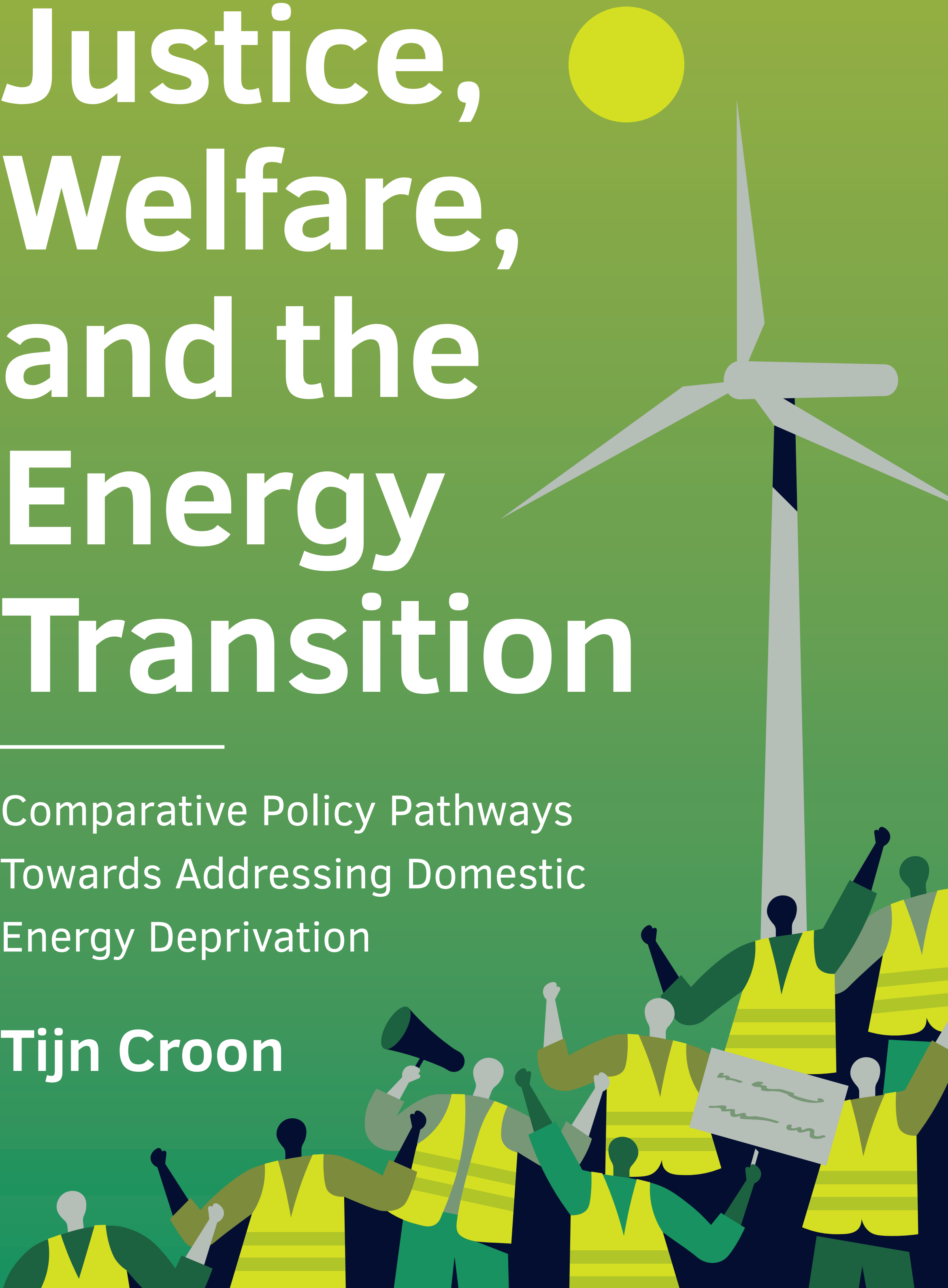
Justice, Welfare, and the Energy Transition

Comparative Policy Pathways Towards Addressing Domestic Energy Deprivation

Tijn Croon



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A+BE | Architecture and the Built Environment | TU Delft BK

26#07

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Cover image | © Eline Schipperen

Keywords | energy deprivation, energy transition, energy poverty, social welfare, just transition

ISBN 978-94-6518-295-7
ISSN 2212-3202

This dissertation is open access at https://doi.org/10.71690/abe.2026.07

Justice, Welfare, and the Energy Transition

Comparative Policy Pathways Towards Addressing Domestic Energy Deprivation

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus,
Prof.dr.ir. H. Bijl,
chair of the Board for Doctorates
to be defended publicly on
Friday 1 May 2026 at 12:30 o'clock

by

Tijn Melle CROON

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Key words: energy deprivation, energy transition, energy poverty, social welfare, just transition
Printed by: CB
Cover by: Eline Schipperen

Series: A+BE | Architecture and the Built Environment
ISBN: 978-94-6518-295-7

An electronic version of this dissertation is available at: http://repository.tudelft.nl

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"The test of our progress is not whether we add more to the abundance of those who have much; it is whether we provide enough for those who have too little."

Franklin Delano Roosevelt, Second Inaugural Address (1937)

"We are to compare schemes of cooperation by seeing how well off the least advantaged are under each scheme, and then to select the scheme under which the least advantaged are better off than they are under any other scheme."

John Rawls, Justice as Fairness (2001, pp. 59-60)

"Fuel poverty is a serious social problem that continues despite considerable state expenditure. Policies have been inadequate and misdirected, partly because they were based on an analysis of the symptoms of fuel poverty, rather than the causes. With social problems needing inter-disciplinary study, the events that trigger public concern, such as the numbers of disconnections or deaths from hypothermia, can be poor indicators of the true causes and necessary solutions. The energy efficiency of the home environment is what determines whether a low-income family can obtain adequate warmth."

Brenda Boardman, Fuel Poverty: From Cold Homes to Affordable Warmth (1991, p. 230)

"The twin defining challenges of the twenty-first century are overcoming poverty and managing climate change. If we fail one, we fail the other."

Nicholas Stern, Why Are We Waiting: The Logic, Urgency, and Promise of Tackling Climate Change (2015, p.79)

"Fin du mois et fin du monde: même combat."

Attributed to the French Gilets Jaunes (Yellow Vests) movement, 2018-2019

Acknowledgments

The idea of embarking on a PhD took shape only gradually. For years, I imagined it as something narrow in scope and detached from the world beyond the page. It proved to be neither. Over these past years, I have been fortunate to be surrounded by people who made this journey far more dynamic and rewarding than I could have anticipated. This is not a complete account, space does not allow it, but it is a small attempt to acknowledge at least some of them.

To begin with the most important shoulders on which I have been allowed to stand: my promotors, Marja and Joris. Thank you for the example you set through your scholarship and the networks you opened up to me. It is hard to overstate how much that mattered, especially early on, when confidence is often borrowed. More than that, thank you for a style of supervision that combined a lot of freedom with well-timed interventions: the right question at the right moment and a careful challenge when I was too convinced by my own argument. I also appreciated your clear conviction that the impact of our collaborative work lay more in its societal contributions than in its citation count. And through coffees, conference trips, and lunches with the research group at Marja’s, you made this PhD feel like a team endeavour.

Research stays in Cambridge and New York shaped this project in ways I could hardly have imagined. I am deeply grateful to Minna and Ray in Cambridge, where conversations sharpened my thinking considerably. Minna, your openness and curiosity made it easy to think well and to think honestly. Ray, your principled clarity and boundless energy are qualities I can only hope to match at your age. In New York, Diana was a constant source of inspiration. Your ability to translate abstract questions of justice into concrete lived realities is something I deeply admire. Equally striking is your sense of community, whether in the Bronx, in Brooklyn, or within your own research group.

This PhD would not have been possible without the RE-DWELL coordinating team: beyond Marja and Joris, I would like to thank Leandro, Karim, Adrienne, Marietta, Gerard, Lorraine, Adriana, Krzysztof, Gojko, Nadia, Carla and Alexandra, for building not just a project, but a great network. To my fellow early-stage researchers – Annette, Saskia, Lucia, Aya, Mahmoud, Marko, Anna, Andreas, Effrosyni, Zoe, Alex, Androniki, Carolina, Leonardo and Christophe – it was a privilege to share this

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journey with you. The secondments were among the most formative experiences of the PhD, my sincere thanks to the amazing teams at Clarion, Housing Europe and EFL, and in particular to my mentors there, Elanor, Alice, and Ben. I am grateful for the EU's Marie Skłodowska-Curie funding that made these experiences possible, in return I shall refrain from asking for a raise or complaining about long hours in my current role at the European Commission. I also thank the Fulbright programme for enabling time in the U.S., at a time when transatlantic learning (or learning in general) was still a relatively uncontroversial idea in the White House.

Another cornerstone of this PhD was TNO. One of the most important emails I have ever sent may well have been on 27 September 2021, when I wrote to Koen Straver to congratulate (and gently critique) a report he had just co-authored. That message opened a collaboration that fundamentally shaped this PhD. I want to thank Peter Mulder explicitly for the support and for the kind of professional generosity that makes collaboration feel energising rather than extractive. I also really enjoyed working on papers with Francesco Dalla Longa, Arianne van der Wal, and Caroline van Ooij, and on the provincial studies with Anika Batenburg. The regular TNO symposia remain a particularly warm memory, and a reflection what a remarkable organisation this is.

At TU Delft, I was lucky to work in a faculty where doors were always open, even for a somewhat nomadic member of the club. Thank you to Alex, Stefanie, Afua, Eline, Queena, Shiyu, Shutong, Karel, Boram and Céline for the exchanges that made my time at Delft all the more enjoyable. Organising the Energy Transition Changemakers lunch seminars with Elham was a particular highlight. I am also grateful to have taught and supervised many talented students, and it was deeply rewarding to see some of them exceed their own expectations.

Some of my favourite parts of the past years were the side quests. Thank you to Meike and David Bokhorst for the fun and surprisingly rich exploration of Amsterdam's social investment strategies; to Barend Wind for the work on land policy, social homeownership, and the manifesto of PvdA; and to Mohammed Chahim for the collaboration on industrial policy, as well as the east coast college tour in the U.S. that led to many memorable encounters.

I am indebted to the reviewers, interview participants, focus group contributors and countless colleagues who offered feedback at seminars and conferences. Their questions strengthened this work in ways both visible and invisible.

Beyond academia, there are many people who ensured that this PhD remained part of a life rather than its entirety.

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To my parents, Hans and Darja. Thank you so much for the steady encouragement and for nurturing curiosity from an early age. I realise more and more how much that foundation matters. I loved showing you around Cambridge and New York, those visits meant a lot to me. To my sister and fellow academic, Djuna: although our research paths have been very different, you have always reminded me that a scientific life need not crowd out other passions. I am honoured that you will stand beside me as paranymph during the defence. To Luke, bruv-in-law and fellow wind turbine enthusiast, may the North Sea continue to fill up at the pace you prefer. To my wonderful nephews Cian and Renn for always making me laugh. And to Eric and Irene, and to Emma and Pim, thank you for your warmth, especially during a period that asked a great deal of you.

To friends such as Bouke, Jazz, Laurens, Reinout, Rick, and Thijmen, thank you for keeping me grounded, even after my recent triumph in the highly contested GG Peace Prize. To Guus, Sebas and Anthony, for the many Amsterdam and Berlin nights (and mornings). To Abel and James, for the good vibes and the Groningen and Hamburg roadtrip (the streets will never forget). To Sietse and Jarre, for the Borgen-like spin-doctor debates (and future marathons?). To Jonne, for our shared attempt to deliver Georgia for Kamala in our finest Southern accents. To Jurriaan, for the spontaneous encounters and pseudo-intellectual discussions. To Thomas and Catharina, for the lovely dinners and for making everything feel unhurried. To the Okkers for never overcomplicating things. And of course, to the Azzurro Bianchi of TOS Actief, thank you for the occasionally good but often dreadful 5th-league football, the excellent company, and the infamous third halves.

And finally, my deepest thanks go to Lisa, the love of my life. You encouraged me to seize every opportunity, even when that meant five long months apart. You tolerated the occasional zombie phase behind my Mac, quietly carrying more than your fair share. I am happiest when I am with you, and sometimes I wish our weekend breakfasts could last forever (on some Sundays, they almost do). Later this year, our breakfast table will be a little fuller, and I cannot wait.

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Summary

Domestic energy deprivation – the inability of households to attain adequate energy services in the home – has emerged as a significant social risk within the energy transition. Recent price shocks laid bare long-standing fragilities in the European energy system and heightened concerns over the legitimacy of climate action, as across-the-board cost increases have distinctly regressive effects. This thesis develops new diagnostic tools and comparative evidence to reveal where and why domestic energy deprivation occurs, and examines how welfare state traditions influence the design and durability of policy responses. Together, these insights show how governments can better align social protection with climate goals in pursuit of a just energy transition.

The analysis is grounded in a sufficiency-oriented view of justice, which holds that the primary moral imperative is to ensure that everyone has *enough* to live with dignity and participate fully in society. From this standpoint, domestic energy deprivation constitutes a fundamental injustice: when households cannot afford adequate warmth, light, or energy for daily routines, and effectively have to choose between "heating or eating", they fall below a socially recognised threshold of basic capabilities, making full participation impossible. Alongside this sufficiency lens, the thesis draws on John Raws' difference principle, which requires that social arrangements prioritise those who are least advantaged. In the context of the energy transition, measures that place unequal burdens across groups, such as carbon pricing, are legitimate only if the overall framework ultimately improves conditions for households most exposed to domestic energy deprivation and least able to adapt. Though distinct, these two lenses converge on the same core commitment: giving greatest moral weight to securing a minimum standard for all and improving the position of the worst-off, even when this entails trade-offs with aggregate efficiency.

Building on these foundations, this paper-based thesis pursues three strands of inquiry, undertaken within the Marie Skłodowska-Curie Innovative Training Network RE-DWELL. First, it refines problem diagnosis by integrating enhanced measurement with explanatory analysis of its underlying determinants. Second, it evaluates targeted measures at local and national levels, analysing which instruments work, for whom, and under what conditions. Third, it investigates how institutional logics and welfare traditions shape the incorporation of social provisions into energy and climate governance across the EU, UK, and selected US states.

Research findings

Part I – Problem definition: gaps in understanding domestic energy deprivation as a social risk (Chs. 2-3)

Chapter 2 demonstrates how measurement choices shape the visibility of domestic energy deprivation and, in turn, the targeting of support. Conventional headcount statistics apply a single threshold and only register changes around that cut-off, masking both the depth and distribution of shortfalls. The gap-based indicators developed here move beyond binary counts to capture the depth and distribution of deprivation, while making explicit the welfare choices implicit in any metric. Using Dutch microdata, the modelling shows that had allocation to municipalities during the energy crisis been guided by intensity rather than incidence, resources would have been distributed markedly different, exposing welfare trade-offs otherwise hidden.

Chapter 3 examines the drivers of households' energy spending in England and finds that housing conditions, particularly energy efficiency and dwelling size, are the dominant determinants. Raising income alone offers only limited relief: for low-income households not classified as energy poor, heating demand is largely unresponsive to additional income, while for those classified as such, demand does increase, though only modestly. This demonstrates that income and energy poverty only partly overlap, as the latter reflects unmet needs that income measures cannot capture and that remain largely rigid and non-discretionary. The findings underscore that targeted retrofits deliver far more substantial and lasting relief than modest income gains. Yet during the energy crisis, governments channelled hundreds of billions into short-term income support rather than structural measures, missing the opportunity to prioritise housing interventions as a cornerstone of a just energy transition.

Part II – Policies and practice: design and delivery of targeted household energy support (Chs. 4-6)

Chapter 4 analyses the role of social housing providers (SHPs) in France, England, and the Netherlands. Focus group discussions reveal that SHPs favour targeted retrofits and tenant energy-saving guidance as the most viable ways to support vulnerable residents to mitigate deprivation, while systemic measures such as altering rent setting and housing allocation based on vulnerability indicators are considered impractical under current constraints. Institutional barriers and data gaps limit their ability to target effectively. The chapter concludes that broader reform is needed to recognise energy costs as a core dimension of housing governance and to enable SHPs to act on this potential.

Chapter 5 evaluates municipal programmes in the Netherlands that deliver small, cost-effective physical upgrades (such as draught-proofing, radiator balancing, and LED installation through 'Fix Teams') and behavioural interventions (including single- and multi-visit energy coaching). Survey and control group data show measurable improvements in comfort and lower bills, with more intensive engagement outperforming one-off visits, highlighting the benefits of sustained support. Notably, households with higher energy burdens saw the largest gains, indicating that targeting resources to the most vulnerable amplifies impact. The results illustrate the value of local, tailored action in complementing broader policy frameworks for a just transition.

Chapter 6 offers a comparative assessment of how 18 European countries balanced relief for households with fiscal, environmental, and political considerations during the 2021-2023 energy crisis. It finds a general shift in strategy over time: early crisis responses tended to be broad and universal (e.g. tax and levy cuts) to maximise speed and salience, while later measures became more targeted, enhancing cost-effectiveness and preserving conservation incentives. National approaches varied, but hybrid schemes mixing universal and targeted elements often emerged as a pragmatic balance. The analysis underscores that while crisis responses inevitably involve trade-offs, careful sequencing and blending through policy learning can reconcile objectives often seen as competing, such as adequacy and efficiency.

Part III – Principles and governance: institutional and normative logics in shaping just energy transitions (Chs. 7-9)

Chapter 7 traces how household energy support in the United Kingdom shifted from broad, preventive schemes to a residual, reactive model. While well-designed targeting can ensure that scarce resources reach those in greatest need, the UK experience shows how an excessive reliance on narrow means-tested and privatised relief leaves households vulnerable to austerity cycles and undermines structural resilience. The chapter argues that political and institutional factors have entrenched this residualist approach. Crises occasionally prompted universal measures, but these were short-lived, and government rhetoric on energy efficiency co-benefits rarely translated into sustained funding. The chapter concludes that although levels of support may differ by means and need, embedding a right to energy and to adequate housing standards would offer the most durable and legitimate basis for long-term social protection.

Chapter 8 examines the gradual integration of social provisions into EU climate and energy policy, with particular attention to the European Green Deal. Using Hall's framework of policy change, it finds that while the Green Deal has introduced important adjustments, it has not fundamentally altered the EU's market-centric model of climate and energy governance. Consumer protections and redistributive mechanisms such as the Just Transition Fund and the Social Climate Fund have been layered onto an essentially market-oriented paradigm. In Hall's terms, these constitute second-order change rather than a third-order shift towards a justice-centred regime. Moreover, many provisions remain largely procedural, limited to monitoring obligations and planning requirements, rather than substantively guaranteed, and their durability depends on fiscal and political conditions rather than rights-based entitlements.

Chapter 9 investigates how US state-level cap-and-trade programmes allocate carbon pricing revenues. All three cases mandate that roughly 35-40% of investments benefit disadvantaged communities, but the design and implementation of these provisions vary. Differences lie in the rigour of tools used to identify target communities, the enforceability of benefit definitions, the protection of equity funds, and the extent of community involvement in spending decisions. New York appended equity measures to a technocratic framework; California embedded them through conflict and legislation; and Washington built equity in by design. The chapter concludes that where equity is institutionally anchored, programmes secure broader legitimacy and resilience, as evidenced by Washington's programme surviving repeal in a statewide referendum.

Main conclusions

This thesis demonstrates that domestic energy deprivation is not a marginal affordability issue but a multidimensional social risk at the heart of the energy transition. Diagnosing it through gap-based, sufficiency-anchored indicators reveals both the depth and distribution of shortfalls and surfaces policy trade-offs that binary headcounts obscure. This diagnostic shift reframes energy deprivation as the absence of a guaranteed floor and provides a principled basis for directing resources to those in deepest need. Since energy performance and fuel characteristics are decisive drivers, structural remedies that reduce needs at source, particularly targeted retrofits for low-income households in the least efficient dwellings, offer a more reliable route out of deprivation than marginal income boosts or short-term subsidies.

Social housing providers emerge as pivotal actors of structural prevention. In Western European welfare states, they house a large share of low-income households and are uniquely positioned to target the worst-performing dwellings. Yet their capacity is constrained by data gaps, regulatory barriers, and funding pressures, underscoring the need to empower them to direct investment where it matters most.

While deep retrofits remain the long-term solution, the research highlights the value of interim measures, such as coordinated 'Fix Team' models of shallow retrofits that could bridge long renovation pipelines and already alleviate a substantial share of the burden for households unable to wait. At the national level, the analysis shows that during the energy price crisis, governments combining a universal tiered price cap with targeted transfers achieved the strongest balance of equity, fiscal efficiency, and conservation incentives. This 'targeting within universalism' preserved legitimacy while concentrating support on those most in need.

Finally, the findings show that institutional design determines whether just energy policies endure. Where support remains residual or ad hoc, preventive ambitions are vulnerable to fiscal retrenchment and political reversal. Where social protection and decarbonisation are embedded in stable or rights-based arrangements, distributive and procedural justice are more likely to persist. U.S. state-level cap-and-trade programmes illustrate how justice can be institutionalised: earmarked revenue shares, transparent tools to identify disadvantaged communities, and direct community involvement in allocation decisions all help sustain legitimacy. Across contexts, policies prove credible and resilient only when they keep households above a minimum energy standard while advancing decarbonisation. This means that addressing domestic energy deprivation is not a secondary concern but a precondition for the legitimacy of climate policy itself.

Samenvatting

Energiearmoede – de situatie waarin huishoudens hun woning niet voldoende kunnen verwarmen, verlichten of van energie voorzien voor alledaagse activiteiten – is uitgegroeid tot een belangrijk sociaal risico binnen de energietransitie. Recente prijsschokken hebben kwetsbaarheden in het Europese energiesysteem blootgelegd en de legitimiteit van klimaatbeleid onder druk gezet. Generieke kostenstijgingen werken immers regressief en treffen huishoudens met lagere inkomens relatief het zwaarst. Dit proefschrift ontwikkelt nieuwe meetinstrumenten en biedt vergelijkend empirisch inzicht in de patronen en oorzaken van energiearmoede. Daarnaast onderzoekt het hoe verschillende verzorgingsstaattradities bepalen hoe beleid wordt vormgegeven en of het op langere termijn standhoudt. Gezamenlijk laten deze analyses zien hoe sociale zekerheid beter kan worden afgestemd op klimaatdoelen in het streven naar een rechtvaardige energietransitie.

De analyse is verankerd in een sufficiëntaristische benadering van rechtvaardigheid. Centraal staat het uitgangspunt dat iedereen over ‘genoeg’ middelen moet beschikken om waardig te leven en volwaardig aan de samenleving deel te nemen. Vanuit dit perspectief vormt energiearmoede een fundamentele onrechtvaardigheid: wie moet kiezen tussen “koken of stoken” zakt onder een maatschappelijk aanvaarde ondergrens van bestaanszekerheid. Naast het sufficiëntarisme bouwt het proefschrift voort op het verschilprincipe van John Rawls. Dit principe stelt dat maatschappelijke regelingen zo moeten worden ingericht dat zij in het bijzonder ten goede komen aan de minst bedeelden. Omdat maatregelen zoals CO_2-beprijzing relatief zwaarder drukken op lagere inkomensgroepen, zijn zij alleen gerechtvaardigd wanneer het bredere beleidskader corrigerend werkt en de positie verbetert van huishoudens met risico op energiearmoede. Hoewel deze twee normatieve kaders van elkaar verschillen, delen zij een kern: het waarborgen van een minimumniveau voor iedereen vraagt om prioriteit voor de minst bedeelden, ook wanneer dit in de praktijk een afruil met efficiëntie betekent.

Voortbouwend op deze uitgangspunten volgt dit proefschrift, samengesteld op basis van wetenschappelijke artikelen en uitgevoerd binnen het Marie Skłodowska-Curie *Innovative Training Network* RE-DWELL, drie onderzoekslijnen. Ten eerste wordt de probleemanalyse aangescherpt door verbeterde meetmethoden te combineren met onderzoek naar de oorzaken van energiearmoede. Ten tweede worden gerichte beleidsmaatregelen op lokaal en nationaal niveau geëvalueerd, waarbij wordt nagegaan welke instrumenten werken, voor wie en onder welke omstandigheden. Ten derde wordt onderzocht hoe institutionele logica's en verzorgingsstaattradities de manier beïnvloeden waarop sociale zekerheid wordt ingebed in energie- en klimaatbeleid binnen de EU, het Verenigd Koninkrijk en een aantal Amerikaanse staten.

Onderzoeksbevindingen

Deel I – Probleemdefinitie: lacunes in het begrip van energiearmoede als sociaal risico (Hoofdstukken 2 en 3)

Hoofdstuk 2 laat zien hoe keuzes in meetmethoden bepalen in hoeverre energiearmoede zichtbaar wordt en daarmee ook hoe steun wordt verdeeld. Veelgebruikte indicatoren werken met één vaste armoedegrens en tellen vooral hoeveel huishoudens daarboven (of onder) vallen. Daardoor blijven zowel de ernst van tekorten als de verschillen tussen groepen grotendeels buiten beeld. De in dit proefschrift ontwikkelde maatstaven laten daarentegen zien dat er een grote groep huishoudens is met relatief kleine tekorten, naast een kleinere groep met zeer diepe tekorten. Dat onderscheid is cruciaal: beleid kan het aantal huishoudens onder de grens verminderen, terwijl de grootste tekorten nauwelijks afnemen, of andersom. Op basis van Nederlandse microdata laat de analyse zien dat middelen tijdens de energiecrisis aanzienlijk anders zouden zijn verdeeld als niet het aantal getroffen huishoudens, maar de ernst van hun situatie leidend was geweest.

Hoofdstuk 3 onderzoekt welke factoren de energiekosten van huishoudens in Engeland het sterkst beïnvloeden. Daaruit blijkt dat vooral de energie-efficiëntie en de grootte van de woning bepalend zijn. Bij huishoudens met lage inkomens die *niet* als energiearm worden aangemerkt, verandert de warmtevraag nauwelijks wanneer het inkomen stijgt. Bij huishoudens die wél energiearm zijn, neemt het energiegebruik significant meer toe. Dit laat zien dat energiearmoede niet samenvalt met armoede zoals die doorgaans op basis van inkomen wordt gemeten, omdat de onvervulde basisbehoeften niet vanzelf verdwijnen door alleen het inkomen te verhogen. De resultaten maken duidelijk dat gerichte woningverbetering een duurzamere en effectievere aanpak is dan tijdelijke inkomenssteun. Tijdens de energiecrisis kozen veel overheden echter vooral voor ongerichte inkomenssteun, waardoor een kans werd gemist om energiearmoede structureel te verminderen.

Deel II – Beleid en praktijk: vormgeving en uitvoering van gerichte steun aan huishoudens (Hoofdstukken 4-6)

Hoofdstuk 4 onderzoekt de rol van sociale verhuurders in Frankrijk, Engeland en Nederland. Uit focusgroepen met groepen professionals blijkt dat zij vooral inzetten op gerichte woningverbetering van kwetsbare huurders en ondersteuning bij energiebesparend gedrag als meest haalbare manieren om energiearmoede te verminderen. Meer ingrijpende systeemveranderingen, zoals het aanpassen van huurprijzen of het toewijzen van woningen op basis van kwetsbaarheid, worden binnen de huidige bestuurlijke kaders als moeilijk uitvoerbaar gezien. Een gebrek aan betrouwbare data en beperkende regelgeving verkleinen hun mogelijkheden om hier gericht op te sturen. De analyse maakt duidelijk dat bredere hervormingen nodig zijn om energiekosten expliciet te erkennen als integraal onderdeel van woonlasten, evenals grotere investeringen om sociale verhuurders beter in staat te stellen hun preventieve rol te vervullen.

Hoofdstuk 5 evalueert de deels gedecentraliseerde aanpak van energiearmoede in Nederland tijdens de energiecrisis. Gemeenten kregen middelen om te experimenteren met verschillende beleidsinterventies. Een belangrijk voorbeeld zijn de zogeheten Fix Teams, die kleinschalige en relatief goedkope woningaanpassingen uitvoeren, zoals tochtwering, het beter afstellen van radiatoren en het plaatsen van ledverlichting. Daarnaast boden gemeenten gedragsgerichte ondersteuning in de vorm van energiecoaches. Op basis van een grootschalige enquête onder interventie- en controlegroepen, gekoppeld aan administratieve data van de respondenten, blijkt dat beide aanpakken in verschillende mate kunnen leiden tot wooncomfort, stressverlichting, gedragsaanpassing en in sommige gevallen ook lagere energiekosten. Meerdere huisbezoeken van een energiecoach blijken duidelijk effectiever dan een eenmalig contactmoment. Opvallend is dat juist huishoudens met energiearmoede het meest profiteren van beide interventies, wat erop wijst dat gerichte inzet de impact vergroot. De resultaten onderstrepen het belang van lokaal maatwerk als aanvulling op nationaal beleid in de energietransitie.

Hoofdstuk 6 vergelijkt hoe achttien Europese landen tijdens de energiecrisis van 2021-2023 steun aan huishoudens vormgaven, en hoe zij daarbij een afweging maakten tussen het beschermen van kwetsbare groepen, het beheersen van overheidsuitgaven, het stimuleren van energiebesparing en het bieden van politiek zichtbare steun. In de eerste fase van de crisis kozen veel landen voor snelle, ongerichte maatregelen, zoals belasting- of accijnsverlagingen. In latere fases verschoof de aandacht naar gerichtere instrumenten, die doelmatiger waren en energiebesparing minder ondermijnden. De precieze aanpak verschilde per land, niet alleen afhankelijk van de mate waarin het land door de crisis werd getroffen, maar ook van de politiek-economische en institutionele logica van de desbetreffende verzorgingsstaat. De analyse laat zien dat crisisbeleid onvermijdelijk gepaard gaat met afruilen tussen beleidsdoelen, maar dat een doordachte mix van gerichte en universele maatregelen zowel sociale zekerheid als doelmatigheid kan waarborgen.

Deel III – Principes en governance: institutionele en normatieve logica in rechtvaardige energietransities (Hoofdstukken 7-9)

Hoofdstuk 7 beschrijft hoe energiegerelateerde overheidssteun aan huishoudens in het Verenigd Koninkrijk zich heeft ontwikkeld van bredere, preventieve regelingen naar een meer selectieve en reactieve aanpak. Gerichte steun kan ervoor zorgen dat schaarse middelen terechtkomen bij wie ze het hardst nodig heeft. De Britse ervaring laat echter zien dat een sterke nadruk op strikt inkomensafhankelijke regelingen huishoudens kwetsbaar maakt voor bezuinigingen en politieke koerswijzigingen. Tijdens crises werd soms gekozen voor bredere, universele steun, maar deze maatregelen bleken meestal van tijdelijke aard. Ambities op het gebied van energie-efficiëntie kregen in beleidsdocumenten wel aandacht, maar werden niet altijd ondersteund door structurele financiering. Het hoofdstuk concludeert dat duurzame sociale zekerheid in het energiedomein vraagt om een stevigere institutionele verankering, bijvoorbeeld door het recht op energie en op een minimale woningkwaliteit explicieter vast te leggen.

Hoofdstuk 8 onderzoekt hoe het klimaat- en energiebeleid van de Europese Unie geleidelijk meer sociale elementen heeft gekregen, met bijzondere aandacht voor de Europese Green Deal. In de afgelopen drie decennia zijn belangrijke hervormingen doorgevoerd, zonder dat de onderliggende vrijemarktgrondslag fundamenteel is veranderd. Instrumenten zoals het Just Transition Fund en het Social Climate Fund voegen herverdelende elementen toe, maar laten de onderliggende beleidslogica intact. Veel sociale bepalingen blijven bovendien procedureel van aard, bijvoorbeeld in de vorm van monitorings- en rapportageverplichtingen. Zij verplichten lidstaten om kwetsbare groepen in kaart te brengen, maar leggen minder vaak bindende herverdelende verplichtingen op, zoals wettelijk vastgelegde oormerking van middelen voor deze groepen. Waar dergelijke materiële waarborgen ontbreken, blijft sociale zekerheid kwetsbaar voor afbouw zodra politieke prioriteiten verschuiven of begrotingsdruk toeneemt.

Hoofdstuk 9 richt zich op de besteding van inkomsten uit emissiehandel in drie Amerikaanse staten. In alle gevallen is vastgelegd dat een substantieel deel van de opbrengsten ten goede moet komen aan kwetsbare regio's. De manier waarop dit wordt ingevuld verschilt echter aanzienlijk. Verschillen betreffen onder meer de criteria waarmee doelgroepen worden vastgesteld, de mate waarin specifieke

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bestedingen juridisch zijn verankerd en de betrokkenheid van doelgroepen bij besluitvorming. De analyse laat zien dat wanneer rechtvaardigheid expliciet institutioneel wordt verankerd, beleid breder wordt gedragen en beter bestand is tegen politieke tegenwind.

Hoofdconclusies

Dit proefschrift laat zien dat energiearmoede geen marginaal betaalbaarheidsprobleem is, maar een structureel sociaal risico dat centraal staat in de energietransitie. Door energiearmoede te analyseren met maatstaven die niet alleen het aantal getroffen huishoudens tellen, maar ook de ernst en verdeling van tekorten zichtbaar maken, wordt duidelijk hoe beleidskeuzes verschillende groepen ongelijk raken. Daarmee ontstaat een heldere normatieve en beleidsmatige basis om middelen gericht in te zetten waar de nood het hoogst is. Omdat vooral de energie-efficiëntie en het verwarmingssysteem van woningen bepalend zijn voor de energievraag, bieden gerichte woningverbeteringen bij lage inkomens een duurzamere oplossing dan tijdelijke inkomenssteun.

Sociale verhuurders spelen een sleutelrol in een structurele preventiestrategie. In veel West-Europese verzorgingsstaten huisvesten zij een groot deel van de lage inkomensgroepen en zijn zij daardoor bij uitstek in staat om juist de energie-efficiëntie van woningen van deze huishoudens te verbeteren. Hun handelingsruimte wordt echter beperkt door gebrekkige data, bepaalde regelgeving en financiële druk. Dit onderstreept dat zij beter moeten worden toegerust om investeringen te doen waar de behoefte het grootst is. Hoewel grootschalige renovaties de structurele oplossing vormen, laat dit proefschrift ook zien dat tijdelijke, gerichte maatregelen, zoals gecoördineerde Fix Teams die kleinschalige verbeteringen uitvoeren, een belangrijke overbrugging kunnen bieden voor huishoudens die niet kunnen wachten op ingrijpende renovatie. Op nationaal niveau blijkt dat landen die tijdens de energiecrisis een universeel prijsplafond combineerden met gerichte inkomenssteun het beste evenwicht bereikten tussen sociale zekerheid, doelmatigheid en behoud van besparingsprikkels. De brede basis versterkte de legitimiteit van het beleid, terwijl de gerichte steun vooral terechtkwam bij de meest kwetsbare huishoudens.

Tot slot blijkt dat het institutionele ontwerp bepalend is voor de continuïteit van rechtvaardig energiebeleid. Waar steun beperkt blijft tot tijdelijke of ad-hocregelingen, blijven preventieve ambities kwetsbaar voor bezuinigingen en politieke koerswijzigingen. Wanneer klimaatdoelen en sociale rechten steviger zijn verankerd in duidelijke institutionele kaders, is de kans groter dat zowel verdelende als procedurele rechtvaardigheid standhoudt. De emissiehandelssystemen in verschillende Amerikaanse staten laten zien hoe rechtvaardigheid structureel kan worden ingebed, bijvoorbeeld via wettelijk vastgelegde oormerking van middelen, transparante criteria om kwetsbare groepen te identificeren en actieve betrokkenheid van doelgroepen bij bestedingsbeslissingen. Beleid is pas geloofwaardig wanneer het voorkomt dat huishoudens onder een minimale energienorm zakken en tegelijk bijdraagt aan emissiereductie. Het tegengaan van energiearmoede is daarmee geen aanvullende sociale correctie, maar een voorwaarde voor de legitimiteit van klimaatbeleid.

1 Introduction

1.1 From energy crisis to legitimacy crisis

1.1.1 Energy affordability as a catalyst for civic unrest

Rising energy costs are well known to spark public discontent: the 1973 oil crisis and more recent regional disruptions have shown how such shocks can swiftly trigger mass mobilisation and even destabilise governments (Deese, 1979; Schramm, 2023). In recent years, the affordability of household energy bills has once again moved to the centre of political debate across Europe and beyond.

Two events of the past decade – one largely endogenous and policy-driven, the other exogenous and geopolitical in nature – clearly illustrate these contentious political and social dynamics. In late 2018, the Yellow Vest *(gilets jaunes)* protests erupted in France in response to a proposed fuel tax increase. Initially dismissed by some commentators as an expression of France's revolutionary tradition, the protests soon revealed deeper grievances about social injustice and economic exclusion. Although the tax proposal was framed by the government as a climate measure, it followed the abolition of France's wealth tax: a move widely perceived as favouring the rich. For many rural and households reliant on private vehicles, the tax shift symbolised a broader pattern of regressive policymaking that disproportionately burdened lower- and middle-income groups. In this way, the Yellow Vests became one of the first mass mobilisations to challenge climate policy explicitly on the grounds of distributive injustice (Irwin, 2024; Martin & Islar, 2020). Similar tensions resurfaced in Germany in 2022, when legislation mandating a shift away from gas and oil heating coincided with sharp price increases (Haas et al., 2025). Here too, the measures were heavily criticised as disproportionately burdening ordinary households. As Hajer and Oomen (2025) argue in *Captured Futures*, such episodes exemplify an emerging 'age of backlash', in which climate policies increasingly shape everyday life and, in doing so, expose their contested distributive consequences.

A few years later, this distributive conflict was amplified on a continental scale during the 2021-2023 European energy crisis. Unlike the nationally specific controversies in France and Germany, the crisis was triggered by exogenous shocks – post-pandemic demand recovery, Russia's invasion of Ukraine, and broader gas supply disruptions – yet its severity was magnified by Europe's own structural vulnerability, above all its long-standing dependence on cheap Russian gas. Prices reached historic highs across the continent (see Figure 1.1). The shock likewise translated into civic unrest: in Italy, protesters set electricity bills alight to denounce the rising cost of living, while in the Czech Republic more than 70,000 people marched through Prague against sanctions on Russian energy imports, portrayed as an unfair burden on the working class (Savage, 2023; Tait, 2022). Governments across Europe deployed hundreds of billions in emergency relief to shield households, yet these broad and often untargeted measures struggled to match the scale and speed of the crisis. The episode exposed the fragility of existing welfare and energy policy frameworks, highlighting the difficulty of recognising unequal needs and delivering targeted interventions that protected the most vulnerable without fuelling demand and driving prices even higher.

