies were not generally accessible to vulnerable members of society and continued to exclude them from the energy transition. This applied to insufficient mobilization of funds to renovate the building stock in the LTRS and RRP policies (following quote). These observations are substantiated by the findings of Palma *et al.,* (2021), who posit that €71700 million is needed to rehabilitate the building stock versus the approximate €240 million that is allocated in the RRP for this purpose (Recuperar Portugal, 2023).

"The Long-Term Strategy for the Rehabilitation of Buildings. They also present some costs, numbers of how much remains, how much it would cost to rehabilitate the buildings, and what's there compared to the funding available in the RRP to do it. The RRP is a drop of water of what is necessary, isn't it?" Interview PT013.

Comments regarding the failure of the More Sustainable Buildings policy to reach those in energy poverty were often made by participants from NGOs and Environmental and Energy Agencies. They were countered by views from the Governmental sector, which emphasized that they were attempting to improve on the learnings from previous policies under the pressures of tight resource constraints. One interviewee from the Governmental sector also identified a high level of "elasticity" in the political response to less successful policy elements, allowing for a high degree of flexibility in redesigning policies. *"The Government has been very, very elastic and has permitted us to adapt the notices to reach, to reach the people; therefore, we are always in constant evolution."* - *Interview PT029.*

Despite criticism of the policies, many interviewees outside the Governmental sector did recognise a strong commitment (as demonstrated by the cited increases in renewable energy installations in the Introduction) to climate change and energy transition agendas in Portuguese policy. They noted that energy poverty was increasingly becoming an important political focus. The importance of the 2050 carbon neutrality roadmap and the NECP2030 as guiding documents was also recognised, as was the important influence of the EU on the evolution of Portuguese policy. This influence was generally viewed as positive in holding the Member States accountable. However, one interviewee from the NGO sector identified that responding to a continuously changing paradigm did not allow sufficient time for policy maturation. Stressing that under the current policy scenario, Portugal was required to install more renewable power in eight years than they had in the past twenty. This comment highlights the pressures imposed by the speed at which energy transitions need to occur to meet climate change targets. This speedy implementation has implications for the contemporary institutional bodies responsible for putting these goals into practice.

These observations are further evidenced by the fact that the measure with the highest number of applications in the More Sustainable Buildings II programme was solar photovoltaic, followed by heat pumps (Gabinete do Ministro, 2021). Each measure implies a high upfront investment and associated electricity production costs, thus implying limited access to such measures for those in energy poverty. This shows a parallel between the Portuguese case and the work of Sherriff *et al.,* (2022) primarily in the UK, which refers to tight deadlines imposed by the urgency of climate change resulting in inequitable access to energy poverty mitigation measures.

7.4.3. Factors influencing public awareness and participation in the climate change, energy transition and energy poverty agendas

Two separate but complementary sections of the interviews focused on the public's awareness of climate change, energy transition and energy poverty agendas. These sections explore whether the interviewees perceived differences in public awareness of energy poverty and the broader agendas of climate change and the energy transition. This area was explored during the interviews under thematic areas 3 & 4 (section 7.3, Annex B part 2, questions 2 & 3). We consider these investigations valuable as Portugal has only recently begun to engage politically with energy poverty. Furthermore, insights on public knowledge of climate change and energy transition agendas are more generally informative for contemporary decarbonisation strategies.

In the case of the climate change and energy transition agendas, due to strong EU impetus on citizens as active transition agents, we focused on public capacity for general participation in climate change and energy transitions. In the case of energy poverty, we referred to participation in the sense of capacity to mitigate the condition. With limited data on the Portuguese public's experience of energy poverty, a cross-comparison of the subthemes identified (presented in Figures 7.6 & 7.7) is informative regarding the policy links between energy poverty and broader decarbonisation goals. In one of the existing surveys relatively high levels (40%) of thermal discomfort are reported in the winter in Porto and Lisbon (Lisboa E-Nova & AdEPorto, 2023), which represent a high proportion of Portugal's purchasing power (IEFP, 2017).

Comparison of the figures reveals important similarities and differences between the subthemes linked to the agendas; in both cases, the subthemes of literacy, information & education and elitism and inequality are identified. On the other hand, several subthemes are uniquely associated with either the climate change and energy transition agendas or energy poverty, such as stigma and poverty in the case of energy poverty and extreme events in the case of climate change and energy transition agendas. These divergences between subthemes partially reflect the respective scopes of the agendas in question. We argue this difference also ties into the perceived divergence in awareness levels between the climate change and energy transition agendas compared with energy poverty. This is shown in the comparison of the following quotes, showing that according to our interviewees awareness of climate change was higher than of energy poverty:

"It's like this, I think currently it's a problem, it's a theme that doesn't escape anyone. It seems that everyone is aware", interviewee PT030 about climate change.

This is compared with the low level of awareness of energy poverty as per:

"I think that it's a concept which is very unknown, practically unknown" (Interview PT019).

In the case of climate change and the corresponding energy transition, high levels of awareness were attributed to intensified media coverage of extreme climate change induced events in recent years. Views regarding public awareness of energy poverty presented an interesting nuance, where some noted that while the general public may be familiar with the symptoms of energy poverty, such as being unable to maintain comfortable temperatures in the home, general issues related to building quality and high energy costs, they may would not necessarily use the term "energy poverty" to describe these phenomena, in part due to stigma attached to the term as per Interviewee PT008:

"I think it's a matter, because the people still don't like to assume the concept itself maybe, it makes it that people don't like, they don't like to admit that they are in energy poverty."

In Figure 7.7 we observe that Energy Agencies, NGOs & Associations and a Political Party perceive this stigma, it was not, however, referred to by representatives from the Governmental sector. Pellicer-Sifres *et al.* (2021) highlight that energy poverty stigma can lead to citizens concealing hardship from outsiders; combining this knowledge with the assertions of our interviewee, we argue that denial of the condition makes citizens less likely to seek help. A reflection on the language used in targeted schemes would potentially increase adhesion to energy poverty policies.

The subtheme of lack of technical expertise was only identified by two organizational types (Environmental & Energy Agency & University representatives), referring specifically to a deficit of expertise among technicians in the energy transition supply chain (Figure 7.6). While this subtheme was not directly mentioned regarding energy poverty, it has implications for the speed at which energy efficiency works can be realised, where a dearth of qualified agents represents risks to energy transition success and thus indirectly to the mitigation of energy poverty and climate change. Therefore, an important next step for Portuguese policy, as for Southern European counterparts, is to increase the level of qualified expertise in the country, particularly as training activities can imply an undesirable time lag.

Energy poverty was considered a relatively recent concept, even at the political level. Uncertainties regarding definitions, measures and corresponding strategies impacted the public's awareness of the topic and their ability to improve their situation (as reflected in the corresponding subthemes in Figure 7.7). The lack of agreement around definitions and monitoring was considered problematic at the national level and EU levels. There has been much well-intentioned discussion on how best to define and measure energy poverty (Faiella, 2021); here, we reveal that prolonged debate can impede progress, which is a worthy reflection for policymakers.

Due to the poor quality of the building stock, a systemic level of energy poverty almost independent of income level was described, with several of the interviewees drawing on first-hand experience to describe coping strategies, as per interviewee PT004:

"...I live in the centre of Lisbon, and my apartment is from the '70s. It's so cold that I had to buy a dehumidifier because inside my house, the walls sweat".

This idea of a systemic vulnerability outside the constraints of income is substantiated in interview PT005 by a representative of a Consumer Organization.

"...What we have defended is that energy poverty is not the poverty of those who are economically most vulnerable, it's all those who, in their homes, independent of their income can't, don't have the capacity to maintain the respective thermal comfort and this is, this difficulty has direct implications for the consumer in question. Be it at the social level, be it at the economic level, be it at the health level."

Systematic vulnerability links closely with a concerning level of cultural acceptance of energy poverty outlined in the quote below, highlighted in Figure 7.7, which identifies culture as a subtheme and substantiated in the work of Horta *et al.* (2019).

" Many times, it's a question of choice and it's difficult to explain that to the person in question... The person prefers to put on a jumper, prefers to suffer than to maintain the house at 21 degrees.... It's a big fringe of society... these are people with good incomes that are like this" interviewee PT012.

Thus, improving building quality reduces the incapacity to achieve thermal comfort, correspondingly our findings support the strong drive for building stock renovation in Portuguese policy (DGEG, 2022). Indeed, as some interviewees commented, younger generations have higher thermal comfort expectations, this cultural shift is also found by Castro & Gouveia (2023) and may help promote policy success.

Several interviewees pointed out that the result of this systemic vulnerability manifested in adverse health effects. The reduced recognition of the severity of these impacts was a serious concern, as the below excerpt from Interview PT0026 shows:

"We are a country with really good weather, but we are among the countries where more people die from cold... Now, this theme people don't discuss much".

Importantly, under-recognition of the link between poor quality buildings and health implies a lower likelihood for citizens to undertake costly investments in energy efficiency, especially considering the economically constrained context of Portugal. Here an interesting contrast between the lack of engagement with the issue of Excess Winter Deaths in Portugal (as described in the above quote) and EU survey data arises. Where data from an EU survey showed that when asked whether climate change and environmental issues should be tackled as a matter of public health, 94% of Portuguese respondents agreed (EU, 2023). Building on our previous arguments, we suggest the reason for this discrepancy is a missing link in public perceptions between improving domestic energy efficiency and public health. Building quality issues were also viewed as problematic in the context of property tenure, concerning both private rentals and social housing. In the case of private rentals, interviewees raised the question of whether landlords or tenants should be responsible for energy efficiency investments.

Finally, a comparison of the two figures shows that overall, the subthemes linked with energy poverty tended to pertain less to the personal agency of citizens. For example, in the case of the climate change and energy transition agendas, subthemes of responsibility and motivations and conflicting interests suggest a degree of personal choice on the part of the citizens. We provide further reflections on this point in the following sections.

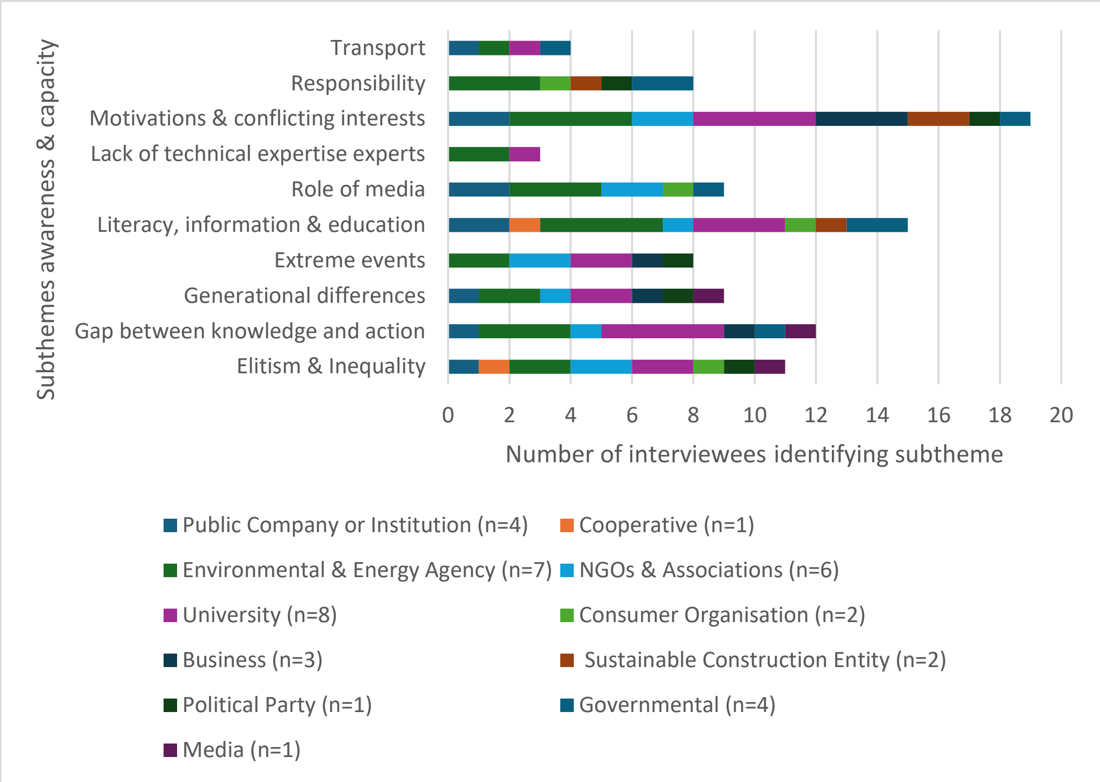

Figure 7.6 Subthemes awareness of & capacity to participate in CC and ET agendas (n=39)

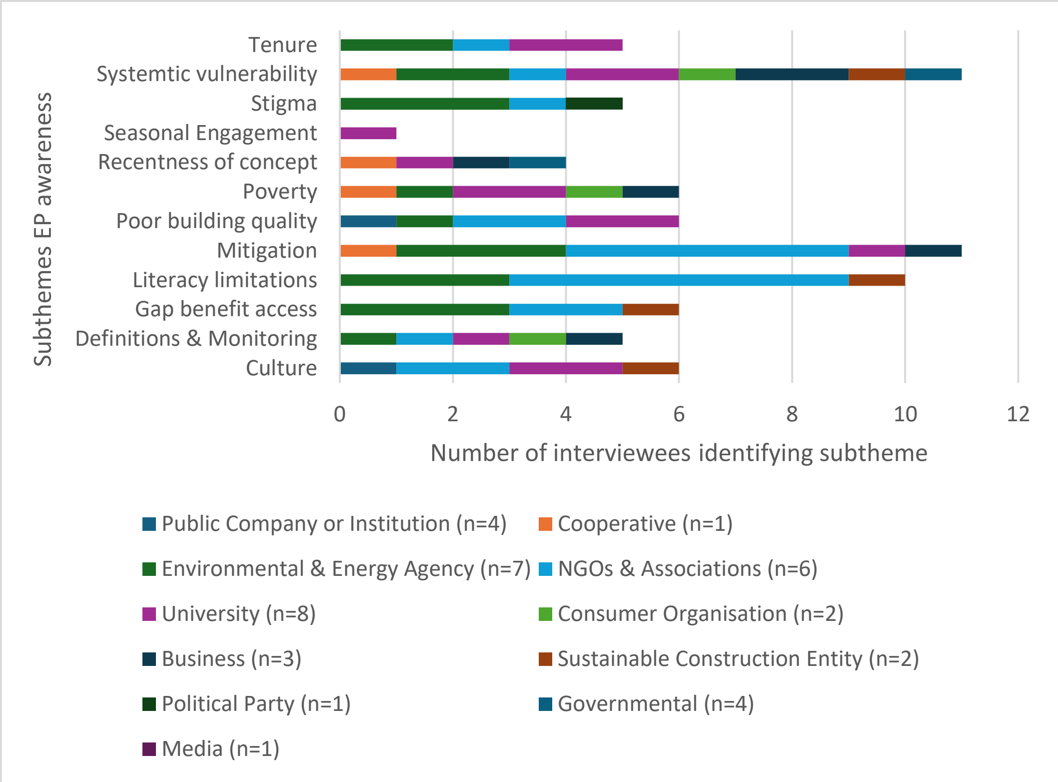

Figure 7.7 Subthemes public awareness of EP (n=39)

7.4.3.1. Factors of awareness and capacity

A deeper analysis of these subthemes and the interviewees' responses revealed three broad categories worthy of further investigation: Factors of awareness, factors of capacity and compounding effects. Awareness factors were those subthemes that affected the public's perceptions of the climate change, energy transition and energy poverty agendas, such as the role of the media. Capacity factors were defined as those subthemes which affected the public's ability to participate in the agendas, such as poverty. Applying this new lens revealed that the interviewees had identified several compounding effects in reference to participation in the agendas, which were typically amplified by the respective awareness and capacity factors, (shown in Figure 7.8). These compounding effects are not definitively either positive or negative, instead, the direction of their influence is context-specific. For example, the visibility of impacts when applied to climate change could equally imply reduced visibility of impacts due to lower literacy levels or increased visibility due to the increased frequency of extreme weather events. In both cases, however, the visibility of impacts is compounded by the relevant awareness factors in this case, literacy information and education and extreme events.

Importantly, similar subthemes, such as literacy limitations and literacy, information and education have been merged, as the latter seemed more appropriate to generically describe capacity to participate in the agendas. Others, such as mitigation or the gap in benefit access are more generally implied in this analysis, i.e., our exploration focuses on how the factors of awareness, capacity, and the corresponding compounding effects influence citizen's ability to access benefits or mitigate energy poverty, these subthemes aren't included in Figure 7.8 for this reason. Finally, our analysis indicates inter and intra-relations between the factors of awareness and capacity, often through the compounding effects. While the degree of inter-relation of awareness and capacity factors and the compounding effects differs, for example, transport does not obviously relate with extreme events, we find several inter-relations which have implications for citizen agency in the agendas of climate change, the energy transition and energy poverty in Portugal and explore these in the following sections through the combined results of Figures 7.6, 7.7 and 7.8.

7.4.3.2. Awareness factors

The increasing frequency of extreme events was seen as a clear contributor to increased agenda awareness, particularly weather catastrophes and energy price shocks due to the war in Ukraine. This intersected with the capacity factors of motivations and responsibility, as these events tend to have highly visible impacts and deepen the sense that something should be done. On the other hand, as identified previously, the recentness of the energy poverty concept and the lack of a common definition had the compounding effect of reduced awareness of the concept at both the Government and citizen levels, with corresponding impacts on the development of the supply chain.

The subtheme of literacy, education and information was seen as very influential on citizen awareness of the decarbonisation agendas. Various aspects of literacy were discussed, including general literacy, energy literacy, and digital literacy. Our interviewees generally referred to ideas of basic-energy-related knowledge, understanding the environmental impacts of energy production and consumption and behavioural changes, as per DeWaters & Powers (2011). Understanding cost benefit and return on investment were also considered forms of energy literacy, as in Brounen *et al.* (2013). References to digital literacy pertained to skills in the online accessing and management of information, as per, Ali *et al.* (2023).

Higher levels of these different literacy types (generally attained through higher levels of education) were perceived to enhance information management abilities (representing a positive compounding effect in this case). This, in turn, improved the capacity to participate in the agendas and, indeed, to access energy transition benefits and mitigatory measures for energy poverty (such as funding for energy efficiency measures). Digital literacy limitations were linked with generational differences, computer access, and a reduced ability to fill in funding applications based on online forums (as required by the More Sustainable Buildings II and Efficiency Voucher programmes discussed earlier). A key perceived contributor to generational differences in literacy was the pre-democracy era in Portugal, when illiteracy levels were high, at 25.7% in 1970 (INE, 2014). These results correspond with the work of Marra & Colantonio (2021), which finds that education is an important facilitator of increased public consumption of renewable energy. According to our interviewees, discrepancies in literacy skills linked to the theme of elitism and inequality (discussed in the following sections) through the creation of an increasing social gap, indicative of a negative compounding effect where lower literacy led to increased inequity.

We also observe intra-relationships between the awareness factors. For example, literacy, education, and information overlapped with the role of the media in that literacy competencies influenced the ability of the public to access and digest media material. Specifically, the role of the media was linked to ideas of scepticism and mistrust, with social media identified as a spreader of misinformation. This revealed that the role of the media was perceived to be powerful and as having both positive and negative effects on the agendas. Government officials particularly emphasised the challenge of misinformation and its impacts on policy adhesion, describing social media as 'noise', which is difficult to combat. Media is thus perceived to influence motivations and conflicting interests through the compounding effects of mistrust and disillusionment, which partly explains the commonly expressed view that a generally high level of awareness of climate change and the energy transition does not translate into participation. This is bolstered by the knowledge versus action gap that interviewee PT001 pertains to below:

"I think that the "knowing", between knowledge and understanding, a person being aware of the situation to their attitude and behaviour, sometimes a lot of time passes, and it takes a while. Therefore, it's difficult for a person to change like that suddenly, some habits in the, in the day to day, I think. Still, there is that laziness or that natural tendency not to change, to see what happens, wait a while and see if things get better."

The quote shows that in this interviewee's perception, there is a level of inertia which is optional. In the description of *"laziness*" and the "*tendency not to change*", the interviewee suggests that engagement is a matter of choice, rather than being dictated by individual circumstances (e.g., literacy level, socioeconomic status). In this sense the identified knowledge versus action subtheme highlights an important insight for understandings of citizen agency, where those who are informed and able will not automatically become active participants. This assertion contrasts with the generally positive view of citizen of citizen agency promoted in European and Portuguese policies (APA, 2019a, b; EC, 2019).

This notion of optional participation occurred in energy poverty more at the cultural level (as described previously) and ties into the cultural norms highlighted by Horta *et al.* (2019) where citizens who had sufficient income still suffered thermal discomfort, however, this was perceived as unconscious choice rather than as "*laziness*". A relevant contributor to this occurrence may be that individual behaviour changes do not have immediate visible impacts on climate change mitigation. Similarly, an interviewee noted that investment in literacy activities does not have directly measurable impacts, which makes them less attractive to policymakers.

Despite these challenges, Portuguese policies place a strong emphasis on the potential of increasing energy literacy (APA, 2019a, b; DGEG, 2022), however, we observe that a combination of awareness and capacity factors, such as the role of the media and the knowledge versus action gap can lead to compounding effects such as inertia and disillusionment. Thus, we argue that the benefits of educational activities have limitations. Valenzuela-Flores *et al.,* (2023) found such limitations, revealing that families with higher educational levels in Chile did not necessarily reduce electricity consumption after participating in an energy literacy programme. In our case, generational gaps in literacy and the negative impacts of social media were perceived as current policy barriers, where social media can exert complex influences over context-specific climate change perceptions (Tuitjer & Dirksmeier, 2021). Portugal and Europe remain in the early stages of understanding these effects.

Ultimately, these reflections reveal different layers to the concept of citizen agency, where precise definitions of conscious choice, unconscious actions and inability to act warrant further investigation.

7.4.3.3. Capacity factors

We found similar discrepancies in the interviewee's perceptions of the level of personal agency in the subthemes of responsibility, elitism and inequality, and general challenges around accountability. A key influence on capacity to participate was seen as housing tenure, as per Interviewee PT020 when discussing public capacity to mitigate energy poverty:

"And then I think there is another layer of energy poverty, maybe the middle class, lower middle, which are the people that live, that live (in houses that) aren't their own and therefore they can't intervene to renovate."

Here, comparing our results with the work of de La Paz *et al.* (2022) shows considerable similarities with Spain regarding systemic vulnerability, building quality and tenure. Like Portugal, Spain exhibits high private home ownership rates yet presents a high level of energy poverty within this homeowner group. Furthermore, within the 12% of properties that constitute the rental housing sector, 3.2%–3.4% of households are in energy poverty. A parallel in vulnerability is also evident between Portugal and Italy, where Castro & Gouveia (2023) found equal levels of energy restriction behaviours among student renters in Lisbon and Padua.

Questions of who should and should not be required to adapt their behaviour due to the energy transition were raised at both the organizational and the citizen level. They linked the subthemes of responsibility, elitism, and inequality. Indeed, at the organizational level, a Government interviewee noted that responsibility for mitigating climate change is not solely a Government concern, implying the necessity of citizen action. Research at the European level shows that in Portugal, 47% of survey participants viewed national governments in the EU as responsible for addressing climate change, compared with 28% who saw this as a personal responsibility (EU, 2023). Questions of responsibility link to energy poverty and the need to reduce domestic energy consumption; in this vein, Interviewee PT011 reflected that:

"The answer is simple; the answer is that global objectives are a common challenge. But this doesn't mean that we all have to give the same contribution and some people, you can't demand this contribution from them. They should, they should, including, this just means an extra effort on the part of the other people who have benefitted quite a lot. Those who have emitted..."

Here, we draw a broader connection to theories of energy justice and inequities linked to the energy transition (McCauley *et al.,* 2019) and links with the identified subthemes of responsibility, elitism, and inequality. In the Portuguese case, as with many other nations, the combined pressures of climate change and energy price increases incentivise a drive for energy independence. This unintentionally contributes to a fragmented nationalised vision of energy systems, which tends to undervalue trans-local adverse impacts (Jenkins *et al.*, 2017). In Portugal, the drive to decarbonise is generally viewed from a national policy perspective, with less accounting for regional nuances of policy effects (Mahoney *et al.,* 2022). This national policy approach does not account for just the allocation of energy transition benefits and burdens. With protests against mining exploration occurring in rural areas of the country (Pinto, 2021) and the rapid deployment of large-scale solar plants in economically disadvantaged zones (Silva & Sareen 2020), this centrist approach poses risks to the acceptance of energy transitions in Portugal.

Finally, linking to discussions of citizen agency in the previous section, the subtheme of motivations and conflicting interests added a further dimension to the question of citizen agency. Specifically, interviewees noted that due to the demands of daily life, some simply did not have additional resources (time or economic to give to climate change). This overlapped with the subtheme of elitism and inequality and the perception that involvement in decarbonisation agendas was a luxury, rather than a choice (as below when discussing knowledge and participation in climate change and energy transition agendas):

"It's an elite, continues to be an elite, uh, uh, in the end speaking about the matter (climate change), discussing it and worrying about it." Interview PT011

Here we find that citizen capacity to participate in both climate change, energy transition (which we view jointly here) and energy poverty policies is compounded by socioeconomic status and unclear understandings of responsibility. Critically, drawing on the outputs of the previous section, which uncover various nuances to citizen agency including factors which can detract from citizens motivations (such as contradictory media information), we argue that those who don't perceive themselves as responsible will be less incentivized to participate.

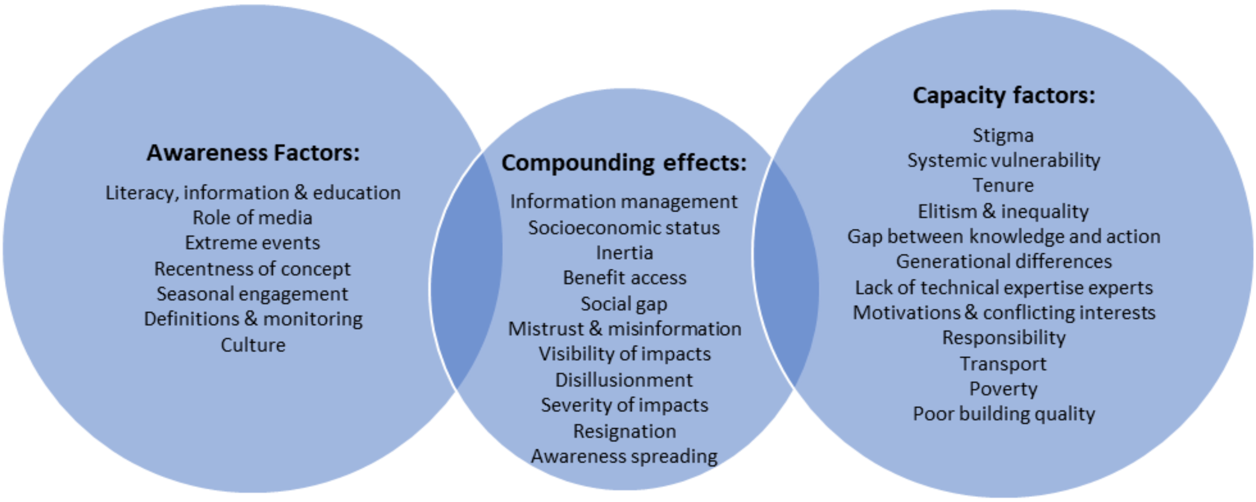

Figure 7.8 Factors of awareness, capacity and compound effects in the CC, ET and EP agendas

7.5. Conclusions and Policy Implications

We employ an exploratory qualitative interview approach to evaluate the political agendas of climate change, energy transition and energy poverty in the Portuguese national context. Our interviews with experts with diverse experiences in these various agendas reveal several areas of agreement, including a perceived gap between the theoretical ideal of linking these agendas and the reality on the ground, a shared perception that the current policy approach remained inaccessible to the most vulnerable groups in society and the perception of a general level of energy poverty in Portugal, sometimes independent of income level (due to poor building quality and cultural habits). This suggests that a broader fringe population group is affected by energy poverty in Portugal than those captured by income-based measures alone. In identifying these policy gaps, we achieved our aim of gaining a better understanding of how the policy agendas of climate change, the energy transition and energy poverty intersect. We also deepened insights into the perceptions of different groups and the relevant implications for policy synergies.

The results of agenda disconnection at the policy level led to several "competing agendas" centring on uneven access to energy transition benefits, including alternative energy models and adhesion challenges for the energy poor concerning energy efficiency programmes. Other important competition points were the use of sustainable building materials in the supply chain, essentially putting human needs above those of nature and a lack of visible return on investment both at the political and the domestic level. This referred to investment in literacy-boosting policies in the political case and to climate mitigation activities at the household level.

Identifying these competition points contributed to our development of the "influences on awareness" and "influences on capacity", which we argue is an innovative contribution of this paper, providing a deeper reflection on the nuances of citizen agency. Citizen agency was viewed very differently by our interviewees, despite a firm reliance on this concept in both the Portuguese and the EU contexts. Critically, our results present a high level of subjectivity regarding the level of choice citizens had when it came to participation in decarbonisation agendas.

Based on a combination of the identified competing agendas and our awareness and capacity factors, we make the following recommendations for the development of the Portuguese decarbonisation policy:

1. Increase the values offered towards renovation works in targeted energy poverty schemes to achieve meaningful interventions
2. Definitions of energy poverty should reflect the broader fringe affected by poor building quality, not just those in economic poverty
3. To overcome the mentioned cultural and behavioural challenges, improving energy literacy is important but has limitations. To enhance the benefits of literacy programmes, focus on the multi-faceted positive benefits of participation to citizens, such as the betterment of personal health through improved building quality, emissions, and financial savings
4. Conduct citizen surveys and interviews to understand who can participate in carbon neutrality agendas and how. Themes of socio-economic status, educational status, as well as digital and general literacy and how these interlink are of particular importance here

To conclude, we suggest that an essential next step in the Portuguese case would be to gain insights into these issues at the citizen level, as our results offer a first glimpse into the topics covered through the eyes of our interviewees. On this note, we emphasize that our findings refer strictly to the interviewees included in our analysis, and wider comparisons should be supported by evidence from the case in question. That said, we assert that a deeper reflection of the competing aspects of the agendas explored in this paper is essential, as is a more nuanced understanding of what enables citizens to participate in carbon neutrality agendas. We consider further work in this area urgent in the creation of just and inclusive policies that can unleash synergies as European countries work to achieve laudable ambitions in the mid-2020s and beyond.

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Chapter 8 | Loops, Triangles and Transitions- Participatory Perspectives on Energy Poverty Policies in Portugal

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Paper submitted and under review:

Mahoney, K.,., Lopes, R. and Gouveia, J, P. "Loops, Triangles and Transitions- Participatory Perspectives on Energy Poverty Policies in Portugal". Submitted and under review.

Abstract:

Current policy trajectories integrate energy poverty under the broader decarbonisation policy agenda; links between energy poverty, building efficiency and energy prices justify this approach; however, the multi-dimensional nature of energy poverty means it intersects several policy sectors. In recent years, research has uncovered a comprehensive set of policy debates linked to energy poverty, yet understandings of the interrelations of these debates are relatively underdeveloped. Furthermore, the energy poverty system consists of diverse actors with different visions of how energy poverty should be tackled. Elaborating on these different visions is essential for policy acceptance. We employ a participatory workshop method to build a Causal Loop Diagram depicting the energy poverty system in Portugal, where energy poverty is prevalent, but uptake of renewable energy is high. The resulting Causal Loop Diagram reveals solutions and challenges for energy poverty mitigation in Portugal, exposing narratives around the causes of energy restriction behaviours, drivers of increased maintenance of the building stock and alternative energy models incentivized by citizen participation. The conclusions present a set of policy and research recommendations for Portugal which centre on enhancing citizen participation in energy transition activities.

Keywords

Energy poverty, Participatory Workshop, Just Transition, Citizen Participation

8.1. Introduction

In the context of increasing pressure for rapid decarbonisation of the energy supply, global governing bodies such as the European Union (EU) are searching for pathways to address the inequities associated with energy systems in their current form. One such inequity is energy poverty (EP), generally understood as a lack of sufficient access to energy services (Bouzarovski & Petrova, 2015). Mitigating energy poverty presents a natural synergy with policies such as the European Green Deal (COM/2019/ 640 final) and the Renovation Wave (COM/ 2020/ 662 final), which include ambitious targets for improved energy efficiency and decarbonisation of heating and cooling systems. Additionally, recent EU policy moves, such as the Revision of the Energy Efficiency Directive, require the prioritization of energy-poor consumers in implementing energy efficiency measures. Member States must also assess the number of households in energy poverty and implement supportive policies where there is a “significant incidence” of the condition (COM/2023/ 650 final) (pg. 23).

Despite the broader EU (and indeed global) decarbonisation policy context in which energy poverty is situated, mitigation of energy poverty requires improvements at the individual household scale. Thus, the problem is multi-scalar and involves multiple stakeholders (Hale *et al.*, 2023). For this reason, while measures such as energy efficiency improvements and lower energy costs can be considered as generally applicable remedial approaches, the resolution is, in fact, far more complex and presents a political challenge. This challenge stems from the diversity of contextual specificities such as culture, household demographics, physical building characteristics and geographical location (Robinson *et al.*, 2018; Gouveia *et al.*, 2019), as well as socio-political influences (Gillard *et al.*, 2017; Hargreaves & Middlemiss, 2020) which can influence how a household experiences energy poverty and how well positioned they are to take advantage of mitigatory policies. Therefore, no "one size fits all" approach to energy poverty can be consistently applied across the European context.