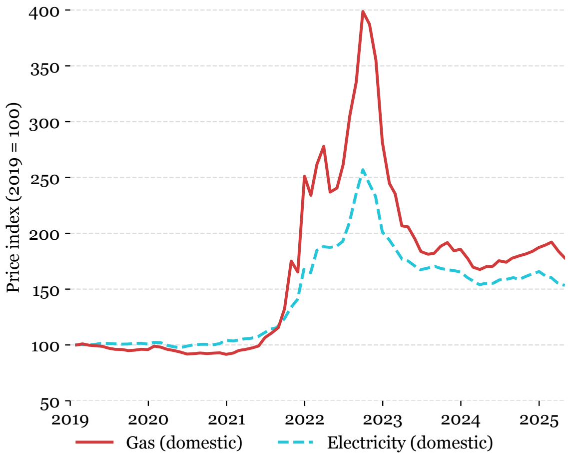

FIG. 1.1 Indexed domestic electricity and gas prices in the EU (January 2019 – May 2025), drawn from the Household Energy Price Index (HEPI), which reflects all components of the household energy bill: energy, network charges, taxes, levies, VAT, and subsidies or compensations (VaasaETT, 2025)

Although domestic energy prices across Europe have fallen from their peak, currently hovering at around one and a half to twice the long-term annual average in real terms, it would be a mistake to view domestic energy deprivation as yesterday's problem. The energy crisis did not create new vulnerabilities so much as expose longstanding ones: affordability challenges that had remained politically marginal until they began to affect middle- and higher-income households. This broadened impact propelled energy deprivation into mainstream political discourse and compelled large-scale government intervention (Panchendrarajan et al., 2024; Westberg et al., 2025). Yet the emergency relief measures that followed did little to confront the structural drivers, such as inefficient housing stock, stagnant wages, weak consumer protections, and reliance on fossil fuels (Bersalli et al., 2024; Chancel, 2020). For many households, therefore, the burden has not lifted with the easing of prices; it merely risks slipping back into political latency.

Nor is the idea of s stable return to 'normal' prices tenable. Geopolitical shifts, particularly the permanent loss of Russian pipeline gas, have fundamentally reconfigured the European energy market, deepening reliance on liquefied natural gas imports subject to global price volatility (Emiliozzi et al., 2024). At the same time, the electrification of heating, mobility, and industry is straining ageing electricity infrastructure, requiring extensive and costly grid modernisation efforts, the expense of which will in part fall on end-users (Heussaff & Zachmann, 2025). Decarbonisation measures, including carbon pricing and new regulatory standards, are likewise projected to raise consumer costs unless carefully offset (Günther et al., 2025; Morão, 2025). These are not isolated disturbances but structural transformations, suggesting that energy price surges will be a recurring feature of the transition rather than temporary exceptions.

As energy price volatility becomes endemic, its regressive distributional effects demand particular attention. Figure 1.2 illustrates that although lower-income households spend slightly less on energy than wealthier households in absolute terms, they devote a much larger share of income to it. The figure also highlights a crucial distinction between energy uses: domestic energy for heating, cooking, and lighting is largely inelastic, while transport energy, such as petrol for private vehicles, can sometimes be replaced by alternatives like public transport (Mattioli et al., 2017). Domestic energy is essential for basic daily functioning and much harder to reduce, delay, or substitute (Middlemiss & Gillard, 2015), which distinguishes it from other consumption goods and helps account for the inherently regressive impact of energy price spikes (Carroll et al., 2025).[1] As Stiglitz (2012, 2019) argues, when energy inflation falls disproportionately on those with limited financial resilience, it undermines both material well-being and public confidence in the fairness of economic systems. Carlisle et al. (2017) take this further, warning that persistent exposure to such inequities can erode the perceived legitimacy of institutions altogether, especially when protective measures are absent or ineffective.

1 See also the Dutch central bank's analysis of energy inflation in the Netherlands, which shows how the 2021–2023 energy crisis affected income groups in markedly different ways (Lehtonen & Eijsink, 2025).

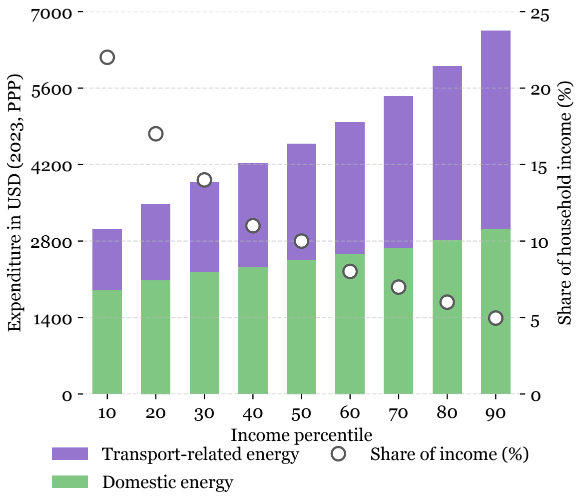

FIG. 1.2 Average household energy expenditure across income percentiles in advanced economies (2019–2023), showing annual domestic and transport-related energy spending (stacked bars, left axis) and energy's share of household income (circular markers, right axis) in 2023 USD (PPP) (IEA, 2024)

1.1.2 Legitimacy at risk in the energy transition

Civic mobilisations around rising energy costs reveal more than temporary discontent: they demonstrate how affordability pressures can destabilise the perceived fairness of climate action. In this context, social legitimacy has become the critical fault line of the energy transition. The question is not only whether policies accelerate decarbonisation cost-effectively, but also whether citizens are genuinely heard in the process and whether their burdens and benefits are perceived as fairly distributed (Montfort et al., 2025). The former concerns input legitimacy (public participation and procedural fairness), the latter output legitimacy (distributional outcomes and perceived effectiveness).

Domestic energy deprivation presents an especially acute expression of this legitimacy challenge. The housing stock plays a pivotal role in this equation: climate measures often demand extensive upgrades to the built environment, such as insulation, electrification, and heating system replacement, yet such improvements remain inaccessible to many of the most vulnerable households (Bouzarovski, 2014). Expecting low-income households to absorb higher energy costs while living in inefficient dwellings and unable to secure basic energy services reinforces perceptions of neglect and injustice. In this way, energy deprivation becomes a symbolic flashpoint: a lived contradiction that erodes public trust, delegitimises climate action, and deepens cleavages between social groups and between citizens and the state (Gough, 2017).

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Survey evidence strongly supports the centrality of fairness to public acceptance. A cross-national study by Fabre et al. (2025) found that majorities in both high- and middle-income countries support redistributive climate measures, even when these entail personal costs, provided they are seen to promote justice. An IMF survey across 28 countries similarly showed that support for carbon pricing rises significantly when revenues are earmarked for low-income households (Dabla-Norris et al., 2023). Citizens consistently emphasise fairness and sufficiency: ambitious climate policies are acceptable only when assured by credible safeguards that no one falls below a minimum standard of living. European evidence points in the same direction. A 2022 Eurobarometer survey reported that nine in ten EU citizens agree that *"no one should be left behind"* and support for climate policy is strongest when it includes redistributive safeguards (European Commission, 2022), while a YouGov (2025) survey found that UK respondents support climate measures only if low-income households are adequately protected from additional costs.

Dutch research provides further confirmation. In its 2023 report *Klimaatrechtvaardigheid in beleid*, the Scientific Council for Government Policy (WRR) set out competing principles for allocating costs, ranging from outcome-based principles (efficiency, sufficiency), to contribution-based ones (polluter pays, ability to pay), to entitlement-based logics (rights, merit, or per capita equality). The WRR commissioned I&O Research to conduct a nationally representative survey and see how these would resonate publicly (Theelen & Kanne, 2022). The results revealed overwhelming support for solidarity-based principles: ensuring no one falls below a minimum standard and prioritising the least well-of ranked highest (see Figure 1.3). By contrast, principles such as equal per capita contributions or strict own responsibility were widely judged unfair. Building on this, the newly established Scientific Climate Council (WKR, 2023) has urged the Dutch government to embed justice more explicitly in its 2025-2035 Climate Plan, stressing that legitimacy rests not only on abstract fairness but on visible safeguards for the most exposed groups.

Despite this public preference, climate policy in the Netherlands and other advanced economies remains dominated by a narrow logic of efficiency (Adler, 2018), creating a gap between expectations and practice. Benefits often accrue to higher-income early adopters, those able to provide upfront capital, while vulnerable groups shoulder a disproportionate share of the costs (Gazzotti et al., 2021). Market-based policy instruments, such as emissions trading schemes, exemplify this dynamic. While achieving decarbonisation at relatively low aggregate cost, their distributional effects are regressive: they place a heavier relative burden on lower-income households, who spend a larger share of income on energy. Meanwhile, subsidy regimes such as electric vehicle (EV) incentives or tax credits for energy efficiency renovations are formally universal but in practice reward those with resources to invest and navigate bureaucratic procedures (Gesang, 2013; Tol, 2009). Economically rational in early phases of technology deployment, such mechanisms nonetheless risk reinforcing perceptions of injustice. As Figure 1.3 shows, Dutch citizens define fairness primarily in terms of sufficiency and protection, with little support for equal-per-capita or individualised approaches.

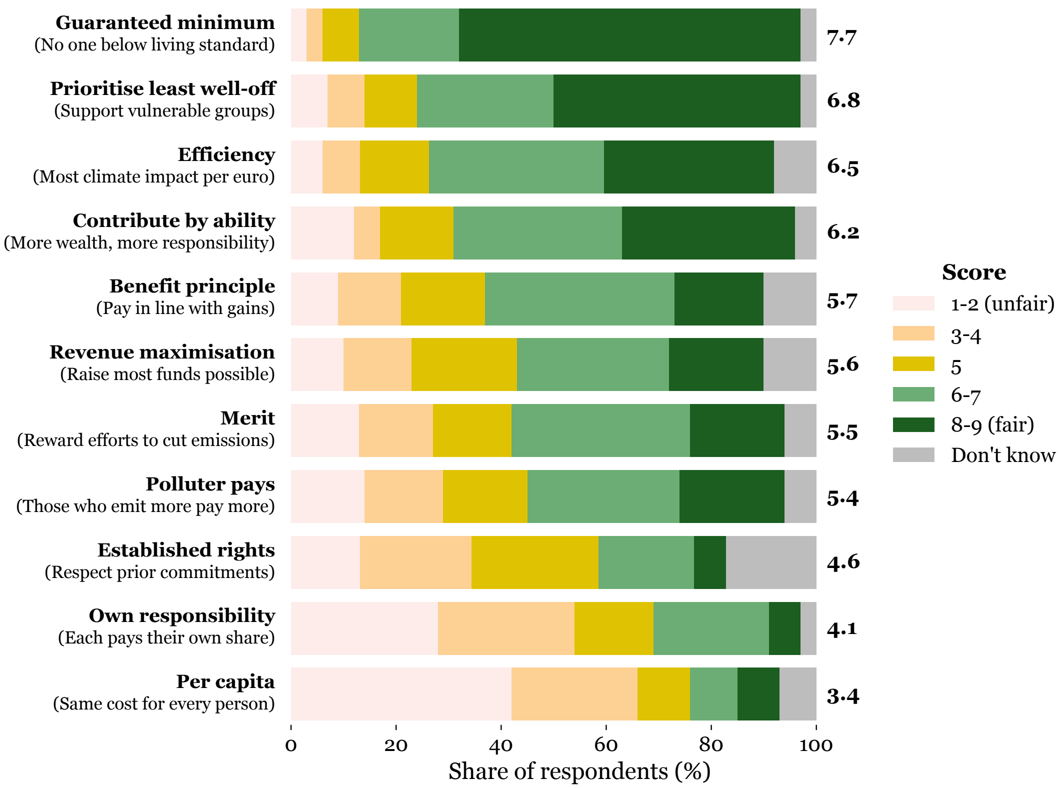

FIG. 1.3 Perceived fairness of distributional principles in the energy transition among the Dutch public, based on an I&O Research (2022) survey (N = 2,313) conducted for the Dutch Scientific Council for Government Policy (WRR), with respondents rating fairness of eleven principles on a scale from 1 (very unfair) to 9 (very fair), and average ratings shown to the right

Addressing domestic energy deprivation is therefore not merely a social policy imperative but a foundational condition for the legitimacy of climate action (Stojilovska et al., 2023). When households cannot access adequate energy, climate measures that increase costs across the board – even if highly effective in reducing emissions – risk provoking backlash, especially when support mechanisms are fragmented, underfunded, or difficult to access (Champion & Bonoli, 2011). In such contexts, energy deprivation becomes more than a symptom of inequality: it signals institutional failure to administer the transition in an equitable manner. Without visible and credible commitments to prevent it, Europe risks fuelling new cycles of contestation, eroding public trust, and undermining the very transition it seeks to advance.

1.2 Theoretical positioning

1.2.1 The social risk of domestic energy deprivation

Domestic energy deprivation refers to a household's *"inability to attain a socially and materially necessitated level of domestic energy services"*, which leads to *"discomfort and difficulty"* and undermines *"the lifestyles, customs and activities that define membership of society"* (Bouzarovski & Petrova, 2015, pp. 32-33). It encompasses overlapping terms such as 'fuel poverty', 'energy poverty', and 'energy insecurity', each emphasising different geographies or aspects of affordability, access, and lived experience.[2] Throughout the chapters, the specific term employed reflects the policy context under examination, but this introductory discussion adopts domestic energy deprivation as an umbrella category denoting inadequate, unaffordable, or unreliable energy in the home.

The intellectual foundations of this field owe much to Brenda Boardman, whose pioneering work in the late 1980s and early 1990s first distinguished 'fuel poverty' from general income poverty. Boardman showed that cold homes were rooted less in temporary income shortfalls than in capital deficits: draughty buildings, obsolete heating systems and landlord neglect forced low-income households to *"buy the most expensive warmth"* (Boardman, 1991a, p. 37). At the heart of her analysis lies a three-part nexus: low income, poor energy efficiency, and high energy prices. Subsequent research has confirmed that this triad remains central to understanding domestic energy deprivation across national contexts (Thomson et al., 2017; Tirado Herrero, 2017). When these

2 *Fuel poverty* is used primarily in the UK and Ireland to emphasise affordability; *energy poverty* originated in development contexts to describe lack of access to energy but is now more broadly used in European policy to address both access and affordability; *energy insecurity*, common in North American literature, centres on the lived experience of energy precarity, including disconnections and coping strategies (Bouzarovski & Petrova, 2015; Hernández, 2013).

conditions persists, households face an inflexible and non-discretionary cost burden that displaces other basic needs, giving rise to the now widely cited 'heat or eat' dilemma (Beatty et al., 2014; Burlinson et al., 2022). This triad is clearly reflected in Figure 1.4, showing that domestic energy costs rise disproportionately with both retail prices and declining energy efficiency. The highest burdens fall on low-income households living in inefficient homes, reinforcing Boardman's argument that energy deprivation is driven as much by structural housing deficits as by low income.

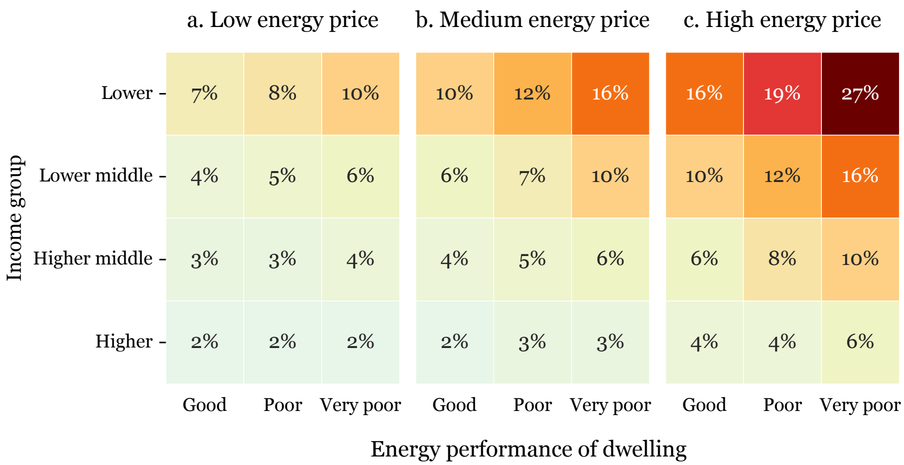

FIG. 1.4 Median energy burden (share of disposable household income spent on domestic energy) among Dutch households by income group and energy performance level of the dwelling under low (a), medium (b), and high (c) energy price scenarios, based on 2022 household data, with darker colours indicating a higher burden (TNO, 2023)

Subsequent interdisciplinary research has documented the far-reaching effects of energy deprivation on physical, mental, and social wellbeing. Epidemiological studies have established robust links between underheated homes and a range of health outcomes, including excess winter mortality, respiratory and cardiovascular disease, and worsened symptoms for those with chronic conditions (Liddell & Guiney, 2015). Mental health effects have also been documented, with cold or dark environments contributing to heightened stress, anxiety, and depression, particularly where households experience repeated disconnections or are forced to ration energy in ways that affect daily routines (Hernández et al., 2016; Petrova, 2018). These effects are further compounded by the stigma and embarrassment associated with energy deprivation, which can discourage social interactions, such as hosting visitors in cold or draughty homes, thereby deepening isolation (Middlemiss & Gillard, 2015).

Children face additional compound risks: Dutch research combining administrative microdata with health data shows that underheated or damp homes significantly increase the risk of upper respiratory illnesses, including asthma, bronchitis, and related ear, nose, and throat infections. infections. These illnesses contribute to increased school absences and poorer educational and social outcomes, and their impact is magnified by children's still-developing immune systems and thermoregulation (van Maurik et al., 2023).

These drivers and outcomes are mutually reinforcing: poor housing and inadequate heating exacerbate health problems, which in turn can limit income, intensify stress, and entrench coping strategies that sustain the cycle of energy deprivation. As Baker et al. (2018) argue, it must be understood as a 'complex problem', one characterised by dynamic feedback loops between material conditions, health outcomes, and social vulnerability. Addressing it therefore requires policy frameworks capable of recognising and interrupting these reinforcing cycles.

From a social policy perspective, domestic energy deprivation exemplifies a new generation of compound social risks. Welfare states have always adapted to changing patterns of 'social risk', defined as the likelihood of welfare loss driven by evolving social and economic conditions (Yang, 2014). While 'first wave' risks (such as illness, old age, or unemployment) were primarily tied to the life course, and 'second wave' risks (like precarious employment or single parenthood) arose from post-industrial and demographic shifts, 'third wave' risks reflect the socio-ecological transformations of the 21st century.[3] These include both the physical impacts of climate change and the distributional effects of decarbonisation policies (Gough, 2021; Johansson et al., 2016; Mandelli et al., 2024; Schoukens et al., 2023; Zimmermann, 2024).

3 First-wave or 'old social risks' emerged alongside industrial capitalism and centred on predictable life-course events and labour market contingencies such as illness, old age, unemployment, and work-related injury (Taylor-Gooby, 2004). These risks were largely exogenous to individual behaviour and underpinned the expansion of welfare protections in the 20th century through models such as Bismarck's contributory insurance system in Germany and Beveridge's tax-funded universalism in Britain (Flora & Heidenheimer, 1981; Manow, 2020; Lund et al., 2021). In contrast, second-wave or 'new social risks' arose from post-industrial transformations, such as labour market flexibilisation, demographic change, and evolving gender roles, and include precarious employment, single parenthood, care burdens, and work-life imbalance (Bonoli, 2005; Palier, 2006). These risks tend to be more diffuse, less predictable, and unevenly distributed, disproportionately affecting women, young people, and migrants—groups often underserved by traditional welfare regimes (Esping-Andersen, 1996; Vandenbroucke & Vleminckx, 2011). Policy responses have included a shift towards 'social investment' strategies focused on enabling labour market participation through childcare, training, and active labour market programmes, though such responses have often remained fragmented and insufficiently redistributive (Hemerijck, 2017; Morel et al., 2012).

This shift has been theorised most prominently by Beck and Giddens. Beck (1992) argued that modern societies were becoming ‘risk societies’, in which hazards are increasingly endogenous, produced by the very processes of industrial development. His early work focused on the disembedding of individuals from traditional social structures and the erosion of standardised life courses, developments closely tied to deregulation and labour market precarity. In his later writings, Beck extended this analysis to encompass what he described as global risk constellations, such as climate change and ecological degradation, which are systemic in origin, incalculable in character, and unequally distributed across populations (Beck, 1999, 2009). Giddens (1991) similarly described late modernity as marked by ‘reflexivity’, in which risk is not merely external but is produced, interpreted, and managed through reflexive processes, often resulting in new risks or unintended consequences. He later identified climate change as the paradigmatic case of ‘manufactured uncertainty’: a human-made threat, producing both direct dangers and new risks through the very efforts undertaken to mitigate it (Giddens, 2009).

While the direct effects of climate change, such as heatwaves, droughts, flooding, and soil degradation, create acute threats to health, housing, and livelihoods, many of today’s most pressing social vulnerabilities arise from decarbonisation efforts themselves. The phase-out of fossil fuel industries and resulting job losses have led to localised economic decline and long-term unemployment, prompting trade unions and affected communities to call for a ‘just transition’ (Newell & Mulvaney, 2013). At the household level, carbon pricing has raised energy and transport costs, at least in the short term, disproportionately affecting low-income and rural populations (Callan et al., 2009; Vandyck & Van Regemorter, 2014). Without compensatory measures, such policies risk deepening inequality and reinforcing existing patterns of deprivation (Markkanen & Anger-Kraavi, 2019).

Emerging research shows that these climate-related risks increasingly overlap with first- and second-wave risks such as income poverty, poor health, and housing precarity, but also interact with them in ways that amplify harm. For instance, excess mortality during heatwaves is disproportionately concentrated among low-income households in poorly ventilated dwellings without access to cooling, particularly affecting older adults and those with chronic illnesses (Thomson et al., 2019; Uejio et al., 2011). In former coal regions, ‘carbon lock-in’ leaves many households reliant on coal-based heating and exposed to rising energy costs from carbon pricing, costs that are increasingly unaffordable amid declining local economies plagued by job losses and weakening public services (Seto et al., 2016). In such cases, domestic energy deprivation is not merely an outcome of disadvantage but a mechanism through which the unequal impacts of climate change are compounded.

These dynamics make third-wave social risks particularly difficult to address within conventional welfare architectures. As World Bank economists note, *"the monetary and energy poor only overlap partly"*, meaning that *"traditional social protection strategies might not target those who are energy poor, and additional policy instruments should be implemented when governments try to tackle energy poverty"* (Robayo-Abril & Rude, 2024, p. 32). While welfare states are increasingly expected to buffer the distributive fallout of climate policy (Zimmermann & Graziano, 2020), institutional responses remain fragmented and reactive. Governments are therefore called upon not only to shield citizens from environmental harm but also to guarantee access to essential, non-discretionary goods like domestic energy, recasting welfare provision as a cornerstone of a just transition (Sovacool, 2012; Varo, 2024).

Recognising domestic energy deprivation as a multidimensional social risk revives long-standing debates in welfare state theory, particularly concerning the balance between prevention and compensation, and between universal and targeted approaches. Preventive measures such as retrofitting, electrification, and heating upgrades address structural *causes*, whereas compensatory tools like rebates and social tariffs offer short-term *relief* but risk institutionalising dependency (Bouzarovski, 2014; Gough, 2015). Universal programmes can build broad legitimacy but may be expensive and benefit higher-income groups, while means-tested schemes are more fiscally constrained yet often stigmatise recipients and suffer from low coverage (Skocpol, 1991). As Esping-Andersen (1990) argued, a welfare regime – i.e., the architecture of welfare institutions rooted in the specific arrangements between state, market, and family – profoundly shapes how social needs are recognised and addressed, influencing both the form and reach of interventions. These dilemmas are further complicated by the fragmented governance of energy deprivation, which often straddles between the responsibilities of energy regulators and welfare institutions, producing inconsistent responses and blurred accountability (Dubois & Sinea, 2023). As climate imperatives intensify, resolving these tensions is no longer a technical question of policy design but a political necessity, central to sustaining the legitimacy of welfare institutions amid the disruptive socioeconomic shifts of the energy transition.

1.2.2 A fragmented and misaligned research field

The body of research on domestic energy deprivation has expanded considerably, yet the field remains characterised by conceptual deficits and methodological siloes. The following discussion does not attempt to present a full account of the field's limitations, but highlights three gaps that are particularly relevant for the questions explored in this thesis.

A first major gap lies in the lack of integration across disciplines and epistemic boundaries. Climate policy research rarely engages with concepts from welfare state theory or social risk analysis, while core social policy literature has been slow to incorporate the socio-ecological dimensions of the energy transition, continuing to treat climate change as exogenous to its concerns (Gough, 2017; Hirvilammi et al., 2023). Energy economics, for its part, tends to prioritise cost-efficiency and assumptions or rational behaviour, sidelining questions of justice and distribution that are central to energy deprivation (Bouzarovski et al., 2021; Sovacool et al., 2016). Housing research, too, often operates in isolation, with limited crossover into energy and health domains, even though evidence increasingly shows their interdependence (Hernández, 2013; Sokołowski et al., 2023).
These disciplinary divides naturally extend to methods, where quantitative and qualitative studies frequently remain in separate epistemic communities with limited engagement across other's assumptions or findings. As Dubois and Sinea (2023) note, this fragmentation has hindered the accumulation of knowledge needed for comprehensive understanding and policy guidance. This brings us to the final example of fragmentation: despite notable initiatives to bridge the gap, the interface between research and practice is still uneven, limiting both the uptake of academic insights and the ability of research to capture context-specific dynamics. As Libertson (2024) and McConalogue et al. (2016) demonstrate, how frontline actors perceive and respond to energy deprivation remains poorly understood. Without deeper integration of their perspectives, research risks reinforcing theoretical silos and overlooking key mechanisms shaping the problem on the ground.

The second gap concerns the methodological limitations of current research on domestic energy deprivation, including how it is defined, measured, and evaluated. Despite decades of attention, there is still no widely accepted definition or shared measurement standard. The field remains conceptually fragmented, with many studies introducing bespoke indicators disconnected from prior frameworks and seldom reused (Bouzarovski & Petrova, 2015; Stojilovska et al., 2022). At the same time, the '10% metric', loosely based on Boardman's (1991) UK operationalisation, which defines fuel poverty as spending more than twice the median share of income on energy, has been disproportionately applied across diverse contexts, often without normative justification or contextual adaptation. This simultaneous proliferation of bespoke measures and overreliance on one blunt tool illustrates the lack of consolidation in the field's diagnostic approaches. Moreover, most indicators reduce deprivation to a binary condition, counting households above or below a threshold while failing to reflect the severity or unequal distribution of deprivation (Moore, 2012; Tirado Herrero, 2017). Although combining multiple indicators is widely recommended, it remains rare in practice (Castaño-Rosa et al., 2019; Thomson et al., 2017). Evaluations similarly focus on headline outcomes such as thermal performance, with limited attention to broader effects on health, wellbeing, or stress (Hernández, 2016). Few studies disaggregate by social group, leaving critical blind spots in understanding how programmes affect subgroups with differentiated energy needs (Middlemiss & Gillard, 2015). As a result, current methodological approaches fall short of capturing how energy deprivation is distributed, experienced, and addressed, limiting the ability of research to inform more effective policy responses.

A third major gap lies in the lack of systematic comparative research across contexts, governance levels, and intervention types. Some dimensions of this gap have already been touched upon, such as the failure to account for varying energy needs and the unequal effects of interventions across target groups. Yet this also reflects a broader absence of comparative inquiry into the measures themselves, particularly in terms of how different instruments perform across contexts and interact within complex policy mixes, a gap that remains largely neglected in both monitoring systems and empirical evaluations (Schoenefeld et al., 2025). A 2023 special issue of *Intereconomics* compiles valuable national case studies on Europe's energy crisis responses and hints at shared challenges in mitigating domestic energy deprivation but stops short of a cross-country comparison.[4] A political economy perspective is essential to close this gap: it treats policy design, implementation and outcomes as conditional not just on instrument choice, but on fiscal capacity, institutional strength, political coalitions, and the sequencing of reforms (Goulder & Parry, 2008; Perotti, 2002). This focus on institutions and ideas is echoed in Hall's (1993) policy paradigm framework, which highlights how deeper structuring ideas and welfare traditions through which governments interpret issues like energy deprivation can decisively shape instrument choice and durability. Alternative lenses such as the advocacy-coalition framework (Sabatier, 1988) and punctuated equilibrium theory (Baumgartner & Jones, 2010) also underscore how power, interests and institutional logics condition policy evolution. Recent scholarship has begun to explore how welfare state logics,

4 See the country case studies on France (Rüdinger, 2023), Germany (Weber et al., 2023), Italy (Simone & Pianta, 2023), and the United Kingdom (Waddams, 2023), all published in *Intereconomics*, 58(1).

justice interpretations, and policy trade-offs shape the design of energy and climate policies, but their capacity to reveal the deeper normative tensions at stake remains insufficiently developed (de Looze et al., 2024; Zimmermann, 2024).

These limitations underscore the need for more integrated, comparative, and context-aware approaches to understanding the policy pathways through which domestic energy deprivation is, or could be, addressed. By engaging with selected aspects of these gaps, this thesis contributes to ongoing efforts to better align academic research with the complex institutional realities of tackling this problem within the broader pursuit of a just energy transition.

1.2.3 Positionality and philosophical orientation

In recent years, energy transition research has been increasingly challenged to move beyond technical and economic framings and to engage more directly with questions of justice. As Sovacool et al. (2016) argue, core challenges, from access and affordability to pollution and climate change, carry ethical weight because they shape who benefits, who is burdened, and whose needs are recognised or ignored in decision-making. The emerging field of ‘energy justice’ responds to this challenge by foregrounding fairness, equity, and responsibility in energy governance, and has gained influence across disciplinary boundaries, particularly in debates on the uneven social impacts of decarbonisation (Heffron & McCauley, 2017).

Domestic energy deprivation as an injustice

Energy justice is not a single framework but intersects with other normative traditions, notably the capabilities approach, which frames energy access as a precondition for basic functionings and full participation in society (Day et al., 2016). From this perspective, energy is not merely a commodity but an enabler of wellbeing. This thesis draws on Sen’s (2009) insistence that justice should begin not from ideal theory but from identifiable injustices that can be remedied. Domestic energy deprivation is such an injustice: empirically documented, morally troubling, and open to policy intervention. It restricts people’s ability to live with dignity, undermines health and wellbeing, and disproportionately affects already marginalised groups. This pragmatic orientation, centred on real-world harms and institutional remedies, underpins the normative framing of this research.

Building on this starting point, this thesis adopts a perspective rooted in Rawlsian justice, particularly the difference principle, which holds that unequal treatment by governments and public institutions are only justifiable if they benefit the 'least advantaged' members of society (Rawls, 1971). In the context of the energy transition, this calls for institutional arrangements that prioritise those most exposed to the costs of decarbonisation and least able to adapt. It aligns with a prioritarian welfare criterion, which emphasises improving the condition of disadvantaged groups, even at the expense of aggregate efficiency or equality (Fleurbaey et al., 2019; Parfit, 1997).[5] Within the broader 'just transition' debate, originating in trade union advocacy for workers displaced by decarbonisation and now expanded to societal concerns over who gains and who loses (McCauley & Heffron, 2018), the principles of Rawls' thinking of justice has been influential, albeit often implicitly (Adler et al., 2017; Zimm et al., 2024). They are helpfully operationalised via Schlosberg's framework of distributive, procedural, and recognition 'tenets' of justice in environmental and climate contexts, each of which is deeply rooted in Rawlsian principles of fairness (Galvin, 2019; Schlosberg, 2004).[6]

Distributive justice addresses how benefits and burdens are shared, drawing attention to how inequalities in income, housing, and access shape exposure to energy deprivation (Sovacool, 2015). Procedural justice concerns who participates in decision-making and whether marginalised groups have genuine access to information, rights, and policy processes (Stojilovska, 2021). Recognition justice, meanwhile, highlights the importance of acknowledging diverse needs and lived experiences, which are often misrepresented or overlooked in standardised energy solutions, such as those affecting renters, migrants, or people with disabilities (Hernández et al., 2022; Young, 1990). Restorative justice, increasingly emphasised in energy debates, calls for addressing historical exclusions by repairing long-standing harms and embedding intergenerational equity (Heffron & McCauley, 2017). Together, these tenets capture the multiple and overlapping disadvantages that sustain domestic energy deprivation across contexts.

5 Although John Rawls's theory has at times been interpreted in technocratic, outcome-optimising terms, the reading here foregrounds its normative ordering of claims and its institutional implications for protecting disadvantaged households, rather than an overly economistic account of justice. In this respect, it is attentive to concerns expressed by Michael Sandel (2003), who cautions against reducing justice to a procedural calculus detached from substantive moral reasoning.

6 Meanwhile, distributive concerns also reflect Marxist critiques of inequality, procedural justice mirrors Nozick's focus on legitimate entitlements; and recognitional justice is influenced by Fraser's politics of difference, among others (Sovacool & Dworkin, 2015).

Among these tenets, distributive issues are central insofar as they concern the unequal allocation of energy-related goods and burdens. The position taken here is that domestic energy deprivation is problematic not only because it mirrors wider inequalities but because it constitutes a failure to secure a minimum threshold of energy services essential for wellbeing. This aligns with the sufficiency doctrine, which holds that justice requires ensuring that everyone has 'enough' to live with dignity and participate fully in society (Frankfurt, 2001; Shields, 2012). From this perspective, justice requires that no household fall below a socially recognised threshold of energy access necessary for full participation in everyday life; domestic energy deprivation, as a shortfall from that threshold, constitutes a fundamental injustice.

This thesis adopts the positive conception of sufficiency: not as a replacement for equality as a moral ideal but as a distinct concern, where securing a threshold of well-being is the most urgent condition of justice and priority must go to those furthest below it (Casal, 2007). The negative conception, by contrast, holds that once individuals have 'enough', further inequalities are of no moral consequence (Frankfurt, 1987). In this thesis, inequality is engaged merely in a subsidiary analytical capacity, as a means of characterising disparities in domestic energy deprivation and of evaluating whether policies amplify or correct regressive outcomes. The normative focus, however, remains firmly on sufficiency: ensuring that no household falls below the socially defined threshold of domestic energy access required for a dignified standard of living and full participation in society. Crisp (2004) refines this view by emphasising that the moral urgency of distributive concerns diminishes above the threshold, even if inequality does not cease to matter entirely. Timmer (2021) adds that justice also depends on *relative positioning* around that threshold, since differences in distribution can shape the legitimacy of claims and perceptions of fairness. Huseby (2020) likewise affirms the positive conception, contending that while sufficiency remains central, inequalities above the threshold can retain normative weight, particularly when they affect social standing, voice, or political influence.[7]

Determining the appropriate sufficiency threshold raises fundamental questions about fairness and moral reasoning. For Rawls (1971), such decisions should be made from behind a 'veil of ignorance', a hypothetical position in which individuals do not know their own social status, talents, or preferences, thereby ensuring

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7 This relative positioning extends beyond deprivation: extreme wealth can confer disproportionate political influence, as illustrated by the Gilded Age or the lobbying power of contemporary tech elites. Such inequalities above the sufficiency threshold may undermine democratic equality and social cohesion, reinforcing Huseby's argument that justice must account not only for absolute shortfalls, but also for the relational impacts of surplus.

fairness by removing self-interest from the equation. In this thesis, the threshold is conceptualised through Sen's notion of 'basic capabilities': the opportunity to achieve essential functionings, such as staying warm, cooking food, or maintaining a healthy home environment. Lacking these capabilities constitutes a clear instance of domestic energy deprivation. As Robeyns (2017) argues, this notion is the most widely accepted framework for operationalising well-being, but its practical value lies in its ability to inform concrete assessments of deprivation. In line with Sen (1987, 1992), this involves establishing a specific cut-off point, such as the moment when a household can no longer afford the energy bill and, as a result, cannot stay adequately warm.[8] Related scholarship on the 'consumption corridor' extends this reasoning by arguing that justice requires not only a social floor but also an ecological ceiling: a defensible range that combines meeting basic needs with curbing overconsumption (Gough, 2020). While both dimensions are important, the concern in this thesis is the floor: eliminating domestic energy deprivation as a baseline condition of justice.

This positionality also situates the thesis within contemporary policy paradigms and their political economy. Degrowth scholarship has drawn important attention to planetary limits and the upper end of the consumption corridor (Hickel, 2019; Newell & Mulvaney, 2013), but its proposals often remain confined to academic debates and depend on deep structural transformations that are unlikely to materialise within the tight timelines of the climate crisis (Keyßer & Lenzen, 2021). Mainstream climate governance, by contrast, prioritises aggregate efficiency and cost-effectiveness under the banner of 'green growth' and relies on instruments such as carbon pricing, regulatory standards, and green subsidies (Fiorino, 2018; Vazquez-Brust et al., 2014). While effective at accelerating deployment and driving down costs, these tools can exacerbate socio-economic disparities and fail to protect structurally disadvantaged groups from rising costs or unequal access to infrastructure (Lekavičius et al., 2020; Winter & Schlesewsky, 2019). They also often lack a clear distributive baseline against which fairness can be assessed. Accordingly, the thesis advances a sufficiency-first claim: the most urgent and actionable injustice of the transition lies in the failure to ensure a socially acceptable minimum level of domestic energy access. The analytical task is to recalibrate prevailing instruments to secure that floor over the long term: embedding social protection mechanisms in energy markets, offsetting the regressive impacts of carbon pricing through targeted compensation, and investing preventively in housing retrofits.

8 This aligns with Jenkins et al. (2017), who contend that energy justice must move beyond abstract ethical reasoning to guide policy that delivers just outcomes at the household level.

Critical realism as epistemological foundation

These normative commitments are paired with an epistemological stance that guides how the inquiry proceeds. To examine domestic energy deprivation as both a matter of justice and a policy problem, the thesis is grounded in critical realism, drawing particularly on realist evaluation (Pawson & Tilley, 1997). Domestic energy deprivation is treated as produced by real, generative mechanisms embedded in institutional, material, and policy contexts. These mechanisms are rarely directly observable but can be inferred by examining how they operate across configurations of context and outcome. The focus, therefore, is not on discovering universal laws, as in positivist traditions, nor primarily on analysing discursive framings, as in some constructivist approaches, but on explaining how interventions, structures, and governance arrangements produce different effects for different groups in different settings. In critical realist terms, the guiding question is not simply *"what works?"* but *"what works, for whom, in what circumstances, and how?"* (Pawson & Tilley, 1997, p. 125).

Central to this approach is the context-mechanism-outcome (CMO) configuration, which provides a flexible analytical lens across the thesis' varied inquiries. CMO reasoning recognises that social programmes do not operate through linear cause-effect chains, but by activating mechanisms, such as behavioural incentives, institutional logics, or normative expectations, whose effects are contingent on enabling or constraining features of their context. As Pawson and Tilley note, the *"relationship between causal mechanisms and their effects* [is] *not fixed, but contingent"* (1997, p. 69), and must be understood in light of the *"interplay between individual and institution, agency and structure, and micro and macro social processes"* (1997, p. 63). In political economy terms, the mechanisms that determine policy outcomes are not simply technical but shaped by institutional rules, fiscal capacities, and political feasibility. For example, during the 2021-2023 energy crisis, governments' choices of tax cuts, price caps, or transfers were less a matter of optimal efficiency than of budgetary limits and electoral pressure. This perspective therefore not only informs the evaluation of interventions but also the diagnosis of structural drivers, the analysis of institutional responses, and the tracing of policy trajectories.

This epistemological stance supports a pluralistic, problem-driven use of methods, in which the nature of the question dictates the tools of inquiry. As Cronbach et al. (1980) argue, meaningful evaluation in complex social settings requires flexible designs embedded in context, aimed not at universal conclusions but at fostering practical understanding. Accordingly, this thesis combines statistical inference, cross-contextual case comparison, and institutional process tracing, each chosen for its capacity to illuminate how domestic energy deprivation is shaped and addressed in particular settings. This problem-driven flexibility reflects a realist-pragmatist logic of inquiry (see Flyvbjerg, 2001, and Sabel & Zeitlin, 2012), in which the value of research lies not only in explanation, but also in its capacity to inform institutional practice and support normative aims. These aims, such as improving distributive fairness or strengthening the legitimacy of energy and climate policy, are not treated as external to the inquiry but as analytically relevant. This orientation also resonates with the institutional setting of TU Delft, a technical university with a strong applied focus but one that explicitly acknowledges the role of values in guiding research agendas and design choices. Knowledge, in this view, is provisional and situated, yet actionable, capable of guiding improvements in both the design and delivery of support.