In response to the need for tailored approaches, initiatives such as the European Energy Poverty Advisory Hub (EPAH), which supports local European governments in implementing decarbonisation and energy poverty mitigation strategies (EC, 2023), have emerged. However, there is still some way to go in creating synergistic approaches to decarbonisation and energy poverty policies which do not "leave anyone behind". For example, in Spain, citizen awareness and education levels have been highlighted as potential barriers to the uptake of energy communities (Parreño-Rodriguez *et al.*, 2023). In the UK, low digital literacy and resource limitations associated with smaller "grassroots" retrofit schemes pose challenges to energy poverty mitigation efforts (Putnam & Brown, 2023). In Portugal, Mahoney *et al.* (2024) found that expert stakeholders perceived higher levels of education and literacy as important contributors to participation in the energy transition, with corresponding impacts on access to energy poverty mitigation measures.

In line with European policy movements, Portugal has placed energy poverty mitigation within its decarbonisation policy trajectory, feeding into narratives of delivering a just and fair energy transition. Noteworthy contemporary decarbonisation policies in Portugal include the 2050 Carbon Neutrality Roadmap (APA, 2019a), the National Energy and Climate Action Plan (APA, 2019b) and the 2021 Climate Law (Diário da República, 2021). Importantly, these policies (albeit to greater or lesser degrees) refer to energy poverty and the need to mitigate the condition. After a somewhat shaky performance under the Kyoto Protocol, Portugal´s rate of renewable energy uptake has been impressive; where between the years 2000-2019, renewable energy supply in Portugal increased by 26%, accounting for 28% of total final energy consumption in 2019 (IEA, 2021). Portugal's political recognition of energy poverty is relatively recent, with an official strategy published in early 2024 following two rounds of public consultation on the document (República Portuguesa, 2024).

To date, evidence demonstrating how different policies, measures, and targets impact the various strata of the population in Portugal is still emerging. Delicado *et al.* (2023) highlight a challenging institutional setting for alternative energy models (which should theoretically mitigate energy poverty) where large project tenders are auctioned. This scenario favours larger and well-established energy companies. More positively, a pilot energy efficiency project called the "Transition Point" testing a mobile One Stop Shop found that the appropriate location of the unit, positive messaging, and the involvement of local, trusted agents helped boost attendance. The limited financial capacity of vulnerable households was identified as an important future area of focus (Gouveia *et al.,* 2023). Scharnigg & Sareen (2023) reveal that funding conditions for individual solar installations in Portugal are more favourable for independent houses than for houses of multiple occupancy, implying divisions in access to energy transition benefits, in this instance, cheaper and cleaner energy. Finally, Standal *et al.* (2023) find that a lack of concrete examples obscures clear visions of what renewable energy communities in Portugal entail, contributing to a sense of mistrust among citizens.

In summary, Portugal is in the early stages of implementing energy poverty policies under the umbrella of decarbonisation goals. The inter-sectional relations between energy poverty and decarbonisation efforts implicate multi-disciplinary actors from the local to the national scale. To address the challenge of delivering decarbonisation policies inclusively, it is important to understand the complexity of the system underpinning energy poverty in Portugal. Thus, we propose a Participatory Systems Mapping (PSM) approach. PSM has previously been applied in different fields, such as ecosystem services and sustainable consumption, which, like decarbonisation policy, involve multiple values and require a high level of stakeholder participation for policy success (Sedlacko *et al.,* 2014; Lopes & Videira, 2015). Considering the complexity inherent to meeting the various goals implied by tackling energy poverty through decarbonisation policy, we argue that PSM is a suitable method to structure the engagement of stakeholders in identifying the main interactions between different policy domains. Furthermore, this method facilitates a deeper understanding of potential energy poverty solutions.

To the authors' knowledge, the application of PSM techniques in the field of energy poverty remains relatively unexplored. Hale *et al.* (2022) apply participatory behavioural systems mapping to the challenge of decarbonising homes in Wales, touching on fuel poverty but not taking a specific focus on this element. In 2021, Barbrook-Johnson & Penn explored UK policies which affect the "energy trilemma", namely the provision of secure, sustainable and affordable energy to test the utility of systems mapping in policy evaluation processes. This work sets the scene for further exploration of maps in similar processes. Che *et al.* (2023) employ CLDs to illustrate feedback loops in the energy poverty system in China. However, this method is used as a precursor to further quantitative methodologies and thus has a reduced emphasis on the participatory element of the analysis. Furthermore, as a zone with high vulnerability to climate change (CC) (Feyen *et al.*, 2020), generally high levels of energy poverty (Bouzarovski & Tirado Herrero, 2017) and comparatively low incomes in (Eurostat, 2023), Southern Europe is a particularly relevant study setting. Portugal, positioned as an energy transition frontrunner (IEA, 2021), where conversely, energy poverty levels are particularly severe (Gouveia *et al.,* 2019), presents a particularly intriguing case. Thus, the study's overarching aim is to create a holistic vision of the Portuguese energy poverty system, mapping the interrelations between different variables and understanding their causal relations. In doing so, we aim to contribute to policy recommendations for energy poverty mitigation in the broader framing of decarbonisation pathways.

The article structure is as follows; the Methods are presented in Section 8.2; the Results & Discussions (Section 8.3) outline the causal relationships and policy pathways in the Portuguese energy poverty system. Section 8.4 concludes, offering research and policy recommendations based on the findings of this paper.

8.2. Method

To develop a holistic understanding of the Portuguese energy poverty system, a Participatory Systems Mapping workshop was undertaken. During the workshop 35 participants were split into five working groups to develop a Causal Loop Diagram based on one of the drivers of energy poverty, with at least one moderator per table to guide the process. The co-construction of CLDs is particularly valuable in its capacity to provide insights into the dynamic nature of the relationships between different elements in the system, some of which remain relatively undefined in these early stages of policy engagement with energy poverty in Portugal. With European initiatives underscoring the fundamental role of local interventions in energy poverty mitigation (EC, 2023), the workshop included participants operating at the local scale and encouraged reflections on the role of local agents in energy poverty mitigation.

Building on an earlier qualitative interview phase, which explored the interactions of the climate change, energy transition and energy poverty agendas in Portugal (Mahoney *et al.*, 2024), the workshop required participants to contribute to the development of Causal Loop Diagrams that represent the integrated energy poverty system in Portugal. In energy transition and decarbonisation studies, PSM has been recommended in instances where the emphasis of the study is on stakeholder engagement and where the aim is to reflect complexity (Barbrook-Johnson & Penn, 2021). Similarly, in their exploration of the decarbonisation of the building stock in Wales, Hale *et al.* (2022) consider PSM a valuable approach for policy-decision-making scenarios, which imply multiple actors with diverse perspectives on the system. Gudlaugsson *et al.* (2022) recommend CLDs for understanding policy design challenges on energy transition pathways, primarily due to their ability to conceptualise the multifaceted problems encountered by policymakers. In testing the PSM approach in the context of energy poverty, this paper presents an innovative progression of these important works.

The participatory modelling process consisted of three key stages (following: Lopes & Videira, 2015), which we label as the pre-workshop, workshop and postproduction phases (shown in Figure 8.1), each entailing its associated set of activities. A description of each phase and the corresponding activities (as articulated in Figure 8.1) are provided subsequently. Importantly, due to limited studies focused on participatory modelling in energy poverty (described in the previous section), we have adapted techniques from other environmental fields (for example, sustainable consumption, ecosystem services, and sustainable tourism) (Sedlacko *et al.*, 2014; Lopes & Videira, 2015; Tourais & Videira, 2021).

PSM aims to depict diverse perspectives in a single model (Wu *et al.*, 2021); in other words, this approach gives insight into the complex system surrounding an issue (which includes diverse stakeholder viewpoints and the co-constructed view of the group participating in the CLD development) instead of viewing the problem in isolation. CLDs, also known as system maps, are a specific type of model representation used in systems dynamics approaches (Forrester, 1971; Lane, 2008; Sterman, 2000) and allow the identification of feedback processes through the use of variables (labels used to describe the various elements in a system, e.g., income and living costs). Arrows in the diagram represent the causal links (the direction of the relationship) between two variables, and the type of relationship (positive or negative) is represented by a "+" in the case of a positive relationship and a "-" in the case of a negative relationship. A series of links can form feedback loops, categorised as reinforcing or balancing (Lopes & Videira, 2017). Where a reinforcing loop maintains change in the same direction and a balancing loop counteracts change, generally loops with an uneven number of "-"'s are labelled as balancing and loops with an even number of "-"s are labelled as reinforcing (Kim, 1999; Sternman, 2000).

Stakeholder interests in the energy system present a range of overlapping, shared and competing interests at multiple scales (van der Schoor, 2016; Creamer *et al.*, 2018; Sovacool *et al.*, 2020). The benefits of the collaborative process, namely a widening of stakeholder perspectives and thus potentially greater understanding between different groups (Wu et al., 2021), demonstrate the relevance of this method for our research question.

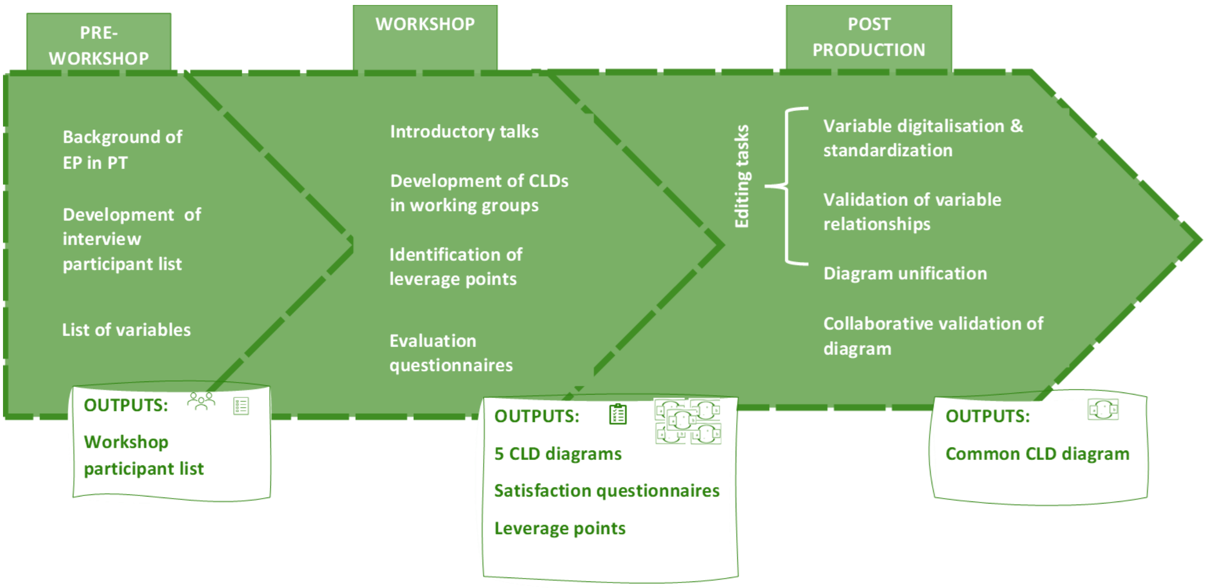

Figure 8.1 Workshop method schematic

The pre-workshop phase gathered collaborative insights into the policy landscape and stakeholder groups active in the area. Here, we draw on approaches recommended by Lopes & Videira (2015), Hale *et al.* (2022) and Rossade *et al.* (2023), who suggest scoping activities to set the scene for the case, as in the former two instances, both policy review and stakeholder engagement activities are recommended, in this case we drew on inputs from a policy assessment and qualitative interviews with expert stakeholders which the research team had previously undertaken. Both research activities focused on the degree of integration of energy poverty into decarbonisation policy in Portugal, as elaborated by Mahoney *et al.* (2022) and Mahoney *et al.* (2024). The second and third steps of this phase (with inputs from the preparatory phase) were the development of a workshop participant list and a list of variables for use during the workshop as a prompt for participants if necessary.

It is important to add that the workshop was held as a national activity by the Energy Poverty Advisory Hub. EPAH is the leading European initiative aiming to support energy poverty mitigation at the local scale. With increased policy emphasis on energy poverty in Portugal, running the event as an EPAH activity had the advantage that the participants were familiar with the project and willing to engage with events within its scope.

The 35 participants were engaged in a four-step workshop (Figure 8.1). The first step was an introduction to the Portuguese case study, which included talks from workshop participants involved in different areas of energy poverty in Portugal. The talks focused on themes of Governance, Energy efficiency financing programmes, Community Energy and Local level citizen support); the second was the development of collaborative CLDs. For this activity, the attendees were divided into five working groups, and each group was attributed a "driver" of energy poverty to focus on as the starting point of the problem to be mapped. These drivers were income, energy efficiency and energy price, which are recognised as elemental drivers of energy poverty (Boardman, 1991; C/2023/4080). There were two working groups for energy efficiency and income and one for energy prices. Participants were orientated with a leading question, which aligned participants' perceptions towards a common goal and created a shared baseline for generating comparable diagrams (Lopes & Videira, 2015). Each working group was asked to map the energy poverty system based on their given driver. Building on the system map they had developed; participants were asked to consider how local solutions could contribute to mitigating energy poverty.

The working group activities led to five different CLDs, one for each group. Workshop participants were asked to give a short presentation of the resulting diagram from each group, allowing them to share their process for building the diagram and main discussion points. After sharing their insights, participants were asked to mark "leverage points" on the CLDs constructed by the other groups. Participants circulated through the different groups to mark the leverage points, allowing them to reflect on the different variables and connections. Leverage points are defined by Kim (1999) as "An area where a small change can yield a large improvement" pg.19. At the end, participants were asked to fill out an evaluation questionnaire. To conclude the workshop phase, a round-up discussion summarised the existing body of work on the research topic and the next steps for developing a common diagram based on the workshop outputs.

The final part of the participatory mapping process was the postproduction phase, consisting of three editing tasks. Lopes & Videira (2015) identify two key editing tasks in this process:

format editing and content editing. To these, we add a third task (Figure 8.1) to describe our method of unifying the CLD diagrams, adapted from Lopes & Videira (2015; 2017). We summarise these briefly below:

Format editing - Digitalisation of the variables from the workshop versions of the CLDs into a common file. A standardisation process followed, which involved a thorough revision of all the variables and a cross-comparison of all the variables from the five diagrams. This cross-comparison allowed for the removal of duplicates. At this stage, intermediate variables were developed where necessary; these reflected concepts expressed in the CLDs, which were then further adapted for suitable use in the common diagram.

Causal links - In this step, each of the five diagrams were checked for any missing relationships between variables; the polarity of relationships was also identified if it had been omitted from the original version. At this stage, we also created digital copies of the CLD diagrams. A check was made for feedback loops in the diagrams.

Diagram unification - Having digitalised the variables and verified the causal links, we unified the five CLDs into one. We started this phase by unifying all the variables and corresponding relationships in one diagram. Drawing on the core structures of the energy poverty systems represented in each of the individual diagrams, this unified version was adapted to create a clear and meaningful representation of the ideas expressed in the workshop. To simplify the diagram, repetitive ideas were merged, and adaptions of the variables were cross-checked against the originals. This phase was complete only when we had a version of the diagram that accurately represented the concepts articulated in the five original versions. This was achieved through the internal revision of several iterations of the diagram by the research team.

The combined results of the post-production phase contributed to the development of a series of "loop narratives" described in Section 8.3.1 (Figures 8.3-8.7). These narratives emerged iteratively by reflecting on the key themes articulated in the workshop and the translation of these themes into variables and causal relationships throughout the three post-production stages. For example, the narrative "Cost of living causing bill arrears and reduced thermal comfort; bill arrears as a driver of vulnerability" combined relationships identified by different working groups describing causalities between the cost of living, debt, and thermal comfort with the distinct but linked relationships between thermal comfort and health and quality of life, where poorer health ultimately leads to greater vulnerability.

Development of the loop narratives facilitated a deeper reflection on overarching themes that bridged these narratives, revealing two main pathways representing the perceived solutions to the various problems in the system, according to the workshop participants. These pathways are outlined and evaluated in Section 8.3.2. For example, the pathway "Energy restriction and building renovation" is derived from loop narratives linking energy consumption and human well-being and combining these with narratives proposing building renovation as a tool to target both energy restriction and climate change problems. Unpacking the solution pathways in this way provided an opportunity to comment on the dynamics of the proposed solutions. It also promoted the exploration of generally under-recognized topics in Portugal, such as energy disconnections (discussed in later sections).

The number of participants by organizational type, including the moderators, is shown in Table 8.1. The workshop participants consisted of key stakeholders in the Portuguese energy poverty system, operating at different scales (from the national to the local) and with a wide range of expertise (from consumer protection to civil engineering), thus despite the skew towards the “University” category the mapping activity and following roundup talks resulted in a well-balanced discussion.