In a recent perspective in *Nature Energy,* Fell et al. (2022) identify three reasons why critical realism is well suited to energy research that centres justice, all of which underpin the present study. First, it recognises different starting points and moves beyond averages to reveal the mechanisms through which deprivation is produced and sustained for specific social groups, enabling policies that address the needs of those most disadvantaged. Second, it sidesteps the long-running empiricist-interpretivist divide. In doing so, it offers a common causal vocabulary that enables interdisciplinary teams to integrate insights from welfare studies, housing research, and energy policy analysis. Third, by explicitly articulating mechanisms and contexts, it supports the careful transfer of policy insights across settings, an essential capacity at a time when climate action cannot await lengthy experimental validation.

1.2.4 Empirical focus and scope

This thesis investigates how domestic energy deprivation is addressed, or left unaddressed, in high-income welfare states, with the aim of informing the design of more just and effective climate and energy policies. To do so, it is necessary to clarify both the empirical boundaries and the deliberate exclusions made for analytical focus. This section outlines the geographical, temporal, and institutional parameters that define the scope of the thesis.

The empirical focus of this thesis is on high-income welfare states in Europe, complemented by one comparative case study from the U.S., over the period from 2018 to 2025. This timeframe captures a critical juncture shaped by the COVID-19 recovery, the 2021-2023 energy price crisis, and the accelerated implementation of the EU's 'Fit-for-55' climate package. Although the main focus is on contemporary developments, the thesis also examines institutional legacies and continuities, including enduring welfare state logics and market liberalisation trajectories, insofar as they condition current distributive outcomes and social protection mechanisms in energy and climate policy. While domestic energy deprivation is a global phenomenon, this thesis focuses on advanced economies, where extensive data enables granular policy analysis and where mature welfare infrastructures and ambitious climate agendas typically coexist yet still fail to address domestic energy deprivation (Bouzarovski & Petrova, 2015; Gough, 2015).

The thesis adopts an expansive understanding of policy, encompassing not only formal instruments such as carbon pricing, regulatory standards, and retrofitting subsidies, but also the administrative practices of public and publicly mandated institutions, such as social housing providers, whose decisions and routines directly influence domestic energy outcomes. It analyses interventions across the full policy cycle, from agenda-setting and instrument design to implementation and revision, recognising that energy deprivation is shaped as much by institutional processes as by stated goals (Sovacool & Dworkin, 2015). It takes a perspective towards public policy analysis that is multidisciplinary, solution-oriented, and explicitly normative in its commitment to addressing real-world problems, a focus integral to the field since its inception (Lasswell, 1951). The thesis assesses both long-standing programmes and more recent innovations, especially where they demonstrate institutional learning or experimental adaptation. In this respect, and particularly in the empirical chapters on local-level interventions, it takes inspiration from the ethos of 'experimentalist governance' (Sabel & Zeitlin, 2012), which sees learning from implementation in diverse contexts as essential to informing and scaling policy change. These innovations are considered in relation to the broader policy frameworks that shape and constrain their effects.

Several exclusions are necessary to maintain conceptual clarity and analytical depth. The thesis focuses specifically on domestic energy deprivation and does not extend to related domains such as transport poverty, which is shaped by distinct vulnerabilities and infrastructural systems (Mattioli et al., 2017). It also excludes industrial decarbonisation and labour-market transition measures, which, while central to just transition debates, lie beyond the household-level lens adopted here. Broader energy infrastructure issues, such as grid stability, generation portfolios, and wholesale market design, are considered only insofar as they directly affect household energy costs or access. Similarly, the thesis does not examine tariff structures themselves, though this remains an important area of inquiry for addressing 'upstream' drivers of domestic energy deprivation (Shumway et al., 2024); instead, it considers how fiscal relief measures interact with household energy costs within existing pricing regimes.

Moreover, while distributive justice is a central concern, the study does not engage in population-wide modelling of inequality across the income spectrum. Instead, it adopts a Rawlsian lens, focusing on securing socially and materially necessary thresholds of energy access for the least advantaged, as outlined in Section 1.2.3. The research takes a policy-facing orientation, prioritising the design, implementation, and institutional framing of interventions. As such, it does not focus primarily on the lived experiences of households, but builds on a substantial body of scholarship that has already yielded critical insights into overlapping forms of disadvantage, coping strategies, and health impacts (Hernández & Laird, 2025; Longhurst & Hargreaves, 2019; Middlemiss & Gillard, 2015). End-user perspectives are nonetheless incorporated, particularly to assess the perceived effectiveness and welfare impacts of support schemes. Finally, while the analysis draws on natural experiments and micro-level policy evaluation, it does not engage in predictive modelling or econometric forecasting.

This thesis was undertaken as part of the RE-DWELL MSCA-ITN project (*Delivering Affordable and Sustainable Housing in Europe*, 2020-2024) and is situated within its Policy and Financing research pillar – one of three core dimensions, alongside Design, Planning and Building, and Community Participation. The RE-DWELL network shaped the scope and structure of this research in multiple ways. First, it enabled comparative empirical work across European contexts that would not have been possible otherwise: secondments at Clarion Housing Group (London), Housing Europe (Brussels), and the European Federation for Living (Amsterdam) provided access to key actors in the social housing sector and made it possible to explore how providers attempt to address domestic energy deprivation. More broadly, RE-DWELL supported the thesis not only through financial funding, but also by providing intellectual and professional infrastructure, including research training, cross-sector exchange, summer schools, conferences, site visits, and ongoing dialogue with a multidisciplinary cohort of early-stage researchers. These experiences offered critical opportunities to test, refine, and situate the thesis' normative and empirical approach in conversation with broader European debates on housing, welfare, and sustainability.

1.3 Research aim and framework

1.3.1 Aims and questions

In light of growing concerns about fairness in the energy transition and the shortcomings of current welfare responses to domestic energy deprivation, this thesis investigates how policies at multiple levels of governance (local, regional, national, and supranational) can more effectively address the needs of affected households. It is guided by one overarching question:

- **How do different policy approaches across governance levels guide efforts to identify, address and integrate domestic energy deprivation within the broader just energy transition?**

Together these strands, from problem definition through policies and practice to principles and governance, form the backbone of the thesis. This overarching question is therefore pursued through three interconnected strands of inquiry: how the problem is diagnosed, how it is addressed through policy interventions, and how justice and welfare concerns are embedded in broader governance frameworks.

The first strand focuses on refining the problem definition. Existing measurement practices, particularly those relying on binary expenditure-based thresholds, compress a complex social condition into a single cut-off, concealing the severity, unequal distribution, and structural drivers of deprivation. Building on the argument that energy deprivation emerges from the intersection of financial constraints, housing inefficiencies, and differentiated energy needs, the thesis develops and operationalises diagnostic tools that capture the shortfalls from socially defined sufficiency thresholds, thereby situating households in terms of their relative positioning. Diagnosis is approached as both a technical and normative act: the way deprivation is measured directly shapes which households become visible to policymakers, which forms of need are recognised as legitimate, and which interventions are judged necessary.

Building on this refined diagnosis, the second strand evaluates targeted policies and practices. It examines the effectiveness of interventions at different levels of governance, including both national and local measures, ranging from emergency fiscal relief to structural interventions targeting behaviour and infrastructure. By

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comparing different types of interventions and delivery contexts, the thesis explores how design features, institutional capacities, and governance structures shape coverage, accessibility, and reported outcomes. The analysis asks whether and how interventions reach those most in need, for whom they are most effective, under what conditions they work, and where gaps in provision or impact remain. It pays particular attention to tensions between social protection and competing priorities, such as cost-efficiency, climate goals, or political feasibility. This reflects a broader political economy perspective, which helps explain why some interventions endure, while others remain marginal or short-lived.

Shifting focus from on-the-ground interventions to institutional context, the third strand examines principles and governance. It investigates how welfare traditions and dominant policy paradigms shape the incorporation of justice concerns into energy and climate governance. Focusing on the UK, EU, and selected U.S. states, the analysis examines how concepts such as affordability, vulnerability, and equity are defined, translated into policy language, and embedded in existing welfare and regulatory frameworks. Particular attention is paid to how these concepts are operationalised through redistributive mechanisms, eligibility criteria, and allocation practices, and how such choices reflect broader institutional logics. The thesis does not assume these approaches as inherently adequate or inadequate but asks how they affect the reach and legitimacy of measures to address energy deprivation, and whether they open or constrain pathways towards more structurally preventive solutions. By linking these institutional patterns to normative theories of justice, the analysis clarifies how high-income welfare states frame, prioritise, and address deprivation in the context of the energy transition.

Together, these aims are pursued through three guiding research questions, each corresponding to one of the above strands of inquiry:

1. **How can domestic energy deprivation be more accurately identified and incorporated into policymaking as a multidimensional social risk shaped by factors beyond income alone?**

2. **To what extent do targeted policy interventions across governance levels respond to the needs and vulnerabilities of households at risk of domestic energy deprivation?**

3. **In what ways do governance traditions and institutional logics shape the integration of justice and welfare provisions into energy and climate policy frameworks?**

1.3.2 Methods and data sources

Consistent with the thesis' critical realist and problem-driven orientation, the research design combines quantitative, qualitative, and mixed-method approaches, with the choice of method shaped by the specific objectives of each chapter. This sequencing ensures that the methods are not treated as an abstract exercise, but as tools directly aligned with the inquiry strands set out in Section 1.3.1.

Table 1.1 provides an overview of the overall design, methods, and data sources. In general, chapters focused on measurement and diagnosis draw on large-scale administrative or survey microdata to enable precise, disaggregated analysis. Chapters evaluating interventions or tracing institutional change use experimental, comparative, or interpretive strategies suited to capturing context, mechanisms, and outcomes in line with the CMO reasoning outlined in Section 1.2.3.

TABLE 1.1 Summary of methods and data sources by chapter

Part	Ch.	Overall design	Method	Data
I	2	Quantitative	Cross-sectional indicator analysis	Administrative microdata (Statistics Netherlands, 2019, N ≈ 5.7 million)
	3	Quantitative	Multivariate regression modelling	Survey microdata (English Housing Survey, 2019, N = 11,974)
II	4	Qualitative	Comparative focus group study	6 focus groups with social housing professionals (conducted in 2022)
	5	Quantitative	Field experiment with matched regression	Survey of treatment and control groups (2022-2023, N = 467), linked to administrative microdata (Statistics Netherlands 2020)
	6	Quantitative	Cross-country static incidence modelling	Policy database (Bruegel Fiscal Tracker, 2021-2023) and uprated EU Household Budget Survey microdata (2020; N ≈ 180,000)
III	7	Qualitative	Historical policy analysis	Policy and legislative documents (1948-2023; incl. budgets, consultations, impact assessments)
	8	Qualitative	Process tracing of legislative change	Policy and legislative documents (1993-2024; incl. directives, regulations, proposals, and impact assessments)
	9	Qualitative	Comparative case study with content analysis	Legislation, regulatory documents, and semi-structured stakeholder interviews (2024-2025, N = 35)

Data sources were selected for their analytical value, reliability, and contextual relevance. Preference was given to materials that allowed for cross-contextual or longitudinal comparison and offered sufficient granularity to reveal variation across social groups. In several cases, the raw data required additional processing, such as income uprating, imputation, or linkage to supplementary records, to ensure comparability and completeness. These refinements, along with any associated limitations, are described in the individual chapters.

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Ethical and secure handling of all data was governed by a dedicated Data Management Plan (DMP), prepared in consultation with the faculty's data steward, the supervisory team, and the Human Research Ethics Committee (HREC) of TU Delft. The DMP specifies procedures for data collection, storage, access, anonymisation, and archiving, each tailored to the sensitivity and format of the dataset concerned. For personal or sensitive material, such as focus groups and stakeholder interviews, GDPR-compliant protocols were applied: all participants provided informed consent, identifiable information was stored separately from transcripts, and administrative microdata from Statistics Netherlands was accessed exclusively through secure remote environments under strict confidentiality agreements. The DMP was formally approved by the HREC in 2022, with amendments reviewed in 2024 and 2025. Wherever possible, anonymised data and associated metadata will be made publicly available via the 4TU.ResearchData repository,[9] in line with TU Delft's FAIR data principles and open science policy.[10]

Alongside these methodological choices, the research design was embedded in close engagement with practice. Practitioner perspectives were integrated throughout the project via the RE-DWELL network, ensuring that analysis was informed by operational realities, policy priorities, and cross-sectoral expertise. This engagement shaped access to data, enriched interpretation of findings, and guided the formulation of practically relevant questions. A fuller account of this transdisciplinary dimension is provided in Section 1.4.3.

1.3.3 Analytical and thematic framework

Building on the epistemological commitments outlined in Section 1.2.3, Figure 1.5 summarises the analytical structure guiding the thesis. Its foundation is the overarching objective of contributing to a just energy transition by examining how domestic energy deprivation is identified, addressed, and governed within diverse welfare and institutional contexts.

Immediately above sit three normative principles: recognitional, distributive, and procedural justice. The thesis treats these not as fixed ideals but as evolving orientations whose meaning emerges in specific governance settings. They determine how problems are framed, how burdens and benefits are allocated, and

9 Publicly shared datasets from this thesis can be accessed at https://data.4tu.nl/authors/68a40a4a-0384-423b-abf7-b499ee71dd2d.

10 FAIR stands for Findable, Accessible, Interoperable, and Reusable. These principles promote the transparency, discoverability, and responsible re-use of research data across disciplines.

whose voices are heard (Galvin, 2019; Schlosberg, 2007). Although analytically distinct, these three dimensions are deeply interwoven; distributive concerns, for example, are inseparable from whether recognition is granted or procedural rights are upheld. In practice, all three are present throughout the policy process, reflecting the interdependence of ethical concerns in shaping just energy transitions.

The second structuring dimension is the policy cycle, depicted in Figure 1.5. Adapted from Sabel and Zeitlin's (2012) theory of experimentalist governance, it conceptualises policymaking as a iterative and adaptive, a trial-and-error process that is shaped by institutional constraints and social demands. While not strictly linear, the stages of diagnosis, design, evaluation, and institutionalisation follow a recognisable sequence: diagnosis renders domestic energy deprivation visible; design formulates and pilots interventions; evaluation assesses responses against competing objectives; and institutionalisation embeds justice claims within governance arrangements.

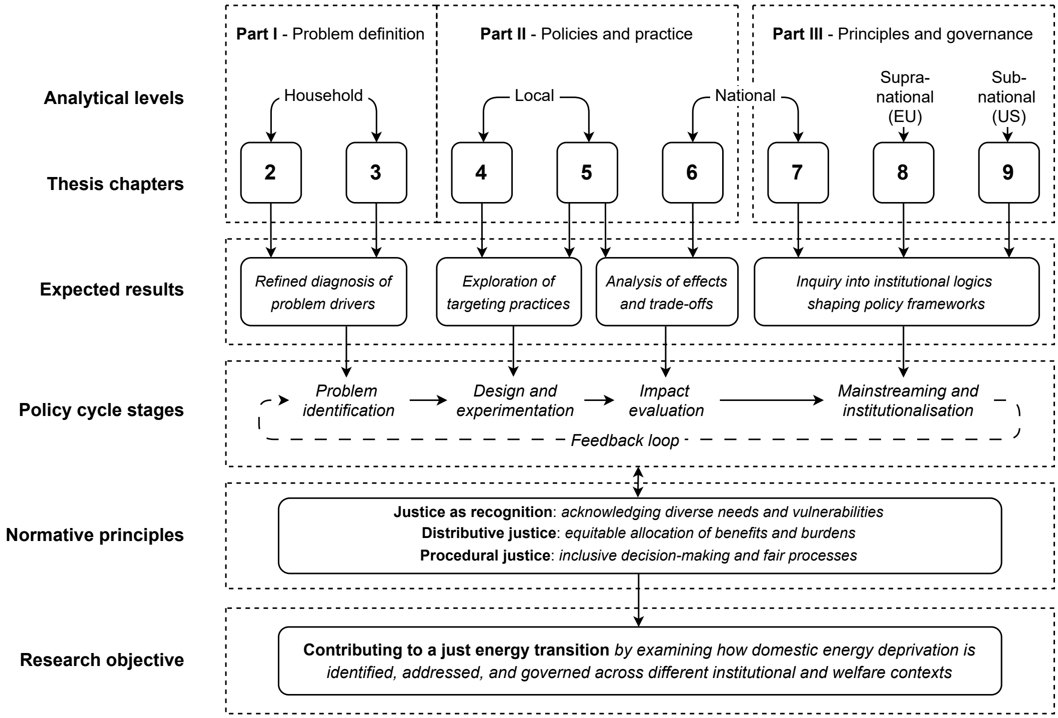

FIG. 1.5 Overview of analytical structure, illustrating how governance levels, justice principles, and policy cycle stages interconnect as core dimensions of the thesis

The thematic organisation of the thesis mirrors this progression. **Part I** (*'Problem definition: gaps in understanding energy deprivation as a social risk'*, Chapters 2 and 3) refines diagnosis by moving beyond income-based thresholds to metrics that capture depth, inequality, and drivers. **Part II** (*'Policies and practice: design and delivery of targeted household energy support'*, Chapters 4-6) analyses how interventions are designed, implemented, and experienced at local and national levels, assessing reach and trade-offs across effectiveness, efficiency, sustainability, and political salience. **Part III** (*'Principles and governance: policy pathways for a just energy transition'*, Chapters 7-9) examines how justice principles are interpreted and institutionalised across supranational, national, and subnational contexts, showing how welfare regimes, policy paradigms, and administrative logics condition what forms of fairness become actionable. Together, the framework links governance levels, normative principles, and iterative policy cycle stages, enabling a comparative, mechanism-oriented analysis of how domestic energy deprivation is tackled, and with what distributive, recognitional, and procedural consequences, across varied institutional contexts.

1.3.4 Chapters and objectives

Table 1.2 outlines the focus of each chapter, and the following discussion shows how they build cumulatively to develop the thesis' argument.

TABLE 1.2 Summary of chapters with corresponding objectives and geographic focus

Part	Ch.	Objective	Geographic focus
I	2	Develop and apply poverty gap metrics to assess the incidence, intensity, and inequality of domestic energy deprivation	Netherlands
	3	Analyse socioeconomic and sociodemographic drivers of domestic energy deprivation	United Kingdom
II	4	Investigate the role of social housing providers in addressing domestic energy deprivation across welfare regimes	Netherlands, United Kingdom, France
	5	Evaluate the impact of local behavioural and physical interventions on energy-related comfort, savings, and wellbeing	Netherlands
	6	Assess the distributive trade-offs in national energy relief policies during the energy crisis	Eighteen EU member states
III	7	Trace the evolution of household energy support to identify structural constraints and paradigmatic shifts in welfare governance	United Kingdom
	8	Examine the integration of social protection and investment principles into energy and climate legislation	European Union
	9	Examine how procedural and distributive justice principles shape revenue recycling in cap-and-trade programmes	Fourteen U.S. states

Part I (Chapters 2 and 3) establishes the conceptual and diagnostic foundation. Chapter 2 focuses on the Netherlands, developing gap-based metrics that capture not only how many households are affected by domestic energy deprivation, but also the depth and inequality of their shortfall. This enables a more differentiated assessment of energy needs, moving beyond simplistic headcount indicators. Chapter 3 turns to the United Kingdom and examines the structural drivers, analysing how a dwelling's energy efficiency, a household's characteristics, and occupancy patterns shape the income elasticity of energy demand across income groups. By capturing how sensitively energy spending responds to income changes, this indicator highlights forms of deprivation not fully explained by income levels alone. Together, these chapters refine the problem definition and establish a stronger basis for targeted responses.

Chapters 4 to 6 make up Part II, which investigates how responses are formulated and delivered across governance levels. Chapter 4 analyses the evolving role of social housing providers in France, the Netherlands, and the UK. As key landlords to vulnerable populations, these providers are increasingly engaged in mitigating energy deprivation. The chapter examines how they navigate competing mandates and limited resources while managing the impacts of their strategic choices in retrofitting, rent setting, and housing allocation. Chapter 5 examines municipal pilot programmes in the Netherlands, evaluating how low-cost energy coaching and shallow retrofitting improved thermal comfort, energy-saving behaviour, and reduced financial stress, particularly among households with high energy burdens. Chapter 6 extends the analysis to eighteen EU member states during the 2021-2023 energy price crisis, developing a comparative framework based on effectiveness, efficiency, sustainability, and political salience to assess relief measures. The findings highlight the distributive tensions and strategic trade-offs that shaped crisis responses across Europe.

Part III, including Chapters 7 to 9, examines how principles of justice are interpreted, prioritised, and institutionalised across governance settings. Chapter 7 traces the historical evolution of household energy support in the UK, situating shifts in welfare logics within broader debates on welfare state recalibration and highlighting how crises have reopened space for rethinking support logic and eligibility. Chapter 8 analyses EU energy and climate legislation from the 1990s onwards, identifying phases of market liberalisation, the addition of social safeguards, and recent moves towards redistributive mechanisms. It evaluates whether these changes mark deeper paradigm shifts or pragmatic adaptations to political pressures. Chapter 9 turns to the US, examining how procedural and distributive justice are operationalised in state-level cap-and-trade programmes. By analysing how carbon revenues are allocated, it reveals divergent interpretations of a just transition and the institutional variation shaping equity-oriented investments.

1.4 Aims of the thesis

1.4.1 Scientific aims

This thesis aims to advance the study of domestic energy deprivation as a multidimensional social risk within the energy and climate domains and to clarify how sufficiency-oriented justice can be operationalised as an analytical framework for its study. Conceptually, it seeks to link diagnostic choices to normative reasoning and to show how metrics based solely on incidence of energy deprivation obscure the depth, distribution, and patterning of shortfalls. Methodologically, it aims to develop and apply distribution-sensitive, gap-based indicators anchored in socially defined thresholds, making it possible to see who is furthest below an acceptable standard and by how much (e.g., Foster et al., 1984). Substantively, it will examine how domestic energy deprivation is co-produced by housing conditions, energy systems and differentiated needs in ways that standard poverty metrics may miss (Boardman, 1991b; Bouzarovski & Petrova, 2015). Together, these objectives aim to provide a common language that integrates welfare analysis, housing research, and energy policy scholarship.

A second set of scientific aims is explanatory and comparative. The thesis adopts a mechanism-aware, context-sensitive perspective, grounded in critical realism, to connect policy design and delivery with observed outcomes across levels of governance. Rather than treating interventions as static instruments, it will analyse how they are framed, implemented, and revised within particular institutional settings, and how trade-offs are navigated in practice. In doing so, it seeks to bring process-tracing and comparative analysis to bear on questions often addressed only descriptively, to clarify where and why targeted measures work (or fail), and to situate these findings within broader literatures. By integrating insights from welfare state theory and political economy, the work aims to set out an agenda for comparative research that treats energy deprivation as an object of social policy in its own right, and as a test of how just transition commitments are interpreted and made actionable across governance levels (Bouzarovski et al., 2021; Middlemiss et al., 2023).

1.4.2 Societal aims

The thesis is intended to be usable by public authorities and delivery organisations tasked with safeguarding basic living standards during the energy transition. Its diagnostic tools are designed to make deprivation more visible, comparable, and actionable: to enable analysts to identify severity as well as incidence, to disaggregate needs across places and groups, and to assess whether policies reduce shortfalls where they are greatest. The evaluative approach seeks to support evidence-informed choice among instruments, helping decision-makers to weigh policy impact, fiscal implications, conservation incentives, and perceived fairness. The broader aim is to sustain the legitimacy of climate and energy policy when prices are volatile and burdens uneven.

Beyond its conceptual and empirical contributions, the thesis aims to engage directly with the practice of policymaking and service provision. Practitioner collaboration, discussed in detail in Section 1.4.3, is intended to ensure that the tools and findings developed here are not only theoretically robust but also usable in institutional settings. This dual orientation aims to enhance the societal value of the research: its indicators, evaluative frameworks, and comparative insights seek to inform ongoing policy debates, while its practitioner partnerships strive to facilitate their uptake in government, statistics agencies, social housing providers, and international institutions and policy forums.

1.4.3 Engagement with practice

Engagement with practice was not an afterthought but a structural element of this PhD, embedded from the outset through the RE-DWELL network. The project was conceived as a transdisciplinary endeavour, not only integrating academic disciplines, but involving practitioners, policymakers, and civil society actors in the co-production of knowledge. In the context of just energy transitions, scholars highlight the *"large potential for greater impact through transdisciplinary research that involves academics coproducing knowledge with practitioners and activists"* (Jenkins et al., 2020). Here, transdisciplinarity is understood as a mode of inquiry that integrates academic and non-academic knowledge across the whole research cycle, from problem framing to solution design (Seidl et al., 2013). It is not merely multi- or interdisciplinary exchange among scholars; it crosses the boundary between science and society to produce usable, 'socially robust' knowledge (Nowotny et al., 2001).

The RE-DWELL network operationalised this approach through three complementary types of knowledge, as outlined by Pohl and Hirsch Hadorn (2007). Systems knowledge (*what is?*) concerns understanding the structures, drivers, and dynamics that shape the problem context. Target knowledge (*what ought to be?*) clarifies which outcomes are considered fair, inclusive, or sustainable by different stakeholders. Transformation knowledge (*how to act?*) identifies practical pathways and instruments to move from present conditions towards desired change. These three forms of knowledge also structure the overarching design of the thesis. Part I develops systems knowledge through a diagnosis of domestic energy deprivation and its structural determinants; Part II primarily advances transformation knowledge by co-producing actionable strategies and evaluating their effectiveness, while also engaging with target knowledge in relation to the normative goals these strategies aim to achieve; and Part III, in turn, focuses mainly on target knowledge by examining how principles of justice are interpreted, prioritised, and institutionalised across governance settings, while also incorporating aspects of transformation knowledge by analysing the institutional and political dynamics that enable or constrain reform.

While every chapter benefited from practitioner engagement, Chapter 4 is the most direct outcome of it, developed in collaboration with social housing providers in three European countries. Their insights were indispensable in revealing institutional mandates, operational constraints, and regulatory differences (systems knowledge), surfacing contrasting value priorities such as the balance between individual choice and collective solidarity (target knowledge), and co-producing strategies to overcome barriers including limited capacity, information gaps, and coordination challenges (transformation knowledge).

This engagement was made possible by the secondment programme, a cornerstone of MSCA-ITN projects, through which three two-month placements were undertaken: at Clarion Housing Group in London, providing access to operational realities and resident engagement; at Housing Europe in Brussels, offering a policy-level perspective on EU energy, housing, and climate agendas; and at the European Federation for Living (EFL) in Amsterdam, facilitating contact with a broad network of innovative housing providers. These secondments did not simply supplement the research but shaped its design, created access to key informants, and ensured that findings were circulated back into the professional communities from which they were drawn.

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PART I

Problem definition

Gaps in understanding domestic energy deprivation as a social risk

TOC

2 Definitions and metrics in energy poverty measurement

This chapter is based on a peer-reviewed article published as:
Croon, T. M., Hoekstra, J. S. C. M., Elsinga, M. G., Dalla Longa, F., & Mulder, P. (2023). Beyond headcount statistics: Exploring the utility of energy poverty gap indices in policy design. *Energy Policy, 177*, 113579.

ABSTRACT

Recent energy price spikes have led to increased energy poverty among low-income households living in inefficient homes. Accurate statistics on energy poverty help inform resource allocation and better target relief schemes and retrofit funds. Existing indicators are predominantly defined in terms of a headcount ratio – the share of population living below a certain threshold or poverty line. In this paper we draw from the literature on income poverty evaluation to argue that the use of more elaborate energy poverty gap indices can substantiate the design and monitoring of energy poverty policies, by not only considering incidence but also intensity and inequality of energy poverty across households. We demonstrate that the choice for a particular energy poverty (gap) indicator makes the implicit welfare choices of energy poverty policies explicit. We illustrate our arguments for the case of the Netherlands, using recently developed microdata statistics on energy poverty, and an imposed energy price shock. We show that spatial targeting of relief funds based on incidence would neglect the full depth of energy poverty deprivation. Finally, we argue that visualisation techniques from the income poverty literature help to comprehend different poverty orderings and draw comparisons between time periods, regions, and subgroups.

2.1 Introduction

In 2021 and 2022, energy prices rose sharply in Europe. Because of geopolitical uncertainty and the transition towards a low-carbon energy system, high energy prices as well as strong energy price fluctuations are likely to persist for some time (Mišík, 2022; Pahle et al., 2022). This puts pressure on household expenses and leads to more energy poverty, particularly among low-income households living in energy inefficient homes. Energy poverty – the inability to secure sufficient domestic energy services that allow for participation in society – can have deteriorating effects on livelihoods (Bouzarovski & Petrova, 2015). Previous studies have demonstrated its negative impact on physical health (Liddell & Morris, 2010), mental health (Liddell & Guiney, 2015), stress (Longhurst & Hargreaves, 2019), social isolation (Harrington et al., 2005) and absenteeism (Howden-Chapman et al., 2007).

In most European countries, policymakers have responded to the energy price surge by creating energy cost relief schemes that support households in paying their energy bills. Accurate statistics on energy poverty can help inform policymakers to design effective support measures that target households most in need of support. In this paper we draw from the literature on income poverty evaluation (J.E. Foster & A.F. Shorrocks, 1988a, 1988b, 1988c; Sen, 1976) to argue that the use of carefully designed energy poverty gap indices can substantiate the design and monitoring of energy poverty policies. We also show that the choice for a particular energy poverty (gap) indicator makes the implicit welfare choices of energy poverty policies explicit.

The wish to alleviate energy poverty in high-income countries is not new. Over the past decade, the alleviation of energy poverty has become an important policy and research area in most high-income countries, more or less following the UK where the issue had already been debated since the 1990s (Bouzarovski et al., 2021; Primc et al., 2021). Governments and other relevant stakeholders are increasingly committing themselves to the universal 'right to energy' and take measures accordingly (Hesselman et al., 2021). The European Commission, for instance, has made tackling energy poverty a key pillar of its 'Renovation Wave' strategy (2020) and Social Climate Fund proposal (2021). Moreover, EU law obliges member states to monitor domestic energy poverty (European Union, 2019). National governments in the U.S. (Bednar & Reames, 2020), the UK (DBEIS, 2021b) and the Netherlands (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties [BZK], 2021) have even started to use energy poverty indicators to allocate resources for energy poverty alleviation to subnational authorities, which underlines the importance of reliable statistics.

Data and definitions of energy poverty used by policymakers differ across countries and over time, following longstanding debates on indicators in the academic literature (Romero et al., 2018; Siksnelyte-Butkiene et al., 2021; Thomson et al., 2017). This led to many proposals to quantify the multidimensional nature of energy poverty (see for an overview Hills, 2012; Pelz et al. 2018; Tirado Herrero, 2017). Remarkably, however, despite this variation of energy poverty metrics, in most countries (with the UK being an important exception) energy poverty indicators are predominantly defined in terms of a headcount ratio – the share of population living below a certain threshold or poverty line. However, in a seminal article on the theory of poverty evaluation, Amartya Sen (1976) already argued that a poverty indicator should not only be sensitive to the number of people below the poverty line ('incidence'), but also to the extent of the shortfall of the income of the poor from the poverty line ('intensity') and to the distribution pattern of the incomes among the poor ('inequality'). After all, for the design of effective poverty policies it is important to know if increasing poverty is due to more people becoming poor (the headcount ratio), to increasing deprivation of the poor (poverty gaps, i.e. shortfalls below the poverty line) or because of a more unequal distribution of the poverty gaps. In the literature on poverty evaluation this led to the development of a class of poverty indicators that allow for decomposing aggregate poverty changes into these contributing factors (Aristondo et al., 2010; Clark et al., 1981; J.E. Foster & A.F. Shorrocks, 1988a, 1988b, 1988c; Jenkins & Lambert, 1997, 1998a, 1998b; Kakwani, 1999).

These poverty indicators, that have become known as the so-called class of Foster, Greer and Thorbecke indicators (Foster et al., 1984), relate directly to welfare considerations because of their inherent poverty orderings – not all poor are considered to be equally poor (J.E. Foster & A.F. Shorrocks, 1988c). This contrasts the headcount ratio that does not consider welfare effects of (changes in) poverty inequality: since it only counts whether or not households are poor it can only measure changes in welfare effects around the poverty line, while poverty changes among households that remain (far) below the poverty line remain unnoticed. In other words, the headcount ratio is unequipped to measure the extent to which policies provide more support to households in greater need (Simshauser, 2021). Evidently, this is an important limitation for developing and evaluating energy poverty policies that aim to alleviate the negative welfare effects of rising energy prices among low-income households (Sefton, 2002). The matter at hand is exemplified by a recent assessment of the Spanish social tariff conducted by Bagnoli and Bertoméu-Sánchez (2022). The authors concluded that the policy had hardly been successful in its aim to alleviate households from energy poverty. However, this inference was solely based on the 'headcount'. Thus, positive welfare effects for households that remained energy poor were by definition neglected.

Besides improving the accuracy of energy poverty monitoring, the use of poverty gaps in official statistics can also stimulate political accountability and commitment. An exclusive focus on the headcount ratio might even tempt policymakers to direct energy poverty alleviation measures disproportionally to households close to the poverty thresholds because this may yield the largest reduction in number of poor people against the lowest cost of alleviation. The use of a more elaborate poverty gap indicator would make such a welfare policy choice explicit and enables to show the welfare trade-off between such a policy choice and an alternative focus on primarily supporting the most deprived households (Heindl, 2015). Moreover, defining and calculating (changes in) an aggregated energy poverty gap can indeed help to project the 'cumulated social costs' (Imbert et al., 2016) or social welfare effects of energy poverty, while a microlevel analysis of energy poverty gaps would allow for a better understanding of welfare differences between households and thus raise awareness of specific vulnerabilities (Tirado Herrero, 2017).

The UK government and several scholars (Faiella & Lavecchia, 2021; Foster et al., 2000; Heindl, 2015; Meyer et al., 2018) have used poverty gap indices to improve energy poverty measurements. However, to the best of our knowledge, the energy poverty literature, remarkably enough, lacks an in-depth study of how to use decomposable poverty indices to evaluate the welfare trade-offs inherent to energy poverty reduction policies that aim to reduce energy poverty incidence, intensity or inequality, or some combination of these goals.

The aim of this paper is therefore to provide an elaborate discussion on the practical implications of using the Foster-Greer-Thorbecke indices in the field of energy poverty. In doing so, we focus on the use of energy poverty gap indices and show how they can be used to examine the intensity and inequality of energy poverty while allowing for decomposition and comparison. Following Sen (1976) and Ravallion (2016), we argue that headcount poverty measurements do not meet the monotonicity axiom (when poor households become poorer, figures must rise) and the transfer axiom (after regressive transfers from poor to richer households, figures must rise), whereas the Foster-Greer-Thorbecke indices meet both axioms. Furthermore, we introduce the so-called TIP curves from Jenkins and Lambert (1997) to the energy poverty literature, in line with the notion to decompose aggregate poverty trends into changes of, respectively, the incidence, the intensity and the inequality of the poverty – the three I's of poverty according to Jenkins and Lambert (1997, 1998a, 1998b). We argue that this is a potentially useful approach to grasp poverty distributions and draw robust comparisons between regions, time periods, and subgroups. We illustrate our arguments with a microdata assessment of energy poverty patterns in the Netherlands, and show that while incidence was relatively low, part of Dutch households dealt with rather intense energy poverty. This implies that targeting of resources to alleviate energy poverty based on incidence only would neglect the full depth of their deprivation.

The organisation of the paper is as follows. In Section 2.2 we describe how the poverty orderings from development economics could enrich insights from institutionalised energy poverty indicators. In section 2.3 we introduce the dataset and explain the conducted transformations. In section 2.4 we illustrate the use of poverty gap indices by performing an analysis of energy poverty in the Netherlands. Finally, in section 2.5 we discuss which policy consequences arise from the results and suggest opportunities for future research.

2.2 Three 'I's of Poverty

2.2.1 Poverty Orderings and Axioms

As noted before, since the seminal contributions of Sen (1976), it is widely believed that poverty measurement should be decomposable into three orderings: incidence, intensity, and inequality. This paragraph describes their use and the extent to which they satisfy axioms from development economics (see Table 2.1).

The first ordering, *incidence*, refers to the 'headcount', the most used measure to represent poverty. Typically, it is illustrated by a ratio or 'headcount index' that simply indicates the proportion of a population (e.g. a neighbourhood or country) that is classified as living in poverty. Ravallion (2016) described how this satisfies the focus axiom (independence from changes among the non-poor) and scale invariance axiom (stability when incomes and poverty line increase by the same proportion). The headcount index received criticism from Sen (1976), who pointed out that the headcount index would not increase when an already poor household becomes poorer. Despite this flaw, which makes it an inadequate measure to analyse the impact of specific policies on poverty alleviation, it gained widespread popularity because of its intuitive explanation.

TABLE 2.1 Characteristics of various poverty orderings, based on Foster et al. (1984)

Poverty ordering	Numeric expression	Focus axiom	Scale invariance	Monotonicity axiom	Transfer axiom
Incidence	Usually a proportion (0 – 100%) of population living in poverty	Satisfied	Satisfied	-	-
Intensity	Poverty gap as sum per household, index as ratio between 0 (non-existent) and 1 (extremely intense)	Satisfied	Satisfied	Satisfied	Partially satisfied*
Inequality	Ratio between 0 (equal poverty) and 1 (completely unequal poverty)	Satisfied	Satisfied	Satisfied	Satisfied

** This index satisfies the axiom with transfers from poor to non-poor households but not with transfers from poor to less poor households*

The second ordering, *intensity*, corresponds to the poverty gap. Instead of counting households, it counts shortfalls of income or consumption, usually presented in monetary terms. It represents the minimal means needed to eliminate poverty if progressive transfers would be costless and perfectly targeted, and while this is only theoretically possible it enables a prompt evaluation of the extent of deprivation (Morduch, 2005). Besides the focus and scale invariance axioms, measuring the poverty gap also satisfies the (subgroup) monotonicity axiom: when already poor households become poorer, the outcome of the measure increases (Kakwani, 1980).

To arrive at the third ordering of the poverty measurement, *inequality*, it must comply with the transfer axiom (J.E. Foster & A. F. Shorrocks, 1988). This axiom, first introduced over a century ago by Dalton (1920), indicates that regressive welfare transfers from households below the poverty line to richer (or *less* poor) households must affect the outcome. This way, the index penalises the worsening of inequality to the detriment of the most impoverished households, giving greater weight to the deficit of the poorest households than that of the relatively less poor ones.

2.2.2 Conventional Energy Poverty Indicators

Given the complex nature of the concept, a variety of rather different energy poverty indicators have emerged. Most scholars agree that measurement should focus on the three most important drivers of energy poverty: a household's lack of financial means, a home's low energy efficiency, and high energy prices (Walker & Day, 2012).[11]

An important distinction in the literature is the difference between 'consensual' and 'income/expenditure'- based indicators'. Consensual indicators stem from self-reporting, and indicate the share of the population that is not able to afford adequate heating or cooling at home, while income/expenditure- and more recently 'income/efficiency'-based indicators rely on administrative data (Romero et al., 2018).[12] As national governments are generally opting for the latter school of indicators to monitor energy poverty and inform resource allocation, we focus on those in this section (complemented with less prevalent ones in Table 2.2).[13]

Boardman's 10% and 2M

The most-used energy poverty indicator is often credited to Brenda Boardman, while she built on the first attempt to quantify 'the fuel poor' in England from Isherwood and Hancock (1979). They suggested to calculate each household's share of income spent on 'fuel, light and power', the so-called 'burden', and focus on those spending over twice the national median. Boardman (1991) adopted the twice the median (2M) approach, which amounted to 10% in England at the time she published her pioneering work. Despite her own concerns, that exact proportion was embraced by policymakers and even institutionalised by governments abroad without context-specific contemplation (Tirado Herrero, 2017).

11 Resident behaviour is sometimes referred to as the 'fourth driver' of energy poverty (Kearns et al., 2019).

12 Increasingly, the 'multi-indicator' approach is advocated in the literature, as a combination of indicators can capture the diverse drivers of energy poverty (Best et al., 2021; Castaño-Rosa et al., 2019; Thomson et al., 2017). This approach identifies a household as being in energy poverty when at least one out of two or more indicators confirms this. It differs from the 'multi-criteria' or 'composite' school of energy poverty measurement, which integrates a relatively large number of variables and assesses their relative importance based on expert weighting (Nussbaumer et al., 2012). While these analyses appreciate the local context, the variable-selection and weight-allocation process is sometimes also regarded as overly value-driven and somewhat arbitrary (Nussbaumer et al., 2012; Simoes et al., 2016).

13 We do not go into the 'hidden energy poverty' branch of expenditure-based indicators that focuses on curiously low rather than high energy expenditures, as it assumes some low-income households consistently ration their energy use because of wider financial problems (Betto et al., 2020; Meyer et al., 2018). Other less-used indicators are described by Heindl (2015).

Besides the arbitrary threshold, there is a more fundamental difference between the two interpretations. While 2M is a 'relative' indicator with flexible thresholds that increase when most households are spending more on energy, the 10% approach is far more dependent on market dynamics. When prices are unusually high, it may classify a large majority of households as being energy poor, which undermines the indicator's 'prioritising function'. In a way, it presents energy poverty as a cyclical problem rather than a structural one (Imbert et al., 2016). This complicates the evaluation of policy interventions and the commitment of governments to alleviate or even eradicate energy poverty (Charlier & Legendre, 2021).

Moreover, simply looking at a proportion of income has another practical disadvantage. It could label high-income households who live in large energy-inefficient homes as energy poor (Hills, 2012). This effect could be mitigated by applying an income correction, shown by Heindl (2015) who filtered out all incomes above the median, although this remains rather uncommon. Nevertheless, variants of this indicator remain the most important energy poverty statistic, as they are still dominant across the European academic and policy literature.

Low Income High Cost (LIHC)

The UK government commissioned John Hills in 2011 to enhance expenditure-based energy poverty measurement and replace the 10% metric. Hills developed the residual Low Income High Cost (LIHC) indicator, an expenditure-based metric that considers households energy poor if they *"have required fuel costs that are above the median level"* and if they *"would be left with a residual income below the official poverty line"* (Hills, 2012, p. 9).[14] Hills (2012, p.32) thus suggested two threshold values: one for high (above-median) expenditure and one for low (60% of median equivalised) income after deducting housing and required energy costs.

While the UK government adopted and institutionalised the LIHC indicator in 2013, its practical implications were not without controversy. Walker et al. (2014) pointed out that choosing the median as a threshold would overlook smaller homes, while these are often occupied by 'vulnerable, lower income households'. In fact, by opting for the median energy expenditure, half of all households would always remain above the threshold – no matter how low the prices – and eliminating energy poverty would become practically impossible (Moore, 2011). Housing quality and energy efficiency

14 The income threshold is sloping rather than straight in Figure 2.1 because lower energy expenditure would also decrease the income threshold (as energy expenditure is used to calculate disposable income in this residual approach).

improvements would hardly decrease the calculated incidence of energy poverty. Moore (2012) therefore suggested to complement or replace the energy expenditure threshold with one based on energy efficiency.

Low Income Low Energy Efficiency (LILEE)

The suggestion by Moore (2012) to concentrate on energy efficiency was welcomed by policymakers, as evidenced by the UK government's proposal of the new Low Income Low Energy Efficiency (LILEE) indicator, which replaced the LIHC indicator (DBEIS, 2021a). The rationale behind this shift was that this indicator would better allow the government to track its progress in achieving energy poverty targets.

As with all indicators, the LILEE indicator received critical reflections, although there have not been empirical studies in the literature yet. Deller et al. (2021) argued that a shift from expenditure to efficiency would classify fewer elderly households as energy poor, while it does not consider their significantly higher energy needs compared to other household types. The same argument applies to other situations in which a household typically requires more energy – for instance because of physiological or social reasons – and thus represents a more fundamental difference: household characteristics lose importance to housing quality.

TABLE 2.2 TCharacteristics of several expenditure- and efficiency-based energy poverty indicators

EP indicator	Focus point	Energy-related threshold	Nature of threshold	Price sensitivity	Means tested	Official statistic (institutionalised)
10%	Ratio of energy expenditure to income signalling high burden	10% of disposable inco-e	Absolute	High	-	Belgium, England (dropped), France (dropped), Ireland
2M	Ratio of energy expenditure to income signalling high burden	Twice the median energy burden	Relative	Low	-	EU, France *, Spain
M/2	Low energy expenditure signalling rationing	Half the median energy expenditure	Absolute	Low	-	EU, Spain
MIS	Residual income falls below minimum income standard	Disposable income after energy cost (AEC)	Absolute	Low	Yes	-
LIHC	Residual income and energy expenditure	National median energy expenditure	Relative	Low	Yes	England (dropped), France (dropped)
LILEE	Residual income and energy efficiency	National efficiency target (or median efficiency)	Absolute or Relative	Low	Yes	England

** But only of the 30% lowest-income households*

2.2.3 Energy Poverty Gap Indices

While the use of poverty gaps remains rare in energy poverty research and policy, the initial impetus was given at the turn of the century by World Bank economists. Foster et al. (2000) defined energy poverty as energy consumption not meeting basic energy needs, and the gap as the distance separating the energy poor from the energy poverty line.[15] Sefton (2002) first applied the energy poverty gap to policy evaluation and defined it as the difference between what households can afford to spend, set at 10% of income, and what they would need to spend to 'heat their homes satisfactorily'.

The gap was first introduced in the wider policy arena by Hills (2012) in his LIHC indicator. He believed that the indicator would gradually lose its primacy to the poverty gap in assessing policy impact, as it is sensitive to prices, policies, and programmes (Bogaars, 2020). However, Boardman (2012) foresaw that Hills' poverty gap could be neglected when presented as a subsidiary element of the indicator, while she acknowledged its benefit of combining both extent and depth of energy poverty.

Figure 2.1 illustrates the various definitions of energy poverty incidence and poverty gaps considered in this study. The proportional Boardman's 2M indicator is visualised in the first panel, by plotting (household) energy expenditure on the vertical axis versus income on the horizontal axis. Therefore, the energy burden (e_i), i.e. the share of energy expenditure as percentage of income, is represented by an arrow pointing to the bottom left (as the direction of increasing energy expenditure on the y-axis points 'downwards'). The dashed diagonal line marks 2M's energy poverty line, that is set to twice the median energy burden (z_{2M}). The grey area below the line represents all energy poor households. By counting the number of households that fall within this area we can obtain a measure of energy poverty incidence, while their distance from the line yields an estimate of the energy poverty gap (g_i). Consequently, if a household's energy burden is 15%, and twice the median energy burden is 10%, the energy poverty gap represents 5% of the household's income.

15 As they focused on underconsumption of Guatemalan households, Foster et al. (2000) set the energy poverty line on 2,154 kWh per year.

On the other hand, LIHC and LILEE in the bottom two panels are residual indicators with two thresholds. First, they share a low-income threshold (z_{LI}) with a sloping line, because income (I_i) is considered after deducting energy expenditure and a household would need more income (horizontal axis) to be able to afford increasing energy expenditure or decreasing energy efficiency (vertical axis). Households only classify as energy poor if their income I_i does not exceed the low-income threshold z_{LI}. Second, the horizontal thresholds or energy poverty lines of LIHC and LILEE differ, with the former line depicting the national median energy expenditure (z_{HC}) and the latter as the energy costs needed to properly heat a house with a reference energy efficiency quality standard (z_{LEE}). While e_i is defined as a household's energy burden in 2M, it represents a household's energy expenditure in LIHC, and energy costs needed to properly heat a household's home with the current energy efficiency in LILEE. The presence of two thresholds explains why for most households – such as Household A in Figure 2.1 – the energy poverty gap represents the distance to the regular energy poverty line, but since some households – such as Household B – already surpass the low-income threshold (z_{LI}) with a more modest decrease in energy costs a household's energy poverty line could also be lower than z_{HC} or z_{LEE}. Yet again, the grey area represents all energy poor households, while deviation from the horizontal line yields the energy poverty gap (g_i).

The methodological roots of the notion of energy poverty gaps can be found in the so-called class of Foster, Greer and Thorbecke indices, henceforth FGT indices. The various FGT indices to measure poverty are decomposable into their underlying contributing factors: incidence, intensity, and inequality. Also, these indicators are sub-group-consistent and (thus) satisfy the key invariance, dominance, and subgroup axioms (see Table 2.1). Conventionally, the FGT class is based on the income poverty gap, which is the shortfall of income as compared to the poverty line.

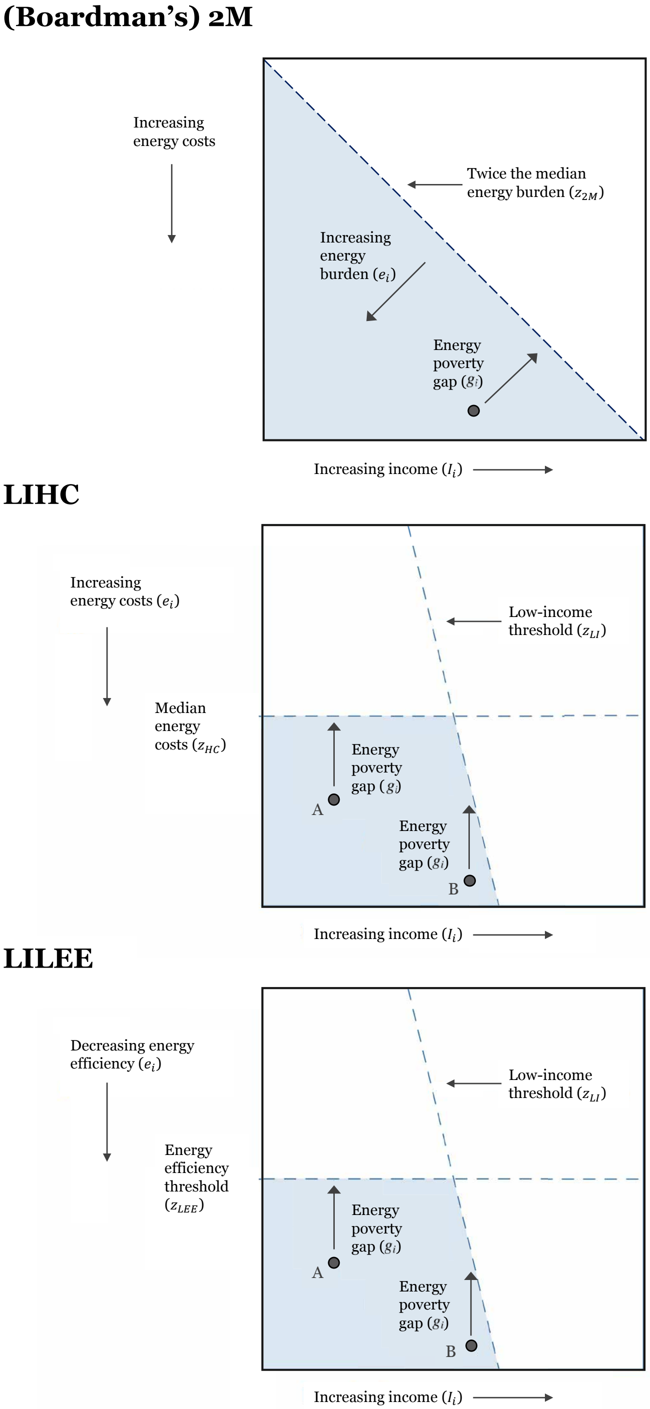

FIG. 2.1 Illustration of incidence (blue) and intensity (arrows) of energy poverty in terms of three commonly institutionalised energy poverty indicators, inspired by the UK Department of BEIS

In parallel, the energy poverty gap is defined as the reduction in energy costs that is needed to lift a household out of energy poverty (Hills, 2012). Formulated differently, a households' energy poverty gap is defined as the energy cost surplus as compared to the energy poverty line. Hence, the energy poverty gap of an energy poor household *i* can be formulated as:

$$g_i = e_i - z_i \qquad [1]$$

in which the household's energy poverty line (z_i) is deducted from the household's energy costs (e_i). In sum, whereas conventional income poverty metrics are defined in terms of income falling short of a certain threshold, the energy poverty metrics are defined in terms of high energy costs, i.e. excess energy consumption above a threshold energy consumption level. To arrive at the normalised energy poverty gap, the remainder is divided by the energy poverty line. Normalisation is crucial as it allows for thorough comparison between households with different energy poverty lines (e.g. 2M yields different energy poverty lines for households with varying levels of disposable income) and thus implies expressing the energy poverty gap as a share of the energy poverty line.

Within the class of FGT indices, various individual energy poverty indices can be derived by substituting different values of the parameter α into the following poverty metric:

$$P_\alpha = \frac{1}{N} \sum_{i=1}^{H} \left(\frac{g_i}{z_i} \right)^\alpha \qquad [2]$$

where N is the number of all households under consideration, H is the number of energy poor households, g_i is the energy poverty gap, z_i is the energy poverty line that is used to normalise the energy poverty gap, and α is a parameter that essentially defines the implicit social welfare function underlying the poverty metric P. The higher the value of P, the more energy poverty there is in an area. When α is set at a low value, the poverty metric weights all households with energy costs above z roughly the same. The higher the value of α, the greater the weight placed on the poorest households.

With $\alpha = 0$, equation (1) reduces to the headcount ratio, measuring energy poverty *incidence*: the fraction of the population that is energy poor:

$$P_0 = \frac{H}{N} \qquad [3]$$

TOC

With $\alpha = 1$, equation (3a) measures energy poverty *intensity*, expressed in terms of the energy poverty gap index:

$$P_1 = \frac{1}{N} \sum_{i=1}^{H} \left(\frac{g_i}{z_i} \right) \qquad [4]$$

which equals the average normalised energy poverty gap of all households. In contrast to the head count ratio poverty indicator P_0, which considers all energy poor households equally poor, the poverty gap index indicator P_1 estimates the depth of energy poverty by considering how far, on average, energy poor households are from the poverty line.

With $\alpha \geq 1$, equation (1) measures energy poverty *inequality* along with energy poverty. With $\alpha = 2$, equation (1) becomes:

$$P_2 = \frac{1}{N} \sum_{i=1}^{H} \left(\frac{g_i}{z_i} \right)^2 \qquad [5]$$

The 'squared poverty gap index' P_2 does satisfy the transfer axiom, allocating exponentially more weight to the most intense energy poverty. Watts (1968) was the first to develop a poverty metric that satisfied the transfer axiom, by dividing income over the poverty threshold and taking the logarithm of the result. However, log values make his index less intuitively applicable to energy poverty gaps as these gaps, in contrast to income gaps exceed the poverty thresholds (since they are defined as an energy costs surplus) rather than falling short of a threshold.[16]

As hinted at before, the various energy poverty metrics P defined by the value of α, each imply an energy poverty ordering that links to a certain aggregation of individual welfare functions (Foster & Shorrocks, 1988a). The energy poverty P_0, which measures energy poverty incidence in terms of the headcount ratio, corresponds to symmetric welfare functions that are increasing in energy costs reductions of each energy poor household ('first degree' welfare dominance). The energy poverty ordering P_1, which measures energy poverty intensity in terms of an energy poverty gap, corresponds to symmetric welfare functions that exhibit both monotonicity and equality preference; the latter implies that all progressive transfers to energy poor households improve welfare ('second degree' welfare dominance). Finally, the energy poverty ordering P_2, which measures energy poverty inequality

16 Using ordinal energy poverty indicators would allow for the Watts index to be applied, as proposed by Best et al. (2021).

along with energy poverty, corresponds to symmetric welfare functions that are not only monotonic and equality preferring but also 'transfer sensitive'; the latter implies that welfare increases disproportionally with transfers to households with highest energy poverty gaps ('third degree' welfare dominance). In other words, for $\alpha \geq 1$, greater value is given to the 'poorest' energy poor households, while $\alpha \rightarrow \infty$ makes it into a 'Rawlsian' maximin measure that focuses *solely* on the 'least advantaged' (i.e. the single poorest energy poor) household (Foster et al., 1984, p. 763).[17]

TIP curves

Following equation (1), we can develop various energy poverty metrics that concentrate on the incidence, the intensity, and the inequality of energy poverty, respectively. To graphically represent these *"three 'Is of poverty"*, Jenkins and Lambert (1997) introduced the 'TIP curves' in the literature on measuring income poverty. This method of representation (illustrated in Figure 2.2) works as follows.

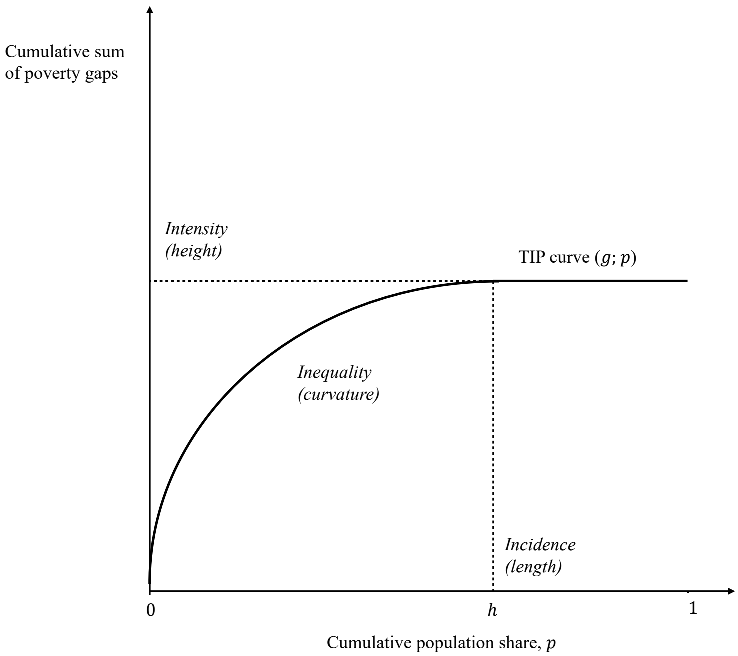

FIG. 2.2 TIP curves from Jenkins and Lambert (1997) representing incidence, intensity, and inequality of poverty

17 Kanbur (1987, p.111) states that "*government's aversion to inequality can be continuously varied from one extreme where no particular attention is paid to the poor, to the other where it cares only about the welfare of the very poorest, the so-called Rawlsian maximin outcome*".

First, all households in the population are ranked from poorest to richest. Then, the cumulative share of the population is plotted against the cumulative poverty gaps of the population. Households that are not in poverty represent a poverty gap of zero. Therefore, the line becomes horizontal when it reaches non-poor households, meaning that the x-coordinate of the point where the curve becomes horizontal represents the incidence (P_0 in Figure 2.2) of poverty. At the same time, the y-coordinate of the point where the curve becomes horizontal depicts the intensity (P_1 in Figure 2.2) of poverty among the population, i.e. the aggregate poverty gap. Finally, the line increases in curvature when the (poor) population becomes more unequal, in similar but mirrored fashion when compared to the one from Lorenz (1905).

As they represent all poverty orderings in one visual summary, the TIP curves provide an excellent instrument to describe the distribution of poverty in a single population, but also to test whether one distribution of poverty dominates another. When populations A and B are graphed together, and line A lies completely above line B without intersecting, one can unambiguously conclude that population A suffers from more severe poverty than population B. However, this conclusion cannot be drawn when the lines cross, as this implies a trade-off between the incidence, intensity, and inequality of poverty in the two populations. Therefore, the TIP curves allow for robust and complete comparison between regions, time periods and subgroups, given that the same indicator or combination of indicators is used.

2.3 Data and Methods

In the remainder of this paper, we illustrate the use of the FGT indices in measuring welfare trade-offs of different energy poverty policies, using a microdata assessment of energy poverty patterns in the Netherlands. In this section we describe the data set used, and data corrections, classifications, and transformations that we opted for.

2.3.1 Dataset

This study makes use of household-level microdata from 2019. The dataset from Statistics Netherlands (2021), referred to in Dutch as CBS, covers all Dutch municipalities and 78 per cent of the households, which amounts to approximately 5.7 million households.[18] For most households excluded from this dataset there is no reliable data on energy consumption, for instance because they are connected to district heating or because they have unconventional housing arrangements.[19] Descriptive statistics for several key variables are given in Table 2.3.

TABLE 2.3 Descriptive statistics for several key variables

Household variable (per annum)	Sample	Mean	Min	Max	Standard deviation
Income (euros)	5,679,529	49,853	-2,722,540***	50,776,410***	57,549
Low-income threshold (euros)	5,628,774	20,441	15,171	77,952	4,437
Gas consumption (m^3)	5,680,162	1,256	0	8,559	686
Electricity consumption (kWh)	5,680,162	2,769	0	11, 250	1,534
Energy expenditure (euros) *	5,680,162	1,819**	237	9,281	753
Energy efficiency threshold (expenditure in euros of same-sized band C housing) *	5,669,195	1,807	1,096	3,577	495

** Estimation based on the average supply tariffs of 2019*
*** The median expenditure is 1,697, which is the high-cost threshold of the LIHC indicator*
**** As described in 3.2.1, we also consider capital gains (and losses) as income, which explains these considerable income extremes*

18 Under certain conditions, this microdata is accessible for statistical and scientific research. For further information: microdata@cbs.nl.

19 Unconventional housing arrangements could for instance refer to houseboats or homes partially functioning as shops.

2.3.2 Analysis and Transformations

Income and energy expenditure

While researchers from the UK often use their national definition of a 'low-income' – which is 60% of the median income – we opt for the Dutch definition from Statistics Netherlands: 130% of the 'social minimum'. The social minimum threshold is different per household, as it is based on household characteristics, benefits, and living conditions.[20]

In line with previous studies, energy expenditure was deducted from net income to arrive at a household's disposable income for LIHC and LILEE. However, our method differs from some of those studies since housing costs were not deducted. This is mainly because Statistics Netherlands does not yet provide the data. While we acknowledge that future research into the driving characteristics of energy poverty must include housing cost as it is of increasing importance to purchasing power (Burlinson et al., 2018), its inclusion remains contested. Moore (2012) states that it could overvalue underoccupied housing, inner cities with high housing cost, or households who simply prefer more expensive housing.[21]

To enhance the low-income threshold we add a correction term that accounts for a household's financial capital, calculated by annuitising households' financial assets (Mulder et al., 2023).[22] We include this correction term to properly account for households in our dataset that have no income, but do have capital at their disposal. This method prevents misclassification of households living off financial wealth in large homes in affluent neighbourhoods as energy poor. Moreover, it was demonstrated by Best et al. (2021) that household wealth has a decisive but often neglected impact on energy poverty.

20 Statistics Netherlands provided the authors with an extra variable named 'BMNORMH2019', which considers social assistance benefits, state pensions, student grants, child benefits, child-related budgets, health care allowances, nominal health care premiums, allowances for disabled people (formerly known as Wtcg), rent allowances, and government grants for owner-occupied home..

21 Considering 'user cost' is a conventional method to calculate housing cost of homeowners and tenants in way that allows for comparison, but it is also much debated in the Netherlands (Haffner & Heylen, 2011). Not considering housing cost is a way to avoid this complexity.

22 The annuity is predicated on the estimation of the remaining lifespan of the longest-living member within a household, in conjunction with long-term interest rates provided by the De Nederlandsche Bank (DNB), which are also utiliSzed for pension computations by prominent Dutch pension funds. It is important to note that this approach is contingent upon various assumptions such as interest rates, life expectancy and the absence of inheritance, which could result in the misclassification of certain households. The decision to only consider financial assets of a household and exclude other forms of assets such as property value, business capital and substantial investments, is due to their inability to be easily converted into funds for paying energy bills. A more accurate estimate of 'salary from assets' could contribute to future energy poverty research.

Regarding energy expenditure, we use ‘actual’ instead of ‘required’ costs. This involves advantages and disadvantages. The main critique is that expenditure-based indicators (2M and LIHC) do not detect households in hidden energy poverty that restrict energy use due to limited budgets (Roberts et al., 2015; Tirado Herrero, 2017). Due to behavioural patterns like rationing before thermal retrofit (‘prebound’ effects) and increased consumption afterwards (‘rebound’ effects), predicted energy savings based on aggregated statistics (LILEE) may over- or underestimate savings of individual households (Sunikka-Blank & Galvin, 2012). On the other hand, relatively high energy needs of elderly, disabled and unemployed people are reflected in higher actual energy expenditure but not in ‘required’ expenditure, which is modelled solely based on household size, referred to by Snell et al. (2015) as ‘one-size-fits-all’. A lack of data has also caused other researchers to use actual energy expenditure (Heindl, 2015; Legendre & Ricci, 2015; Roberts et al., 2015).

We estimate energy expenditure based on average fixed costs and proportional tariffs in 2019 and the gas and electricity consumption of households. The dataset from Statistics Netherlands only considers gas and electricity consumption that households have procured from their energy suppliers, which means self-produced electricity is excluded. This effectively lowers energy poverty lines for households without renewable energy installations that are not shielded from price surges. To assess the response of different indices to varying market conditions, we introduce a price shock that sets the variable supply tariffs of gas and electricity to the levels of January 2022 (see Appendix 1).[23] This is however not an attempt to assess energy poverty in 2022, as consumption patterns can wildly differ, but rather to explore the indices’ theoretical nature and behaviour. Furthermore, we do not equivalise energy expenditure based on household size to avoid that specific household types are overweighted (single-person households) or underweighted (large families) using income/expenditure based indicators (Heindl, 2015).

Data correction, classification, and transformation

As Mulder et al. (2023) already demonstrated, the Dutch energy burden was 4% in 2019, which implies a 2M threshold of 8% (15.6% after the price shock). In addition to the conventional 2M indicator, we also calculate the poverty orderings for a means-tested 2M* indicator. This would respond to critique that 2M labels high-income households who live in large energy-inefficient homes as energy poor.

23 The average fixed cost and tariffs for 2019 can be found here: https://opendata.cbs.nl/#/CBS/nl/dataset/84672NED/table.

Means-testing was previously done in this context by Heindl (2015), who filtered ('truncated' in his own words) all income groups above the median. We use our own 'low-income-and-wealth-test' that is described above.

Since far from all Dutch homes have been allocated a reliable energy efficiency index, we estimate energy efficiency based on housing characteristics. We categorise all homes in the dataset into 440 housing classes based on a conventional approach from Van Middelkoop and Kremer (2020).[24] This approach differentiates between construction period, typology, and size category (see Appendix 2). We then calculate the median expenditure of each housing class and compare it to the median expenditure of homes with EPC Band C in the same size category.[25] When the median expenditure of a household's housing class is higher than that amount, the home is classified as energy inefficient. An obvious limitation of this approach is that we use measures of central tendency and therefore neglect differences that exist within these housing classes. To arrive at the LILEE poverty gap, we deduct the median expenditure of same-sized homes with EPC Band C from the median expenditure of the household's housing class. This means that resulting poverty gaps vary; not only between size categories, but also among same-sized housing classes.

As described in 3.3, we first normalise the poverty gaps by dividing them by the poverty lines and subsequently normalise the results to avoid high gaps to be capped at 1.

24 These housing classes are publicly available (albeit in Dutch) on the website of Statistics Netherlands: https://www.cbs.nl/nlnl/maatwerk/2020/13/energielevering-woningen-naar-energielabel-en-pv-2018.

25 As mentioned before, we use EPC Band C as threshold because this aligns with the aims of the Dutch government. It also matches the LILEE threshold set by the UK government. As mentioned earlier, we deliberately try to come as close to the institutional context as possible in this paper.

2.4 Results and discussion

In this section we present the results of calculating the various FGT indices for energy poverty statistics in the Netherlands. In doing so, we identify the three 'I's of poverty (incidence, intensity, and inequality) for different energy price levels (2019 ‘base’ prices plus a hypothetical price shock) and across geographies (Dutch municipalities). These aspects are explored in the following sections, respectively.

2.4.1 Poverty orderings before and after price shock (APS)

As noted before, since the seminal contributions of Sen (1976), it is widely believed that poverty measurement

The macrolevel statistics in Table 2.4 demonstrate that the same dataset provides significantly different outcomes for the four energy poverty indicators. This is true both across poverty orderings as well as in different market conditions, although the underlying distributions cause minor variations. The incidence of energy poverty ranges between 4.5% and 8.3% according to these indicators, with higher proportions based on energy expenditure than on energy efficiency. The same applies to annual poverty gaps which vary between €131.57 and €484.19 among those in energy poverty. An important reason for this is that we estimate energy efficiency of housing classes based on measures of central tendency, hence excluding ‘extreme’ values.

As hinted at by Rademaekers et al. (2016), the resulting expenditure-based poverty gaps seem to be higher in the Netherlands than in other countries, such as Italy, Spain, and Slovakia. One possible explanation is that energy prices are generally higher in the Netherlands compared to those countries. The same distribution would therefore yield higher poverty gaps. The high poverty gaps in the Netherlands need to be studied more in-depth to answer this question. However, we do emphasise the need to normalise poverty gaps (see *Intensity* in Table 2.4) when comparing between regions or contexts, which is something that has been hardly done in previous studies.

TABLE 2.4 Energy poverty orderings for four indicators in the Netherlands in 2019 and after a hypothetical price shock

	2019				After Price Shock (APS)			
	2M	2M*	LIHC	LILEE	2M	2M*	LIHC	LILEE
Headcount energy poverty x 1,000	473.96	308.72	248.57	253.72	492.24	337.778	299.60	296.39
Headcount energy poverty ratio in % (*Incidence*)	8.34	5.44	4.38	4.47	8.67	5.95	5.27	5.22
Aggregate annual energy poverty gap in euros x 1,000,000	229.49	148.52	113.67	33.38	493.40	343.82	307.85	85.25
Average annual energy poverty gap of *energy poor* households in euros	484.19	481.07	457.31	131.57	1,002.35	1,017.88	1,027.54	287.62
Average annual energy poverty gap of all households in euros	40.40	26.15	20.01	5.88	86.86	60.53	54.20	15.01
Energy Poverty Gap Index x 1,000 (*Intensity*)	24.62	19.01	11.66	3.82	26.32	20.07	15.98	5.05
Squared Energy Poverty Gap Index x 1,000 (*Inequality*)	13.91	11.04	5.75	0.63	15.13	12.75	8.71	0.95

** Corrected to include only low-income households, with after-energy-cost (AEC) corrected income below social minimum*

While the average poverty gap of energy poor households represents the intensity of energy poverty across the Netherlands in 2019, the average poverty gap of all households shows the average shortfall of the total population as compared to the energy poverty line. The aggregate energy poverty gap represents the total sum of money that would be needed to lift all households from energy poverty in a particular year. Despite the unrealistic assumption of perfectly targeted transfers, this is useful information for government authorities wishing to compensate specific households for high energy burdens. The untargeted alternative – supporting all households – conflicts with energy saving reduction goals in the context of climate policies, as it discourages homeowners to invest in energy efficiency improvements and reduces the incentive for all households to reduce their energy consumption.

Following this rationale, the choice of a particular energy poverty indicator and poverty gap index by policymakers makes their implicit welfare considerations and policy preferences explicit. In turn, the FGT indices can be used to evaluate effectiveness of energy poverty policies, as function of the targets and preferences chosen by policy makers. Would 2M be the preferred indicator, perfectly targeted support reduces the energy burden of households to twice the median share (under APS conditions this would have costed 493 million for all households and 344 million for low-income households). With LIHC, alleviation efforts would focus on subsidising expenditure of low-income households to median levels (under

APS conditions this would have costed 308 million). Alternatively, a LILEE support package would give low-income households a discount on their energy bills based on the estimated inefficiency of their home (under APS conditions this would have costed 85 million).[26] While it must be stressed that perfect targeting is impossible, and despite the existence of arguments favouring the implementation of universal relief schemes, these figures seem incredibly low when compared to the untargeted billions that the Dutch government spent on lowering energy taxation and duties in 2021 and 2022 (Rijksoverheid, 2022).

Let us provide a simple example in the context of our dataset for the Netherlands, to illustrate how using poverty gaps in quantitative policy evaluations and simulations can inform about the impact of policy decisions. Imagine that, given the APS situation (see Table 2.4), the Dutch government would have chosen to intervene with a generic energy price cap that lowers energy prices for all households back to 2019 levels. An evaluation of this policy in the spirit of Bagnoli and Bertoméu-Sánchez (2022), based on their relative indicator (2M), would lead to the conclusion that it had hardly reduced energy poverty (from 8,7% to 8,3%). However, when considering average poverty gaps (from €1,002 to €484), it would demonstrate that while many households were still identified as energy poor, their overall depth of deprivation was reduced.

Hence, not only policymakers but researchers also implicitly choose welfare functions when designing or evaluating relief schemes. When they would predict or assess their effectiveness in alleviating households from energy poverty, the use of different parameters makes this choice explicit and therefore allow for evaluation on the three poverty orderings Incidence, Intensity, and Inequality. While we mainly focus on Intensity as compared to Incidence in this paper, Inequality, measured here with the squared poverty gap P_2, puts more weight on households with relatively high energy poverty gaps. The higher value for the parameter α, the more 'Rawlsian' the targeting or evaluation of a relief scheme becomes – thus reflecting a choice to put higher weight on supporting the 'energy poorest'. However, this is not the case when opting for $\alpha = \leq 1$ and thus for first- or second-degree welfare dominance.

26 Designing relief schemes based on a combination of indicators would align best with the current consensus in the literature that a multi-indicator approach best suits the complex problem that energy poverty is.

Another observation regarding the poverty orderings is that while the non-corrected 2M returns the highest energy poverty Incidence, Intensity, and Inequality of all indicators, the relative difference with the corrected 2M* is smaller for intensity and even more so for inequality. Since we normalised, we can therefore state that, energy burdens of low-income households are higher than those of higher income households. Compared to other indicators, LILEE intensity and inequality are much lower than its incidence. This is because the design of this indicator is based on medians, and therefore neglects outliers (excessively high consumption translated into immense poverty gaps). LIHC results are similar to 2M*, which again stresses the high energy burden of low-income households.

As described theoretically in 2.3.3, the TIP curves in Figure 2.3 illustrate the incidence vertically, the intensity (average and aggregated poverty gaps) horizontally, and the inequality – less intuitively – based on the curvature of the first part of the line. They also visually demonstrate earlier mentioned observations, such as the stochastic dominance of 2M. Better yet, the TIP curves reveal the distributional build-up of poverty gaps (see Appendix 3 for frequency graphs). Therefore, one could for instance immediately determine what the minimal cost would be of compensating the 1% 'energy poorest' households, and how much this would be under different (APS) market conditions. According to 2M, this would be almost 100 million euros in 2019, and above 200 million euros APS.

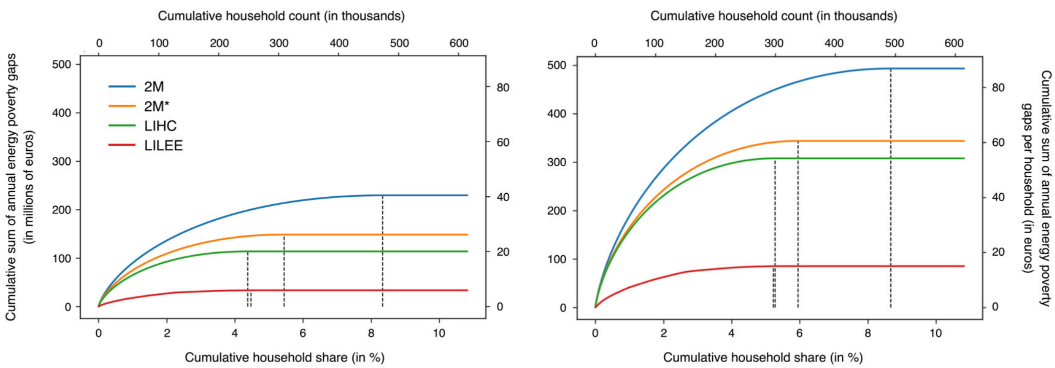

FIG. 2.3 TIP curves illustrating energy poverty incidence, intensity, and inequality according to our four indicators, with the left graph illustrating the 2019 situation and the right graph the situation after a hypothetical price shock

2.4.2 Spatial patterns

The three LILEE poverty orderings are mapped in Figure 2.4 (spatial results for other indicators can be found in Appendices 4-6). The maps show the geographic variance and can therefore be seen as spatial decompositions of energy poverty incidence, intensity, and inequality. While the overall picture is rather similar across the orderings, with high levels in the northeast of the Netherlands, a closer look demonstrates significant differences between the orderings.[27]

First, the number of municipalities with above-average scores for energy poverty tend to decrease across orderings (from about a quarter in Figure 2.4a, to one in ten in 2.4b, and only about one in twenty in 2.4c). Upon closer examination, this elucidates a crucial lesson: many municipalities with high incidence rates exhibit relatively higher poverty gaps on average, whilst also accommodating the most significant gaps. This phenomenon can be attributed to the fact that the measure of intensity provides a normalised average, whereas inequality, in contrast, assigns greater importance to relatively high gaps. Consequently, the map depicting intensity values provides a more accurate portrayal of energy deprivation than the map displaying incidence values, whereas the map depicting inequality scores illuminates the effect if policymakers intend to specifically target the most disadvantaged households. Ultimately, these maps could prove useful in informing policy decisions, resource allocation, and policy evaluations.

Second, the distinctions between various poverty orderings imply that resource allocation would inevitably diverge in the event of deploying different (gap) indices. To illustrate this, we normalised the values for LILEE intensity and inequality per municipality and compared them (see Figure 2.4d). The findings indicate that if the Dutch government were to allocate funding based on intensity instead of incidence, funding for *Purmerend* would experience an almost threefold increase (185% increase), whereas *Zeewolde's* funding would undergo an approximate halving (79% decrease). This suggests that in *Zeewolde*, most households experiencing energy poverty inhabit homes that only slightly surpass the inefficiency thresholds we established, resulting in relatively low intensity values. In contrast, energy poor households in *Purmerend* live in considerably inefficient homes. Resource allocation based on incidence instead of intensity would thus underestimate their deprivation.[28]

27 This picture would most probably differ when housing cost would be deducted from disposable income before calculating incidence and intensity.