Table 8.1 Number of workshop participants by organizational type

Organization Type	Number of participants
Energy & Environment Agency	5
Cooperative	1
NGO & Associations	6
University	14
Media	1
Consumer Organization	1
Governmental	7

8.3. Results and Discussion

Figure 2 presents the unified Causal Loop Diagram (CLD) following the postproduction process described in the Methods section, outlining the causal relationships in the Portuguese energy poverty system as perceived by our workshop participants. The CLD also reveals how the workshop participants viewed local solutions to energy poverty. Despite the focus on the local scale, the energy poverty system, as perceived by workshop participants, included broader national or international variables, e.g., "Legislation and regulation". This highlights that the multi-dimensional nature of energy poverty renders it subject to influences on a larger scale; for instance, "Energy prices" are influenced by "External dependency".

Comparison of the variables identified in the diagram shows a reasonable degree of overlap with works scoping out the breadth of topics which are linked to energy poverty, e.g., education, health status and national economic conditions (Stojilovska *et al.,* 2020; 2022; ul Husnain *et al.,* 2021). Variables such as "Professional training" and "Bureaucracy" are particularly relevant in the Portuguese case, where bureaucratic processes in energy community establishment have been problematic (Scharnigg & Sareen, 2023). Detailed statistics on the Portuguese retrofit market are difficult to locate but calls for rapidly increasing the renovation rate (Palma *et al.,* 2021) imply an increased need for skilled professionals in the face of youth emigration trends stemming back several decades but particularly intense following the 2008 global economic crisis (Justino, 2016).

In addition to the variables, the diagram reveals several balancing and reinforcing loops representing essential dynamics in the Portuguese energy poverty system. The reinforcing and balancing loops labelled correspondingly in the diagram uncover a set of critical narratives depicting systemic patterns relevant to the resolution of energy poverty (loops B1, B6, R3), as well as some systemic challenges to the realisation of this aim (loops, R1, R2, R4, R7). The following sections present these loops and their corresponding narratives. Finally, at the conclusion of the workshop, participants were asked to identify variables they perceived as leverage points in the system and to complete an evaluation questionnaire. These leverage points are outlined in the diagram; the workshop evaluation results are presented at the end of this section.

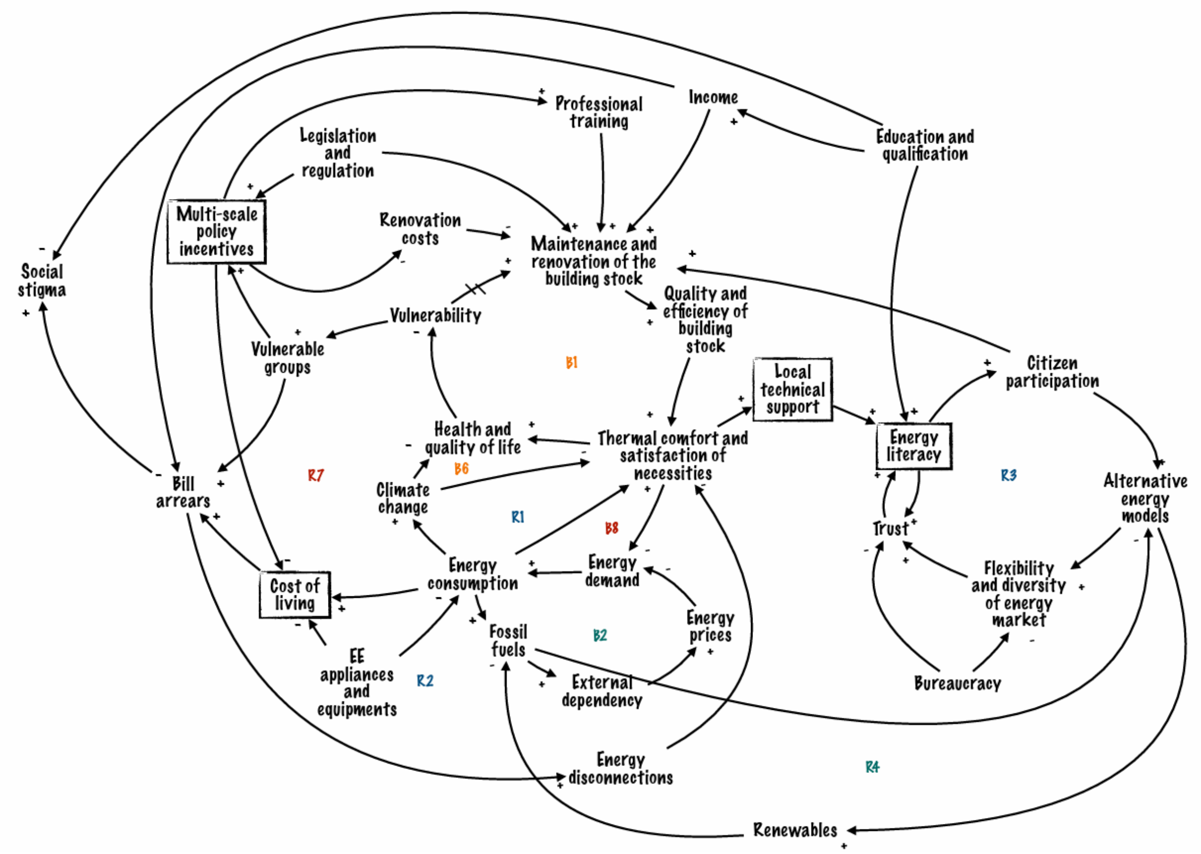

Figure 8.2 Unified CLD diagram representing the Portuguese energy poverty system (leverage points marked in squares)

8.3.1. Loop narratives

Drawing on the loops presented in the final CLD and the iterative process described in the Methods section, the following sections detail the key narratives the diagram depicts in Figures 8.3-8.7. It is important to note that all relations represented should be read according to the rule of *ceteris paribus*, translated as "as all other things being equal", meaning that the relation between two variables should be viewed in isolation.

Buildings' renovation as the primary response to energy poverty and climate change (B1 & B6)

Loops B1 and B6 (Figure 8.3) both illustrate this relationship, where in the case of B1 "Vulnerability" acts (after a delay) as a driver of increased "Maintenance & renovation of the building stock" to increase "Quality & efficiency of building stock", this improves "Thermal comfort and satisfaction of necessities" which positively affects "Health & quality of life", thus reducing "Vulnerability", illustrating the positive impacts of renovation on energy poverty. The additional benefits which occur as a result of renovation are shown in B6, where "Thermal comfort and satisfaction of necessities" drives "Energy demand", increasing "Energy consumption", leading to intensified "Climate change", which reduces "Health & quality of life", this increases "Vulnerability", which (as in B1) drives, "Maintenance & renovation of the building stock", and, assuming all other variables are constant, mitigates the impacts of climate change and energy poverty simultaneously. These loops confirm current policy trajectories encouraging building renovation and energy efficiency measures (APA, 2019a; APA, 2019b; COM/2020/ 662 final), showing the alignment of the workshop participants (important stakeholders in the Portuguese energy poverty system) with this course of action.

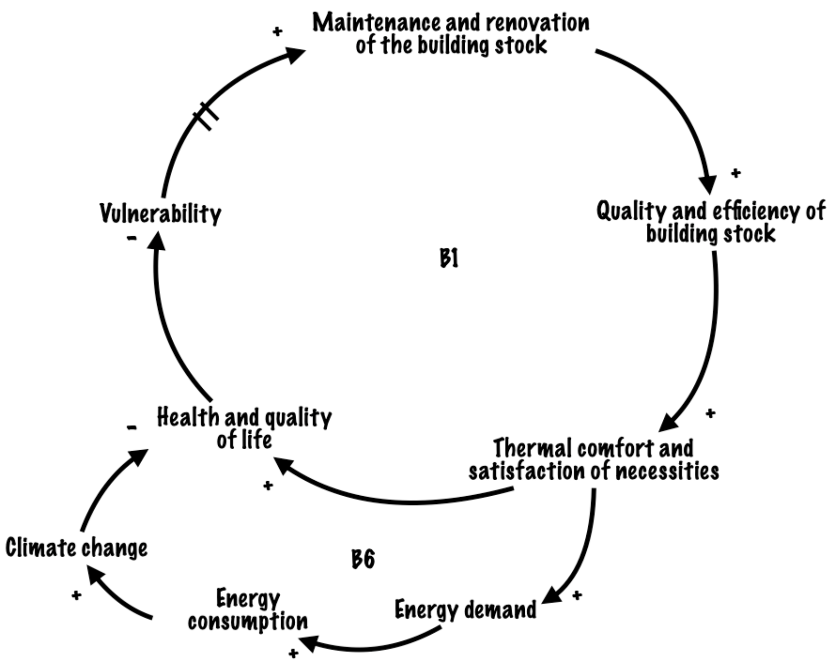

Figure 8.3 Loops B1 & B6 renovation as response to EP & CC

Climate change as a driver of reduced thermal comfort and increased energy consumption (R1)

Loop R1 (Figure 8.4) highlights the threat "Climate change" poses to "Thermal comfort and satisfaction of necessities" where the worse the effects of "Climate change" the lower the levels of "Thermal comfort and satisfaction of necessities", where considering all other variables to be constant, higher "Thermal comfort and satisfaction of necessities" reduces "Energy demand" and higher "Energy demand" increases "Energy consumption", ultimately more "Energy consumption" results in more severe "Climate change" impacts. Critically, this loop is relevant to works such as Gouveia *et al.* (2019) and Gouveia & Palma (2019), which indicate threats to the Portuguese decarbonisation strategy as a result of the thermal comfort gap in

Portugal and the amount of energy needed to bridge it. It is also significant to note that R1 exposes challenges for energy poverty and climate change policy agendas.

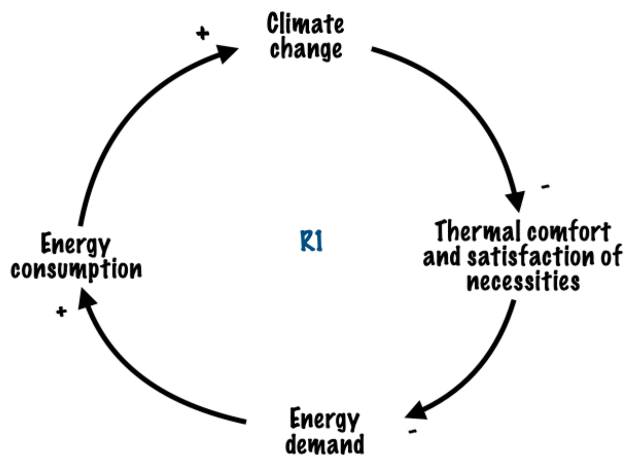

Figure 8.4 Loop R1, CC impacts on thermal comfort & energy consumption

Cost of living causing bill arrears and reduced thermal comfort; bill arrears as a driver of vulnerability (R2, R7)

The reinforcing R2 (Figure 8.5) loop shows how "Bill arrears" contribute to reduced "Thermal Comfort & satisfaction of necessities", where the higher the "Cost of living", the greater the level of "Bill arrears" and the more "Energy disconnections", this reduces "Thermal Comfort and satisfaction of necessities", which (where all other variables are equal) reduces "Energy demand", lessening "Energy consumption". R2 also shows a negative causal relationship between "Energy disconnections" and "Thermal comfort and satisfaction of necessities", highlighting the relationship between energy and human well-being (Pesch *et al.,* 2023). Loop R7 illustrates how "Bill arrears" lead to more "Energy disconnections", the more "Energy disconnections", the less "Thermal comfort and satisfaction of necessities", the more "Thermal comfort and satisfaction of necessities" the better the level of "Health & quality of life", with better health comes less "Vulnerability", where increased "Vulnerability" leads to more "Vulnerable groups" and more likelihood of "Bill arrears". Thus, loop R7 adds the dimension of compromises to "Health & quality of life" due to "Energy disconnections". These loops are problematic from a perspective of energy poverty, but as they imply reduced energy consumption, they are not problematic from a climate change perspective.

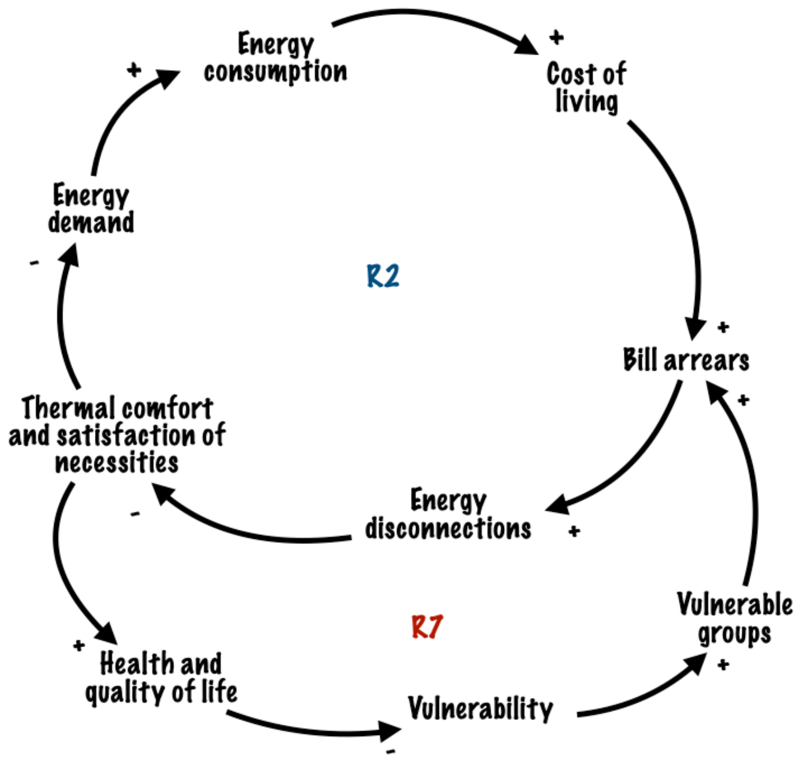

Figure 8.5 Loops R2 & R7 costs, bill arrears, reduced thermal comfort & vulnerability

Energy prices as a limit on energy consumption, energy consumption as a provider of thermal comfort (B2, B8)

In loop B2 (Figure 8.6), "Energy prices" increase as a result of a higher level of "External dependency", which is a consequence of reliance on "Fossil fuels"; the higher the "Energy prices", the less "Energy demand" and thus less "Energy consumption". Tying into the links between human well-being and energy use, B8 adds the dimension of lower "Thermal comfort and satisfaction of necessities" as a consequence of reduced "Energy consumption", where more "Energy consumption" enhances "Thermal comfort and satisfaction of necessities", the more "Thermal comfort and satisfaction of necessities" (with all other variables remaining equal) the less "Energy demand". These tie into loops B1 & B6 in that if "Thermal comfort and satisfaction of necessities" can be achieved without the use of fossil fuels, the outcome is positive for both climate change and energy poverty; loops B2 & B8 present a scenario where consumers are forced into energy restriction, where once again this energy restriction is detrimental to the energy poverty agenda but not the climate change agenda.

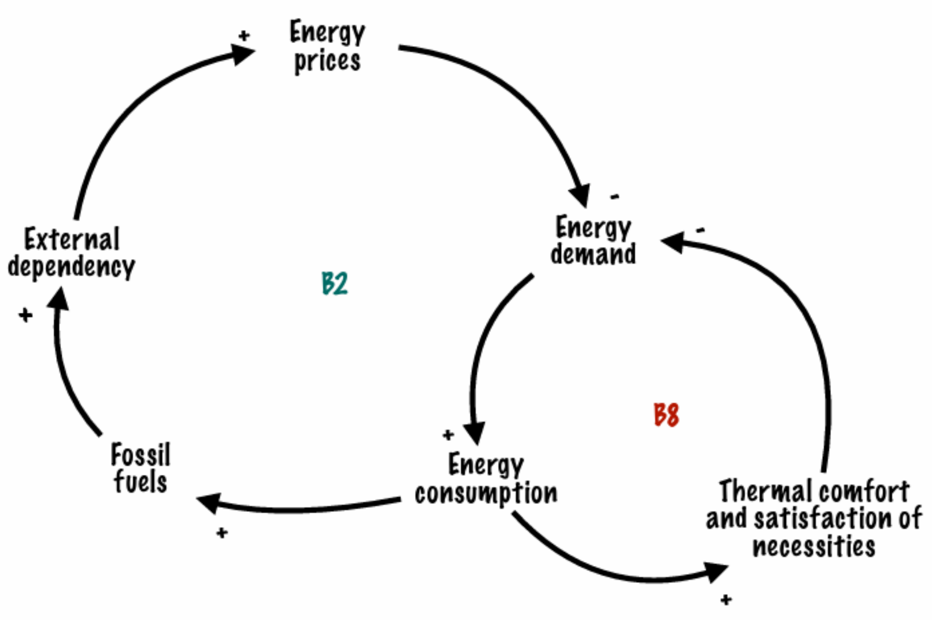

Figure 8.6 Energy prices, energy consumption & thermal comfort

Citizen participation as a driver of alternative energy models and a more flexible energy market, fossil fuels as a threat to the uptake of alternative energy models and renewable energy (R3, R4)

R3 (Figure 8.7) presents a solution from an energy poverty perspective where the higher the level of “Citizen participation” the more significant the uptake of “Alternative energy models”, and more “Alternative energy models” increase “Flexibility and diversity of energy market”, a more flexible and diverse market (where consumers are not locked into limited choices of large incumbent suppliers) increases levels of “Trust” and correspondingly “Energy literacy” which drives more “Citizen participation”. This loop reflects workshop participants' perceptions of citizen participation and the contribution of “Alternative energy models” to resolving energy poverty. In contrast, loop R4 represents a challenge to energy poverty mitigation, in this case, “Fossil fuels” where all other variables are equal, reduce the uptake of “Alternative energy models”, which promote the uptake of “Renewables” and consequently reduce reliance on “Fossil fuels”. In this sense, while the continued presence of “Fossil fuels” presents a threat to the uptake of “Alternative energy models”, the loop also shows how to mitigate this problem, namely by increasing the uptake of “Renewables”. Despite being beneficial to energy poverty mitigation, R3 is not directly beneficial for the climate change agenda; however, the pathway in R4 indicates a synergistic solution for both scenarios, according to our workshop participants, i.e., renewables-based alternative energy models.