28 Purmerend merged with Beemster into a new municipality on January 1st, 2022, retaining its historic name.

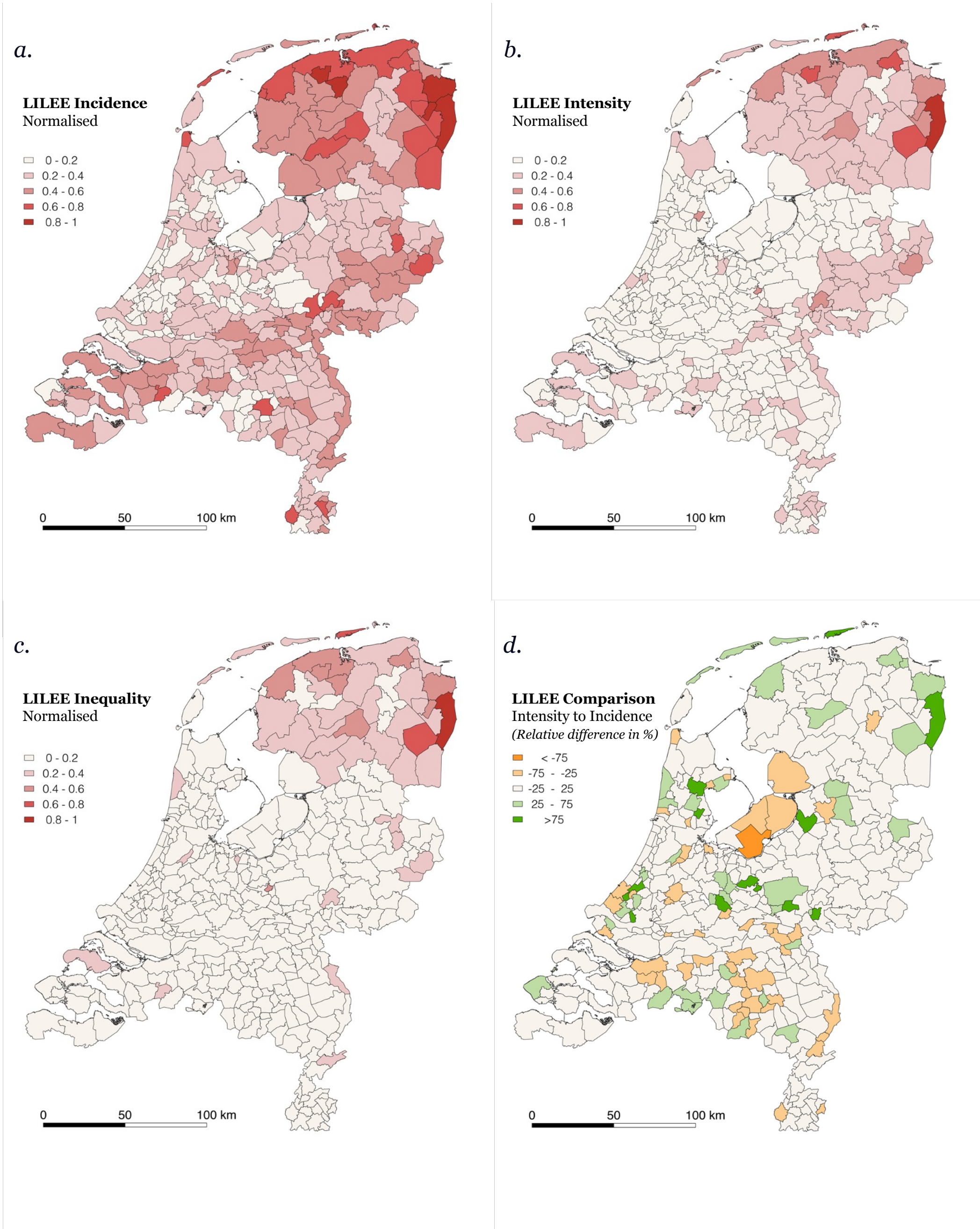

FIG. 2.4 Four maps depicting energy poverty per Dutch municipality according to the LILEE indicator, with normalised scores for a.) incidence, b.) intensity, c.) inequality, and d.) relative intensity set against incidence to illustrate how national resource allocation to municipalities would differ when substantiated by another poverty ordering

While larger municipalities generally demonstrate less significant disparities, *Eindhoven* would lose 33.9% of its funds due to similar dynamics as in *Zeewolde*.[29] This shows that the choice of a certain poverty ordering in resource allocation directly affects spatial welfare outcomes.

Third, energy poverty seems to be relatively more prevalent and severe in rural than in urban areas according to the LILEE indicator (while the picture is less straightforward according to the expenditure-based indicators, see Appendices 4-6). This apparent uran-rural divide in Figure 2.4 corresponds with the conclusions from Roberts et al. (2015), who conclude, based on the 10% indicator, that rural households are more vulnerable due to the nature of the rural housing stock, while urban households generally live in energy poverty for longer periods of time. The former aligns with our results, although our picture is likely to change when housing cost is used to calculate disposable income. The latter remains to be studied in the Netherlands.

2.5 Conclusion and Policy Implications

In this paper we drew from the literature on income poverty evaluation (J.E. Foster & A.F. Shorrocks, 1988a, 1988b, 1988c; Sen, 1976) to argue that the use of carefully designed energy poverty gap indices can substantiate the design and monitoring of energy poverty policies. To date, most researchers and policymakers have focused on the 'headcount' ratio or incidence of energy poverty, but this approach neglects the intensity of deprivation and therefore the degree of inequality among households in energy poverty. Considering poverty gaps would fill this desideratum, and allow for robust comparison between regions, time periods, and subgroups (Foster & Shorrocks, 1991). We also showed that the choice for a particular energy poverty (gap) indicator or index makes the implicit welfare choices of energy poverty policies explicit. We argued that complementing energy poverty Incidence metrics with its associated Intensity and Inequality metrics could greatly benefit the design of effective energy poverty reduction strategies, by improving the accuracy of policy design, resource allocation, and policy evaluation.

29 Furthermore, the population size of the four biggest cities in the Netherlands would still account for a significant resource shift in absolute terms, despite more subtle variations (*Amsterdam* -7.6%, *Rotterdam* +6.1%, *Utrecht* +7.0%, *The Hague* -3.5%).

We illustrated our arguments for the case of the Netherlands, using recently developed microdata statistics on energy poverty, and the use of an imposed energy price shock. Using these data, we calculated the aggregate energy poverty gap - the total sum of money that is needed to lift all households from energy poverty in a particular year - for different indicators of energy poverty, implying different poverty orderings and (thus) welfare functions. In line with these results, we identified differences in spatial targeting of relief funds based on Incidence versus Intensity and Inequality.

The numerical results underline that more elaborate energy poverty metrics may help to decide on the type of government intervention. While a situation of low incidence and high intensity implies the need for more targeted policies, the reverse situation suggests broader relief schemes. The aggregate poverty gap is indicative of the minimal amount of money needed to lift households from energy poverty (according to the indicator in use). Understanding its distribution helps to target policies on the most deprived households and therefore to substantiate future responses to energy crises. It therefore poses the question whether a government wants to distribute its resources evenly across all households in energy poverty or prioritise the most severe cases. Moreover, these investments aimed at maintaining purchasing power could be compared to the cost and benefits of large-scale insulation programmes. The insights therefore not only help to compare policy approaches, but also to weigh short- and long-term objectives.

In addition, evaluating policies across poverty orderings may expose implicit social welfare choices behind relief schemes. The more weight an energy poverty indicator allocates to the welfare of the 'energy poorest', the more 'Rawlsian' policy design or evaluation becomes. While the statistics put forward in this paper are decomposable and therefore allow for straightforward comparison between subgroups, one could also choose to allocate higher weight to the poverty gaps of certain subgroups . Since the literature demonstrates that various characteristics increase health risks for households in energy poverty, policymakers and researchers may decide to differentiate between subgroups by means of using different social welfare functions.

This study also introduces the TIP curves from Jenkins and Lambert (1997) to an energy poverty context. This visualisation technique serves as a rather effective depiction of poverty distributions, intuitively representing all three orderings or 'I's of poverty: Incidence, Intensity, and Inequality. While we use the TIP curves in this paper to compare conventionally institutionalised indicators (2M, 2M*, LIHC and LILEE), one could also use the curves to compare energy poverty in different years, regions, or subgroups. When designing a relief scheme targeted at households identified as energy poor, one could also use the curves to compare the theoretical cost – assuming perfect welfare transfers - of 'compensating' different segments of the energy poor population.

Measurement could be further improved by deducting households' housing cost from their disposable income, and arguably also by considering required instead of actual energy expenditure. To measure LILEE more accurately, reliable energy efficiency data is needed. Our approach – based on a categorisation of housing characteristics and the median of this housing class compared to same-sized EPC Band C homes – neglects exceptionally well or badly insulated homes in certain housing classes. Furthermore, while we choose a relative threshold to prioritise those most in need of support, future research must experiment with absolute thresholds and poverty gaps.

Since energy poverty is a complex and multi-faceted problem, indicators can only estimate particular aspects of deprivation. For instance, most institutionalised indicators hardly consider any characteristics that increase vulnerability, such as the presence of elderly, disabled, or infant household members. Roberts et al. (2015) therefore suggest monitoring not only the levels but also the dynamics of energy poverty. Even Hills (2012), a strong advocate of statistics-based policies, preferred governments to also target beyond the results of his indicator. Ultimately, this is a political decision, and the utility of the poverty gap depends on the functioning of a welfare state. While more focus on the 'energy poorest' could help to detect and benefit the 'worst-off', this must not shift to 'technocratic efficiency thinking' (Middlemiss, 2016).

Nevertheless, it is evident that public entities should explore distributional effects of different types of targeting. This contributes to a more climate-friendly and purposeful response to future energy price shocks without adding inflationary pressure. An example is the reform of the British Warm Home Discount which aims to improve targeting efficiency towards households identified as energy poor (DBEIS, 2021c). It promises to automate rebates by matching data on means-tested benefits and housing characteristics, which is closely aligned with the design of the LILEE indicator in this study. Means- and efficiency-tested discounts would guarantee a certain level of energy consumption in substandard housing while still penalising unsustainable behaviour. It would be interesting to compare the distributional effects of various targeted energy poverty policies, but also compare them to broader progressive fiscal policy (Galvin, 2022).

Further research could also use gap indices to explore the driving characteristics behind energy poverty in various time periods and geographies. While so far, logistic regression techniques have been used to predict a dichotomous distinction between energy poor and non-poor, predicting ratio variables opens the door to other sophisticated predictive models. Furthermore, longitudinal analyses of microdata could provide greater insight into the dynamics of households' responses to changing housing conditions and energy prices. Lastly, future investigations could even experiment with estimating ‘positive’ poverty gaps that illustrate the distance of non-poor households to the threshold values, hence exploring society’s resilience.

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3 Multidimensional drivers of energy deprivation

This chapter is based on a peer-reviewed article published as:
Galvin, R., Sunikka-Blank, M., & Croon, T. (2024). Juggling the basics: How much does an income increase affect energy spending of low-income households in England?. *Energy Research & Social Science*, *118*, 103766.

ABSTRACT

European governments have deployed targeted and untargeted financial support to protect vulnerable households from the impacts of the recent energy crisis. However, there is little knowledge of income elasticity of energy expenditure among households experiencing energy poverty. We therefore examine the link between energy expenditure and household income levels, considering a spectrum of factors including energy poverty status, energy efficiency of homes, and socio-demographics. We use England's official energy poverty definition, 'Low-income, low-energy-efficiency', and analyse the government's 'Fuel Poverty Dataset' from 2019. We find that, for all income groups, by far the greatest impact on energy expenditure is the dwelling's energy-efficiency rating, followed by floor area. An increase in income has negligible effects on energy expenditure for all income groups, but greatest for those in energy poverty, suggesting that even though most of their energy-oriented financial support is used for other pressing needs, this still offers some relief from energy poverty. We conclude that energy-efficiency improvements in homes would yield the most substantial and enduring financial benefits for these households, highlighting the need for targeted retrofitting policies. Additionally, older homeowners in energy poverty may need help to move into smaller, energy-efficient homes that are less expensive to heat.

3.1 Introduction

The ongoing cost of living crisis in the UK has intensified food and energy poverty, particularly affecting vulnerable households (Champagne et al., 2023; Sovacool et al., 2023). Estimates vary depending on the indicator employed, but if energy poverty were defined as being required to spend over 10% of after-housing-cost income on domestic energy, the number of households surpassing this threshold more than doubled from 4.3 million in 2020 to 8.9 million in 2023 in England alone (DESNZ, 2024).[30] Although there may be uncertainties as to the accuracy of official statistics on energy poverty, there has clearly been a very substantial increase in the number of households having to cope with it in the last few years.

Sunikka-Blank and Galvin (2021) demonstrated that single-parent households are notably at risk, as they tend to report a higher frequency of poor conditions in their homes, including issues such as a leaking roof, mould, damp walls, floors or foundations, and rot in window.

Boardman (1991) pioneered the study of energy poverty, commonly referred to as fuel poverty in the UK, and defined it as the situation where a household is required to spend 10% or more of its income on energy to achieve sufficient thermal comfort in the home. Following this, a widespread debate has emerged over the best way to measure energy poverty, with some scepticism as to whether there can ever be a universally agreed definition of energy poverty (Guevara et al., 2023), or whether identifying households vulnerable to energy poverty will necessarily lead to well-targeted interventions capable of substantially mitigating it (Galvin, 2024). Over the years, the UK government has shifted from the 10% indicator to Low Income High Cost (LIHC), and currently uses the Low Income Low Energy Efficiency (LILEE) standard to identify energy poverty in England (Croon et al., 2023).

Regardless of one's preferred definition of energy poverty, it is widely recognised that energy poverty is influenced by four key factors: household income, the energy efficiency of the housing, energy prices, and the characteristics of the household population (Middlemiss, 2022; Tirado Herrero, 2017).

30 Projections indicate a decline starting in 2024 as prices are expected to decrease.

An area not thoroughly explored is the income elasticity of energy demand in this context: by what percentage does energy demand increase for each percentage increase in income? There is evidence that energy demand typically increases alongside income but not proportionally, which is partly attributed to more money being spent directly on energy and partly to the ability of wealthier households to invest in modern, energy-efficient technologies (Meier et al., 2013; Schleich, 2019). However, the literature does not extensively differentiate the income elasticity of energy demand among low-income households, nor distinguish between those in and not in energy poverty. This oversight is significant, as a nuanced understanding of these dynamics is vital for projecting the environmental impact of policy interventions and for formulating strategies that alleviate energy poverty without exacerbating environmental harm.

Accordingly, this study investigates the relationship between energy expenditure and household income categories, paying particular attention to those in energy poverty. It explores whether and how changes in income correlate with changing patterns of energy consumption (the income elasticity of energy consumption), alongside a broader set of factors such as a dwelling's energy performance and sociodemographic features. Using the results of this analysis, the study also aims to evaluate the extent to which energy demand is prioritised by different categories of households: those on high incomes, those on low and middle incomes, and those experiencing energy poverty according to the LILEE definition, namely households with less than 60% of equivalised[31] household disposable income after fiscal transfers and housing costs, living in a dwelling with energy efficiency band D-G[32].

Section 3.2 reviews existing literature on energy demand elasticities, focusing on income elasticity while also considering price elasticity, and discussing their significance for policy. Section 3.3 details the data sources and methodology used in the study, leading to insights in Section 3.4 into how changes in income affect energy spending across various income groups, energy poverty levels, and household characteristics. Section 3.5 discusses these findings within the framework of current energy efficiency and energy poverty alleviation policies in the UK. Section 3.6 concludes by offering recommendations for policy interventions and suggesting areas for future research.

31 'equivalised' means adjusted for household size. In 2023 the this was £17,300/y, and £17,105 in 2019, the date of the data survey.

32 This represents a SAP12 rating of 70 or below.

3.2 Literature and policy review

3.2.1 Evidence on income elasticity of energy demand

Energy poverty, as a concept, aims to capture a specific form of deprivation where households find themselves unable to cover the costs of essential energy for basic needs such as heating, cooking, and lighting (Boardman, 2010; Galvin, 2020). The concept underscores the intersection of energy policy, social equity, and health implications, such as excess winter mortality among vulnerable households (Healy, 2004; Liddell & Morris, 2010). The term's usefulness may differ by context and the prevailing policy discourse within a country. In the UK, the term energy poverty, often used interchangeably with the term fuel poverty, is widely used in policymaking and media. The definition of energy poverty is operationalised through specific metrics, such as the Low Income Low Energy Efficiency (LILEE) indicator, noted above, that are used to improve and evaluate the targeting of policy interventions (Middlemiss, 2016).

However, some governments do not accept the notion of energy poverty. An example is Germany, which focuses instead on reducing poverty. As Andreas Feicht, former Secretary of State for the Federal Ministry of the Economy and Climate Protection explains: *"There is no generally valid definition for the term 'energy poverty'. The Federal Government pursues a holistic approach to assessing poverty and, accordingly, to combating poverty, which does not focus on individual elements of need."* (Author's translation (Feicht, 2019)). Interestingly, in cold Nordic countries energy poverty is not widely recognised as a significant issue, due to developed energy infrastructure, energy efficient housing, and strong social security systems. In Finland, for example, energy poverty is not formally mentioned in the public debate, nor is there any definition of or approach to energy poverty within policymaking (Castaño-Rosa et al., 2019). Similarly, in Sweden energy poverty is treated within the broader context of social policy, although temporary measures, such as subsidies, were implemented during the 2021-2022 energy crisis to help all households with increased energy prices.

A central concept explored in this paper is the income elasticity of energy demand: the percentage increase in energy demand that is associated with a 1% increase in income (Gao et al., 2021). This is distinct from the more extensively studied price elasticity of demand, which assesses how changes in energy prices affect household energy demand (Heindl, 2015). Evidence on price elasticity is more abundant, though results vary greatly across different studies, types of energy, and time frames (Labandeira et al., 2017). In the UK, for instance, a 1% rise in natural gas prices led to a 0.20% decrease in energy demand in the short term and a 0.28% decrease in the long term from 1990 to 2007 (Erias & Iglesias, 2022). Household energy demand, especially for electricity, is often price inelastic in the short term due to it serving essential needs. This implies that even as energy prices rise, the demand for energy remains relatively stable, placing especially low-income households at risk of energy poverty (Borozan, 2019). Fry et al. (2023) demonstrated that in Australia, low-income households tend to prioritise energy over food when prices rise, but also found evidence of heterogeneity within low income in response to price increases.

The study of income elasticity of energy demand, particularly for space heating, has evolved significantly over the decades. Initially, Scott (1980) reported high income elasticity for heating demand, approaching unity; however, subsequent research, such as Gillingham and Hagemann (1984), Nesbakken (1999), and Meier et al. (2013), found that the income elasticity of energy demand is generally much smaller than unity, characterizing energy as a necessary good. The complexity of the debate increases when distinguishing between income groups. For instance, Baker and Blundell (1991) and Harold et al. (2017) found that energy demand of low-income households in the UK and Ireland, respectively, is more responsive to income changes, whereas Nesbakken (1999) and Schulte and Heindl (2017) observed the opposite in Norway and Germany, with higher income elasticity among higher income groups. A U-shaped income elasticity, with low-income households having high elasticity as they want to meet basic energy requirements, middle-income households low elasticity as they are less inclined to allocate additional income to energy, and high-income households high elasticity as they demonstrate demand for luxury energy services is found in in Spain (Romero-Jordán et al., 2016) and the Philippines (Manalo-Macua, 2007), but contrasts with the inverted U-shape observed in the U.S. (Alberini et al., 2011).

Compared to other spending categories, energy expenditure in the UK shows less variation based on income than any other spending category (Bolton & Stewart, 2024). Heating is considered a basic need, with limited substitutes. Therefore, high energy prices disproportionally affect low-income households. Such dynamics can lead to self-disconnections among households on prepaid meters (Ofgem, 2020) or self-rationing prebound effects, where particularly low-income households in energy inefficient dwellings deliberately limit their energy use to spend money on other essential areas (Sunikka-Blank & Galvin, 2012). Notably, self-rationing is not always a result of economic drivers and exists across all income groups, including middle- and high-income households. This can be related to under-occupied and large, partially unheated spaces. It is therefore important to distinguish between 'forced/harmful self-rationing' and 'voluntary/rationalised self-rationing' (Berger & Höltl, 2019; Galvin, 2023; Teli et al., 2015).

However, when discussing income elasticities of space heating demand, Douthitt (1989) emphasised that dwelling attributes, rather than socioeconomic characteristics, play a more decisive role in consumption patterns, a view supported by more recent studies (Braun, 2010; Hansen, 2016; Harold et al., 2015; Sardianou, 2008; Van den Brom et al., 2019). Therefore, the relationship between income, energy demand, and energy efficiency improvements is pivotal in this field of research. Karpinska and Śmiech (2023) found that higher income Polish households tend to live in more energy-efficient homes and use cleaner heating fuels, whereas low-income households in inefficient dwellings cut on energy use to satisfy other basic needs. Similarly, Rhiger Rhiger Hansen and Gram-Hanssen (2023) found that low-income families in energy-inefficient homes had significantly lower heating demands than expected, reflecting frugal heating practices. Conversely, households with higher incomes have the means to invest in energy-efficient appliances, better insulation, and renewable energy sources, reducing energy consumption while enhancing living standards (Sorrell et al., 2009). Finally, tenure reveals a similar disparity: tenants bear higher energy costs when landlords, particularly in countries like the UK where there is no obligation to invest in energy efficiency, neglect such improvements (Bergman & Foxon, 2020; Rosenow et al., 2013).

Despite extensive research on income elasticity of energy demand, significant gaps remain, particularly regarding the differentiated impacts across various household income categories and the interplay with dwelling characteristics and energy performance. Most studies focus on broad aggregate measures, neglecting the heterogeneity within low-income groups and the specific challenges faced by households living in energy-inefficient dwellings. Charlier and Kahouli (2019), who primarily focus on price elasticity, suggest a higher income elasticity for energy-poor households compared to non-energy-poor households. However, this is based on expenditure-based rather than energy efficiency-based energy poverty indicators, and does not compare energy-poor households with other low-income households that are not in energy poverty. This paper addresses these gaps by offering a nuanced analysis that employs an energy poverty indicator combining these factors, aiming to identify the specific income elasticity for households with both low income and energy-inefficient dwellings.

3.2.2 UK's policy response to energy poverty

There have been and are a variety of policy measures targeting energy poverty across Europe (see e.g. Bouzarovski et al., 2021; Economidou et al., 2020; Thomson & Snell, 2013), including one-off ad hoc payments and energy costs subsidies, alongside long-term policies of improving existing housing with thermal insulation. How does income elasticity of energy expenditure relate to recent UK policies?

The UK government recently addressed energy poverty in their updated strategy 'Sustainable warmth: protecting vulnerable households in England', published in response to a consultation to update the 2015 energy poverty strategy. The updated strategy emphasises the government's commitment to the 2030 target for improving fuel poor homes to a minimum energy efficiency rating of Band C, and to add a fourth guiding principle focused on sustainability, updating the metric to simplify the identification and measurement of fuel poverty (HM Government, 2021).

Alongside energy efficiency strategies, the UK government has introduced several welfare payments to alleviate energy poverty over the years, including the Winter Fuel Payment, Warm Homes Discount, and Cold Weather Payments (Palmer et al., 2023). The Winter Fuel Payment, available across the UK to those above state pension age, provides an annual sum of £250-£600 (depending on circumstances) directly into recipients' bank accounts. In 2022, 11.6 million pensioners received a total of over £4.5 billion in support. Cold Weather Payments, applicable in England, Wales, and Scotland, deposit £25 into bank accounts of eligible benefit recipients, such as those on Pension Credit or Universal Credit, during periods of extreme cold. The reformed Warm Homes Discount, available in England, Wales, and Scotland, offers automated rebates that reduce energy bills or credits prepayment meters for low-income pensioners (core group 1) and certain benefit recipients living in high-energy-cost dwellings (core group 2). In England and Wales, both core groups receive the discount automatically, while in Scotland, core group 1 benefits automatically, and core group 2 must apply for the discount.

The UK government's response to the energy price surge in 2022 included additional measures such as a £200 upfront discount on bills, a £150 Council Tax rebate for approximately 80% of households in England, and extra funding for local authorities. The Energy Price Guarantee, introduced in October 2022, aimed to cap the unit rates for electricity and gas below Ofgem's official price cap level, reducing the 'average' household's annual bill to £2,500 in Great Britain and around £2,109 in Northern Ireland.[33] This guarantee also provided a small

33 According to Ofgem, the typical household in Great Britain uses approximately 2,700 kWh of electricity and 11,500 kWh of gas per year (see https://www.ofgem.gov.uk/average-gas-and-electricity-usage)

discount for households using prepayment meters (PPMs) in Great Britain, aligning their charges with those of direct debit customers; however, this did not apply to Northern Ireland due to its distinct energy market. Additionally, every household in the UK automatically received a discount of £400 on their energy bills over the winter of 2022/2023 through the Energy Bill Support Scheme (Zapata-Webborn et al., 2024), though this discount was not repeated in the subsequent winter.

A recent policy change by the Labour government involves limiting Winter Fuel Payments to pensioners who do not receive pension credit, effectively removing the benefit for single pensioners with incomes above approximately £11,300/y, pensioner couples with incomes above £17,300, and others with savings considered too high. This could significantly impact energy poverty by the LILEE indicator, since these income thresholds fall well below the low-income level used in this measure, which is set at 60% of the median equivalised disposable income. Although many pensioners may manage without this support, some risk being overlooked, particularly since this group is already vulnerable to energy poverty.

There is lack of understanding of the effectiveness of energy support payments, what the payments are actually used for, and whether there is a gap between policy intentions and actual outcomes. There is little knowledge on income elasticity of energy demand in low-income households and households in energy poverty in the UK: whether an increase in household income will lead to more spending on energy among these households.

In the UK in 2023 the average homeowner spent £25 per week on energy costs and £50 per week on housing costs (ONS, 2023), across all income groups. However, low-income households, especially in the private rental sector (Papantonis et al., 2022), spent disproportionally more on housing and energy compared to middle- and high-income households. The lowest decile income group spent on average 26% of their total expenditure specifically on housing and energy, whereas the highest income group (top 10% earners) spent on average 11% (ONS, 2023).

Low-income households are also impacted by the cost of digital services. 9% of England’s poorest households have to cut back on essentials like food or clothing to afford phone or home internet costs (Faith et al., 2022). 17% of these households frequently run out of data and the bottom 10% of the income distribution group in England may spend around 19% of their income on fixed broadband tariffs after essential costs, at the expense of other basic needs like food and energy. Since low-income households are short of cash for these basic needs, they may have higher priorities to spend welfare payments on than energy.

Further, the statistics can hide the fact that many low-income households have outstanding debts, including owing money to a friend or family member. According to the Trussell Trust (Bull et al., 2023), 90% of people using a food bank (many of whom are in energy poverty) have various kinds of debts. 60% of food bank users have less than £100 in savings and therefore no liquidity buffer to respond to unexpected demands like dentist payments, car repairs – or increased energy prices. If there is spare income, part of household expenditure will go towards paying off the debt.

Another significant issue is the striking disparity in housing costs between the private rental sector and owner-occupied homes. In the UK, an average household in the owner-occupied sector spent, on average, £53 per week on housing costs (there is a large proportion of older home owners whose mortgages have been paid off), whereas a household who is a social renter spent £104 per week, and an average household renting in the private sector spent £199 per week (ONS, 2023). This means that private renters in the UK on average spend four times as much on housing as owner-occupiers, but also face lower housing standards and lower energy efficiency. There is often a lack of compliance with the Decent Homes Standard and the requirement to have an Energy Performance Certificate (as is the case in the rest of Western Europe, see Dewilde, 2018). The UK decarbonisation policy in the housing sector has focused on 'innovations' and a business-led approach, but factors such as a poor historic record in retrofit rate, very slow energy efficiency improvements and increased energy costs for households are recognised in the government's own Net Zero Review (Skidmore, 2023). The Review promotes heat pumps, a solar rooftop installation 'revolution' and banning gas boilers as acceleration strategies towards net zero, but does not discuss how low-income households living in rental properties will be able to access such installations.

There are, then, a large number of diverse policy interventions to seek to address energy poverty. Some of these are direct payments designed to enable low-income households to increase their energy expenditure. The extent to which these have this effect depends crucially on the income elasticity of energy expenditure among low-income households, and more particularly among households in energy poverty. This paper therefore investigates this metric based on recent countrywide data.

3.3 Method and data

3.3.1 Rationale and regression strategy

This study utilises the ‘Fuel Poverty Dataset’, provided by the UK’s now-disbanded Department for Business, Energy and Industrial Strategy (BEIS). It is derived from the 2019 English Housing Survey (EHS), and the data collection period spans from April 2018 and March 2020, with BEIS designating April 2019 as the reference point for analysis. The dataset consists of 11,974 observations, each featuring 43 variables.

Initially, we performed a comprehensive series of multivariate analyses aimed at identifying variables significantly associated with the annual demand for (i.e., expenditure on) space heating energy[34]. This involved, first, a set of stepwise regressions considering all variables potentially linked to heating energy consumption. Through this process, we systematically excluded variables that either lacked statistical significance or exhibited multicollinearity, defined by a variance inflation factor (VIF) exceeding 3.5. Consequently, from an initial list of 59 variables, we narrowed down to 14 variables of interest, namely:

- Income after housing costs and tax and welfare transfers (Symbol: AHCIncome)
- Floor area, in m^2 (FloorM2)
- Energy efficiency rating according to the Standard Assessment Procedure (SAP12)
- Whether the dwelling is solid walled *and* does not have solid wall insulation (solid_Wall_Unins)
- Whether the dwelling has gas heating (gas_Heating)
- Whether it has central heating (central_Heating)
- Whether the main householder is aged 16-24 (age16 to24)
- Whether the main householder is working (working)
- Whether there is a sick household member (sick_Member)
- Whether the occupants are a couple and their dependents (couple_w_Dependents

34 With a multivariate analysis we can isolate the effect of each independent variable on the dependent variable, which in this case is energy expenditure. So, for example, although it is already well known that house size influences energy expenditure, the multivariate analysis prevents this from polluting the result for the influence of income on energy expenditure. The regression coefficients for each of the different factors influencing energy expenditure thereby indicate that factor’s effect if all the other factors are held constant.

- Whether it is a one-person household (one_Person)
- Whether it is a private rental (private_Rental)
- Whether it is an owner-occupier household (owner_Occupier)

It may be asked why we did not include "household size", i.e., number of persons in the household, in the final list of variables of interest. We included it in the initial regressions but it was eliminated in the stepwise regressions as it showed high multi-collinearity with other variables, especially "one-person household". Hence the effect of "household size" was masking the effect of "one-person household", and only one of these could be included in the definitive regression. We comment again on this in the Results section.

It is also important to note that the household income figure in the database is the "Equivalised after housing costs annual income (£)". The description of this variable given in the dataset documentation is "the full annual income of the household, which is based on the net income, including housing benefit, SMI, MPPI and net council tax payments. This includes income for the whole household from all sources, including benefits and savings and investments" (DBEIS, 2021).

Subsequent regression analysis of these surviving variables against space heating cost, using all observations, yielded a maximum VIF score of 1.98 and a peak p-value of 0.065 (as detailed in Table 3.3 in Section 3.4). The aim of this and subsequent regressions was to find the variables most strongly associated with annual heating energy cost. It is important note that while the regression coefficients are influenced by differing units of measurement for the variables, comparing the coefficients within a specific regression does not indicate the strength of the association. The t-statistics, however, do indicate the comparative strengths of the associations, and therefore these were compared. While normalised regression coefficients could also have been employed, their Beta values proportionally align with the t-statistics.

Further analyses involved applying transformations to variables to achieve normal distributions for each numerical variable, as discussed in 3.3.3.

The next phase focused on performing separate regressions for distinct income groups. This included low-income households, defined as those earning below 60% of the national median income after welfare and fiscal transfers and housing costs, i.e. less than £17,105/y in 2019. Additionally, regressions were conducted for 'high-income households', with incomes equal to or exceeding £17,105/y. The low-income band was further divided into 'very low-income households' (AHCIncome < £9,000/year) and 'middle-low-income households' (AHCIncome between £9,000 and £17,105/year).

Finally, low-income households were segmented based on their energy poverty status by the LILEE indicator, which identifies energy poverty through a combination of low income and a SAP12 rating below 70. Low-income households with SAP12 <70 were classified as in energy poverty, while those with SAP12 >=70 were classified as low-income but not in energy poverty. Subsequent regressions were conducted on these two newly segmented groups to further examine the nuances of energy poverty's impact on income elasticity of energy expenditure.

This granular approach allowed us to compare t-statistic profiles across various regressions, using both actual and transformed variables. Such comparisons were instrumental in pinpointing the variables with the most significant impact on space heating costs across different income groups. Moreover, by scrutinising the regression coefficients for specific variables, we could quantify the effect of a one-unit change, or in some cases a 1% change, in each variable on the annual space heating cost. This methodology not only provided insights into the dynamics influencing heating costs but also highlighted the differential effects across income strata.

A factor we have not included is an energy cost equivalation based on the number and type of householders. After wide ranging public discussion, the Hills Fuel Poverty Review (Hills, 2012) suggested that a dwelling's heating demand should be adjusted for the type of household. In one suggested approach, the energy demand of a dwelling in which a couple with dependent children live is regarded as 1.15 times that of a similar dwelling in which a couple without children live. The suggested range is 0.82-1.15. In our statistical analysis, however, we found that the impact of number of householders is very small compared to other factors. Rather than interfere with the raw data for such small gain, we decided to leave this out of the reckoning.

3.3.2 Descriptive statistics

The descriptive statistics of space heating cost and the 16 associated variables are presented in Table 3.1, covering all households and each of the four income segments. Meanwhile, Table 3.2 focuses on households classified as living in energy poverty according to the LILEE indicator, as well as low-income households not considered to be in energy poverty. These statistics are further explored alongside regression findings in Section 3.4. Note that aside from the first four variables, the remainder are binary dummy variables with values 1 or 0. Consequently, the mean for these variables reflects the proportion of households having specific characteristics. For instance, 63.1% of high-income households have a working head-of-household, compared to only 35.3% for very low-income households.

TABLE 3.1 Descriptive statistics: relevant variables for different categories of household and dwelling

Variable	All households		Higher-income households (AHCIncome >= 17,105)		Low-income households (AHCIncome < 17,105)		Very low-income households (AHCIncome < 9,000)		Mid-low-income households (AHCIncome 9,000 <= 17,105)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
space heating cost	540	319	580	347	483	264	470	267	488	262
AHCIncome	24434	17132	33700	16507	10984	4298	5405	2808	13189	2341
FloorM2	78.7	27.1	84.3	27.5	70.4	24.3	68.9	25.1	71.1	23.9
SAP12	65.7	10.4	64.9	11.0	66.9	9.5	66.9	9.9	66.8	9.4
solid Wall Unins	0.226	0.418	0.228	0.419	0.223	0.417	0.253	0.435	0.212	0.409
gas Heating	0.852	0.356	0.853	0.354	0.850	0.358	0.831	0.375	0.857	0.350
central Heating	0.919	0.272	0.924	0.265	0.913	0.282	0.897	0.304	0.919	0.273
age16to24	0.023	0.151	0.013	0.115	0.038	0.191	0.068	0.252	0.026	0.159
working	0.548	0.498	0.631	0.483	0.428	0.495	0.353	0.478	0.458	0.498
sick Member	0.416	0.493	0.341	0.474	0.524	0.499	0.548	0.498	0.515	0.500
couple w. Dependents	0.208	0.406	0.189	0.392	0.235	0.424	0.204	0.403	0.247	0.431
one Person	0.310	0.462	0.289	0.453	0.340	0.474	0.416	0.493	0.310	0.462
private Rental	0.202	0.402	0.172	0.377	0.247	0.431	0.307	0.461	0.223	0.416
owner Occupier	0.448	0.497	0.628	0.483	0.187	0.390	0.147	0.354	0.203	0.402
observations	11,974		7,090		4,884		1,384		3,500	

TABLE 3.2 Descriptive statistics, households in energy poverty by the LILEE indicator and low-income households not in energy poverty

Variable	Households in energy poverty by LILEE indicator		Low-income households not in energy poverty	
	Mean	Std. Dev.	Mean	Std. Dev.
space heating cost	642	320	383	153
AHCIncome	9961	3960	11619	4376
FloorM2	73.9	24.9	68.3	23.7
SAP12	59.5	9.8	71.4	5.7
solid Wall Unins	0.366	0.482	0.135	0.342
gas Heating	0.798	0.402	0.882	0.323
central Heating	0.869	0.338	0.940	0.238
age16to24	0.038	0.191	0.038	0.191
working	0.459	0.498	0.409	0.492
sick Member	0.502	0.500	0.539	0.499
couple w. Dependents	0.267	0.442	0.215	0.411
one Person	0.287	0.452	0.373	0.484
private Rental	0.346	0.476	0.185	0.389
owner Occupier	0.229	0.420	0.160	0.367
observations	1,872		3,012	

Note that Table 3.2 shows a very large difference in expenditure on energy between households in and not in energy poverty by the LILEE indicator, £642/y compared with £383/y. Although the latter are in homes with good SAP12 ratings, some may still be underheating due to their low income. While the LILEE indicator generally performs better than expenditure-based measures in identifying such households experiencing hidden energy poverty, it does not capture all cases of underheating (see discussion in (Antepara et al., 2020; Barrella et al., 2022; Betto et al., 2020; Meyer et al., 2018)).

3.3.3 Shapes of the distributions

The variables representing space heating costs and AHCIncome are right skewed, while transforming these through natural logarithms yields close-to-normal distributions. Conversely, the SAP12 variable is left-skewed, and its cubed transformation achieves a normal distribution. The FloorM2 variable already approximates a normal distribution without the need for transformation.

This offers two distinct approaches for conducting the multivariate analyses. Initially the analyses were performed using the original untransformed data, facilitating straightforward interpretation of the results, despite potential inaccuracies. Subsequently, the analyses were repeated with the transformed variables, to assess the impact on the t-statistics and the overall analysis accuracy.

The results of the regressions were examined to draw conclusions about the parameters associated with higher or lower heating energy consumption, in two ways. First, within each specific group (high-income, low-income, etc.), the t-statistics indicated the relative impact of each variable on space heating consumption. Second, by comparing across the groups, the regression coefficients for each variable provided a basis for comparing their effects on space heating consumption the different income and energy poverty categories.

3.4 Results

3.4.1 Regression results for all observations

Table 3.3 presents the regression results for all observations using only the variables that remained after the stepwise process (hereinafter called the 'relevant variables'), without log and other transformations. These variables all have p-values below the threshold of 0.1, which, albeit somewhat arbitrary, denotes the degree of statistical significance we are using in this study[35]. Note that 15.6% of the households represented in the database are in energy poverty by the LILEE indicator (1,872 households out of 11,974).

TABLE 3.3 Regression results with relevant variables, for all households in the database

Regressed against space heating cost	Coef.	Std. Err.	t	P-value
AHCIncome	0.000998	0.000105	9.48	0
FloorM2	4.09	0.071	57.16	0
SAP12	-21.11	0.175	-120.5	0
solid Wall Unins	9.59	4.07	2.36	0.018
gas Heating	-68.08	6.04	-11.26	0
central Heating	-14.44	7.83	-1.84	0.065
age16to24	-33.41	10.36	-3.22	0.001
working	-10.88	3.64	-2.99	0.003
sick Member	8.75	3.38	2.59	0.01
couple w. Dependents	20.94	4.25	4.93	0
one Person	-39.49	3.81	-10.37	0
private Rental	-34.92	4.65	-7.51	0
owner Occupier	-19.19	4.29	-4.47	0
_cons	1,677.36	13.50	124.25	0
F	0.000			
Adj R-Sq	0.726			
Observations	11,974			

35 A p-value of 0.1 indicates that there is greater than a 10% probability that the sign (+ or -) of the regression coefficient is the opposite, in the population, from its value in the sample, or that it is zero in the population.

In Table 3.3, each variable's regression coefficient gives the increase in annual space heating costs for an increase of 1 in the value of the variable. For example, an increase of £1/y in income (after housing costs and fiscal transfers) is associated with a marginal increase in heating costs of £0.000998/y (about one-tenth of a penny). A $1m^2$ increase in floor area is associated with an annual heating cost increase of £4.09/y, and each unit increase in SAP12 rating corresponds to a reduction in heating costs of £21.11/y.