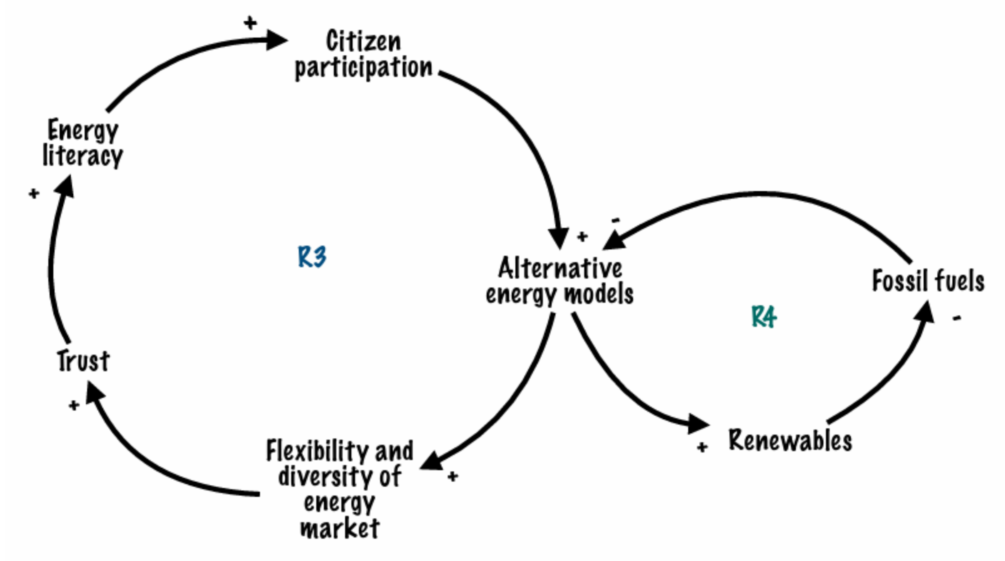

Figure 8.7 Loops R3 & R4 citizen participation, alternative energy models & fossil fuels

The previous sections describe the main reinforcing and balancing loops presented in Figure 8.2. However, several variables shown in the diagram do not form part of the loops but are important influences on the system. For instance, "Legislation and regulation" implies top-down pressure (either at the National or EU level) driving "Multi-scalar policy incentives" which encourages "Professional training" (where participants perceived that in Portugal, a lack of skilled professionals to undertake retrofit work is problematic). "Professional training drives "Maintenance and renovation of the building stock", which forms an integral part of loops B1 & B6 described above. Both "Multi-scalar policy incentives" and "Cost of living" were identified as leverage points by our participants, "Multi-scalar policy incentives" reduce "Cost of living", which also forms part of loop R2 and is significant in its influence on "Bill arrears". "Multi-scalar policy incentives" also reduce "Renovation costs" driving increased "Maintenance and renovation of the building stock".

The diagram also reveals some systemic variables outside the loops, which are linked to questions of social status and equity, including the level of "Education and qualification", "Income", and "Social stigma". The "Income and "Education and qualification" variables either directly or indirectly influence "Maintenance and renovation of the building stock", "Education and qualification" also influences "Energy literacy", and "Income" influences "Bill arrears". These relationships are unpacked subsequently.

8.3.2. System complexity and possible pathways

Overall, the causal loops identified in Figure 8.2 reveal a series of potential solutions and challenges relevant to energy poverty mitigation as perceived by the workshop participants.

The causal loops uncovered narratives related to the energy restriction behaviours resulting from energy affordability challenges and drivers of vulnerability (B2, R2, R7), the challenge that climate change poses to future energy needs (R1), the links between energy consumption and human well-being (R2, R7, B2, B8), and citizen-led solutions to energy poverty (R3). Interestingly, the loops presented conflicts between energy poverty, climate change and energy transition goals, which are significant in the current policy framing of energy poverty under broader decarbonisation targets. A deeper reflection on these narratives (as described in the Methods section) led to the identification of two overarching pathways exposed by the diagram; the first pathway we identified was "Energy restriction and building renovation solutions", and the second was "Participatory solutions". The following subsections explore the of significance of these pathways.

Energy restriction and building renovation

An important policy goal conflict between energy poverty and efforts to mitigate climate change arises in the context of involuntary energy consumption restrictions referred to in loops B2, R2 and R7. In these loops, energy consumption restriction is imposed by higher "Energy prices" and "Bill arrears", with the most severe impact in the latter case being "Energy disconnections". These loops set the scene for deeper reflection on themes of energy restriction and disconnections in Portugal.

Previous sections detail the somewhat contradictory nature of the Portuguese case, where low levels of self-reported thermal comfort clash with relatively low rates of bill arrears. This low rate of bill arrears is attributed to restrictive energy behaviours (Antunes *et al.*, 2023; Stojilovska *et al.*, 2023), to some extent reducing the risk of energy disconnections. Dedicated literature on energy disconnections in the Portuguese case is sparse. However, an analysis of the recently published Portuguese energy poverty strategy reveals 524143 energy supply interruptions due to failure to pay bills on time in 2019. Reasons for non-bill payment are not known, yet consumers in the lowest national earnings bracket with average earnings of 6608 € a year/550 € a month, spent 14% of their income on energy expenditure compared to 10% in the 10 365 € a year / 864 € a month income bracket (República Portuguesa, 2024).

The above suggests that those in the lower income bracket are more likely to spend more of their income on energy costs in Portugal, with corresponding impacts on bill arrears and the likelihood of suffering energy disconnections. In recent years, activist movements and the research community have raised concerns about the adverse effects of disconnections. For example, Hesselman (2023) finds that energy disconnections impact several human rights, including housing, health and education rights. Formed in 2017, the Right to Energy Coalition campaigns for a "right to energy" in European legislation, implying a ban on disconnections (Right to Energy, 2024). These efforts have begun to reap the rewards, with a provisional agreement protecting the vulnerable and energy poor from disconnections reached by the European Council and the European Parliament in December 2023 as part of broader electricity market reforms.

Such progress is undoubtedly encouraging, with the provisional agreement stating, "*Member States shall ensure that vulnerable and energy-poor customers are fully protected from electricity disconnections by taking the appropriate measures, including the prohibition of disconnections or other equivalent actions*." pg.5 (Council of the European Union, 2023)

In Portugal, due to described energy restriction practices, accurately accounting for the scale of vulnerability to energy poverty presents a challenge, where damaging coping strategies have been identified (Horta *et al.,* 2019) and concerns about "underconsumption" of energy have been raised (Palma *et al.,* 2019). Definitions of vulnerability and energy poverty in the Portuguese Energy Poverty Strategy are translated as follows:

Vulnerable consumer: "*Domestic energy consumers who find themselves in a situation of economic deprivation and or social need and potentially in a situation of energy poverty*" pg.98

Energy poverty: "*A household's lack of access to essential energy services where these services provide basic levels of dignity and health, namely heating, hot water, cooling, sufficient lighting and the energy necessary for running appliances, taking into account the national context, social policy and other relevant national policies, caused by a combination a factors, including at least, the lack of affordability (of energy prices), insufficient income, high energy costs and poor energy efficiency of buildings*." pg.73

Comparing these strategy excerpts reveals that those categorised as vulnerable are not, by default, those defined as energy-poor. This recognition of vulnerability, in addition to energy poverty, is necessary given the described uncertainties surrounding accurate energy poverty assessment in Portugal (Horta *et al.*, 2019; Palma *et al.,* 2019). Critically, however, in the Portuguese case, the reason for disconnections is unknown (República Portuguesa, 2024). Without explicit knowledge of the cause of disconnections, it is difficult to predict to what extent the EU provisional ban will protect consumers, where they must be categorised as "vulnerable" or "energy poor" to benefit. Therefore, understanding the underlying causes of disconnections is an essential next step in achieving the desired level of consumer protection in Portugal.

Moreover, while efforts to ban disconnections for the energy poor and the vulnerable are undoubtedly commendable, the diagram reveals that vulnerability is not the only pathway to disconnection, with “Cost of living” identified as the other cause. In Portugal, between 2021 and 2022, the inflation rate increased from 1.3% to 7.8% (Raposo Santos & Piteira 2023), with average costs for weekly food shopping increasing from 184 € in February 2022 to 229 € euros in February 2023 (Martins & Pereira, 2023). These cost increases emphasize the increased financial difficulties Portuguese households face. Critically, disconnection affects not just the bill payer but all household members, including children, where a review of the energy poverty strategy does not reveal any direct reference to protecting children from energy disconnections (República Portuguesa, 2024). González-Pijuan *et al.* (2023) state that children suffer physical, mental and educational impacts due to energy disconnections. Each of these impacts has a distinct moral dimension and, from an energy justice perspective, crosses into the area of recognition justice (on the basis that children are a vulnerable group) (Patel, 2024). Impacts on education and corresponding implications for later employment opportunities also have links to energy justice and sustainability framings of not harming future generations (McHarg, 2020).

Themes of energy-restrictive behaviour also tie into causal relationships between energy consumption and thermal comfort (shown in loop B8). This ultimately represents the relationship between human well-being and energy consumption, where energy contributes fundamentally to quality of life (Pesch *et al.,* 2023). This dynamic is at the crux of policy conflicts arising between goals for mitigating energy poverty and the achievement of carbon neutrality by 2050. Existing policy approaches to energy poverty mitigation on the pathway to decarbonisation seek to achieve thermal comfort through more efficient buildings and renewable energy sources, providing essential needs without compromising climate change goals (COM/2019/ 640 final; COM/2020/ 662 final). In Portugal and Europe, climate targets are now enshrined in law (REGULATION/EU 2021/1119; Lei n.º 98/2021); simultaneously, policy requirements for energy poverty mitigation are becoming more stringent. These increasingly tight policy requirements explain limited accounting for increases in energy consumption in Portuguese decarbonisation policies (Mahoney *et al.,* 2022) and justify the pathways to energy poverty solutions via “Maintenance & renovation of the building stock” presented in loops B1 and B6. These findings, in turn, lend support to current drives for decarbonising Portugal’s building stock (República Portuguesa, 2020).

Renovating the building stock is a challenge given the prevalence of poor building quality, the high costs implied (Palma *et al.,* 2021) and the lack of official statistics on the renovation rate

(República Portuguesa, 2020). Recent partially subsidised energy efficiency programmes have shown high adherence rates, suggesting increased public interest in renovation (Gabinete do Ministro, 2021). The importance of renovating the building stock cannot be understated. However, loop B6 reveals how the "Climate change" variable adds complexity to the problem of ensuring sufficient energy provision for thermal comfort, where climate change implies negative impacts on achieving thermal comfort. However, uncertainties regarding its exact manifestation make it challenging to predict future domestic energy requirements (Gouveia & Palma 2019). This issue is more broadly applicable in Europe, with climate change causing increasing temperature extremes and residential energy consumption trends correlating with the number of Heating Degree Days (HDD) and Cooling degree days (CDD) (days when theoretically heating or cooling would be required), i.e., generally when the extremes of heat and cold are greater more energy is consumed (Tsemekidi Tzeiranaki *et al.,* 2022). Research has also indicated that the number of CDD in 2050 will significantly increase and that the anticipated temperatures will be higher than the thresholds recommended for comfort and health Castaño-Rosa *et al*., (2021).

The preceding discussion details themes of energy consumption, achieving thermal comfort and building renovation, revealing that the diagram presents two routes to reducing energy consumption. These routes are either through involuntary restrictive behaviours or through building renovation activities. With the variables of "Renovation costs" and "Income" linked to "Maintenance and renovation of the building stock", a level of social division in access to renovation measures is suggested. Another motivator of building renovation is "Vulnerability", which eventually stimulates renovation as a mitigation policy response. A practical example of vulnerability incentivizing change in Portugal is the "Efficiency voucher", a funding stream dedicated to energy efficiency measures for the energy-poor (Fundo Ambiental, 2021). The "Efficiency voucher" was implemented as part of the COVID recovery package and in sense is a policy action motivated by vulnerability. While ultimately effective, this pathway implies suffering as a motivator of change, clashing against policy ideals of a "just transition."

Participatory solutions

Loop R3 presents a bottom-up solution where citizens drive the uptake of "Alternative energy models", combined with the links between "Alternative energy models" and "Renewables" (loop R4). These loops present a synergistic solution for energy poverty and climate change objectives. Presently, in Portugal, "Alternative energy models" (including energy cooperatives and communities) represent a limited market share (Delicado *et al.,* 2023) and can, therefore, be considered a somewhat unknown quantity in terms of energy poverty mitigatory capacity. Such models generally seek to offer fairer conditions to energy consumers (Hoicka *et al.*, 2021) and can imply lower energy costs (EEA, 2022). That said, evidence suggests accessibility limitations for marginalised groups (Hanke & Guyet, 2023), where supportive policy conditions are needed to ensure increased levels of prosumerism do not push up costs for non-prosumers (EEA, 2022).

In Portugal, the energy poverty strategy emphasizes the need to remove barriers for citizens participating in energy communities, with funding schemes for residential energy communities and collective auto consumption activities (República Portuguesa, 2024). This is an encouraging move; however, Scharnigg & Sareen (2023) find a mixed profile of actors involved in alternative energy models in Portugal. These actors include the renewable energy divisions of existing energy incumbents; the authors also observe increased trust in non-profit institutions motivated by the lack of vested financial interests. During the workshop, however, participants viewed "Alternative energy models" with active citizen involvement as a powerful tool for mitigating energy poverty, where variables of "Energy literacy" and "Trust" were essential elements of this process.

The contributions of "Citizen participation" to "Alternative energy models" are significant in the current policy scenario. The fundamental role of citizens in the energy transition underpins both European and Portuguese policy approaches (APA, 2019a, b; COM/2020/ 662 final). Policy rhetoric often includes narratives of citizens taking ownership of the transition and greater choices regarding energy suppliers. However, research on citizens' capacity to participate in energy transitions has indicated that citizens can feel "locked out" and disconnected from energy system decision-making processes (Lennon *et al.*, 2019).

The CLD diagram shows that "Citizen participation" drives the uptake of "Alternative energy models" and, in turn, greater "Flexibility & diversity of energy market", where actions linked with citizen participation include adopting renewable energy technologies, membership in energy communities and participation in political decision-making (Wahlund & Palm, 2022). Regarding energy citizenship, Beauchampet & Walsh (2021) highlight that citizenship involves greater consumer rights and responsibilities. Correspondingly, we argue that consumers must perceive they are receiving their rights to feel motivated to assume responsibility. Linking back to the arguments of Lennon *et al.* (2019) and connecting these with loops describing forced energy restriction practices, we suggest that the groups affected by these conditions in Portugal will potentially consider themselves disempowered and thus less incentivized to participate in the transition. This ties into broader questions about the true meaning of citizen participation and who it benefits (Lennon *et al.,* 2020).

Like "Alternative energy models," the variables "Energy literacy" and "Trust" (identified in loop R3) can be considered concepts that warrant deeper investigation and understanding to maximise their potential and establish their limitations. In 2019, Martins *et al.* investigated energy literacy in Portuguese university members, including students and technicians, finding the energy literacy level to be "moderate". Later, the work of Martins *et al.,* 2020, finds high levels of energy literacy but lower levels of financial knowledge in the Portuguese university community. A general assessment of energy literacy in Portugal (ERSE, 2020) characterized energy literacy on a scale of 1-100 (with 100 implying a total knowledge of all study areas linked to energy literacy and 0 no knowledge of these study areas) 66.4% of participants ranked as having a low or medium level of energy literacy, where participants with higher education levels scored better.