The t-statistics provide a more nuanced understanding of each variable's impact on space heating costs. The larger the absolute value of the t-statistic, the bigger the impact[36]. Figure 3.1 illustrates the t-statistics derived from regressions using actual values, transformed variables (natural logarithm of space heating cost and AHCIncome, cube of SAP12), and normalised variables. This set of displays shows minor differences in the relative impact of the most impactful variables regardless of which of the three methods is used. However, using the transformed variables (second graph), a clear point of difference is the impact of AHCIncome, which is shown to be even smaller, relative to other impacts, than when using the non-transformed data. We therefore use the transformed variables when displaying t-statistics from here on.

We commented in the methods section that the variable "household size" was eliminated in the stepwise regression process due to its high correlation with other variables. To explore this further, we performed an extra regression that includes "household size" along with the surviving variables. "One-person household" showed the larger absolute t-statistic value (-5.87 compared to 2.95) and was more strongly statistically significant (0.000 compared to 0.003). This confirmed that eliminating "household size" rather than "one-person household" was the correct procedure. Further, in this extra regression the variance inflation factor (VIF), which indicates multicollinearity, was high, at 4.01 for "household size". When we eliminated this variable, the highest VIF was 1.96, and the VIF for "One-person household" was very low, at 1.33.

36 Note that the same is true for beta values if we were to use normalised variables in the regressions. There is a one-to-one relationship between the t-statistics for a non-normalised regression and the beta values for a normalised regression.

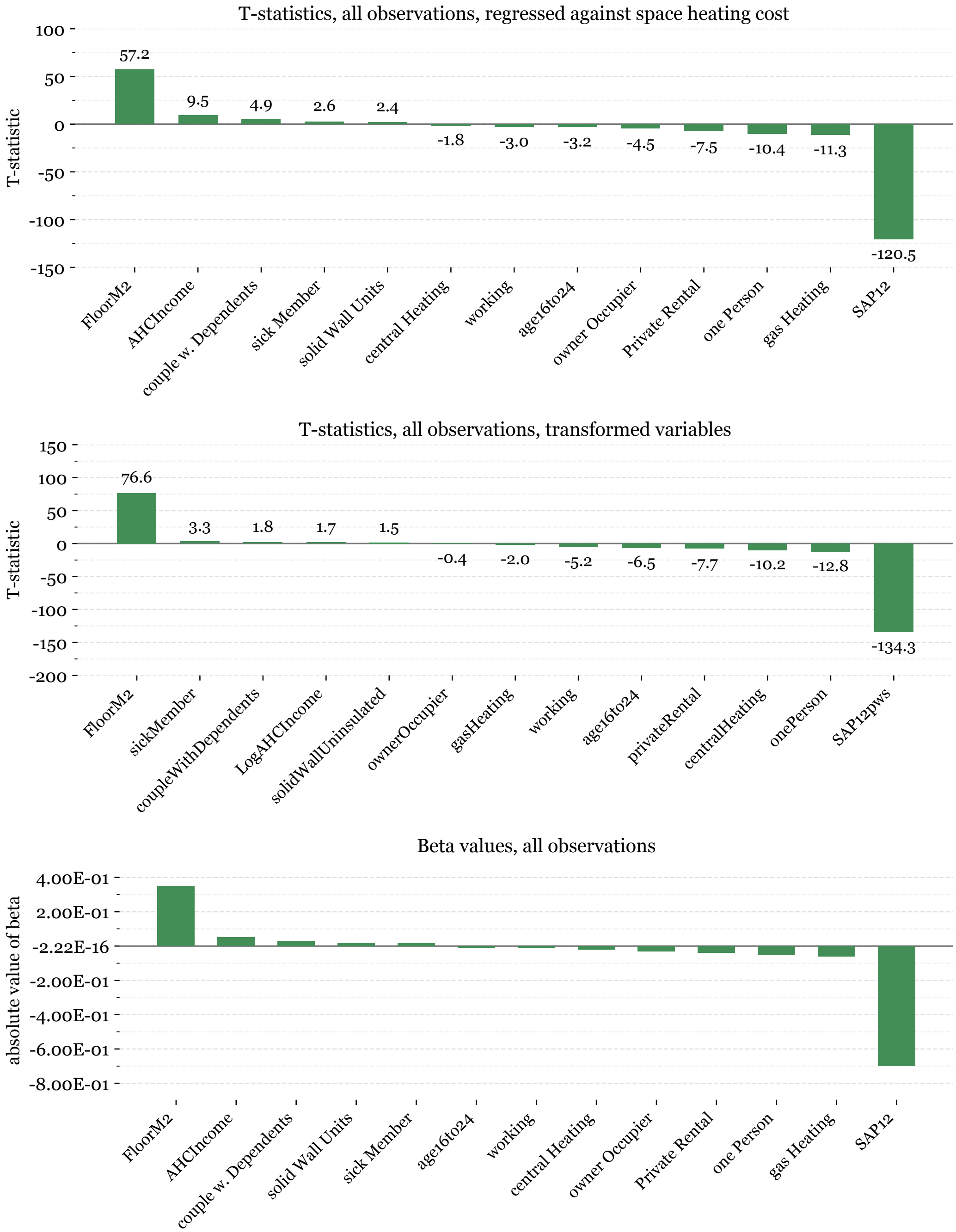

FIG. 3.1 T-statistics for regression of all observations, using untransformed and transformed variables, and beta values using untransformed variables

3.4.2 Regression results for different income groups

Tables 3.4 and 3.5 provide a breakdown of the regression results for the distinct income brackets and for households identified as being in energy poverty according to the LILEE indicator, compared with low-income households not facing energy poverty. The p-values here indicate that not all variables show statistical significance in all income bands and categories, a point discussed further below in relation to the t-statistics.

In the analysis of regression coefficients for the most impactful variables across different income brackets and categories, a distinct pattern emerges in the response to energy efficiency improvements, as indicated by changes in the SAP12 rating. High income households exhibit the most pronounced response to a one-point increase in the SAP12 rating (i.e. a marginal energy efficiency improvement), with a reduction in annual space heating costs of £21.74/y, closely followed by households in energy poverty, which show a decrease of £21.59/y. Conversely, the response from very low-income households is somewhat muted at a £19.45/y reduction, and lowest among low-income households not experiencing energy poverty, at -£17.02/y. In other words, *living in energy poverty or having a high income significantly increases a household's adjustment in heating expenditures in response to improvements in their home's energy efficiency,* whereas having low-income but not being in energy poverty shows a more modest response.

A similar dynamic is observed in the reaction to an increase in floor area by $1m^2$. Households facing energy poverty demonstrate the greatest increase in annual space heating costs, at £5.04/y, suggesting a more substantial financial burden from larger living area. This compares with £4.18/y for high-income, £3.65/y for low-income, and £2.99/y for very low-income households not in energy poverty. This indicates that *low-income households overall are constrained in their ability to financially manage increased heating demands, but respond much more strongly if they are in energy poverty*.

Descriptive statistics in Tables 3.1 and 3.2 provide further context, revealing that high-income households have a relatively low (bad) SAP12 rating, at 64.9, while the average SAP12 rating for low- and low-mid income households is better, at around 66.9. The lowest average SAP12 rating, however, is for households in energy poverty, at 59.5, while the highest is for low-income households who are not in energy poverty, at 71.4. It seems, then, that *low energy efficiency (low SAP12 rating) is a far more decisive factor than income in determining energy poverty – though both do play a role*, since income had to be below about £17,105/y in 2019 for a household to fit the LILEE definition of energy poverty.

TABLE 3.4 Regression of relevant variables against space heating costs, for the four income bands

Regressed against space heating cost	Low income			High income			Very low income			Mid-low income		
	Coef.	t	p-value	Coef.	t	p-value	Coef.	t	p-value	Coef.	t	p-value
AHCIncome	0.00058	1.26	0.206	0.00157	10.750	0.000	-0.00117	-0.790	0.430	0.00075	0.790	0.428
FloorM2	3.87	41.38	0.000	4.18	41.49	0.000	3.65	20.16	0.000	3.98	36.45	0.000
SAP12	-19.93	-84.28	0.000	-21.74	-89.61	0.000	-19.45	-42.84	0.000	-20.15	-72.95	0.000
solid Wall Unins	1.96	0.38	0.700	12.31	2.10	0.036	6.79	0.70	0.486	-0.92	-0.15	0.877
gas Heating	-52.66	-6.79	0.000	-74.08	-8.65	0.000	-40.96	-2.64	0.008	-55.38	-6.20	0.000
central Heating	-9.70	-0.99	0.323	-25.45	-2.25	0.024	-10.80	-0.56	0.573	-12.15	-1.07	0.286
age16to24	-45.35	-4.37	0.000	-25.12	-1.29	0.196	-60.87	-3.71	0.000	-27.22	-1.94	0.052
working	-9.95	-2.20	0.028	-9.37	-1.75	0.080	-2.24	-0.24	0.807	-13.04	-2.50	0.012
sick Member	4.83	1.17	0.242	10.04	2.03	0.042	5.16	0.61	0.543	4.45	0.94	0.345
couple w. Dependents	-3.56	-0.69	0.491	39.68	6.34	0.000	-24.12	-2.19	0.029	4.05	0.70	0.486
one Person	-20.53	-4.32	0.000	-55.99	-10.17	0.000	-47.15	-5.10	0.000	-9.72	-1.74	0.082
private Rental	-14.32	-2.80	0.005	-51.20	-6.63	0.000	-27.71	-2.79	0.005	-8.42	-1.40	0.160
owner Occupier	18.06	3.21	0.001	-33.41	-5.13	0.000	15.25	1.20	0.232	17.32	2.76	0.006
_cons	1,600.87	86.39	0.000	1,711.56	89.24	0.000	1,601.21	45.48	0.000	1,605.73	66.91	0.000
F	0.000			0.000			0.000			0.000		
Adj R-Sq	0.745			0.715			0.715			0.758		
Observations	4,884			7,090			1,384			3,500		
highest VIF	2.12			2.05			2.32			2.06		

High-income households also have the largest average floor area, averaging 84.3 m^2, compared to low-income households not in energy poverty, who have the smallest, at 68.3 m^2, followed closely by very low income households, at 68.9 m^2. *Households in energy poverty have a larger average floor area, at 73.9 m2, which may add to space heating difficulties.*

With regard to income after housing costs, tax and transfers (AHCIncome), households in energy poverty have the largest response to income: for each extra £/y of income, they spend an extra £0.00184/y on heating, whereas low-income households not in energy poverty spend have only about one-third this amount, at £0.000694/y. High-income households have the second-highest response, at £0.00157/y, while very low-income households spend only £0.00117/y, and low-mid-income households spend even less, at £0.000715/y. This suggests that *increasing the income of households in energy poverty has a positive effect on energy use.* Even though these responses are low for all income groups and categories, the response of households in energy poverty is the highest, even higher than that of high-income households.

TABLE 3.5 Regression of relevant variables against space heating costs, for households in energy poverty by the LILEE indicator, and low-income households not in energy poverty

Regressed against space heating cost	Households in energy poverty by LILEE indicator			Low income, not in energy poverty		
	Coef.	t	p-value	Coef.	t	p-value
AHCIncome	0.001843	1.7	0.089	0.000694	1.83	0.068
FloorM2	5.0435	25.76	0.000	2.991576	38	0.000
SAP12	-21.591	-40.91	0.000	-17.02066	-56.29	0.000
solid Wall Unins	7.5247	0.8	0.423	-5.125177	-1.06	0.290
gas Heating	-68.399	-4.26	0.000	-8.790812	-1.3	0.195
central Heating	-2.9467	-0.16	0.873	-48.76863	-5.32	0.000
age16to24	-56.621	-2.51	0.012	-34.63644	-4.07	0.000
working	-6.1906	-0.64	0.521	-11.5084	-3.05	0.002
sick Member	6.6706	0.75	0.454	5.682106	1.67	0.094
couple w. Dependents	4.0006	0.38	0.707	-9.142963	-2.08	0.038
one Person	-36.772	-3.47	0.001	-15.64551	-4.05	0.000
private Rental	-9.80122	-0.94	0.346	-16.17914	-3.62	0.000
owner Occupier	5.0218	0.43	0.671	30.77569	6.46	0.000
_cons	1,602.8	43.64	0.000	1,450.46	59.07	0.000
F	0			0		
Adj R-Sq	0.69			0.686		
Observations	1,872			3,012		
highest VIF	2.45			1.97		

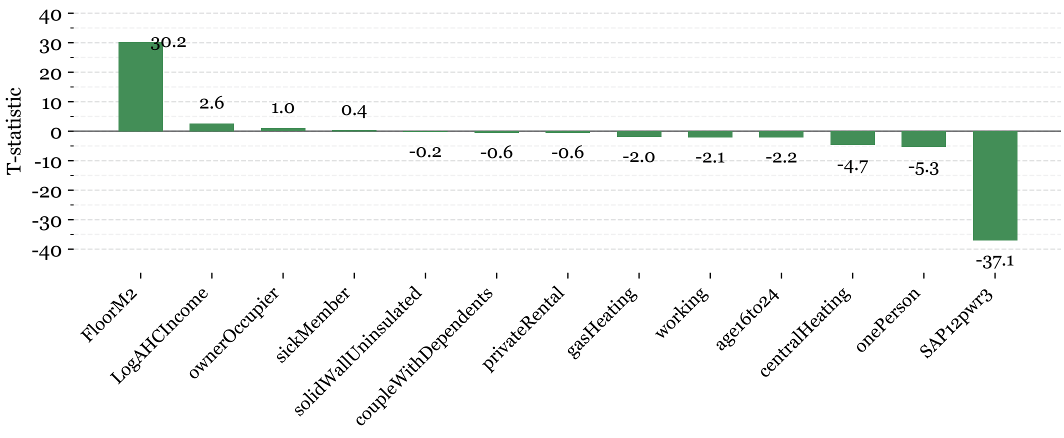

FIG. 3.2 T-statistics for households in energy poverty by LILEE indicator, using variables transformed for normal distributions

We now examine the t-statistics (of the transformed variables) to see which variables have the biggest impact on space heating cost, for each income band and category.

Looking at the t-statistics in the regression tables and in Figure 3.2 (and Appendices 7-11), it is clear *that for all income bands and categories, by far the greatest impact on space heating expenditure is the SAP12 rating*. For all income bands and categories this is an order of magnitude higher than the impact of income, followed by a very large impact of floor area.

The next largest impact after SAP12 and floor area for households in energy poverty is whether there is gas heating, which reduces energy expenditure by £68.40/y. Next is whether it is a one-person household, which reduces space heating expenditure by £36.77/y for households in energy poverty compared to £15.65/y for low-income households not in energy poverty (Table 3.5) and by £47.15/y for very low-income households. For high/income households this is has the fourth largest impact, at approximately £56/y, behind having central heating, which reduces costs by approximately £9.70/y for high-income households and £10.80/y for very low-income households.

For all these we say “approximately” because the regression of non-transformed variables, given in Table 3.3, is subject to error due to the non-normality of the variables' distributions. A re-transformation of the results to the actual values is also subject to error, because it only holds true at the mean value of the transformed variable (e.g. the mean of the logarithms of the space heating costs). In any case, these impacts are so low, compared to those of the SAP12 rating and the floor area, that they are hardly “significant” in the general meaning of this term.

We also note that the only variables which give p-values <= 0.1 for all income bands and categories are SAP12, floor area, and one-person household, while income after housing costs, tax and transfers also gives p-values <= 0 for low-income households both in and not in energy poverty We therefore focus mostly on these variables in the following summary discussion.

3.5 Discussion

An important finding is that although a change in income after housing costs and fiscal transfers (ANCIncome) makes relatively little impact on heating expenditure for households in general, its biggest impact is for households in energy poverty. For this reason, we cannot dismiss it in a discussion of how to alleviate energy poverty.

Using the same database, Galvin (2024) found that higher fiscal transfers to low-income households are highly unlikely to lead to substantial increases in energy consumption. This aligns with the findings of the study by Bagnoli and Bertoméu-Sánchez (2022) who found that households receiving a social electricity tariff in Spain hardly increased their electricity consumption, even if they paid a lower rate. However, by categorising low-income households according to whether or not they are in energy poverty, we find a subtly different result. A change in income among households in energy poverty does make a significant difference to their energy expenditure, even though this is small.

Our findings therefore suggest that the current UK government approach of targeting energy policy with one-off payments like The Winter Fuel Payment, Warm Homes Discount and Cold Weather payments are at least partially effective. However, they may not relieve energy poverty as effectively as hoped, since the additional income is not necessarily all being spent on increasing thermal comfort. This might explain to some extent the ineffectiveness of several targeted energy poverty programmes in reducing specific energy deprivation, as this can be partially attributed to the fact that some households use their additional funds to cover other essential needs (Barrella et al., 2021; García Alvarez & Tol, 2021). But this does not mean that fiscal transfers to households in energy poverty are of no use. It more likely means that these households' most pressing priorities for spending have very little to do with heating. They may have to do with food, clothing, education, getting a better dwelling, medical needs (ONS, 2023) or paying off debt (Bull et al., 2023).

A second key finding is that in all cases the SAP12 rating – i.e. the energy efficiency of the dwelling – is by far the strongest determinant of space heating expenditure. Therefore, probably the most effective strategy for warming up the homes of households in energy poverty is to increase the energy performance of their dwellings. Each increase in SAP12 rating corresponds to a reduction in heating costs of around £20/y. Therefore, for households in energy poverty, with an average SAP12 rating of 59.48, increasing the SAP12 rating to the level of low-income households not in energy poverty, namely 71.45, could reduce space heating costs by about £240/y.

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Although this will not help these households' finances as much as the direct monetary allowances outlined in Section 3.2, it will make a substantial, direct impact on cold, unhealthy homes. There needs to be extra focus on developing policies for the long-term solution of retrofitting energy-inefficient homes. This can provide enduring reductions in energy bills while also improving thermal comfort. This approach may also align better with the goal of reducing carbon emissions and tackling climate change.

This of course raises the further issues of how this would be paid for and whether it is economically viable, i.e., whether the reductions in energy use would pay for the renovations over the course of their technical lifetime, say 30 years – a topic currently being explored at length in Germany due to sharp increases in energy, finance and building costs. A reduction in energy bills of £240/y only amounts to £7,200 over a 30-year technical lifetime of the renovation measures, while a retrofit to increase the SAP12 rating from 59 to 71 will cost tens of thousands of pounds per dwelling. Sources of finance other than the household's reduced energy bills would need to be found. There are almost certainly co-benefits of energy efficiency and warmer homes, such as fewer sick days, longer lives and less strain on the health service (Baniassadi et al., 2022; Bisello, 2020; Reuter et al., 2020). Energy-efficiency upgrades therefore require financial support that is unlikely to come from direct energy savings. Schleich (2019) investigated the adoption of energy efficient technologies by income categories in eight EU countries. He concluded that there are differences in retrofit measures implementation rates between the highest and lowest income quartile households and these differences would likely have been smaller with support schemes in place for lower income households, especially in the UK.

Without retrofit initiatives, energy poverty will persist in the UK, since for low-income households, immediate needs often take precedence over thermal comfort, even with rising incomes. Moreover, many live in properties owned by private landlords who lack the motivation to improve housing standards. Nevertheless, there are positive examples. The Scottish Landlord Register (https://www.landlordregistrationscotland.gov.uk/) requires all landlords to register and meet certain standards. This helps to improve the standards of private renting by ensuring a property is fit to be let, though this is still far from ideal (Farnood & Jones, 2021). Some local authorities in Scotland offer specific 'Good Landlord' schemes aimed at encouraging best practices, offering advice, and sometimes financial incentives for improvements to properties. These schemes aim at enhancing tenant-landlord relationships, improving the quality of rental accommodation, and ensuring compliance with legal standards.

Another viable strategy would be constructing additional Council housing that is both energy-efficient and affordable. For instance, Cambridge City Council mandates that all newly constructed Council housing adheres to the Passivhaus standard. In this context, it is crucial to provide social housing providers with the necessary funding to accelerate a retrofitting strategy for households in need (Croon et al., 2024).

A third finding is that floor area makes a substantial difference to space heating energy costs, with about half to two-thirds the impact of SAP12 rating. On the one hand, this could suggest that low-income households are wise to live in dwellings that have the right size for their needs. On the other hand, this is not easy for older households whose dependants have left home and who find themselves with a large, older home that is very expensive to keep warm. Our analysis showed that for households in energy poverty, floor area has a much higher t-statistic in relation to other variables, than it does for other categories of households. This suggests that inability to downsize may be a significant driver of energy poverty.

A fourth and very interesting finding is that for all income groups, being a one-person household is associated with reduced energy expenditure, and for households in energy poverty the reduction is twice as large as for low-income households not in energy poverty. This needs more exploration because it might suggest that many one-person households are able to control their energy consumption more strategically than a multi-person household is able to. Note that other factors such as floor area are controlled for by the regression method, so it is not just a case of low-income households living in smaller dwellings. Further research could survey one-person households to find out if they have skills and practices that could be transferred to multi-person households.

A fifth finding is that there are some variables that are statistically significant for some income bands and not for others, though the t-statistics show their impacts to be small. The main examples are:

- For high-income households, having uninsulated solid walls increases heating energy expenditure.
- For high-income households, having central heating reduces heating energy expenditure.
- For all households, having gas heating reduces heating energy expenditure (though heat pumps are not considered in the data).
- For low-income households of all categories, having a household head aged 16-24 reduces heating energy expenditure.
- For all except very low-income households and households in energy poverty, working (having a job) decreases heating energy expenditure.

- For high-income households, having a sick member increases heating energy expenditure.
- For high-income households, being a couple with dependants increases heating energy expenditure, but for a very low-income household this reduces heating energy expenditure.
- For most bands, being in a private rental dwelling reduces heating energy expenditure but for households in energy poverty no significant effect is evident.
- For high-income households, being an owner-occupier increases energy expenditure, but the opposite is the case for middle-low-income households.

Finally, an interesting issue for further detailed research: the household income figures in the database include all welfare transfers, and some of this, for some households, includes subsidies on energy bills. (though this is very uneven throughout England). Therefore, to some extent some households' energy consumption behaviour may be in part a response to a reduction in expenditure, rather than to an increase in direct income. A question for further research is, in the context of subsidies for energy costs, do low-income households respond differently to a reduction in expenditure, from how they respond to a direct increase in income.

3.6 Conclusion

This study contributes new knowledge in identifying which factors are associated with income and heating expenditure among low-income households in the UK, particularly those who are in energy poverty by the LILEE indicator. It takes household income as a starting point to understand heating demand in these households, while also comparing these with high-income households and with low-income households who are not in energy poverty. An important finding is that for low-income households who are not in energy poverty, a change in income (after housing costs and fiscal transfers) makes very little impact on heating expenditure and therefore, by implication, on heating practices. However, for households in energy poverty (who are also low-income) the impacts are significantly stronger, though still not large. This could be due to the priority given to other essential needs or expenses, and/or because these households have got used to under-heating and living in unhealthy conditions. It could also indicate that additional income is allocated mostly towards other necessities or savings rather than increasing heating consumption. In short, heating expenditure is relatively income-inelastic, and less so among households in energy poverty.

It is clear that for all income bands, by far the greatest impact on space heating expenses is the SAP12 rating. The advocacy for payment top-ups and a cash-first approach in policies is often rooted in the aim to provide immediate relief to low-income households facing energy poverty. This is at least partially effective among households in energy poverty, and in any case it is very important to increase the income of low-income households. However, our findings suggest that the approach that will have the largest impact by far on energy cost reductions is to increase the dwellings' energy-efficiency: more specifically, to increase the SAP12 rating to at least 72. However, because this will result in reduced energy bills of only about £240/y, the energy-efficiency upgrade will not be paid for out of energy savings. This points to the need for targeted financial support for these upgrades. Society may well find these pay back through co-benefits of fewer days off work, longer lives and less strain on the health service.

Finally, this study argues for a holistic understanding of household economics when addressing energy poverty. As well as the technical inadequacy of many dwellings, energy poverty is rooted in poverty. Many UK households are at the nexus of energy and food poverty and are often in debt, including to friends and family. They do not have a liquidity buffer. Both poverty and technical energy efficiency issues need to be addressed persistently and universally. The study highlights the differential income inelasticity of energy expenditure and confirms that energy poverty indicators can effectively identify those in greatest need of support. However, while targeted support can alleviate some deprivation, the study argues that addressing both the root causes of poverty and technical energy efficiency issues is crucial for a holistic solution to energy poverty.

A limitation of the study is the volatility of energy prices in the years since the survey in 2019. The evolution of the price households pay for energy has been complex since then due to a series of government interventions, but actual average prices are now around twice their mid-2019 level. Nevertheless, an advantage of this study is that it estimates micro-level changes in energy expenditure that are associated with micro-level changes in energy price, regardless of the absolute value of the price. It is highly unlikely that the ratios between t-statistics for the effect of energy price compared to SAP12 rating and floor area would be substantially different in a regime of higher energy prices.

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PART II

Policies and practice

Design and delivery of targeted household energy support

4 Social housing providers at the frontlines of the energy transition

This chapter is based on a peer-reviewed article published as:
Croon, T. M., Hoekstra, J. S. C. M., & Dubois, U. (2024). Energy poverty alleviation by social housing providers: A qualitative investigation of targeted interventions in France, England, and the Netherlands. *Energy Policy*, *192*, 114247.

ABSTRACT

Decisions made by social housing providers (SHPs) profoundly affect their tenants' energy affordability, a group characterised by above-average energy poverty rates. Concentrated deprivation in this tenure has intensified due to policy-driven 'residualisation', compelling SHPs to serve almost exclusively low-income and marginalised households. Despite this, research exploring the potential of SHPs to tackle energy poverty through targeted interventions for their most vulnerable tenants remains sparse. The 2021-2022 energy price crisis offers a unique context to investigate this issue, given its substantial impact on household energy affordability. This study delves into insights of social housing professionals through focus groups conducted in France, England, and the Netherlands. It examines their views on the effectiveness of interventions and assesses their feasibility within the respective institutional contexts. We find that SHPs generally favour retrofit prioritisation and behavioural interventions as effective means of supporting at-risk tenants, whereas alterations in rent setting or housing allocation are considered potentially impactful but often undesirable or impracticable. We identify institutional barriers and lack of data as key obstacles to SHPs' adoption of more targeted interventions. To empower SHPs in tackling energy poverty, housing policy reforms must acknowledge and address the significant impact of energy costs within total housing expenses.

4.1 Introduction

The European energy price crisis of 2022 has disproportionately burdened households with high energy needs, low incomes, and limited financial means – or agency – to retrofit their energy inefficient homes. This may lead to energy poverty, formally defined by the European Union as *"a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes"* ("Directive (EU) 2023/1791 on energy efficiency," 2023). Studies have indicated it can cause respiratory and cardiovascular issues, mental distress, and social isolation (Liddell & Morris, 2010).

In Europe, energy poverty is more prevalent among social housing tenants as compared to other tenures, a pattern that seems to persist irrespective of variations in the proportion of social housing units across countries (Desvallées, 2022; Mulder et al., 2023). Such a concentration of energy poverty within the social housing sector is, in part, an expected phenomenon, given that social housing providers (SHPs) traditionally, and in some countries evolvingly, bear the institutional responsibility of catering specifically to low-income groups and vulnerable residents (Hoekstra, 2017; Pearce & Vine, 2013). Yet the lack of research dedicated to the unique role of SHPs in addressing energy poverty remains rather conspicuous considering these circumstances.

Energy poverty is primarily driven by inadequate energy efficiency, high energy costs, and a low income (Boardman, 1991), all of which are closely tied to social housing governance. To illustrate this: SHPs directly impact the energy efficiency tenants must contend with through initial housing allocation and subsequent renovations, mitigate their dependence on fluctuating energy prices through deployment of renewable energy sources and specific heating systems, and determine part of their financial burden through rental rates. Previous studies on the self-perceived role of SHPs in the energy transition have evaluated attitudes towards specific retrofit strategies (Desvallées, 2022; Sdei et al., 2015), community participation (Breukers et al., 2017), justice aspects (Broers et al., 2022), and regulatory incentives (Egmond et al., 2005). However, a comprehensive investigation into the scope for SHPs to modify their strategies or introduce new targeted interventions to effectively combat energy poverty has not yet been conducted.

To address this gap, this study aims to thoroughly investigate the perceptions and practices of social housing professionals in France, England, and the Netherlands regarding targeted interventions to mitigate energy poverty among tenants. The emphasis on 'targeting' signifies our deliberate treatment of energy poverty alleviation as a distinct challenge, rather than addressing it as a mere by-product of traditional objectives in social housing governance, such as keeping rents affordable and retrofitting dwellings. The study's objective is to move beyond merely reinforcing the urgency of these existing efforts, aiming to uncover a fuller understanding of SHPs' capacities and strategies in mitigating energy poverty.

The structure of this article is as follows: first, we provide a concise review of literature on policy targeting and explore relevant developments in the context of social housing governance. Subsequently, we detail the methodology employed in this study, highlighting the focus groups conducted with social housing professionals. Following this, we present and analyse the findings on the respective advantages and disadvantages of the identified interventions. This article concludes with a discussion on the implications of these findings and suggests recommendations for policy and practice.

4.2 Background and Literature Review

4.2.1 Policy Targeting

Targeting involves the strategic allocation of programme benefits to those most in need, thereby reducing inequality and ensuring efficient resource utilisation (Simshauser, 2023). The literature predominantly examines the theoretical and practical costs and benefits of implementing targeted public and particularly social policies, primarily from a governmental viewpoint. In the context of energy poverty, Croon et al. (2023) for instance argue that targeted financial relief by governments during energy price spikes is climate-friendlier and less inflationary compared to universal schemes.

The initial step in policy targeting is the precise choice of a target group. This is particularly challenging in the case of a multidimensional and debated concept like energy poverty, which lacks a universally accepted definition (Moore, 2012). To address the multidimensionality of energy poverty, it is widely accepted in Europe that national-level measurement approaches should incorporate multiple complementary indicators (EPAH, 2023b). Additionally, local approaches to diagnosing the issue should actively engage stakeholders from diverse backgrounds (EPAH, 2023a). The choice of the target group then informs the selection of indicators, which in turn are crucial for identifying beneficiaries (Fizaine & Kahouli, 2019). Different use of indicators can lead to the identification of very different beneficiary groups, thereby influencing the nature and scope of the targeted interventions (Croon et al., 2023; Dubois, 2012).

Simshauser (2021) emphasises the importance of accurate data in preventing targeting errors, including the risk of providing support to non-eligible individuals (inclusion errors) or missing eligible ones (exclusion errors). Middlemiss (2016) highlights a trade-off in the pursuit of greater accuracy in identifying the ‘most vulnerable’ or ‘most deserving’ for energy poverty support: while it enhances cost-effectiveness, it may also compromise the goal of reaching all who are in need. Whether identification should occur at higher or local levels is debated, given local actors’ proximity to those in need (Koďousková et al., 2023; Koďousková & Lehotský, 2021) versus their often limited financial and capacity resources.

Given the multidimensional nature of energy poverty, which complicates direct assessment, targeting actors frequently resort to using proxies for identification, including household income, energy usage data from smart meters, and geographic location (Best et al., 2021; Sareen et al., 2020). Once the target group is chosen and a tangible policy objective is established, the subsequent phase entails evaluating the most effective delivery mechanisms among the various policy instruments available to the targeting actor (Schuck & Zeckhauser, 2007). Targeted delivery mechanisms could take the form of money transfers, in-kind provision of goods or services, or even training and education (Devereux et al., 2017). In the context of energy poverty, they could for instance consist of energy allowances, social tariffs, subsidised thermal retrofits, free repairs and energy saving appliances, or energy advice services (Bessa & Gouveia, 2022). While targeting strategies are less commonly employed by semi- or non-state actors, the act of providing social housing is increasingly seen as a form of targeted in-kind shelter provision, sparking a profound ideological debate within social policy and housing policy circles regarding narrowly means tested versus more universal accessibility of social housing (Clarke et al., 2022; Poggio & Whitehead, 2017).

For governments and non-state actors alike, evaluating the impact of targeted policies is an essential component. Beyond immediate outcomes, this evaluation could encompass an assessment of the long-term sustainability and scalability of the intervention, serving as a feedback mechanism for refining and adjusting it as required (Bednar & Reames, 2020). This adaptability is particularly crucial in addressing energy poverty, where sudden increases in energy prices or general cost-of-living hardships experienced by tenants can necessitate swift action. Furthermore, emerging scientific insights, such as those regarding the vulnerability of different populations to living in cold homes or the effectiveness of specific alleviation methods, can also prompt changes in the target group or the delivery of services.

The utility of policy targeting thus lies in its ability to combat inequalities effectively and efficiently by channelling resources towards disadvantaged groups (Murray & Mills, 2014). Targeting allows for a customised and more flexible approach, tailoring interventions to the unique needs and capabilities of different groups and thereby increasing the probability of successful outcomes (Della Valle et al., 2024). For example, targeted energy conservation advice in a building with higher-than-average consumption is likely to be more effective than a generic, wide-reaching campaign. Targeting interventions holds the potential of concentrating efforts and resources on households where they can yield the most substantial impact. Therefore, a targeted approach can save costs, which allows organisations to offer more substantial support or redirect funds to other institutional goals. When targeting objectives are clear and well-communicated, they can also enhance the transparency and accountability of decision-making processes (Maestre-Andres et al., 2021).

Despite these advantages, scepticism about policy targeting remains, as expressed by scholars like Sen (1998). He identifies several potential challenges: (a) the costs incurred by beneficiaries in acquiring necessary information, (b) the expenses associated with the application process and verification of eligibility, which can lead to inefficiencies and elevated administrative costs, thereby reducing the available resources for the intended beneficiaries, (c) 'disutility and stigma' associated with being categorised as in need of assistance, (d) the creation of 'perverse incentives' that might provoke unintended behaviours among beneficiaries, and (e) the varying levels of political support determined by the specific groups of beneficiaries targeted and the nature of the implemented measures (van de Walle, 1998). In efforts to address energy poverty in a targeted manner, some of these challenges can now be mitigated using technology[37], though others remain critical (Grossmann et al., 2021).

37 Appropriate use of technology and data matching could help governments to drastically reduce the costs associated with a) and b), as demonstrated by the reform of the UK's Warm Home Discount (Lausberg & Croon, 2023)

Therefore, when devising targeting methods, it is essential to consider not only their effectiveness but also their feasibility. This entails analysing two dimensions (Grosh et al., 2022): the technical dimension, which relates to administrative feasibility, including practical considerations such as identifying beneficiaries and the associated costs; and the institutional dimension, which involves political support, privacy issues, rights to target specific groups, connections with other policy interventions, and legitimacy considerations.

4.2.2 Residualisation of Social Housing

As previously mentioned, there is limited research regarding the use of targeting strategies by non-governmental entities, such as SHPs, in the context of energy poverty alleviation. To navigate this intricate policy landscape, it is imperative to first establish a clear understanding of their role and function within the housing and social welfare landscape.

As a starting point, it is important to define what we mean by social housing providers. Social housing is defined as a government-regulated tenure of housing in which affordable rental dwelling are administratively allocated on the basis of need with a traditional aim to improve the overall living conditions of workers and low-income residents (Granath Hansson & Lundgren, 2018; Haffner et al., 2010; Scanlon et al., 2015). Social housing is typically developed by government agencies with state support or non-profit organisations receiving favourable financing from public banks or government guarantees, and housing allowance programmes often retain affordability after construction (Czischke & van Bortel, 2018).

In various European countries, the social rental sector has been undergoing significant changes over the past several years, as demonstrated by Scanlon et al. (2015). Often, due to deliberate government policies involving reduced public funding and stricter eligibility criteria, it has not only diminished in size but it also has become more ‘residualised’ in nature (Hoekstra, 2017; Kholodilin et al., 2022). This term implies that available social housing is increasingly allocated to people with very low incomes and marginalised societal groups with an ‘urgency status’, such as refugees, individuals with mental health issues, or those recovering from personal crises like divorce. This results in a notable clustering of these groups in neighbourhoods with a high social housing density (Hoekstra, 2017).

This residualisation represents a significant contributing factor to the prevalence of energy poverty within the social rental sector and has amplified the adverse effects of the energy crisis in neighbourhoods characterised by a high density of social housing. Consequently, social housing providers are important stakeholders in efforts to alleviate energy poverty.

4.2.3 Traditional objectives of SHPs

In this section, we will outline the decision-making spectrum of social housing providers (SHPs) and start to examine its impact on the alleviation of energy poverty, by examining the sector's traditional objectives.

SHPs operate on a non-profit basis, which means that their activities are guided by a societal mission balancing various social duties rather than shareholders' interests, adhering to regulatory frameworks while exercising varying degrees of discretion in execution (Cowan & McDermont, 2021). Van Bortel et al. (2018) refer to *availability*, *affordability*, and *quality* as the universal performance criteria of social housing providers. Translating these criteria to more concrete objectives, SHPs must ensure the adequate supply of new built dwellings, fair allocation of units, affordable rents, and maintenance of building quality, while upgrading them to meet sustainability and energy efficiency standards. One can already discern the relationship between these objectives and energy poverty drivers, something we will outline comprehensively in the next subsection.

Enhancing *liveability* could be recognised as a fourth criterion, reflecting SHPs' commitment to social investments that improve the quality of life within neighbourhoods (Elsinga et al., 2020). These investments generally addresses the needs of vulnerable populations such as low-income elderly residents, individuals with disabilities, and refugees, by not only providing suitable housing but also facilitating access to supplementary social services like community centres (Van Deursen, 2023).

Reeves (2013) notes that achieving these objectives at the highest level concurrently is challenging, suggesting that due to cost constraints, SHPs are often faced with trade-offs, where prioritising resources in one area may necessitate cost savings in another, consequently, some objectives are met at the expense of others. This reality highlights the inherent compromises in fulfilling the full scope of SHPs' societal mission.

4.2.4 What can Social Housing Providers potentially do to alleviate energy poverty?

The traditional objectives of the social housing sector are closely linked to the key drivers of energy poverty, such as a lack of sufficient financial resources, higher-than-average energy requirements, and the energy inefficiency of the dwelling, occasionally including occupant behaviour as a fourth significant factor (Kearns et al., 2019; Walker & Day, 2012). SHPs thus have the potential to significantly influence these drivers and, therefore, the energy poverty experienced by their tenants. This section, developed from the authors' collaborative brainstorming sessions, delineates potential SHP interventions that can mitigate energy poverty, as illustrated in Figure 4.1.

Firstly, the influence of SHPs on tenants' income primarily manifests through rent policies. For many low-income tenants in social housing, rent burdens – the proportion of disposable income allocated to rent – have increased substantially in recent years, although not as rapidly as for those with private rental contracts (Dewilde, 2022). While operating within their financial and legal constraints, SHPs may have the capacity to alleviate this burden by adjusting rent levels or demonstrating flexibility in rent collection, particularly for those at the highest risk of energy poverty. This includes potentially capping rents based on vulnerability criteria such as a low income, substandard energy efficiency, or high energy needs, or demonstrating leniency during energy price spikes. Additionally, SHPs often offer tenants financial advice and help them navigate government benefit systems or job opportunities. Particularly in England, SHPs support tenants by providing job training programmes (Finney et al., 2018). These interventions directly impact the economic well-being of tenants, thus influencing their vulnerability to energy poverty.