In Figure 8.2, the causal relationship between "Education & qualification" and "Energy literacy" is shown; this link is substantiated by Mills & Schleich (2012), who find high education levels are associated with the adoption of energy-efficient technology and energy conservation behaviours. Despite the valuable insights generated to date, Martins *et al.* (2020) acknowledge that the small sample size is a limit on their study; it is, therefore, important to undertake further research on the true level and potential of energy literacy in Portugal, particularly given that the energy poverty strategy identifies increasing energy literacy as a priority (República Portuguesa, 2024).

Literature exploring energy poverty and trust in the Portuguese context is limited. However, Großmann *et al.* (2021) uncover poor transparency in the energy billing process as a contributor to consumer mistrust in the country. There was also a general distrust in politicians and state institutions due to abuses of power. Portugal's voter turnout is low, steadily declining since 1976 (Manoel *et al.,* 2021). Decreasing voter turnout can indicate disagreement between citizens regarding the parties participating in the election and a general questioning of the system (Freire & Magalhães 2002). Recent accusations of government corruption in Portugal do little to assuage the public's mistrust of politicians (Gustavo, 2023). In Figure 8.2, "Trust" is increased by "Flexibility and diversity of energy market" and has a reinforcing relationship with "Energy literacy"; "Bureaucracy" decreases "Trust". "Trust" is an underexplored topic in Portugal, not explicitly detailed in the energy poverty strategy, thus we suggest deeper explorations of "Trust" are an essential focus of future research.

Figure 8.2 represents the main threat to the uptake of "Alternative energy models" as the continued presence of fossil fuels (shown in loop R4), where loop B2 shows the main driver of fossil fuel use as increased "Energy consumption", as stated previously "Renewables" are the main tool to reduce fossil fuel reliance identified in the CLD diagram. The dynamic revealed in R4 is not an insignificant consideration in Portugal, which, despite receiving international praise for the speed at which it has integrated renewables (IEA, 2021), still has some way to go in reducing fossil fuel reliance. In 2021, natural gas and petroleum fuel sources represented 23.9% and 40.6% of primary energy consumption, respectively. Additionally, while external dependency in Portugal is following a downward trend, in 2021, total primary energy consumption from external fossil fuel sources stood at 67.1% (Observatório da Energia, 2023).

A key mitigation measure addressing energy poverty in Portugal is the social energy tariff. With 751 926 people in receipt of the social electricity tariff and 49 967 in receipt of the social gas tariff (DGEG, 2023). With such high levels of tariff adhesion and government statistics in Portugal suggesting that energy poverty affects between 1.8-3 million people (República Portuguesa, 2024), removing the tariff seems an unlikely option. Despite this, the tariff (in the case of natural gas and partially in that of electricity) funds the use of fossil fuels, undermining carbon neutrality efforts and representing another policy goal conflict between the mitigation of energy poverty and climate change goals.

8.3.3. Workshop roundup discussion and leverage points

In a roundup discussion at the end of the workshop, participants showed a lack of agreement regarding whether it was necessary to increase energy consumption to resolve energy poverty. An important part of this discussion was that the Portuguese climate is relatively mild. Therefore, homes did not require the same level of renovation to achieve thermal comfort as other European countries with greater temperature extremes. This lack of consensus on this key point is potentially problematic for the current policy trajectory, given that stakeholder perceptions can affect the feasibility of future policy options (Brugha & Varvasovsky, 2000). This theme also reinforces the urgency of profiling the energy needs of Portuguese consumers, which was discussed in the previous section.

The participants also identified leverage points outlined (in squares) in the CLD diagram (Figure 8.2). Notably, each leverage point identified an area over which Governments can exert influence, e.g., social support to reduce the "Cost of living". Identifying "Energy literacy" as a leverage point adds weight to earlier arguments for further research on this topic in the Portuguese case. It is noteworthy that these leverage points are not necessarily those with several connections (which are usually the more influential variables), suggesting that there may be more leverage points in addition to those marked in the diagram. Despite this, the leverage points identified in the workshop were considered the most important by the participants, implying that acting on them could bring about system change.

Workshop participants strongly emphasized the provision of local support, attested by marking “Local technical support” as a leverage point; this emphasis can be explained by the workshop’s exploration of local energy poverty solutions. In this scope, however, the participants emphasized the importance of more resounding consumer support and engagement. Drawing on these results and the analysis of the CLD diagram, a series of policy and research recommendations are presented in the Conclusions.

8.3.4. Workshop evaluation

In the interests of transparency and good practice, a short evaluation process was held at the end of the workshop. Figure 8.8 presents the results of this evaluation, where participants were asked nine questions regarding their satisfaction with the workshop on a scale of 1-5, revealing a generally high level of satisfaction among participants. The participants were also asked to evaluate the organization of the workshop; 72% of participants rated the workshop as “very organized”, “28% as “organized”. Finally, the participants were asked if the workshop was a worthwhile use of their time, 97% participants selected “yes”, “3%” selected “to some degree”. The generally high level of participant satisfaction is a positive reflection on the workshop, with one participant noting that the workshop was a valuable opportunity to gather energy poverty practitioners in Portugal and to incentivize discussion between them.

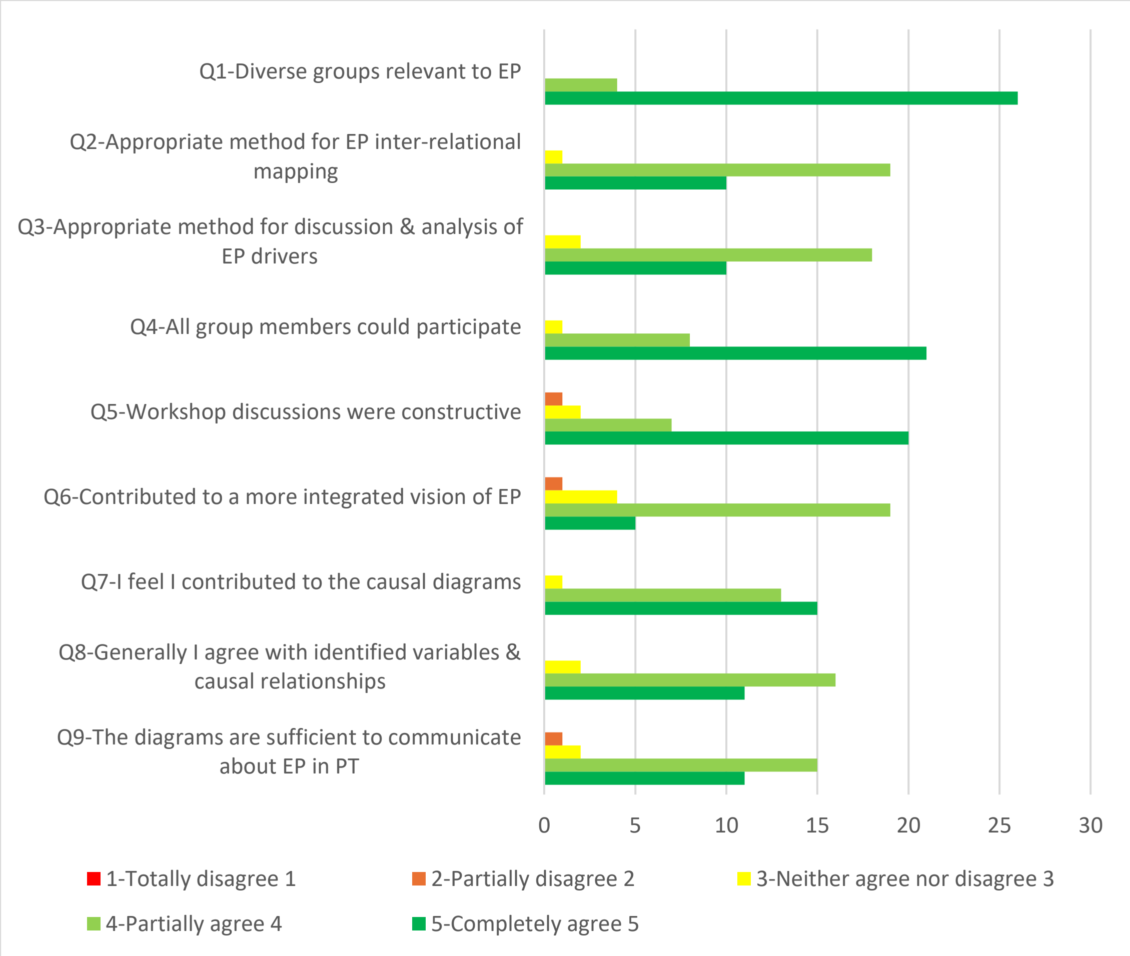

Figure 8.8 Results of the workshop evaluation questionnaire

8.4. Conclusions and Policy Implications

Over the years previous authors have shed light on the complex web of policy debates and structural factors that are either caused by, cause or exacerbate energy poverty, or on occasion, a combination of all three. These valuable contributions have widened contemporary understandings of energy poverty, emphasizing its multi-dimensionality. Yet, a systemic exploration of the cause-effect relationships in the energy poverty system was lacking, particularly in Southern Europe. With early iterations of energy poverty and related decarbonisation policies underway in Portugal, the results presented in this paper are an innovative contribution to the field. This holistic overview of the Portuguese energy poverty system is consistent with the overarching aim of the paper.

The unified CLD diagram built based on the participatory workshop outputs highlights solutions and challenges to mitigating energy poverty in Portugal. The diagram also underpins the relationship between energy consumption and human well-being, which contemporary policy approaches seek to remedy with energy efficiency measures and the uptake of renewable energy. The pathways to energy poverty resolution presented in the diagram show consistency with this approach, suggesting that the workshop participants are aligned with the current policy trajectory. This alignment is important, considering that the workshop participants are key stakeholders in the Portuguese energy poverty system.

The diagram also reveals patterns of energy restriction behaviours, primarily motivated by high energy costs. These behaviours imply reduced energy consumption, which benefits broader emissions reduction goals but compromises the integrity of a just transition. Considering the links between energy consumption and human well-being, the diagram illustrates trade-offs between different policy goals within the decarbonisation policy domain. Despite these trade-offs, the diagram underscores the inter-dependencies between energy poverty and climate change, centred on the balance between sufficient energy use and reducing greenhouse gas emissions. These findings justify current policy approaches for placing energy poverty on the broader carbon neutrality agenda.

These alignments with the current policy approach are encouraging; however, in our explorations of participatory solutions and energy restriction behaviours, we expose various social inequities, which generally apply to consumers on lower incomes, with lower education and qualification levels or a combination of both. We also reveal some uncertainties regarding these solutions, including a reduced exploration of concepts of trust and energy literacy in Portugal, which were perceived as significant influences on citizen participation in our workshop. Exposure to these dynamic uncertainties and the need for further exploration is an essential contribution of this paper.

Another significant "unknown" was exposed by the lack of consensus between the participants regarding whether energy consumption in Portugal needs to increase to mitigate energy poverty. This argument highlights the importance of gaining a deeper understanding of the energy needs of the Portuguese population, which is currently complicated by citizens adopting coping strategies and patterns of underconsumption.

Interestingly, while the workshop explored local solutions to energy poverty and indeed some local solutions were uncovered, e.g., "Local technical support", the CLD diagram presented a set of multi-scale variables, partly explained by Portugal's centralised governance structure but also a reflection of the influences of EU policy and international inter-dependencies. That said, the participants expressed a high regard for the value of local scale solutions; based on this and general discussions held throughout the event, we present a set of recommendations for policy and future research as a final output of this paper.

1. To facilitate participation both in alternative energy models and in the uptake of energy efficiency measures, directed social and technical supports are of critical importance, as is mediation between private enterprises by trusted agents, where often "trusted agents" are those operating at the local scale.

2. To promote community trust, a much deeper level of interaction with citizens focused on energy literacy is needed. Additionally, clear information is necessary to facilitate informed decision-making. This interaction will sometimes require presential step-by-step support through funding applications for, e.g., energy efficiency programmes.

3. It is vital to provide guidance for citizens making energy consumption choices in the home and in the selection of domestic equipment. This extends to helping citizens understand the cost versus benefits dynamics of investments in energy efficiency measures.

4. It is important to further investigate what motivates consumer trust in Portugal and to conduct a deeper evaluation of energy literacy levels in the general population.

5. More investigation is needed into the underlying reasons for energy disconnections, updated public disconnection statistics are also key; this is particularly urgent given the severe adverse effects caused by disconnection.

To conclude, this paper draws on participatory inputs to produce a CLD diagram depicting the energy poverty system in Portugal, a country in the early phases of implementing energy poverty mitigation policies. In exploring the causal relationships between the different variables, many of which overlap with policy debates linked to energy poverty in the literature, the paper contributes more widely to studies of energy poverty. By evaluating the interactions of energy poverty solutions presented in the loops with linked policy agendas (such as climate change), the paper exposes that these solutions are not always fully synergistic for all agendas; nonetheless, it also reveals a high level of inter-dependency between these agendas, which supports the current policy framing. Finally, the policy recommendations provide a crucial basis for enhancing citizen participation in the Portuguese case to promote equitable access to the energy poverty solutions discussed in this paper.

8.5. References

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Chapter 9 | Conclusions

This thesis explored the linked yet distinct policy agendas of climate change, energy transitions and energy poverty, seeking to understand to what extent an integrated policy approach to these agendas results in competing policy goals. The thesis drew on the UK to set the policy background for energy poverty and focused on Portugal to explore mitigating energy poverty in a policy setting with a strong commitment to promote renewable energy sources and carbon neutrality.

An important point of departure for this research was the work Gouveia *et al*. (2019), which outlined the challenge of mitigating energy poverty and increasing thermal comfort whilst adhering to GHG reduction efforts. The results reveal that the inter-relations between these policy agendas are complex, where the explored policy synergies, trade-offs, and less established dynamic policy factors have positive and negative connotations for different policy goals that apply at different spatial scales. Where the term "competing agendas" has been used to describe the overarching relationships between the agendas of climate change, the energy transition and energy poverty, the mix of positive and negative policy impacts resulting from their combined implementation are labelled "agenda conflicts" in the following sections. The thesis reveals that these agenda conflicts can occur within the same agenda or across different agendas. In other words, there are inter and intra-level agenda conflicts. Furthermore, these agenda conflicts have diverse impacts on different socio-economic groups and cross into questions of non-human justice through their impacts on nature (McHarg, 2020).

The question of whether the policy domains of climate change, energy transitions and energy poverty could be considered competing agendas was explored in the thesis through four research questions. It is important to note that (as explained in Chapter 3) Chapters 1-4 set the foundations for the responses to each research question, with deeper explorations undertaken in later chapters as appropriate. Similarly, the elaboration of the energy poverty system in Chapter 8 synthesizes and develops topics laid out in preceding chapters and thus contributes to the responses to research questions 1-4.

The following sections present the responses to each question and the corresponding agenda conflicts revealed in each case. Following this, as an intended aid to policy actors and agenda practitioners, Figure 9.1 subsequently outlines the "Agenda conflicts priority pyramid", a comparative overview of which conflicts are relevant to the respective policy domains of climate change, energy transitions and energy poverty, or combinations thereof.

9.1. Answering the Research Questions

RQ 1: What are the benchmarks for addressing energy poverty, and how do they inform future efforts to tackle energy poverty in the frame of decarbonisation policy?

Chapters 1, 2, 4, 5 and 8 are drawn upon to respond to this question. Chapter 1 sets the scene and introduces the policy background resulting in the "competing agendas". Chapter 2 presents the policy state of the art, pros and cons of measurement techniques and policy benchmarks in Europe, justifying the selected case studies presented in Chapter 4 and outlining two contrasting scenarios. One is a country with a strong policy history with energy poverty (the UK), and the other is Portugal, where energy poverty is an emerging policy theme but which has shown significant political commitment to decarbonisation. This comprehensive review revealed *Agenda conflict 1 - "Meeting thermal comfort obligations (current and future) versus carbon neutrality commitments*". This agenda conflict is identified in the European context (Gouveia *et al.,* 2019) and is a key departure point for the development of this work, where its global relevance in a paradigm of shifting consumption patterns (Pereira *et al.,* 2023; Our World in Data, 2024) is outlined in the introductory sections. The relevance of *Agenda conflict 1* is deepened by explorations of inequalities between quality of life and the adverse effects of energy poverty between Member States in the European context in Chapter 2, and later with particular relevance for Southern Europe (Bouzarovski & Tirado Herrero, 2017) and the Portuguese case in Chapter 4 (Gouveia *et al.*, 2019; Palma *et al.*, 2019). *Agenda conflict 1* is also represented in the Causal Loop Diagram in Chapter 8, indicating its continued relevance in the contemporary policy scenario.

Importantly, *Agenda conflict 1* is addressed in European policy and tackled in policy initiatives focused on energy efficiency measures and the uptake of renewables (COM/2020/ 662 final). Building on *Agenda conflict 1*, later sections explore the practical implications of this policy response across the three agendas, revealing additional conflicts arising from the policy response to the first. Reflections on the policy response to *Agenda conflict 1* and associated agenda conflicts are valuable both in Europe and for the broader global energy supply challenges implied by increased and diversifying energy demands, which are predicted as development in the global South continues (Pereira *et al.*, 2023).

Taking advantage of the valuable lessons to be gleaned from the UK case, Chapter 5 explores the UK's policy response to energy poverty, presenting a deep dive into the availability of data for a high-resolution spatial scale index replicable across the UK countries, revealing that there was sufficient data for the replication of a high spatial scale index across the UK. Critical reflections are derived on the impacts of policy devolution, namely a reduced capacity to draw comparisons of energy poverty levels in the different UK countries, complicating resource allocation for mitigatory actions. The value of these findings is discussed and tied into the European context, where inter-state comparison of energy poverty remains challenging (Widuto, 2023). Another important insight pertains to the frequency of monitoring activities, which are more frequent in England than in the remaining countries. This more frequent monitoring contributed to a better understanding of the condition and its evolution alongside current events, e.g., the effects of economic crises and spikes in fuel prices. These reflections on the value of frequently collected and high-quality data in England are informative for European policy, with the Energy Poverty Advisory Hub flagging discrepancies in data availability across EU member states and making corresponding recommendations for addressing so-called "data gaps" (Gouveia *et al.,* 2023).

Explorations of the UK case across Chapters 2, 4 and 5 reveal that the policy response to energy poverty has increasingly been paired with general energy efficiency targets, to the extent that the various national strategies have presented EPC grade-based targets rather than reductions in fuel poverty percentages (NEA, 2024). These chapters present important insights for tackling energy poverty in the frame of decarbonisation.

Specifically, Chapter 5 highlights how moving towards combining energy efficiency targets with energy poverty mitigation coincided with austerity conditions in the UK, driving government support to focus more tightly on those most in need (Hills, 2012). This, in turn, resulted in a revised energy poverty definition in England, where a comparison of the two indicators (Boardman's 10% with Hill's LIHIC) revealed different overall percentages of fuel poverty (Middlemiss, 2017) and shifts in the geographical manifestation of the condition (Robinson *et al.,* 2018). Critically, these reflections reveal how the selected definition and associated metrics frame the policy response, ultimately affecting who is categorised as energy-poor and the nature of support they will receive. While prioritising resources under austerity conditions appears logical enough, as Middlemiss (2017) highlights, this suggests an acceptance that a total alleviation of fuel poverty is not possible. This acceptance that some will continue to suffer from energy poverty is relevant to contemporary narratives of focusing on a "deserving poor" in the wider European setting (Stojilovska *et al.,* 2022), potentially at the cost of a wider subset of energy poverty sufferers (Robinson, 2019). In the framing of the current European energy crisis, with inflation contributing to a growing class divide, this example from the UK case is particularly timely.

Austerity conditions in the UK also incentivised a greater involvement of private agents (independent of government resource constraints) in the energy efficiency chain, with the co-intention of mitigating energy poverty (Rosenow *et al.*, 2013). Explorations of the role of private agents in the UK case detail the apparently conflicting interests tied up in schemes run by energy companies. Additionally, Chapter 4 presents the problem of private agents pursuing easier renovation measures with less emphasis on vulnerable households (Rosenow *et al.,* 2013). Essentially, in contrast to the identified problem with the policy focus being too narrow, the focus becomes too wide. Thus, the more detailed focus on the UK is a useful benchmark for other European countries in the early phases of energy poverty policy facing similar challenges of resource constraint. Critically, while such policy approaches may result in carbon savings, they do not result in the eradication of energy poverty. Hence, these reflections from the UK reveal two further agenda conflicts specific to energy poverty. These are *Agenda Conflict 2 - "Universal energy poverty eradication versus priority targeting"* and *Agenda Conflict 3 - "Avoiding constraints on public funding versus providing appropriate support for the energy poor"*

RQ2: What are the links, trade-offs and synergies between the climate change, energy transitions and energy poverty agendas?

Chapters 1-4 set out the existing knowledge on synergies and trade-offs, with deeper explorations undertaken in Chapters 5 and 6, Chapter 8 substantiates the contributions of the previous chapters. In explorations of the origins of UK fuel poverty policy and discussions of Broadman's original income, energy price, energy efficiency triangle and how the quality of the UK housing stock affects both fuel poverty and contributes to GHG emissions, Chapter 5 introduces the more obvious links between the agendas. The main policy synergy revealed in Chapter 5 is the move within UK policy to combine energy efficiency and energy poverty policy initiatives, as outlined in the previous section. Chapter 8 highlights the importance of renovation for the resolution of energy poverty, thus adding weight to the results in Chapter 5.

Chapter 6 presents a deeper analysis of the links, trade-offs and synergies between the various agendas, presenting a conceptual framework specifically designed to evaluate competing sustainability agendas. This adaptable framework, tested on the Portuguese case, offers a valuable methodological contribution to the sustainability field. The state-of-the-art knowledge regarding synergies and trade-offs across the agendas is presented. This review includes the important revelation that the agendas are interlinked inherently and are neither fully synergistic nor divergent, justifying the rationale of the "agenda conflict" framing, which accounts for both the positive and negative effects of policy linkages. The review also provides important examples of contemporary competing agendas in the sustainability field, such as the pressing need for renewable energy technology versus trade-offs for local communities and biodiversity at implementation sites (UNCTAD, 2020).

The conceptual framework developed consists of three key steps, which aim to account for the broad range of stakeholder values and diverse policy goals inherent to the climate change, energy transition and energy poverty agendas. These steps are the "What" encapsulating the scope, the "Where" accounting for the scalar manifestation of policy impacts, and the "Who" to represent the stakeholder profile and explore stakeholder interests and influences. The policy links between the agendas are presented for the Portuguese case in the framework's first step, an important contribution of which is the exploration of how these linked topics are addressed and monitored in the Portuguese case, tying into earlier arguments of the importance of monitoring for policy benchmarking. The later steps of the "Where" and the "Who" expose further policy synergies and trade-offs. The "Where" focuses specifically on topics that bridge the three agendas, and the "Who" focuses on how diverging actor interests may affect the agendas. This refinement of bridging concepts is an important methodological contribution for future scholars investigating competing sustainability agendas but finding themselves overwhelmed by the potential scope.

Key linking topics exposed include technical topics such as Building Retrofit and Zero Energy Buildings, Energy Efficiency Upgrades, Uptake of Renewables and socioeconomic topics such as Health and Well-being, Economic Recovery and Just/Citizen-led Transition, showing a level of consistency with the linking policy debates outlined in Chapter 2. Some of the synergies and trade-offs identified were based on a reframing of policy challenges revealed by previous authors, adding weight to these important findings. For example, trade-offs such as limited accounting for the underconsumption of energy are based on the exposure of threats to Portuguese climate policy through the meeting of established thermal comfort standards, as per Gouveia *et al.* (2019). Portuguese policy plans to meet the thermal comfort gap by improving domestic energy efficiency, implying both structural building upgrades and more efficient climatization equipment, yet Palma *et al.* (2021) unearth the barrier of insufficient public funding for renovation activities. The framework added depth to these findings by exploring their social implications, namely by contrasting recognised public concerns about rising energy costs (Magalhães *et al.,* 2018) with comments on contemporary policy strategies, including post-installation reimbursement of retrofit costs and the corresponding exclusion of those unable to pay. This challenge is reflected in *Agenda conflict 4 - "Energy efficiency as a solution to the thermal gap versus low investment capacity citizens".* Agenda conflict 4 is also reflected in the Causal Loop Diagram in Chapter 8 which represents the impacts of financial constraints on building maintenance and renovation activities.

Less established synergies and trade-offs included scalar differences in how employment and economic energy transition benefits may manifest in Portugal, with reduced local and regional emphasis. Critically, this policy gap coincides with existing regional inequities in terms of income, exposure to the impacts of climate change and employment opportunities (IEFP, 2017; PORDATA, 2021). This led to the identification of *Agenda conflict 5 - "General economic and employment gains versus impacts on vulnerable regions and groups".* These novel outputs are important contributions to existing knowledge of the climate change, energy transition and energy poverty agendas in Portugal.

RQ 3: Who are the key actors in the agendas, and what are their respective influences and interests? How can these be better aligned for improved outcomes across all three agendas?

Chapters 1-4 frame the key interests in the agendas, including employment and financial opportunities in the energy efficiency chain. Specific interests and influences in the Portuguese case are explored in Chapters 6 and 7, with the results presented in Chapter 8 supporting these findings. The main contributions of Chapter 6 to this question are presented in the "Who" section of the framework, which applied a ranking system to assess interests and influences in energy poverty in the Portuguese energy transition. The ranking process revealed a power and interest imbalance where the more influential actors in the agendas had an obvious interest in energy transition activities but less interest in energy poverty. Conversely, those groups with less influence were likely to be more interested in mitigating energy poverty. Thus, the conceptual framework presented in Chapter 6 presented an introduction to the types of key actors involved and their respective interests and influences.

Chapter 7 presents the results of a qualitative interview process. It makes use of the stakeholder list built in the CompeSA framework (Mahoney *et al.,* 2022) to identify candidates for the interviews. In total 39 interviews were carried out with experts from different sectors, including NGOs, Consumer organizations and a Cooperative. This chapter further investigates who the key actors are and the nature of their interests and influences. In Chapter 7, results of a thematic analysis based on interview content are drawn upon. To conduct this analysis the NVivo software tool was used to code and process interview content thematically. A particular focus of the interviews was the exploration of the views of the actors (interview candidates themselves) to deepen understandings of stakeholder interests and potential areas for interest alignment across these groups. This section also explores how stakeholder views from different organizational sectors may vary, e.g., differences in opinion regarding levels of public financing for retrofit activities arose between the NGO, Environmental & Energy Agency, and Governmental sectors (Mahoney *et al.*, 2024). These findings are consistent with themes of resource constraint and insufficient funding outlined in the previous section. Questions of cost were also seen to impede the adoption of more sustainable materials. Thus, we identify *Agenda conflict 6 - "Rapid and cost-effective renovation versus using unstainable materials"*

Chapter 7 exposes a diversity of perceptions among the stakeholder group regarding citizens' ability to participate in the agendas and correspondingly to benefit from energy poverty mitigatory actions. The chapter reveals a high degree of nuance and lack of consensus around what lies within citizens' power to control. This was particularly significant in terms of what constituted personal choice and what was involuntarily determined by factors such as literacy, education, informational processing capacities and media content, as well as the general socio-economic circumstances of citizens. Themes of elitism and inequality also came into play, referring specifically to social divisions in who could benefit from energy transition solutions (such as energy efficiency measures and alternative energy models), where generally, citizens with greater investment capacity were perceived as having more beneficiary potential (Mahoney *et al.*, 2024). This revealed *Agenda conflict 7 - "Alternative energy systems versus access barriers for vulnerable groups".* This conflict is also exposed in Chapter 8, which shows a positive relationship between education levels and energy literacy, which influences citizen participation in alternative energy systems.

Exposing this segmented view of citizen agency is significant in the current decarbonisation policy trajectory, which encourages enhanced citizen responsibility (Wahlund & Palm, 2024); these responsibilities also pertain to energy consumption practices, where net reductions are key, yet harmful energy restriction practices remain everyday occurrences for some consumers (Pellicer-Sifres *et al.*, 2021). Thus, consideration of the above yields *Agenda conflict 8 - "Reliance on citizen participation versus limits on citizen agency"*

Despite the divergences in stakeholder views regarding responsibility for costs and levels of citizen agency, the combined outputs of Chapters 6 and 7 contribute insights for better stakeholder alignment. For example, Chapter 7 reveals a general agreement that the agendas of climate change, energy transitions and energy poverty should be treated holistically. Stakeholder alignment on this political framing of the agendas is essential for policy acceptance, impacting how the different groups assume responsibilities. Additionally, the systemic level of energy poverty in Portugal, affecting even middle-class citizens (as explained in Chapter 7) (Mahoney *et al.*, 2024), has impacts not only on the individual citizens themselves but is generally detrimental to society through health impacts, reduced productivity and more days of absence, which adversely impact both employers and national health services (The Marmot Review Team, 2011; Lakasing *et al.*, 2019). Consequently, the resolution of energy poverty is not just a personal or public concern but also a private one. Promoting greater awareness of the impacts of energy poverty on the private sector represents an important future area of focus for greater alignment of stakeholder interests.

RQ 4: What are the dynamic policy uncertainties implied by a holistic approach to the agendas? How can these be managed for maximised policy benefits?

Dynamic policy uncertainties are discussed in the Introductory chapters, with a deeper focus on this issue undertaken in Chapters 7 and 8. Specifically, the reflections on the unknowns regarding citizen agency in Chapter 7 represent a dynamic policy element. Chapter 8 presents the results of a Participatory Systems Mapping process, and the corresponding collaborative development of a Causal Loop Diagram. This process engaged key stakeholders in the field, and included a post-production process integrating different stages of analysis and validation. By considering the interrelations between the different variables and the underling structure of the system, the chapter presents important insights into the dynamics of Portugal's current energy poverty system. The chapter discusses the different narratives revealed from analysing the various balancing and reinforcing loops identified.

An important narrative revealing a dynamic policy uncertainty for the future referred to climate change as a driver of reduced thermal comfort, thus driving increased energy consumption (Mahoney *et al.,*). This narrative makes a relevant connection with the research of foundations of the thesis and balancing the provision of essential energy needs with decarbonisation goals; this also articulates the risks raised by Gouveia *et al.* (2019) regarding increased future energy needs as a consequence of climate change. In a complementary work, Gouveia & Palma (2019) describe residential energy consumption as a "moving target". With later works such as Sherriff *et al.* (2022) highlighting that energy poverty policies do not sufficiently account for climate change impacts, this remains a persistent problem, where future uncertainties around the precise manifestations of climate change present a complex issue for policymakers (IPCC, 2023).

Chapter 8 reaffirms that a critical part of the solution to this problem is home renovations, with the potential to address climate change mitigation and energy poverty simultaneously. The chapter then details how the inter-related variables such as income, education status and energy literacy reinforce systemic inequities in access to renovation measures and other energy transition benefits (Mahoney *et al.,*).

Adding depth to the described social divisions, an important reflection in Chapter 8 is the identified lack of policy engagement with the theme of energy disconnections in Portugal. The exposure of the adverse results of disconnections on all household members fed into themes of social division discussed previously. Aside from the acute moral and ethical considerations of an increasing social divide, as identified in the Introduction, narratives of elitism and exclusion are easy prey for right-wing populist politics and threaten public acceptance of climate change and energy transition policies (Krange *et al.*, 2021). With citizens keenly feeling the crunch of social division in the face of the ongoing energy crisis, this is an essential dynamic policy element for policymakers to consider. Consequently, *Agenda conflict 9- "Rapid transition uptake versus increasing social divide"* is identified.

On top of these concerning imbalances in who is included or excluded from the energy transition, Chapter 8 articulates the cause/effect relationships which bring about and deepen situations of vulnerability to energy poverty, for example, narratives around the cost of living as a driver of bill arrears and the relationship between bill arrears and vulnerability illustrate these undesirable cycles. Critically, these variables are also linked to health; thus increasing public awareness of these impacts is highly important. This is particularly so given that Almendra *et al.* (2016) state that there is little recognition of adverse health impacts in Portuguese public policy, a statement echoed in the interview process in Chapter 7.

Notably, on several points, the results of Chapter 8 corroborate those presented in Chapter 7, adding depth to the exposure of leverage points which indicate where to intervene in the system to bring about change. Key leverage points in the perceptions of workshop participants included technical and financial support at the local level, broader multi-scalar policy incentives, energy literacy and the cost of living (Mahoney *et al.,*). Interestingly, governments have some degree of control over each of these points; this is an important revelation in the face of policy approaches (such as those exposed in the UK), which turn to the private sector in conditions of budget constraint.

The final sections of both Chapters 7 and 8 present several policy recommendations relevant to the climate change, energy transition and energy poverty agendas. In the case of Chapter

7, the recommendations about citizen agency are the most pertinent dynamic policy factors that are not well understood in the current policy scenario. In Chapter 8, suggestions for better managing dynamic policy factors focus on retaining public ownership of community energy and far deeper levels of support and interaction with citizens to foster the necessary levels of trust and literacy for them to make informed decisions regarding their energy behaviours. Considering these suggestions alongside the domination of the energy transition profile by private agents discussed in Chapter 7 unveils *Agenda conflict 10 - "Private financial energy transition interests versus energy poverty mitigation"*

Importantly, the main loops outlined in the Causal Loop Diagram in Chapter 8 showed a consistency with the Agenda conflicts outlined above. For instance, the diagram presented loops pertaining to financial limitations reducing the thermal comfort and health of lower income citizens, these loops link to *Agenda conflict 8* and the dynamics between citizen participation and citizen agency. Systemic relationships presented in the diagram also represent the dynamics between alternative energy systems and social elements such as trust and energy literacy which influence citizen participation in these activities. These relationships link to *Agenda conflict 7* and limitations for vulnerable citizen groups. Notably, the diagram presents a loop representing the negative impacts of climate change on thermal comfort and consequent increases in energy demand, linking to *Agenda conflict 1* and the underlying research themes in this thesis.