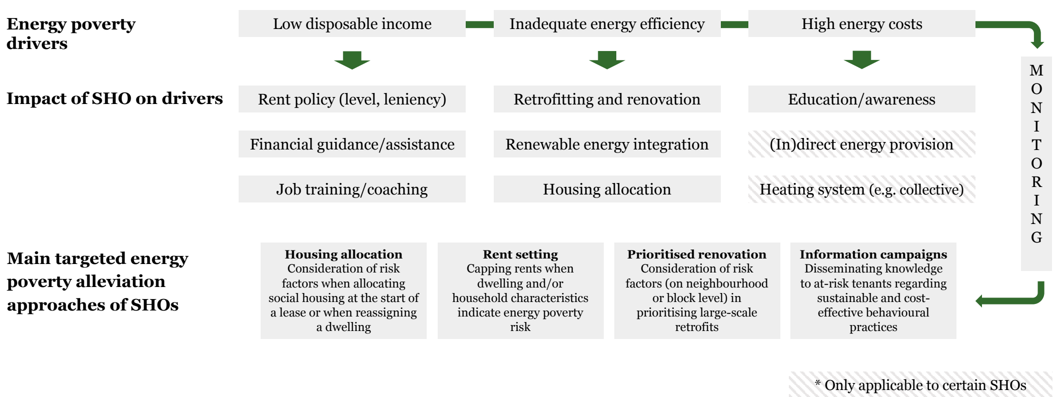

FIG. 4.1 Key energy poverty alleviation interventions in social housing based on energy poverty drivers

TOC

Secondly, the energy efficiency of housing is a critical area where SHPs exert significant influence, largely through their retrofitting and renovation strategies. These strategies, which often include updating insulation, improving heating systems, and installing solar panels, directly reduce utility costs for tenants and may decrease dependence on non-renewable energy sources (Liu et al., 2023). While SHPs typically align these renovations with climate targets and local government collaborations, they often retain discretion in prioritising renovations based on vulnerability criteria, signalling a potential to focus first on building blocks or neighbourhoods most susceptible to energy poverty (Avanzini et al., 2022). Until now, this is not common practice, and SHPs currently tend to approach retrofit provisions primarily from a techno-economic perspective (De Feijter et al., 2019). Another important consideration is the financial burden of these retrofits, specifically whether costs are absorbed by SHPs or passed onto tenants in the form of rent increases, which again underscores the interconnectedness of SHPs' decisions with the broader issue of energy poverty (Galvin, 2023).

Thirdly, the initial allocation of dwellings can have long-term implications on experienced energy efficiency, and SHPs could strategically allocate or reallocate high-risk households to energy-efficient dwellings as a pre-emptive measure against energy poverty. Specifically, targeted (re)allocation of low-income elderly households or those with medical conditions requiring them to stay home, , is perceived an effective method for reducing the likelihood of severe energy poverty. SHPs typically have some discretion in (re)assigning their respective dwellings (Preece et al., 2019), which would allow them to factor in the prospective impact of their allocation decisions on tenants' energy needs.

Finally, alleviating tenants' high energy costs may involve not just physical changes but also behavioural interventions. This can be achieved through initiatives such as providing energy advice, offering tailored guidance on sustainable and cost-cutting energy conservation measures (DellaValle & Czako, 2022; Simcock & Bouzarovski, 2023). Installing smart meters can promote awareness of energy use (Shirani et al., 2020). This is especially pertinent in buildings with collective heating systems, where individual monitoring can encourage more sustainable energy consumption practices and ensure tenants are billed only for their own usage.
In some instances, SHPs act as *de facto* energy suppliers or mediators, further influencing the energy costs incurred by tenants. They may choose to absorb a portion of price hikes themselves or extend the duration over which these price increases are distributed and their substantial bargaining power as large entities may enable them to negotiate for lower prices.

In our analysis, we address the following inquiries:

1. What are the potential advantages of SHPs targeting interventions to alleviate energy poverty?
2. What are the potential disadvantages associated with targeting interventions by SHPs?
3. What practical or institutional constraints might affect the feasibility of targeting interventions in France, England, and the Netherlands as encountered or perceived by social housing professionals?

4.3 Methodology

4.3.1 Country and case selection

The empirical research consisted of six focus groups conducted in France, England, and the Netherlands. These countries were selected because of their traditionally substantial social housing sectors. Nevertheless, the nature, governance, and scope of SHPs somewhat differs between the three selected countries (Housing Europe, 2021).

In France, social rental housing constitutes 16% of housing stock and is managed by both private and public providers under strict central state regulations, with high and regionally varied eligibility income limits in order to promote mixed neighbourhoods (Amzallag & Taffin, 2010). England's approach, with social rental housing encompassing 17% of the housing stock, similarly involves a mix of public (local authorities) and private (housing associations) providers and places great emphasis on serving the lowest income groups. Dutch providers, private non-profit housing associations owning 29% of the total stock, have transitioned from a broad to a more targeted focus on the lowest income groups. They experienced great autonomy until a 2015 housing law increased central government regulation and supervision (Hoekstra, 2017).

Within the three selected countries, six major SHPs (see Table 4.1) were identified based on their substantial size and professionalism, positioning them to exercise thought leadership. Their size however also suggests organisational compartmentalisation, underscoring the need for involving participants from different parts of the organisation to gain diverse perspectives. Focus groups, comprising six to eight participants each, were carefully assembled with help from a liaison in each organisation, bringing together financial practitioners, real estate professionals, legal experts, and social workers to enrich discussions with multifaceted insights.

TABLE 4.1 Characteristics of social housing providers (SHPs) participating in this study

Country	% social housing	% EP in social housing	SHP scope	Organisation	Stock	Governance structure
France	16% (± 5.9 million units)	LIHC*: 25.5% in 2013 (ONPE, 2019)	Countrywide	Polylogis	145,000	NGO
			Paris Metropolitan Area	Paris Habitat	125,000	Owned by City of Paris
England (part of the UK)	17% (± 4.2 million units)	LILEE*: 17.5% in 2022 (DESNZ, 2023)	England	Clarion	125,000	Registered provider
			Greater London	Peabody	104,000	Registered provider
Netherlands	29% (± 2.2 million units)	LIHC*/LILEE*: 19% in 2021 (Mulder et al., 2023)	Amsterdam Metropolitan Area	Ymere	75,000	Housing association
			Rotterdam	Havensteder	45,000	Housing association

** Energy poverty indicators Low Income High Cost (LIHC) and Low-Income Low Energy Efficiency (LILEE)*

4.3.2 Focus group design

The six focus group sessions were held in the fourth quarter of 2022, guided by a semi-structured format. Focus groups were preferred over interviews for their facilitation of dynamic, interactive discussions enabling immediate validation of statements across departments, and over surveys for their capacity to produce richer, more nuanced data. The initial phase sought to establish a collective understanding of energy poverty within social housing, with participants being introduced to common definitions of energy poverty and queried about existing data and obstacles faced by their SHPs in collecting and utilising relevant information, as well as their short-term efforts in addressing the energy crisis. Following this, participants engaged in an in-depth discussion on crucial long-term interventions. These discussions were thoroughly documented to capture diverse viewpoints and suggestions.

4.3.3 Thematic coding and analysis

Following the conduction of the six focus groups, a rigorous and systematic analysis was undertaken to extract meaningful insights from the transcribed discussions. Informed by the framework that we have developed in Section 4.2.4, we applied a thematic coding approach to identify recurring themes, patterns, and key ideas that emerged during the focus group discussions. The primary objective of this comprehensive analysis was to identify and validate approaches that could effectively address energy poverty in social housing.

For this purpose, the analysis evaluated the desirability of proposed solutions, considering their potential impact on energy poverty alleviation and compliance with SHP's overall objectives. Feasibility was assessed in terms of financial resources, data accessibility, organisational competencies (e.g., technical expertise), the autonomy of SHPs within regulatory frameworks, and the likelihood of stakeholder resistance.

4.4 Results

4.4.1 Crisis measures mitigating energy poverty

In the wake of escalating energy prices in the autumn of 2022, SHP professionals were either anticipating or already experiencing a state of crisis. Many participants acknowledged that the harsh reality of energy poverty had *"woken us up"*, prompting a sense of urgency and a newfound awareness among them. In addition to existing government support[38], it led to the implementation of diverse crisis measures tailored to the unique circumstances and regulatory frameworks of each country yet driven by a shared goal of mitigating the impact on vulnerable residents.

38 In 2022 and 2023, several European countries implemented comprehensive price caps and support schemes aimed at assisting their tenants amidst the energy crisis. See for an overview: https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices

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In France, SHPs aligned with the national 'Energy Sobriety Plan' by enforcing regulated temperature limits while fostering awareness among tenants about sustainable energy practices and offering advice on entitlements and benefits access. England saw a variety of support mechanisms, including the distribution of energy and food vouchers and the introduction of 'Warm Hubs', communal heated spaces, where tenants could gather, find comfort, and shower without fearing their energy bill. One notable approach involved an SHP, which also served as heating supplier for part of its tenants, opting to temporarily absorb heating cost increases. Dutch SHPs opted for quick, impactful interventions such as providing LED lighting, radiator foils, shower heads, and radiator fans, while exploring the introduction of Warm Hubs. Finally, SHPs in all three countries decided to accelerate investments in improving their poorest performing stock.

4.4.2 Rent setting

Desirability

There was only limited support for targeted rent setting among all participants. They recognised the value of leniency in rent collection and suggested that rent discounts and hardship grants could provide temporary relief during challenging times for tenants, yet they emphasised that such interventions fail to tackle the underlying systemic issues of energy poverty. Indeed, this approach could negatively affect the investment and, consequently, the retrofitting capabilities of SHPs, ultimately worsening their ability to mitigate energy poverty over the long term. Participants also mentioned the risk that SHPs with outstanding rent payments might become the last creditors to be paid by tenants, due to their benevolent intentions. Moreover, there is a perception that national and local governments promptly resort to SHPs to tackle this issue, despite high energy prices being largely unrelated to SHPs' influence, as illustrated by a Dutch participant:

"So, your fuel costs are not related to your landlord, therefore why would your landlord give you a grant if you're struggling with your fuel payments? It is about roles and responsibilities. And what you find is the housing association picks up where the state is not meeting those needs."

Feasibility

This intervention raises several feasibility issues, as observed in all three countries. Theoretically, reduced rents may enhance tenants' ability to cover energy costs, but participants note there is no certainty that the freed-up funds will be dedicated to such expenses. Rather, tenants may allocate these additional resources to non-energy-related needs, such as food, clothing, and leisure. Furthermore, this intervention is at odds with the governments' housing allowance system in England, France, and the Netherlands. These allowances, which a significant portion of social rental tenants rely on, are determined by factors such as the income of the tenant and the rent level of the dwelling. As a result, lowering rents would simultaneously reduce housing allowances, effectively diminishing the net financial benefit for the tenant:

"If you do this, it means that the rent will go down with for example 21 Euro and the housing allowance goes down with 14 Euro. Thus, the net effect is minimal, with the state profiting more than the tenant."

4.4.3 Housing allocation

Desirability

The idea of targeted (re)allocation based on energy poverty risks received considerable support in all three countries. In France, social rental dwellings are primarily allocated based on a ratio of household income and estimated housing costs, the so-called *taux d'effort*. Since energy costs are included in the estimated prospective expenditure, albeit in standardised form, one may argue that energy poverty risks have already been integrated in the housing allocation system.[39] Nonetheless, some French participants see merit in more nuanced allocation mechanisms based on specific needs. For instance, they suggest allocating sun-exposed dwellings to elderly tenants, while acknowledging the potential risk of summer heat stress. Since individual preferences vary, such decisions might require personal consultation. Participants also stressed the zero-sum nature of housing distribution, highlighting that many current and prospective tenants are in a vulnerable position.

39 The '*taux d'effort*' refers to a ratio that combines housing expenses (rent, housing charges, individual expenses for energy and water) with the household's income (salaries, pensions, social security benefits) to evaluate the affordability of social housing. It aims to ensure that allocated households can manage their housing costs effectively.

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In England and the Netherlands, energy expenses are not incorporated into the criteria for housing allocation, leading to a consensus on the need for system reforms to safeguard vulnerable populations from being assigned to energy-inefficient housing. Dutch participants expressed particular dissatisfaction with the lack of consideration for energy costs in the allocation system. In the Netherlands, social housing allocation relies on a sophisticated choice-based system that enables applicants to select from available housing based on their income, age, family size, with priority given based on waiting duration. Although this system considers the ratio of income to rent, it does not take expected energy expenditures into account. A Dutch SHP once attempted to mitigate this oversight by informing applicants online with an estimation of energy costs in listings, but the practice was halted due to the minimal impact it had on applicants' choices amid long waiting periods. Dutch participants also highlighted the issue of 'empty nesters' occupying larger homes than needed, which is undesirable both from a housing market and energy poverty perspective. They advocated for incentivising moves to smaller, more energy-efficient homes through a personalised approach (*from big to warmer*).[40]

Feasibility

French participants identify data as a significant barrier for improved targeting in housing allocation, as they note that information used for *taux d'effort* calculations is aggregated and outdated, dating from before the energy crisis. This makes the data less useful and reliable in a context characterised by high and volatile energy prices. To enhance precision of policy targeting, some French participants propose considering non-income related aspects that could affect the risk of energy poverty, such as age or disabilities. However, the ability of SHPs to incorporate these factors is constrained by formal housing allocation rules and privacy regulations. Moreover, there is concern that such approaches could complicate the housing allocation process. In England, participants stressed that strong locational preferences of (prospective) tenants would make them reluctant to be (re)located on the basis of lower energy cost. Additionally, the overall scarcity of energy-efficient housing stock substantially impedes the feasibility of this proposed intervention.

40 Dutch SHPs promote relocating older tenants from larger single-family homes to smaller apartments through initiatives like the 'From Big to Better' program. This encourages circulation within the social rental sector and frees up larger dwellings for families with children. Since smaller dwellings generally exhibit better energy efficiency, energy poverty considerations could be further integrated into the programme by specifically targeting older households residing in large energy-inefficient dwellings.

Dutch participants highlighted a significant tension between current housing policies and the objective of mitigating energy poverty. The dwelling valuation system, which informs rent pricing within the social rental sector, incorporates energy efficiency into its 'quality points', resulting in higher rents for more energy-efficient dwellings. However, the current allocation rules stipulate that the lowest-income households are assigned to the lowest rent homes, not accounting for energy costs. Although economically logical in terms of rent, this approach can exacerbate energy poverty, as the most affordable units in terms of rent often have the poorest energy performance. This could be prevented by adopting the French model in the Netherlands, which considers both income and household characteristics on one hand, and overall housing costs, including energy expenses, on the other. Participants generally supported such a reform, despite some concerns over paternalism, as tenants can presently decide for themselves how much energy they would like to consume. Furthermore, like England, acute housing shortages constrain the feasibility of reallocation, and emotional attachment further complicates these efforts:

"A house is also a home. It is not a commodity that can easily be changed."

4.4.4 Prioritised retrofitting

Desirability

Across all countries, SHPs are prioritising the worst performing stock in their retrofit plans driven by regulatory arrangements with governments. Nevertheless, opinions differ on whether to incorporate social factors into this prioritisation. Most participants recognise the advantages of kickstarting retrofitting efforts in areas marked by significant hardship and energy poverty, but there are several principled concerns related to this matter that extend beyond the practical considerations discussed in the *Feasibility* section.

French participants expressed scepticism, partly due to a potential conflict between the goal of developing socially mixed neighbourhoods, as required by law[41], and prioritising retrofits for 'vulnerable' tenants. When allocating adjacent residences to heterogeneous groups based on social attributes, targeting retrofits may be less effective in alleviating energy poverty as benefits will extend to tenants without financial hardship, while simultaneously failing to reach at-risk households in

41 The French law "Egalité et citoyénneté" (equality and citizenship) of 2017 requires SHPs, among other measures, to allocate 25 percent of dwellings in less deprived areas to households with incomes in the lowest quartile.

more affluent neighbourhoods. Conversely, British participants were more open to prioritise retrofits for energy poor households, even if this would incur some extra expenses, but emphasise this would eventually depend on the cost-benefit-analysis. Interestingly, they point out a new ‘split incentive’ issue where the investments made by the SHP may not align with the greatest benefits for the residents. For instance, while solar panel installations would significantly benefit tenants, SHPs may consider them as less attractive investments compared to insulation measures due to the former’s limited lifespan and less significant impact on property valuation.

Dutch participants demonstrated strong support for prioritising vulnerable households, driven by the European energy crisis and concerns over a cost-of-living crisis among tenants. Furthermore, many participants perceive significant short-term potential in the targeted deployment of so-called ‘fix teams’ in neighbourhoods with the highest energy poverty. These consist of skilled craftspeople conducting door-to-door installation of modest insulation measures, such as weather stripping and radiator foil, in addition to fitting LED lighting and performing hydraulic balancing of central heating systems. A participant responsible for building technology states that fix teams could serve as a temporary mitigation measure:

“The tenants whose homes are not scheduled for retrofit for another ten years are now contacting me, asking when it is their turn because they want solar panels and better energy performance, especially now their bills are going sky high. If you could offer them a visit from a ‘fix team’, it makes your message easier to sell. We assure them that the large-scale renovation will indeed take place, but there will be a temporary solution in the meantime.”

Feasibility

There was an overall positive outlook on the feasibility of this intervention across the three countries studied, with varying degrees of success observed among experiments conducted. Nonetheless, several significant obstacles were highlighted by participants, including short-term investment horizons, high tenant turnover rates, low engagement of vulnerable tenants, and data deficiencies.

SHPs generally employ long-term investment models based on maintenance cycles. Therefore, a sequence of retrofitting activities is already in the pipeline, with scope for prioritisation limited to the margins of these pre-planned activities. Furthermore, while prioritising individual housing units is considered impractical due to financial and logistical constraints, it is deemed feasible at larger scales, such as the neighbourhood or building complex level. In fact, all SHPs cited instances where retrofitting projects were expedited due to socioeconomic needs of the neighbourhood.

The importance of cost modelling emerged consistently in the discussions among British participants. While they found prioritised retrofitting an interesting approach, they emphasised the need for *'a backing from finance'* in making decisions on policy targeting. Nevertheless, one SHP professional from England pointed out that unless the housing stock is eventually disposed of, the responsibility for such properties will endure into the future. Consequently, retrofitting expenses are bound to be incurred eventually, and short-term financial considerations should not hinder the adoption of this intervention:

"It just depends how long you model it over. If you're talking 30 or 60 years, you're still going to incur that cost at some point therefore you might as well deal with the residents that need it most at the beginning."

Moreover, participants raised concerns regarding the high turnover rate of tenants, which poses a potential risk to this intervention. Frequent turnover renders decision-making information quickly outdated; a concern shared by French professionals due to the extensive 'preparatory period' of retrofitting projects. They note that between the decision to retrofit a building and the commencement of the work, 30-40% of the tenancy contracts could be renewed. One additional challenge raised by French participants concerns the necessity of educating tenants on using the technical equipment installed during renovations. More advanced heating systems can sometimes be rather difficult to operate, leading some households unfamiliar with them to deactivate and revert to less efficient, individually controllable alternatives, possibly exacerbating energy poverty. To familiarise them with new systems, it is important to complement targeted renovation initiatives with engagement of tenants in training programmes and to develop user-friendly interfaces.

Despite these challenges, two experiments involving prioritised retrofitting were reported. One is presently underway following an early 2022 quantitative study on energy poverty among tenants, commissioned by a Dutch SHP, which has begun to influence prioritisation decisions within its renovation strategy.[42] While its primary focus is on addressing hazardous housing conditions, followed by improving the poorest performing stock (energy labels E, F, and G) as mandatory by 2028, energy poverty statistics have emerged as a third criterion for targeting retrofits and already serve as a *"crucial foundation"* for decision-making. Another experiment based on statistics was identified in England, where one SHP had already developed an energy poverty indicator in 2011 with the intention of targeting retrofits to where they are most needed. Nevertheless, the new indicator ultimately remained underutilised

42 See https://www.woonbond.nl/nieuws/veel-huurders-ymere-kampen-energiearmoede

in prioritising retrofits due to IT issues impeding information sharing between departments and concerns regarding data reliability stemming from incomplete records beyond the start of a rental period:

"Until our data is more reliable and trustworthy, it's very, very difficult to say: 'Let's build a whole programme around it'."

In France and the Netherlands, participants also stressed the availability of reliable individual-level data as essential for incorporating social characteristics into retrofitting prioritisation. While Dutch participants view it as presently feasible, acknowledging the potential requirement for external expertise, it represents a substantial obstacle in France.

4.4.5 Targeted information campaigns

Desirability

There is widespread consensus among participants regarding the necessity of providing tailored information to tenants, particularly those at risk of energy poverty. The discussions surrounding this intervention sparked debate about the obligations of SHPs towards tenants and their role in society.

British participants mentioned that their national government's decade-long austerity measures on public services had created a void that was filled by SHPs and other civil society actors. They now perceive financial and energy assistance as a fundamental responsibility of SHPs, primarily driven by a shared feeling of moral duty to aid vulnerable tenants, particularly amidst the cost-of-living crisis. While French participants expressed strong support for behavioural interventions, some also emphasised the responsibility of their tenants. This led to disagreements among participants over tenants' agency regarding collective heating systems controlled by SHPs and billing often based on occupied square meters, resulting in discussions on the desirability of installing smart meters for individualised energy cost allocation. One perspective highlighted the 'fairness' of adopting an individualised approach and the related sustainability benefits, as tenants would be incentivised to conserve energy through the prospect of receiving lower bills. However, others cautioned about unhealthy energy rationing, arguing that collective heating systems prevent tenants from excessively restricting energy usage due to financial concerns, with one participant recalling a dramatic situation from experience:

"On a recent occasion, I remember a situation in which a gentleman accidentally set his mattress on fire, basically because he was using candles for heating."

The obligation to provide tailored advice was particularly recognised after a retrofit. Participants consider it crucial to provide detailed instructions on the proper use of various installations, such as floor heating, solar water heaters, and balanced ventilation systems. Neglecting to offer such information could result in lower-than-anticipated energy savings. Furthermore, SHPs may also be motivated by self-interest to disseminate this advice, as inadequate ventilation or improper use of appliances might lead to the degradation of the property. An illustrative example that highlights this issue is the destructive cycle of moisture accumulation and energy poverty. Tenants drastically cut back on heating to save on expenses, leading to colder and subsequently damper living conditions. However, the presence of damp necessitates increased heating to restore a comfortable temperature, paradoxically elevating concerns over rising energy expenditures. Promoting tenants' energy literacy[43] by informing about the benefits of using their ventilation grilles could prevent such issues, encouraging them to keep these features open instead of sealing them to reduce expenses.

Participants across all three countries recognise that behavioural interventions can take many forms and their effectiveness may vary depending on the specific tenant group. French participants discussed a broad spectrum of interventions, including the engagement of tenants as energy ambassadors and the creation of a toll-free helpline for energy support. In England, the provision of energy support frequently incorporates financial advice, offering assistance in securing favourable energy contracts, conducting benefit assessments, and providing employment support. Dutch participants highlight the necessity of a personalised approach, acknowledging the diverse characteristics and behavioural patterns of tenants:

"We actually need to provide tailor-made solutions for tenants. We can't generalise them. A family is different from a single person or a couple."

Feasibility

All SHPs have implemented energy advice campaigns, ranging from universal strategies like information on websites and public spaces, to more tailored approaches such as in-person home-visits going through actual energy usage. In certain cases, these interventions were specifically targeted at segments of the housing stock identified as being at high risk of energy poverty.

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43 See DellaValle and Sareen (2020) for additional examples.

Targeting behavioural advice is considered a more moderate intervention compared to basing housing allocation, rent setting, or retrofit prioritisation on social characteristics, and is therefore less hindered by concerns surrounding data accuracy. British participants refer to the warm hubs as a rather targeted way to provide behaviour advice, since they attract the most at-risk tenants. Frontline staff at one SHP have tried to introduce a 'flag' system to focus outbound advisory calls on tenants identified by certain 'risk factors', such as dependence on prepayment metres, residing in energy inefficient homes, or receiving social benefits, especially during winter months when energy poverty is most acute. However, IT and data constraints have posed significant challenges to the implementation of this system:

"In an ideal world, the fuel poverty score should be something that's stored in CRM. So that, if you answer the phone to someone, you get a flag to say this person is in risk of fuel poverty, perhaps direct them. That's not possible at the moment."

In the Netherlands, for instance, one SHP was investigating how to target its 'energy coaching' services on 'attention estates', defined as estates with high energy consumption and poor insulation. Notably, policy targeting is informed not just by statistical data but also by insights from neighbourhood workers and local stakeholders. The SHPs also refer tenants with perceived energy poverty risk to other civil society actors that provide energy advice, including energy banks, community centres, and social organisations. One participant emphasised the effectiveness of face-to-face information delivery, with an emphasis on revisiting messages in subsequent interactions and extending outreach to community homes or places of worship:

"We do have a challenging target audience, people who don't understand it or are not proficient in the language. So yes, in my ideal world, we go door to door, and try to find a way in."

An interesting approach in France involved employing resident ambassadors to aid their neighbours. SHPs also organise awareness events, but these mostly attract residents who are already convinced or potentially receptive to the message. Participants note they struggle to engage resistant, disinterested, and notably, the vulnerable groups who are most in need of support.

Table 4.2 in the conclusion section summarises the main advantages and disadvantages of different interventions targeted at social housing tenants experiencing energy poverty.

4.5 Discussion

There is widespread consensus among participants regarding the necessity of providing tailored information to tenants, particularly those at risk of energy poverty. The discussions surrounding this intervention

The recent surge in energy prices has brought energy poverty issues to the forefront of SHPs' agendas, making our data collection during the price peak in autumn 2022 notably timely. While it must be acknowledged that the heightened awareness during this period might have influenced SHPs' dynamics of responsibility – possibly skewing the full extent of the sector's readiness for targeted interventions – it undeniably opened a window of constructive and imaginative discussion on integrating energy poverty mitigation within SHPs' traditional objectives.

A principal rationale for participants' motivation to provide targeted assistance to vulnerable tenants stems from their first-hand encounters with the impact of the cost-of-living crisis. This is reflected in the numerous anecdotes about energy deprivation of tenants that participants in all focus groups shared. However, the sessions reveal distinct approaches to the tenant-landlord relationship, especially in terms of balancing solidarity with tenant autonomy. French SHPs seem to lean towards a more top-down approach in their efforts to address energy poverty, favouring communal heating systems over individual ones to prevent excessive energy rationing. In contrast, SHPs in the Netherlands and England rather emphasise tenant autonomy, with a preference for individual meters and supporting tenants' agency to make their own housing and heating decisions (Wahlund & Palm, 2022). This contrast suggests that while targeted interventions can be beneficial in all contexts, tailoring and differentiating approaches to meet specific needs of vulnerable tenants might be better suited for implementation by SHPs from the latter countries.

More generally, while the strategies discussed in this study reflect approaches in three European countries, we think they have a broader applicability. However, extrapolating our findings to the rest of the region requires careful consideration of the varied political, economic, and social landscapes, as well as the role of SHPs across different member states.

Another significant theme that occurs is the role of SHPs in society and their interaction with government, aspects deeply influenced by political economic and historical contexts (Lévy-Vroelant et al., 2014). In England, energy poverty has been a topic of political discourse since the energy crises of the 1970s, exacerbated by extended periods of austerity, notably in the 1980s and the 2010s, when the government reduced public spending (Middlemiss, 2016). This backdrop explains why participants from an English SHP felt compelled to pioneer the use of statistics in 2011 to identify and offer targeted support to tenants experiencing energy poverty, stepping in to fill gaps left by the government. Dutch participants willingly assist municipalities in pinpointing households for government energy allowances, highlighting the country's commitment to cooperative 'early detection' in social welfare (Van der Schoor et al., 2021).[44] Yet, their frustrations about the government imposing rent freezes also reflect a broader concern regarding the allocation of responsibilities amidst a cost-of-living crisis for which they do not feel accountable. Conversely, French SHPs express a rather positive view of their relationship with the state, readily embracing government regulations like the cap on indoor temperatures, showing a more harmonious alignment with state directives. These differences suggest that SHPs' motivation to target energy poverty support intensifies when there is a lack of confidence in state interventions. This highlights the importance of broader international comparisons in a research area that frequently concentrates on single-country studies. However, further research would be necessary to confirm the exact nature of the relations between confidence in state intervention and the motivation to adopt targeted approaches.

The willingness of SHPs to adopt targeted interventions often hinges on strategic alignment of temporal challenges and organisational objectives. This balancing act is influenced by various commitments, such as adhering to decade-long plans for building thermal upgrades and maintaining long-term social diversity in neighbourhoods. Additionally, comprehensive, long-term solutions like prioritised retrofitting and allocation reform take years to put in place and fail to address immediate crises, while short-term interventions such as rent freezes provide only temporary relief and are resource intensive. A solution that falls somewhat in the middle is the emergence of 'fix teams' in the Netherlands and elsewhere in Europe (Barrella et al., 2021). These offer fast, surface-level retrofitting to households facing energy poverty, filling the gap before extensive renovations take place, therefore presenting an intriguing area for further research. The question of investment horizons also presents an ongoing debate, with British participants highlighting that adopting a longer-term perspective would facilitate prioritising retrofits for those in need.

44 Dutch SHPs are particularly equipped to do so due to their increasingly residualised nature, as discussed in 2.2.

While it is premature to determine whether SHPs' increased commitment towards energy poverty and their engagement with targeted interventions will persist, the recent energy crisis might have sharpened their awareness of their significant impact in this area, as depicted in Figure 4.1. For instance, internal discussions on a novel 'split incentive' dilemma – where SHPs favour retrofitting measures that boost property value, whereas tenants prefer solutions that reduce their short-term energy bills, reflects this growing consciousness (Desvallées, 2022). This awareness might not revolutionise their strategic decision-making but could shift longstanding practices rooted in a techno-economic perspective on the energy transition (De Feijter et al., 2019), steering towards more equitable, people-centred outcomes in achieving a 'just' transition. Notably, academic discourses on energy justice, such as energy communities, have yet to gain significant traction in SHPs' internal dialogues (Aruta et al., 2023).

4.6 Conclusion

To analyse how social housing professionals in France, England, and the Netherlands perceive and utilise targeted approaches to alleviate energy poverty among tenants, we conducted six focus groups examining potential interventions, challenges faced, and perceived responsibilities by SHPs in this domain. Our study reveals a strong commitment among SHPs to combat energy poverty, spurred by the recent energy price crisis, their unique role in the social fabric, and, sometimes, governmental inaction. Participants expressed a keen enthusiasm for various targeted interventions to address energy poverty, but several limitations exist (outlined in Table 4.2). Here, we highlight our study's main insights and suggest policy recommendations.

Identifying the target group is a fundamental part of policy targeting, and thus, the limited data available to SHPs forms a primary challenge in addressing energy poverty. This requires a deep understanding of how energy poverty is distributed across the housing stock and a knowledge of tenants' financial capabilities and energy needs (Bridgen & Robinson, 2023). Yet, SHPs face considerable obstacles, including limited data gathering capabilities constrained by privacy laws and a general lack of specific tenant information. Some SHPs have leveraged local insights from neighbourhood workers to guide their energy advice services, highlighting the value of using intermediaries to identify 'hard-to-reach' households affected by energy poverty (Dubois & Sinea, 2023). However, for more impactful strategic decisions, such as determining retrofit priorities or reallocating vulnerable households, a more granular level of data is essential. The role of governments becomes critical here; by facilitating access to data within the confines of privacy regulations, they can empower SHPs in their efforts to combat energy poverty. The example of a Dutch SHP that successfully modelled energy poverty within its housing stock underscores the transformative potential of enhanced data accessibility. Nonetheless, the potential stigma associated with being labelled as 'energy poor' necessitates careful consideration to avoid unintended consequences (Longhurst & Hargreaves, 2019).

TABLE 4.2 Comparison of methods for targeted energy poverty interventions in social housing

	Types of policy targeting by SHPs			
	Rent setting	Housing allocation	Retrofit prioritisation	Information campaigns
Potential advantages (desirability)	Temporarily alleviates hardship (participants prefer leniency in rent collection as a similar measure)	Precise: policies targeting vulnerability characteristics (or energy needs) at house-hold-level Considering expected energy expenses as housing costs, as practiced in France, mitigates the risks of energy poverty from the onset of tenancy	Lasting impact: addresses root cause of energy poverty	Improves household resilience and knowledge Increases the gains in energy consumption reduction following renovation
Potential disadvantages (desirability)	Bureaucratic process, need for extra rent-setting criteria May reduce housing allowance, lowering net gains for tenants Undermines long-term investment capacity of SHPs	Only distributional in nature, does not address root causes Neglects households' emotional attachment to homes and other factors that influence their preference for certain dwellings or areas.	Relatively inaccurate, since whole buildings or neigbourhoods are targeted with policies Renovations could be more expensive or slow than with a techno-eco-nomic approach	Risk of individualising the responsibility of energy poverty Lack of trust may complicate information transfer
Practical or institutional constraints (feasibility)	Requires (long-term) reliable household data May conflict with regulations on rent setting in social housing	Requires reliable data on energy needs Challenging to implement in an overheated housing market with strong demand for social housing	May conflict with long-term planning (renovation pipeline)	Difficult to reach the most vulnerable groups

Moreover, our discussions with social housing professionals highlight the complexity of choosing effective delivery mechanisms. Prioritising retrofits for energy-poor tenants seems to yield significant and lasting benefits but is fraught with logistical challenges, such as lengthy preparatory phases and the risk of energy poor tenants relocating before the works commence. Reallocating at-risk households to energy-efficient dwellings is a preventive approach against energy poverty yet constrained by government regulations and a general scarcity of (energy efficient) housing, with participants critiquing it for merely tackling distributional issues without facilitating systemic change. Temporary rent reductions are viewed rather unfavourably as a means of providing immediate financial relief because they compromise the long-term ability of SHPs to perform their tasks adequately. Providing tailored energy advice to vulnerable tenants is considered a feasible and effective intervention to alleviate energy poverty. Nevertheless, further research is necessary to evaluate the impact of such interventions (Simcock & Bouzarovski, 2023) and to devise approaches for engaging tenants who may face language barriers or digital literacy challenges (Bouzarovski et al., 2022).

Finally, we underscore the importance of clearer institutional definitions of roles and responsibilities in mitigating energy poverty (Bednar & Reames, 2020). This would also necessitate a societal and political debate on whether SHPs should proactively aid in achieving a fair transition and support those in need, or concentrate on operational efficiency to fulfil other objectives, like constructing new affordable housing. Such discussions could also garner political backing for specific intervention strategies. Moreover, housing policies must account for expected energy costs when establishing allocation or rent allowance systems based on housing's 'operational' costs. While France implements this through the *taux d'effort* system, the absence of such a practice in the Netherlands often leads to vulnerable households living in energy-inefficient dwellings, inadvertently fostering energy poverty from the outset of a tenancy. Therefore, total housing costs, including likely energy costs, should be the starting point for housing policy interventions targeted at vulnerable groups, emphasising the need to align existing regulatory frameworks with energy poverty alleviation objectives.

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5 Local experimentation with behavioural and physical interventions

This chapter is based on a peer-reviewed article published as:
Croon, T. M., Nia, E. M., He, S., Qian, Q. K., Elsinga, M. G., Hoekstra, J. S. C. M., Van Ooij, C., & Van der Wal, A. J. (2025). Energy coaching and 'fix team' retrofitting to mitigate energy poverty: An ex-post analysis of treatment and interaction effects. *Energy Research & Social Science, 119*, 103807.

ABSTRACT

Rising energy prices across Europe have increased concerns over energy poverty. Despite significant scholarly focus on financial relief measures instituted by national governments, locally tailored crisis measures have remained overlooked. This study delves into the Dutch context, where part of the government's response to the energy crisis was decentralised, allowing municipalities considerable discretion in experimenting with energy poverty interventions. It compares two strategies: 'energy coaching' services – offering advice on sustainable energy practices – and shallow retrofitting by 'fix teams' – installing minor energy-saving measures in homes. The impact of these interventions on residential comfort, sustainable behaviour adoption, and (financial concerns regarding) energy bills is assessed through an extensive survey involving treatment and control groups coupled with detailed administrative data on households and dwellings. Results indicate that, on an aggregate level, local interventions significantly enhanced perceived comfort and reduced energy bills among the treatment groups. Comparing individual interventions, notably, more extensive ones such as fix teams and comprehensive energy coaching were significantly more impactful than those involving a single visit, highlighting the importance of continuous engagement. Additionally, we found that energy poverty status significantly amplified the effectiveness of these interventions, thereby stressing the importance of targeting interventions on vulnerable households.

5.1 Introduction

In recent years, the rising energy prices across Europe have increased concerns regarding energy poverty, a phenomenon characterised by households' inability to afford adequate energy services to maintain a comfortable standard of living (Middlemiss & Gillard, 2015; Mundaca et al., 2023). This complex and multifaceted problem, linked with factors such as income, energy needs, and the energy efficiency of housing, calls for localised, tailored, and targeted solutions that are context-specific (Reames, 2016; Walker & Day, 2012). Specifically in-person home visits for energy coaching and shallow retrofitting have been recognised as effective strategies, although their overall impact is still understudied (DellaValle & Czako, 2022; Simcock & Bouzarovski, 2023).

Energy coaching typically involves motivated volunteers providing guidance and feedback to residents to encourage sustainable behaviour and offer practical tips for reducing energy consumption, aiming to increase residential comfort and affordability of energy (Green et al., 1998). The terms 'energy coaching' and 'energy advice' are often used interchangeably, but this paper adopts the former terminology for uniformity since this is the preferred term in the Netherlands, where the interventions took place (Schneider et al., 2023). Whereas typical information campaigns have a broad target audience, the distinguishing feature of energy coaching is that it is *"specific to individuals and their circumstances"* (Boardman & Darby, 2000). Ambrose et al. (2019) identified four distinct energy coaching services: reducing energy costs through switching suppliers or tariffs, reducing energy demand through energy efficiency improvements and awareness of energy-conserving behaviour, increasing income by guidance on energy-related benefit claims, and navigating consumer rights. In-door behavioural advice could range from pointing residents to likely high-consuming appliances, washing at lower temperatures, switching off lights, and keeping doors in living areas closed to ensure they remain warm. The nature and frequency of these interventions can vary significantly.

Critics have argued that an emphasis on energy coaching serves a neoliberal form of governmentality, attributing the blame for energy poverty to individual responsibility (Malier, 2019). They suggest that 'behavioural interventions' presuppose that better-informed individuals will naturally make *smarter* or *more ethical* choices leading to lower energy consumption. However, energy consumption patterns frequently extend beyond an individual's direct sphere of influence, providing an obstacle to the effectiveness of demand-side advice services (Hall, 2013; Royston et al., 2018).

Moreover, low-income households, particularly those in inefficient dwellings, are often already doing as much as they can to conserve energy and reduce their bills, and if pushed further, some may end up sacrificing residential comfort by severely restricting their use of heating (Chen et al., 2017). Simcock and Bouzarovski (2023) emphasise that while energy coaching can be beneficial, if done thoroughly, it should complement, rather than replace, more substantial structural improvements of housing conditions.

A rather understudied physical intervention that is increasingly popular is shallow retrofitting, often seen as an interim measure before undertaking more comprehensive, deep renovation work (Barrella et al., 2023; Semprini et al., 2017). The difference between the two lies in the fact that deep renovations, though expensive, encompass comprehensive insulation measures throughout all building components aimed at achieving (near) zero-energy status, whereas shallow retrofits offer a more cost-effective alternative, focusing primarily on reducing heat loss through small-scale insulation and draught proofing (Elnagar et al., 2023; Milne & Boardman, 2000). Shallow retrofits are typically carried out in stages, beginning with a basic 'home energy audit' to identify easily achievable efficiency upgrades (Baker et al., 2019; Pierse et al., 2020), followed by installation of top-up insulation and the optimisation of hydraulic distribution within domestic space heating systems, among other services (Ahern & Norton, 2015; Reeves, 2016).