9.2. Priorities Pyramid

Figure 9.1 presents an overview of the agenda conflicts uncovered in the preceding sections, prioritizing them in order of their impact on the policy domains of climate change, energy transitions and energy poverty. It is important to note that *Agenda conflicts 1-3* are based on the general review processes employed in Chapters 2 and 4. *Agenda conflicts 2-3* are more specific outputs of the UK case study review, and *Agenda conflict 1* (as described previously) acted as an introductory point for the research undertaken in this thesis. *Agenda conflicts 4-10 were* revealed as part of the research processes undertaken for the Portuguese case study; despite this, several of these are relevant in the broader European contexts. For example, Ulpiani & Vetters (2023) expose social risks associated with energy transitions in European cities, finding that a lack of equal opportunities and any form of poverty can undermine transition policies, showing the broader relevance of this thesis's findings pertaining to themes of inequity. Alternatively, insights on access barriers to alternative energy models are significant in a European policy context, which places high hopes on energy "prosumers" (COM/2019/ 640 final).

To help policy makers prioritize responses to the agenda conflicts Figure 9.1 presents the "Priorities pyramid". Figure 9.1 ranks policy priorities based on principles of "no significant harm" (Gupta & Schmeier, 2020; 2021/C 58/01), where those agenda conflicts which affect only one policy agenda (in this case, energy poverty) are placed at the bottom of the pyramid, agenda conflicts involving two agendas (in this case energy poverty and the energy transition) are placed in the middle of the pyramid and agenda conflicts which affect all three agendas are set at the top of the pyramid as top priorities.

Figure 9.1 thus establishes an order of priority for addressing these agenda conflicts; where the most urgent agenda conflicts are shown at the top of the pyramid and the least urgent at the bottom. It is striking that applying principles of "no significant harm" (2021/C 58/01) to set policy priorities implies initially neglecting agenda conflicts in the energy poverty and energy transition domains. Despite this, as conflicts addressing all three agendas are the top priority, this approach will at least partially improve outcomes for the energy poor and achieve wider energy transition goals. This leads to a consistent theme across the thesis: There are rarely any win/win policy situations and attempts to address one agenda conflict can result in additional conflicts. For example, conflicts between general improvements in building efficiency and equitable access to energy efficiency measures occur because of the policy strategy resulting from *Agenda conflict-1*.

The results of this thesis highlight that in the drive to achieve carbon neutrality by 2050, contemporary decarbonisation policy approaches do not holistically account for policy goal conflicts. By exposing these conflicts, the priorities pyramid contributes to improved solutions across the three policy agendas of climate change, energy transitions, and energy poverty and thus achieves the underlying aim of the thesis.

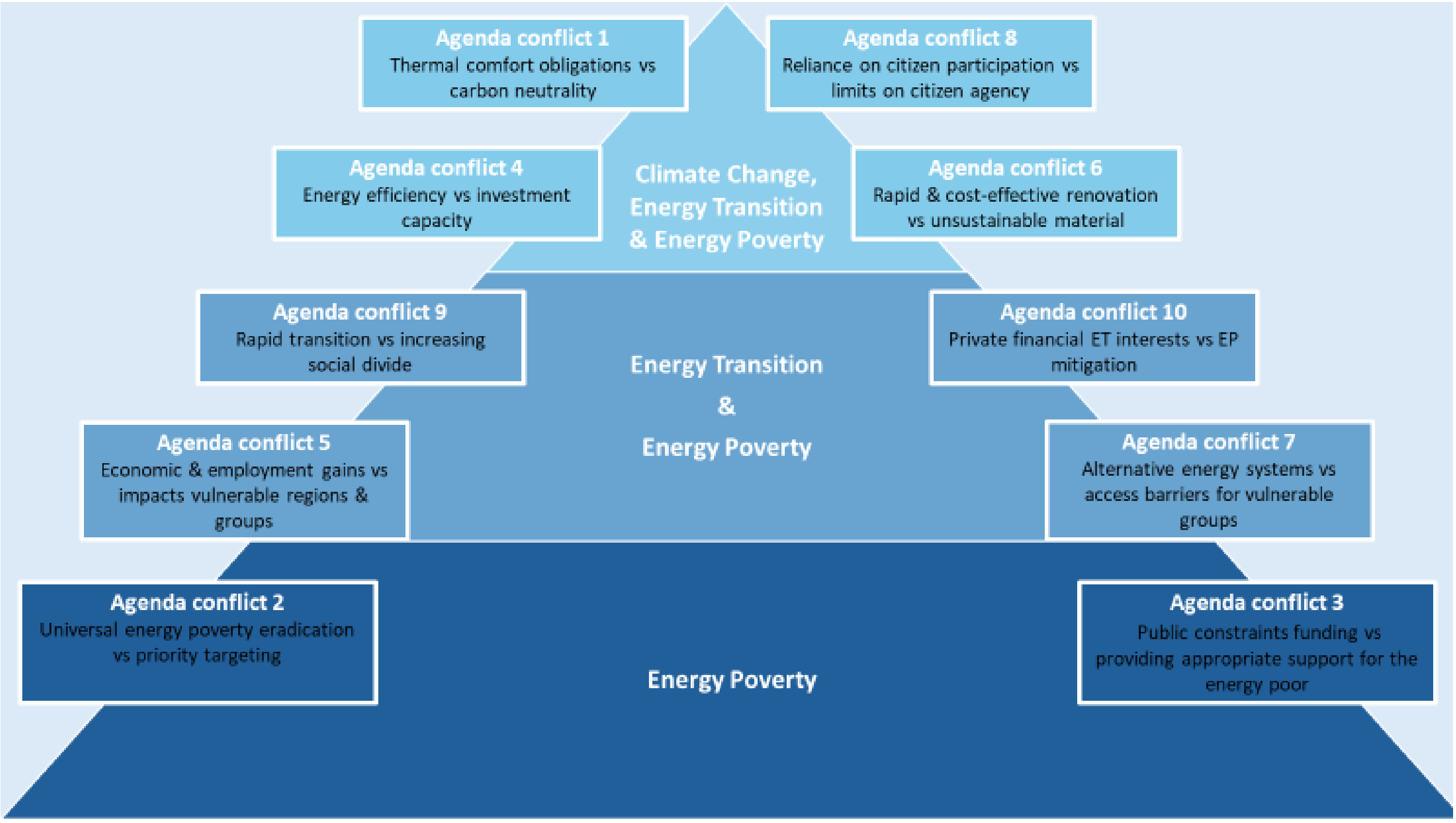

Figure 9.1 Agenda conflict priorities pyramid

The research outlined in this thesis is inevitably subject to some limitations and unearths important future areas of research. These limitations and future research topics mainly relate to the participatory elements of the thesis. Firstly, the described uncertainties surrounding citizen participation were identified by expert stakeholders, rather than by direct engagement with citizens themselves. Thus, while these expert insights are highly valuable, an important next step is deeper engagement with citizen groups to obtain first-hand insights into motivators of citizen participation. Secondly, the Participatory Mapping Workshop explored energy poverty at the local level, leading to insights on how local solutions are linked to wider national and international influences. Therefore, an important future research exercise would be the engagement of high-level policy makers working across the agendas for a deeper elaboration of top-level policy. The Causal Loop Diagram presented in Chapter 8 is the first visual elaboration of the Portuguese energy poverty system, however, the post-production processes undertaken to produce the diagram were completed via internal research team activities. To gain improved insights into the Portuguese energy poverty system the validation of the final Causal Loop Diagram with participants in the qualitative interview and workshop activities is an essential next step.

In conclusion, the exploration of the interlinkages of the climate change, energy transitions and energy poverty agendas throughout the thesis adds weight to assertions that these agendas are intrinsically connected and, as such, should be treated holistically. Despite this, in the overall framing of “competing agendas” applied throughout the thesis and the specific "agenda conflicts" presented in these concluding sections, the thesis exposed several adverse effects of this approach, generally affecting the energy poor and the vulnerable adversely. Additionally, the thesis revealed an over-reliance on citizen participation, where citizens' true capacity and will are not understood sufficiently to justify this reliance. The discussed risks of this over-reliance, essentially energy transition rejection, pose significant threats to achieving carbon neutrality in 2050. Thus, a final suggestion of this thesis is for contemporary and future policy approaches to these agendas to better account for the will and ability of citizens, tightening connections between the social and energy domains to achieve this end.

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Annexes

Annex Contents

This thesis includes two annexes, providing supplementary information for Chapters 5 & 7, as detailed in the corresponding chapters.

Annex A provides the data source review for the replication of the high spatial scale index as detailed in Chapter 5 and Annex B provides the interview guide for the interview process described in Chapter 7.

Annex A - Data source review-Characterisation of data sources for the UK Countries

Annex A1 - Climate region and building typology data sources

Data Type	Required inputs	Availability of Data by Country Grouping													
		U.K. (EC, 2020; Met Office, 2019)		**G.B** (EC, 2020; Met Office, 2019)		**England and Wales** (EC, 2020; Met Office, 2019; MHCLG, 2019a)		**Scotland** (EC, 2020; ; Energy Saving Trust, 2019; Met Office, 2019; Scottish Government, 2019b)		**England** (EC, 2020; Met Office, 2019; UK Gov, 2019a)		**Wales** (EC, 2020; Met Office, 2019; Welsh Government, 2019b)		**Northern Ireland** (EC, 2020; Housing Executive, 2019; Met Office, 2019)	
		Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res
1.Climate/region	1.1 Heating degree days	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3
	1.2 Cooling degree days	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3	EUAGRICAST	NUTS 3
	1.3. Outdoor temperature	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional	Met Office UK & Regional series	Regional
2.Building typology	2.1. Apartment/house, nº of floors	N/A	N/A	N/A	N/A	Domestic EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household
	2.2. Construction years	N/A	N/A	N/A	N/A	N/A	N/A	Scottish House Condition Survey 2017	Local authority	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland House Condition Survey 2016	Council areas

Annex A2 - Building characteristic data

Data Type	Required inputs	Availability of Data by Country Grouping													
		U.K.		G.B.		England and Wales (MHCLG, 2019a)		Scotland (Energy Saving Trust. 2019)		England (UK GOV, 2019a)		Wales (Welsh Government, 2019b)		Northern Ireland (Department of Finance, 2019)	
		Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res
3.Building characteristics	3.1. Walls	N/A	N/A	N/A	N/A	Domestic EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household
	3.2. Pavement/floor area	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household
	3.3. Ceiling/Roof	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household
	3.4 Glazing	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household
	3.5 Ventilation	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland Domestic EPC Register	Household

Annex A3 - Other indicators and energy consumption data

Data Type	Required inputs	Availability of Data by Country Grouping													
		U.K. (BEIS, 2019d; EC, 2019b)		G.B. (BEIS, 2019d-e; BEIS, 2020; DWP, 2019		England and Wales (BEIS, 2019d)		Scotland (BEIS, 2019d; Scottish Government, 2019c, e)		England (BEIS, 2019d ; UK Gov, 2019a)		Wales (BEIS, 2019d; Welsh Government, 2019b-c)		Northern Ireland (BEIS, 2019d,f.g; Housing Executive, 2019; UK GOV, 2019b)	
		Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res
4.Other indicators for benchmarking	4.1. Social tariff support	N/A	N/A	Quarterly benefits summary 2018	National	N/A	N/A	Economic Activity, Benefits and Tax Credits	Data zone 2001	English Housing Survey 2017-18	Country	National survey for Wales 2018	Country	Northern Ireland Benefits Statistics Summary	Small Areas
	4.2. EU SILC indicators	SILC ESQRS UK 16	National	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4.3. Social housing	N/A	N/A	N/A	N/A	N/A	N/A	Local Authority Housing Council Housing	Council areas	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Local authority	Northern Ireland House Condition Survey 2016	Country
5.Energy consumption	5.1. Per end use	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National	Energy consumption in the U.K. 2019	National
	5.2. By region	N/A	N/A	Lower and Middle Super Output Area electricity consumption & Lower and Middle Super Output Areas gas consumption	LSOA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Sub-national electricity consumption in Northern Ireland & Sub-national gas consumption statistics in NI: 2019	Council areas

Annex A4 - Climatization equipment data

Data Type	Required inputs	Availability of Data by Country Grouping													
		U.K. (BEIS, 2019d)		G.B.		England and Wales (MHCLG, 2019a)		Scotland (Energy Saving Trust, 2019)		England (UK GOV; 2019a)		Wales (Welsh Government, 2019b)		Northern Ireland (Department of Finance, 2019)	
		Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res
6.Climatisation equipment	6.1. Levels of ownership	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Country	N/A	N/A	Northern Ireland Domestic EPC Register	Household
	6.2. Type	Energy Consumption in the U.K. 2019	National	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	Household	English Housing Survey 2017-18	Regional	Welsh Housing Conditions Survey 2018	National	Northern Ireland Domestic EPC Register	Household
	6.3. Efficiency	N/A	N/A	N/A	N/A	EPC bulk data	Household	Domestic Energy Performance Certificates	National	English Housing Survey 2017-18	Regional	N/A	N/A	Northern Ireland Domestic EPC Register	Household

Annex A5 - Socio-economic data

Data Type	Required inputs	Availability of Data by Country Grouping													
		U.K. (Department for Education, 2019, ONS, 2019a)		G.B.		England and Wales (ONS, 2019b)		Scotland (Scottish Government, 2019b,d,f,g,h)		England (MHCLG, 2019b; UK GOV, 2019a)		Wales (Statistics Wales, 2019; Welsh Government, 2019b,c)		Northern Ireland (Housing Executive; 2019; NISRA, 2019a,b;)	
		Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res	Relevant source	Spatial Res
7.Socio-economic data	7.1. Educational level	Education and Training Statistics for the United Kingdom: 2018	National	N/A	N/A	2011 Census	Electoral Ward	Education, Skills and Training	Council areas	N/A	N/A	National survey for Wales	National	2011 Census	Small Areas
	7.2. Average income	Regional gross disposable household income, UK: 1997 to 2017	NUTS 3	N/A	N/A	2011 Census	Electoral Ward	Scottish Index of Multiple Deprivation (SIMD) 2016	Data Zone	The English Indices of Deprivation 2019	LSOA	Welsh Index of Multiple Deprivation 2019	LSOA	Northern Ireland Multiple Deprivation Measures 2017	Small Areas
	7.3. Elderly and young people	N/A	N/A	N/A	N/A	2011 Census	Local authority	Children and Young People & Population	Data Zone 2011	English Housing Survey 2017-18	Country	National survey for Wales	Country	2011 Census	Small Areas
	7.4. Conservation status of the building	N/A	N/A	N/A	N/A	2011 Census	Local authority	Scottish House Condition Survey 15-17	Local authority	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	Northern Ireland House Condition Survey 2016	Country
	7.5. Tenure of the house	N/A	N/A	N/A	N/A	2011 Census	N/A	Housing	Local authority	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	2011 Census	Small Areas
	7.6 Occupancy rate	N/A	N/A	N/A	N/A	2011 Census	Local authority	Housing	Data Zone 2011	English Housing Survey 2017-18	Country	Welsh Housing Conditions Survey 2018	Country	2011 Census	Small Areas

Annex B - Interview guide CC, ET & EP agendas in Portugal

Part.1-Introductions and exploration of interviewee's experience with the research topic

Part.2- Views on climate change, energy transition, and energy poverty agendas:

1. Do you see these agendas as linked or separate? Please explain.
2. What is your view on public knowledge of and capacity to participate in the CC and ET agendas?
3. What is your view on public awareness of energy poverty and the ability to mitigate this condition?

Part.3- Free-flowing interview section to pursue unique areas of expertise e.g.,

- Sustainability of the construction & rehabilitation sector
- Social vulnerabilities e.g., poverty, housing tenure
- Business interests

Part.4- Policy section discussing familiarity with and perceptions of key CC, ET and EP agendas (e.g., are you familiar with the RCN 2050?)

Policies:

- Carbon Neutrality Roadmap (RCN 2050)
- National Energy and Climate Action Plan (NECP 2030)
- The Long-Term Strategy for the Renovation of Buildings (LTRS)
- Draft EP Strategy
- National COVID Recovery Package (RRP) and associated energy efficiency funding schemes:
    - More Sustainable Buildings II
    - Efficiency Voucher

2024

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COMPETING AGENDAS - ENERGY POVERTY AND CARBON NEUTRALITY POLICY PATHWAYS

UNIVERSIDADE NOVA DE LISBOA