This paper aims to evaluate the effectiveness of energy coaching and shallow retrofitting interventions in improving the well-being of those affected by energy poverty. In an early study on home visits, Darby (1999) states that 'success' should be assessed in terms of gains in energy savings, comfort, health, and financial relief from energy costs. It is important to emphasise that these can sometimes be in conflict; for instance, setting the thermostat to very low temperatures may achieve energy savings and financial relief but potentially at the cost of reduced comfort or unhealthy living conditions. Focusing on the Netherlands, where local governments have significant leeway to address energy poverty with community-specific solutions, this study investigates the effectiveness of tailored strategies such as 'fix teams' and 'energy coaching' services. Importantly, this study introduces a pioneering approach by integrating survey data on perceived impacts with administrative microdata detailing respondents' actual living conditions and background characteristics. This methodological innovation allows for a nuanced analysis that not only confirms the existence of an impact but also illustrates the conditions under which these interventions succeed.

The paper is structured as follows: Section 5.2 introduces the Dutch interventions under study. Section 5.3 reviews related literature on similar interventions and their effects on criteria such as occupants' comfort, sustainable behaviour, energy bills, and financial concerns relating to energy bills, resulting in the formulation of hypotheses. Subsequently, Section 5.4 outlines the methodology, including survey data collection and statistical analysis, followed by Section 5.5, which presents the empirical results of the Dutch interventions' effectiveness. Finally, in Sections 5.6 and 5.7, we discuss results and present recommendations for future policymaking and research avenues.

5.2 The partly localised Dutch response to the energy crisis

Historically, the Netherlands experienced relatively low levels of energy poverty compared to other European countries, with Dutch policymakers not recognising it as a distinct policy issue (Feenstra et al., 2021). Nevertheless, Mulder et al. (2023) found that, prior to the 2021 energy price hike, over 8% of households spent more than 10% of their income on energy. Furthermore, Croon et al. (2023) showed that a small portion of the population faces intense energy poverty, characterised by significant poverty gaps, making them rather vulnerable to fluctuations in energy prices.

During the energy crisis, starting in 2021 and peaking after Russia's invasion of Ukraine, the Dutch government significantly altered this decade-long position, intervening extensively in the energy sector (Devenish & Lockwood, 2024). While it aimed to limit interventions to provide only targeted support to those in need, thus minimising market distortions while preserving incentives for energy conservation, the costliest measures were broad-based, including both tax cuts and a price ceiling (Sgaravatti et al., 2023). However, the Dutch government also announced a targeted energy allowance for low-income households and designated funds for local energy poverty interventions. Moreover, it dedicated €368.5 million to municipalities, earmarked explicitly to address drivers of energy poverty according to local needs and circumstances (Maghsoudi Nia et al., 2024). Still, considerable autonomy was granted, enabling municipalities to experiment with innovative strategies towards this objective.

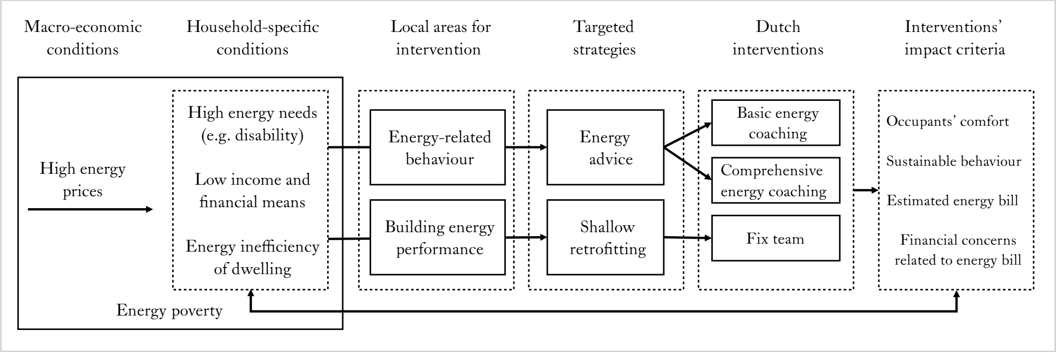

FIG. 5.1 Conceptual framework highlighting the potential impact of targeted Dutch interventions on energy poverty outcomes

Within this policy context, municipalities predominantly adopted two targeted approaches (see Figure 5.1): one aimed at providing information to low-income households on sustainable behaviour and efficient appliance and heating system use, and the other directed at small but impactful physical improvements of their homes (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023). While local interventions frequently tried to combine these two strategies, the former strategy principally sought to promote sustainable behaviours and energy conservation, thereby helping to lower energy expenses. In contrast, the second strategy aimed to reduce energy bills through shallow retrofitting. Therefore, the strategies addressed different drivers of energy poverty, the former targeted the high energy demand of households and the latter focused on the energy inefficiency of the dwelling.

This study examines three local initiatives (detailed characteristics provided in Table 5.1): two aligned with the behavioural strategy but differing in scale – one basic and one comprehensive in terms of visit frequency and duration – and another focusing on the physical strategy through shallow retrofitting. Despite being established prior to the onset of the energy crisis, all three initiatives received municipal support as part of the energy crisis funding. They all target low-income households with their services and aim to mitigate energy poverty, alongside a secondary objective of training 'coaches' or 'fixers' facing barriers to employment.

TABLE 5.1 Background of the Dutch local interventions under study

	Basic Energy Coaching	Comprehensive Energy Coaching	Fix Team
Starting year	2014	2016	2018
Location	Utrecht	Arnhem	Amsterdam
Target group	Low-income households	Low-income households	Low-income households in energy-inefficient dwellings
Background of service providers	Local job seekers with technical expertise	Volunteers, freelancers, and job seekers transitioning to full-time employment	Long-term unemployed and skilled refugees
Training duration	3-6 weeks	6 weeks	26 weeks
Training trajectory of service providers	Theory on energy conservation, conversational techniques, social skills, system usage, and administration (incl. shadowing a colleague)	Theory on target groups, motivational techniques, energy measurement, and administrative protocol (shadowing a colleague during one visit)	One-on-one apprenticeship involving theoretical instruction coupled with substantial practical implementation of energy-saving measures
Visit frequency	1-2 visits	3-5 visits over six months	2-6 visits (on average 3 visits)
Duration of 1 visit	1-1.5 hours	2 hours	6 hours
Support provided	Focus on behavioural advice, along with providing an energy box containing small energy-saving measures	Focus on behavioural advice, with the service provider also implementing basic energy-saving measures	Focus on implementing energy-saving measures with some behavioural advice
Nature of advice	Structured questionnaire offering saving tips (minimising shower time, washing with full loads, defrosting the fridge, etc.)	Structured questionnaire offering saving tips (minimising shower time, washing with full loads, defrosting the fridge, etc.)	Help with issues like curtain length, radiator clearance, ventilation, and behaviour-based energy-saving
Implemented energy-saving measures	The energy box contains radiator foil, draft strips, LED bulbs, power strips, shower timers, and showerheads	Applying radiator foil, draft strips, door brushes, letterbox brushes, window insulation film, power strips, and occasionally radiator fans	Hydronic balancing, ventilation maintenance, infrared scanning, installing draft strips, replacing thresholds, upgrading frame profiles and door frames, applying radiator foil and window frame foil

5.3 The impact of energy coaching and shallow retrofitting services

In this section, the existing literature on the impact of energy coaching and shallow retrofitting services is examined, focusing on occupants' perceived comfort, their adoption of sustainable behaviour, reduction of energy bills, and alleviation of financial concerns. These studies serve as the basis for formulating hypotheses that guide the analysis of the findings in this paper and inform the subsequent discussion on the effectiveness of the interventions under study.

5.3.1 Improvement of occupants' comfort

The rationale behind a causal relationship between energy coaching and occupants' comfort stems from the notion that making informed decisions on energy-related behaviour leads to reduced residential consumption and enhances the overall comfort of living spaces. For instance, proper ventilation advice can lead to significant improvements in terms of reduced dampness and improved thermal comfort (Boomsma et al., 2017; Ramsden, 2020). Moreover, Bashir et al. (2013) demonstrated that providing guidance on energy conservation and installing draft-resistant measures enhanced residents' perceptions of warmth and comfort. Notably, Darby (1999) already found that when energy coaching is targeted at households living in poverty, it can yield considerable advantages in terms of comfort, health, and well-being, with approximately 75% of residents reporting a warmer and more comfortable indoor environment. Further, Baker et al. (2019) observed that thermal comfort substantially improved after an energy coaching intervention, particularly in cases where households previously demonstrated energy rationing. Ringel (2018) noted that some residents may resist accepting energy coaching when it necessitates compromising on thermal comfort.

Shallow retrofitting can have a more direct effect on residential comfort as perceived by occupants since energy efficiency improvements, like draught-proofing, enable a more consistent distribution of warmth within the dwelling, and therefore reduce the risk of dampness and mould (Milne & Boardman, 2000). While quantifying occupants' comfort poses challenges, one method involves examining energy usage increases related to comfort-seeking. For instance, Lomas (2010) measured that households might allocate a portion of their energy cost savings as a result of shallow retrofits towards enhancing their thermal comfort, potentially offsetting as much as 50% of the expected energy savings. This suggests the presence of trade-offs between the various outcomes under study in this article. Another thing to consider is interaction terms. Elnagar et al. (2023) underscored the influence of building typology for enhancements in thermal comfort. Moreover, Barrella et al. (2023) reported that shallow retrofits had more profound impact on the perceived residential comfort of occupants in 'hidden energy poverty', those constraining energy usage due to financial constraints, yet again highlighting the interaction between energy rationing and perceived comfort improvements.

H1.1 All local interventions under study improve occupants' perceived residential comfort.

H1.2 Shallow retrofitting has a greater impact on perceived residential comfort than energy coaching.

5.3.2 Adoption of sustainable behaviour

Energy coaching, by highlighting consumption patterns and their financial and environmental impacts, has been documented to positively affect residents' awareness towards sustainability and encourage sustainable behaviour. Baker et al. (2019) and Reeves (2016) suggested that simple actions such as closing curtains at dusk, using appliances more efficiently, and lowering thermostat settings are influenced by energy coaching. Darby (1999) estimated that behavioural change alone can lower energy consumption by up to 10%. Once behaviour is adopted for over three months, it is likely to persist for at least a year, demonstrating the enduring impact of energy coaching on household habits. However, the effectiveness of energy coaching in altering sustainable behaviour is not uniform. Schneider et al. (2023) noted significant behavioural changes following a visit of an 'energy coach', but crucially, this reduction was observed only among those who were made aware of their higher-than-average energy consumption, pointing to a social comparison effect (Abrahamse & Steg, 2013). Contrarily, Revell and Stanton (2014) and Mahapatra et al. (2011) reported minimal impact of home visits on changing behaviour, even when residents proactively requested the advice. Darby (1999) suggested that the success of energy coaching in changing behaviour is significantly influenced by the interplay between the advisor's characteristics, the client's profile, and the context of the advice given. Further complexity is added by Bouzarovski et al. (2022), who observed that energy coaching services in the UK are not sufficiently tailored to the needs and behavioural patterns of migrant groups, negatively affecting the relevance and therefore effectiveness of the advice provided.

The behavioural impact of physical interventions, such as a Fix Team's shallow retrofitting, is less intuitive. Yet, these interventions can still promote sustainable behaviour, as evidenced by Mahapatra and Gustavsson (2007) who found that technicians installing retrofit measures act as vital information sources, shaping residents' interactions. Revell and Stanton (2017) further argued that integrating behavioural advice with physical interventions can have substantial impacts, emphasising a holistic 'systems view' on behaviour rather than focusing solely on outputs from individual devices. Notably, while shallow retrofitting can lead to significant energy efficiency improvements, they might also trigger 'rebound effects' (Berkhout et al., 2000), as previously hinted at in the context of comfort-seeking. Following this logic, recipients may respond by adopting less sustainable behaviour, or simply ceasing energy rationing behaviour as demonstrated by Sunikka-Blank and Galvin (2012), since they feel they can 'afford' to do so post-intervention. The impact of shallow retrofitting on sustainable behaviour may thus result from spillover effects (Rabaa et al., 2024). These effects can be positive, due to increased awareness of energy consumption and a drive to avoid the cognitive dissonance of living unsustainably in an eco-friendly home, or negative, exemplified by moral licensing where residents believe they have 'done enough' by improving energy efficiency, leading to rebound effects. Thus, while shallow retrofitting can contribute to sustainable practices, its indirect nature and potential for rebound effects may limit its overall effectiveness compared to the more direct and targeted approach of energy coaching.

H2.1 All local interventions under study promote the adoption of sustainable behaviour practices.

H2.2 Energy coaching is more effective in fostering the adoption of sustainable behaviour practices than shallow retrofitting.

5.3.3 Reduction of energy bill

Energy coaching promotes efficient behaviour, which reduces the amount of energy required to maintain a given indoor temperature and therefore the energy bill (Milne & Boardman, 2000). Especially when targeting households in financial distress, Boardman and Darby (2000) estimated a potential 10% reduction in energy bills post-intervention. Emphasising this, Ramsden (2020) and Reeves (2016) reported average annual savings of around £125 to £129 for households in the UK, which were attributable to behavioural change. One Dutch study reported that a year after the visit of an energy coach, gas consumption had decreased by 8.4% and electricity consumption by 6.3% (Schneider et al., 2023), and another Dutch study estimates that when socially and technically equipped energy coaches visit households more than once the annual cost-saving potential could be around 100 euros (Straver et al., 2017). Nonetheless, studies by Revell and Stanton (2017) and Mahapatra et al. (2011) reported only minimal reductions, suggesting a variance in the impact of energy coaching on energy bill affordability.

Reducing energy bills is also a key goal of shallow retrofits, but in this case primarily achieved by enhancing the efficiency of the dwelling rather than promoting more sustainable behaviours. For example, a study from Spain showed that straightforward actions like weather stripping can reduce heating demand by 5% to 19% (Barrella et al., 2023). In the UK, Green et al. (1998) found that a blend of home energy audits and small physical upgrades, along with energy coaching, was linked to a monthly reduction of about £15 in energy bills, but the authors also note that while the savings from behavioural changes are uncertain, the potential energy savings from efficiency improvements or replacing appliances also vary widely. When effectively targeted at households with clearly identifiable and solvable energy challenges, shallow retrofitting can address relatively straightforward issues with high impact at low cost. Still, the direct nature of these interventions, shallow retrofitting tends to produce more consistent reductions in energy bills compared to energy coaching.

H3.1 All local interventions under study reduce the estimated energy bills of households.

H3.2 Shallow retrofitting yields greater reductions in estimated energy bills than energy coaching.

5.3.4 Alleviation of financial concerns related to energy bills

The role of energy coaching has been particularly highlighted in exploring the alleviation of financial concerns related to energy bills. An early study by Darby (1999) already stressed increased confidence and control over heating post-coaching. Moreover, Forster et al. (2019) observed within the Traveller Community in Northern England that trust in energy advisors led to increased comfort with energy bills, anxiety reduction, and a general sense of being more in control over energy finances. Ramsden (2020) noted that this positive effect is not only limited to a better understanding and management of energy consumption but also extends to broader financial stability, as advisors often assist households in accessing and applying for entitled benefits, thereby reducing financial stress further.

Energy efficiency improvements reduce energy expenses and subsequently lower stress levels, as conceptualised by Hernández et al. (2016), who identified energy insecurity as a significant contributor to chronic stress in low-income households. Jessel et al. (2019) emphasised that physical housing deficiencies, economic struggle, and stress are often interconnected, and argue that living with energy insecurity encapsulates the fears and potential mental health implications stemming from the inability to afford energy bills. While primarily focused on physical measures to improve energy efficiency, shallow retrofitting efforts often incorporate energy coaching elements that impact households' energy management. Baker et al. (2019) found that interventions in which physical measures were combined with advice increased residents' awareness and confidence regarding their energy use at home, empowering them to take independent action towards energy conservation. This thus suggests a synergistic effect of energy efficiency improvement and awareness increase. Despite the potential of both interventions, their mechanisms differ significantly, and the current lack of substantial evidence in the literature prevents the formulation of a specific expectation about their relative impacts.

H4 All local interventions under study alleviate financial concerns related to energy bills.

5.4 Data and methodology

5.4.1 Dataset and transformations

The data for this study originates from a natural field experiment commissioned by the Dutch government, focusing on three local interventions: Basic Energy Coaching, Comprehensive Energy Coaching, and Fix Teams, detailed in Table 5.1. We compared treatment groups, which had undergone one of the local interventions, with control groups, consisting of households that had applied but not yet received a visit. While assignment to treatment and control groups was thus not randomised, the fact that all had registered for the service implies a comparable baseline in terms of their motivation for or necessity of the intervention. They were recruited for the study through an email disseminated by the organisations implementing the interventions, which contained a link to an online questionnaire. The treatment group was invited to complete the survey between December 19, 2022, and March 4, 2023, on average 134 days post-intervention. The control group was invited concurrently with the confirmation of their initial appointment, with their participation window spanning from December 12, 2022, to March 12, 2023. Participation was voluntary and uncompensated.

The questionnaire, detailed in Appendix 13, was designed to be completed within five minutes and was available in Dutch, English, Turkish, Arabic, and Polish. Participants were asked about their experiences in terms of residential comfort (e.g., *“Do you experience cold in your home?”*), sustainable behaviour (e.g., *“Do you shower for less than 5 minutes?”*), and financial concerns (*“Are you worried about paying your energy bill?”*). Answers were recorded on a 6-point Likert scale, ranging from ‘never’ to ‘always’. Occupants’ comfort and sustainable behaviour are composite indices derived from the average responses to four questions. For sustainable behaviour, one of the four elements assessed was the indoor temperature setting on thermostats, with answers categorised into six equally sized brackets; cooler temperature settings indicating greater sustainability.[45] Additionally, households were asked to estimate their monthly energy costs. We excluded indoor temperatures and energy bills that were more than 1.5 times the interquartile range (IQR).

For a deeper understanding of the divergences and characteristics between control and treatment groups, respondents granted explicit permission to augment our dataset with extensive household-level microdata from Statistics Netherlands (2023b).[46] This data (see Tables 5.2 and 5.3) includes household characteristics and dwelling features, with a reference date of January 1st, 2020. It is important to note that this data precedes the survey by approximately three years, which, though a limitation, was deemed acceptable due to its relevance and reliability. Table 5.2 also includes the outside temperature at the day the survey was conducted.

45 Cooler temperature settings may stem from financial constraints and/or poor housing quality, described by Sunikka-Blank and Galvin [43] as the ‘prebound effect’, rather than from a fundamental commitment to sustainability. These frugal behaviours often come at the expense of residential comfort. Nevertheless, both factors lead to the same outcome: the adoption of practices that lead to energy conservation practices, which justifies using cooler temperature settings as an indicator of sustainable behaviour, particularly in the Dutch climate.

46 Under certain conditions, this microdata is accessible for statistical and scientific research. For further information: microdata@cbs.nl.

TABLE 5.2 Descriptive statistics for scaled variables: mean/median, standard deviation, and Mann-Whitney U-test results by intervention status (control vs. treatment)

	Basic energy coaching					Comprehensive energy coaching					Fix Team				
	Control		Treatment		Test	Control		Treatment		Test	Control		Treatment		Test
	(N = 56)		(N = 78)			(N = 95)		(N = 120)			(N = 35)		(N = 83)		
	M	SD	M	SD	MWU[a]	M	SD	M	SD	MWU[a]	M	SD	M	SD	MWU[a]
Occupants' comfort	3.7	1.0	3.7	1.2	2.154	3.4	1.2	3.7	1.1	6.626	2.9	1.1	3.4	1.1	1.834
Sustainable behaviour	4.9	0.7	4.8	0.9	1.545	4.3	0.9	4.6	0.8	6.850	4.8	0.9	4.9	0.9	1.179
Estimated monthly energy bill (in €)	177.1	82.3	160.2	76.6	1.203	179.7	65.4	161.2	64.1	1.493	214.1	122.4	168.2	79.7	838
Financial concerns related to energy bill	3.2	1.5	3.0	1.5	1.712	3.5	1.4	3.6	1.3	5.791	4.8	1.3	3.4	1.5	626
Standardised annual income (in €1,000)	23.2	6.8	25.3	11.3	1.426	23.5	10.7	20.9	8.2	3.635	17.3	6.1	23.0	11.7	1.361
Energy burden (in %)	4.6	2.3	4.7	4.6	1.324	5.5	2.8	5.7	2.6	4.719	7.4	3.5	4.9	3.1	570
Number of people per household	1.7	1.1	1.8	1.1	1.488	1.9	1.3	1.7	1.0	3.885	1.9	1.4	1.7	1.1	1.112
Outside temperature at survey (in °C)	5.4	3.2	4.0	9.3	1.333	5.6	3.7	3.6	1.6	3.613	6.4	2.6	2.0	2.0	279
Age (of household reference person)[b]	65.5	17.7	54.0	16.7	1.127	53.0	14.4	56.0	14.2	4.598	61.0	14.4	56.0	13.8	947
Construction year[b]	1973	32.1	1963	32.2	1.258	1964	29.1	1957	31.0	3.820	1954	29.8	1945	35.2	993
Floor area in square meters[b]	80	23.3	76	20.9	1.283	90	24.1	88	22.9	4.081	67.5	34.7	64	20.3	892

[a] *The performed Mann-Whitney U-test was two-tailed. Significance level set at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

[b] *Median given instead of mean.*

TABLE 5.3 Descriptive statistics for dummy variables: mean, standard deviation, and Chi-square test results by intervention status (control vs. treatment)

		Basic energy coaching					Comprehensive energy coaching					Fix team				
		Control		Treatment		Test	Control		Treatment		Test	Control		Treatment		Test
		(N = 56)		(N = 78)			(N = 95)		(N = 120)			(N = 35)		(N = 83)		
		M[a]	SD	M[a]	SD	χ2 [b]	M[a]	SD	M[a]	SD	χ2 [b]	M[a]	SD	M[a]	SD	χ2 [b]
Household type	Single person	0.56	0.50	0.53	0.50	0.04	0.46	0.50	0.55	0.50	1.27	0.67	0.48	0.61	0.49	0.07
	Couple without children	0.31	0.47	0.29	0.46	0.00	0.24	0.43	0.18	0.39	0.69	0.07	0.25	0.10	0.30	0.02
	Single parent family	0.02	0.14	0.03	0.18	0.00	0.21	0.41	0.19	0.39	0.00	0.07	0.25	0.17	0.38	1.14
	Couple with children	0.10	0.31	0.15	0.36	0.20	0.09	0.29	0.08	0.27	0.00	0.20	0.41	0.11	0.32	0.67
Education level (of reference person)	Higher education	0.32	0.48	0.18	0.39	1.11	0.37	0.49	0.30	0.46	0.40	0.15	0.38	0.28	0.45	0.32
	Vocational education	0.32	0.48	0.28	0.46	0.01	0.42	0.50	0.36	0.48	0.26	0.31	0.48	0.17	0.38	0.58
	Elementary (or no) education	0.36	0.49	0.54	0.51	1.49	0.22	0.42	0.34	0.48	1.95	0.54	0.52	0.56	0.50	0.00
Housing tenure	Social rental	0.81	0.39	0.69	0.46	1.37	0.76	0.43	0.83	0.37	1.20	0.84	0.37	0.80	0.40	0.02
	Private rental	0.13	0.33	0.19	0.39	0.36	0.04	0.19	0.04	0.19	0.00	0.06	0.25	0.07	0.26	0.00
	Owner-occu-pation	0.06	0.24	0.12	0.33	0.43	0.20	0.40	0.13	0.34	1.36	0.10	0.30	0.13	0.34	0.01
Dwelling typology	Apartment	0.52	0.50	0.71	0.46	3.35*	0.47	0.50	0.46	0.50	0.00	0.58	0.50	0.82	0.39	5.62**
	Terraced house	0.40	0.49	0.22	0.42	3.10*	0.44	0.50	0.36	0.48	0.80	0.27	0.45	0.14	0.35	1.82
	End-terraced house	0.08	0.28	0.07	0.25	0.00	0.04	0.19	0.14	0.53	4.55**	0.12	0.33	0.04	0.20	1.16
	Semi-detached house	0.00	0.00	0.00	0.00	-	0.05	0.22	0.04	0.19	0.00	0.03	0.17	0.00	0.00	0.16
Background features (dummy variables)	Migration background	0.27	0.45	0.19	0.39	0.65	0.34	0.48	0.18	0.39	5.63**	0.37	0.49	0.46	0.50	0.38
	Female reference person	0.50	0.51	0.42	0.50	0.35	0.54	0.50	0.60	0.49	0.44	0.63	0.49	0.64	0.48	0.00
	Energy inefficient dwelling	0.33	0.48	0.31	0.46	0.01	0.43	0.50	0.50	0.50	0.74	0.43	0.50	0.21	0.41	3.97**

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TABLE 5.3 Descriptive statistics for dummy variables: mean, standard deviation, and Chi-square test results by intervention status (control vs. treatment)

		Basic energy coaching					Comprehensive energy coaching					Fix team				
		Control		Treatment		Test	Control		Treatment		Test	Control		Treatment		Test
		(N = 56)		(N = 78)			(N = 95)		(N = 120)			(N = 35)		(N = 83)		
		M[a]	SD	M[a]	SD	χ2 [b]	M[a]	SD	M[a]	SD	χ2 [b]	M[a]	SD	M[a]	SD	χ2 [b]
Energy poverty status (dummy variables)	Energy burden ≥ 10%	0.02	0.14	0.03	0.18	0.00	0.09	0.29	0.05	0.23	0.41	0.13	0.35	0.07	0.26	0.37
	Low-income, high cost (LIHC)	0.02	0.14	0.08	0.28	1.01	0.11	0.32	0.12	0.32	0.00	0.17	0.38	0.09	0.28	0.70
	Low-income, low energy efficiency (LILEE)	0.08	0.28	0.12	0.33	0.08	0.08	0.27	0.26	0.44	9.35***	0.13	0.35	0.07	0.26	0.37

** Significance level set at * p < 0.1, ** p < 0.05, *** p < 0.01.*

[a] Since these variables are exclusively categorical and binary, the mean represents the proportion of households with this specific characteristic.

[b] Chi-square tests are based on the observed frequencies (counts) rather than the calculated proportions (means) of the dummy variables.

This research places significant emphasis on various energy poverty indicators, detailed in Table 5.3. The methodology for these assessments is extensively outlined by Statistics Netherlands (2023a). These indicators include two widely recognised metrics (Deller et al., 2021): 'Low-income, high cost' (LIHC) and 'Low-income, low energy efficiency' (LILEE). Additionally, the study incorporates a binary indicator reflecting a high energy burden, defined as households where the percentage of disposable income allocated to residential energy exceeds 10%. This threshold is roughly double the median income share spent on energy and aligns with the established criterion for classifying energy poverty in the Netherlands. Table 5.2 further elaborates on the energy burden, presenting it as a scaled variable. Both LIHC and energy burden are based on actual energy expenditures rather than required spending, as provided by Statistics Netherlands. Similar to other household characteristics and dwelling features, the indicators are referenced as of January 1st, 2020, prior to the onset of the energy crisis.

Subsequently, statistical analyses were performed to explore variable distributions and relationships between the control and treatment groups across the three interventions. Descriptive statistics for Mann-Whitney U-tests and Chi-square tests are presented in Tables 5.2 and 5.3. Notably, employing one-hot encoding to categorise nominal data in Table 5.3 highlighted issues with infinite Variance Inflation Factors (VIFs). Consequently, we systematically excluded variables that exhibited multicollinearity, applying a threshold VIF of 5.

Furthermore, diagnostic tests for residuals, including Q-Q plots, the Shapiro-Wilk test for normality, residual scatter plots, and the Breusch-Pagan test for homoscedasticity, unveiled significant skewness in several continuous variables. This led us to apply logarithmic transformations to variables such as outside temperature, household income, household size, construction year, and floor area to mitigate these disparities.

In addressing missing data, we employed a missing value indicator for each potential control and interaction variable, facilitating differentiation between data missing at random and potential biases. To preserve our sample size, we adopted Multiple Imputation by Chained Equations (MICE), a technique that iteratively predicts missing values based on inter-variable relationships within the dataset. This process generates multiple imputed datasets, each embodying the inherent uncertainty of the missing data, resulting in a unified set of robust estimates (Bruderer Enzler & Diekmann, 2019).

Upon completing the imputation process, we employed Propensity Score Matching (PSM), an econometric tool crucial for enhancing the comparability of treatment and control groups in observational studies (Roth et al., 2018). By calculating and matching propensity scores derived from a comprehensive set of observed covariates, we sought to balance the groups in terms of baseline characteristics (Mudombi et al., 2021). This approach is vital in studies where random assignment is not feasible, as PSM helps to minimise potential selection biases, allowing for more reliable attributions of observed outcomes to the interventions. Integrating MICE and PSM provides a solid foundation for the causal inference in our analysis.

5.4.2 GLM and Probit regression models

To assess the impact of the interventions, we used Generalised Linear Models (GLMs) and ordered probit regression models. Specifically, the GLM was applied to analyse the continuous dependent variable, which was the estimated monthly energy bill, while the ordered probit model was used for the three ordinal dependent variables – occupants' comfort, sustainable behaviour, and financial concerns regarding the energy bill.

Both models can be formulated as $Y^{(*)}=\alpha+B_1X_1+\ldots+B_\eta X_\eta+\epsilon$. However, the fundamental difference in the application lies in their treatment of the dependent variable. The GLM directly models the linear relationship between the independent variables ($X_1,\ldots,X_\eta$) and the continuous dependent variable Y through the coefficients β.[47]

47 In this context, GLM resembles Ordinary Least Squares (OLS) but extends its capabilities by supporting various error term distributions and linking functions.

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In contrast, the ordered probit model is tailored for ordinal outcomes. It assumes a latent continuous variable Y^*, shaped by the coefficients β, underlies the ordinal outcomes we observe (Y). This model categorises Y^* into the ordinal outcomes based on set thresholds, meaning a household's perceived residential comfort could range from 1 (very low) to 6 (very high), depending on where Y^* falls within these thresholds.

Moreover, we also aim to explore the influence of varying groups of control variables across our dataset. Therefore, we conducted a series of six models, as displayed in Table 5.4. This structured analysis began with the exclusive consideration of outside temperature in models 1 and 2. It then expanded to include household characteristics in models 3 and 4, and ultimately incorporated dwelling features in models 5 and 6. This progressive inclusion of variables allowed for a nuanced understanding of their individual and combined effects on the dependent variables under study.

TABLE 5.4 Overview of control variables by model

Control variable category	Models 1 and 2	Models 3 and 4	Models 5 and 6
Weather condition	Outside temperature (in °C, log)	Outside temperature (in °C, log)	Outside temperature (in °C, log)
Household characteristics		Age of HRP*	Age of HRP*
		Standardised income (in €, log)	Standardised income (in €, log)
		Number of people per household (log)	Number of people per household (log)
		Singe person (dummy)	Singe person (dummy)
		Singe parent family (dummy)	Singe parent family (dummy)
		Couple with children (dummy)	Couple with children (dummy)
		Higher education of HRP* (dummy)	Higher education of HRP* (dummy)
		Elementary education of HRP* (dummy)	Elementary education of HRP* (dummy)
		Migration background of HRP* (dummy)	Migration background of HRP* (dummy)
		Gender of HRP* (dummy)	Gender of HRP* (dummy)
		Social rental (dummy)	Social rental (dummy)
		Owner-occupation (dummy)	Owner-occupation (dummy)
		Energy burden	Energy burden
		LIHC (dummy)	LIHC (dummy)
		LILEE (dummy)	LILEE (dummy)
Dwelling features			Construction year (log)
			Floor area (log)
			Apartment (dummy)
			Terraced house (dummy)
			Inefficient dwelling (dummy)

** Household reference person*

5.4.3 Analysis of interaction effects

To discern the conditions under which our interventions are most effective, we analysed interaction effects between key variables and the interventions. Our focus is on significant interactions that either amplify or mitigate the interventions' impacts. Identified from our literature review as critical for enhancing intervention effectiveness, the emphasis is on energy poverty indicators (LIHC, LILEE, energy burden) as interaction terms

To analyse all interaction terms within the same model framework, we opted for GLM with a cumulative logit link function for the ordinal dependent variables. This function is particularly effective for ordinal outcomes as it models the cumulative probabilities up to each ordinal level, thereby respecting the ordered nature of the response variable. Before conducting this analysis, we ensured that GLM was appropriate for our ordinal data by testing assumptions such as linearity and independence of residuals. This preliminary validation helps confirm that the models can robustly analyse complex interactions without bias.

In this analysis, we employed marginal plots to facilitate the interpretation of these interactions. These visual tools illustrate how the interactions between variables and interventions impact predicted outcomes, thus pinpointing the conditions under which interventions are most likely to have an impact. This approach allows for a nuanced understanding of effects that might be obscured in conventional tabular analysis.

5.5 Results

5.5.1 Treatment effects of local interventions

In this part of the results section, we present our findings from testing the hypotheses outlined in Section 5.3. This analysis evaluates the impact of various interventions on the output criteria, individually and collectively. The regression analyses produced variable outcomes, as elaborated in Table 5.5. Additional models incorporating fewer covariates are presented in Appendix 12 for further examination.

Exploring Hypothesis 1.1, predicting that both forms of local interventions – energy coaching and shallow retrofitting – would enhance Occupants' Comfort, our analysis reveals nuanced results. The Basic Energy Coaching intervention, with a beta coefficient of 0.023 and a statistically insignificant p-value of 0.816, appears to exert no influence on perceived comfort levels. In contrast, the Comprehensive Energy Coaching intervention suggests a more promising outcome, with a beta coefficient of 0.144 and a marginally significant p-value of 0.059. Notably, the Fix Team intervention stands out with its robust beta coefficient of 0.338 and a p-value of 0.011, demonstrating a statistically significant and strong improvement in perceived comfort levels. Our findings thus support Hypothesis 1.2 in that shallow retrofitting has a greater impact on perceived residential comfort than energy coaching. Furthermore, the aggregated data from all local interventions combined confirms the positive effect, evidenced by a beta coefficient of 0.107 and a significant p-value of 0.038, reinforcing the overarching hypothesis of the beneficial impact of local interventions on issues like indoor temperature, draughts, and moisture problems.

Investigating Hypothesis 2.1, which suggests that local interventions can encourage the adoption of Sustainable Behaviour, the probit model again demonstrates varied results. The Basic Energy Coaching intervention did not significantly impact sustainable behaviour adoption, with a beta coefficient of 0.077 and a p-value of 0.489. However, the results for the Comprehensive Energy Coaching intervention do suggest a potentially positive influence, with a beta coefficient of 0.144 and a marginally significant p-value of 0.061. The Fix Team is the only local intervention with a negative beta coefficient of -0.127, though this result is not statistically significant ($p = 0.374$), implying no clear detrimental impact but rather an unexpected direction in the effect. In support of hypothesis 2.2, these findings suggest that energy coaching, particularly if executed thoroughly, is more effective in promoting sustainable behaviour practices than shallow retrofitting. Aggregated data across all local interventions show a beta coefficient of 0.053 with a p-value of 0.325, which suggests a lack of significance overall, thus indicating minimal combined impact on fostering sustainable behaviour.

TABLE 5.5 Regression results (Probit and GLM) for the impact of the three local interventions individually and collectively on four dependent variables, with results adjusted for household characteristics and dwelling features, corresponding to Model 5 and 6 in Table 4

Dependent variable	Model type	Intervention	Coefficient (β)	Std. error	P-value [a]	Pseudo-R^2 [b]	Log-likelihood	Sample (N)
Occupants' Comfort	Probit	Basic Energy Coaching	0.023	0.099	0.816	0.046	-353.99	134
		Comprehensive Energy Coaching	0.144*	0.076	0.059*	0.034	-596.94	214
		Fix Team	0.338**	0.133	0.011**	0.047	-317.04	118
		Local Interventions (aggregated)	0.107**	0.052	0.038**	0.017	-1,456.30	466
Sustainable Behaviour	Probit	Basic Energy Coaching	0.077	0.111	0.489	0.040	-294.58	114
		Comprehensive Energy Coaching	0.144*	0.077	0.061*	0.042	-499.77	212
		Fix Team	-0.127	0.143	0.374	0.036	-257.87	104
		Local Interventions (aggregated)	0.053	0.054	0.325	0.012	-1,176.80	430
Estimated Energy Bill	GLM	Basic Energy Coaching	-0.128	0.111	0.248	0.333	-129.58	106
		Comprehensive Energy Coaching	-0.168*	0.096	0.081*	0.276	-152.48	121
		Fix Team	-0.059	0.132	0.656	0.343	-117.79	97
		Local Interventions (aggregated)	-0.144**	0.060	0.015**	0.147	-434.57	324
Financial Concerns regarding Energy Bill	Probit	Basic Energy Coaching	-0.074	0.109	0.495	0.047	-200.18	124
		Comprehensive Energy Coaching	0.007	0.079	0.925	0.047	-333.76	212
		Fix Team	-0.428***	0.153	0.005***	0.165	-155.70	109
		Local Interventions (aggregated)	-0.096*	0.055	0.081*	0.043	-729.05	445

[a] *Significance level set at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

[b] *McFadden's pseudo-R^2 (Probit models) and Cox and Snell's pseudo-R^2 (GLM) indicate model fit, yet do not quantify the variance explained by independent variables*

Hypothesis 3.1 posits that local interventions lead to reductions in Estimated Energy Bills, and since this dependent variable is continuous, we used GLM models. The Basic Energy Coaching intervention, with a beta coefficient of -0.128 and a p-value of 0.248, does not achieve statistical significance, implying limited effectiveness in lowering energy costs. Conversely, Comprehensive Energy Coaching has a more notable impact, reducing estimated energy bills with a beta coefficient of -0.168 and a marginally significant p-value of 0.081. The Fix Team intervention, however, shows an insignificant beta coefficient of -0.059 (p = 0.656), indicating no substantial effect on energy costs. Regarding Hypothesis 3.2, the results thus suggest that shallow retrofitting does not outperform energy coaching in reducing estimated energy bills. Notably, when all interventions are considered collectively, they demonstrate a significant combined effect, decreasing energy bills with a beta coefficient of -0.144 (p = 0.015), thus highlighting the hypothesis that local interventions can substantially lower household energy expenditures.

Finally, turning to Hypothesis 4, Table 5.5 indicates the probit model yields varied effects for the impact of local interventions on Financial Concerns regarding Energy Bills. Basic Energy Coaching shows a negative but insignificant beta coefficient of -0.074 (p = 0.495). Similarly, Comprehensive Energy Coaching has a negligible beta coefficient of 0.007 with a p-value of 0.925, indicating no impact. In contrast, the Fix Team intervention markedly reduced financial concerns regarding energy bills, with a beta coefficient of -0.428 and a highly significant p-value of 0.005, offering strong support for this approach's effectiveness. Aggregating the interventions, we observe a beta coefficient of -0.096 with a p-value of 0.081, suggesting a marginally significant reduction in financial concerns regarding energy bills, primarily driven by the impact of the Fix Team intervention.

In conclusion, our analysis reveals varying impact of local interventions on different outcome criteria. While Basic Energy Coaching showed limited impact, Comprehensive Energy Coaching demonstrated marginally significant impact on Occupants' Comfort improvements, Sustainable Behaviour adoption, and Estimated Energy Bill reductions. Moreover, the Fix Team intervention stood out with significant positive effects on Occupants' Comfort and highly significant alleviation of Financial Concern regarding Energy Bills. Collectively, the interventions demonstrated significant effects on improving perceived residential comfort and reducing estimated energy bills.

5.5.2 Interaction effects

In the investigation of interaction effects, our focus is on significant interaction terms that modify the impact of interventions, as discussed in Section 5.3.3. While our primary emphasis remains on energy poverty indicators as crucial interaction terms, we have also observed pronounced interaction effects in a select few other covariates.

In the previous section, we already established aggregated Local Interventions' statistically significant positive impact on Occupants' Comfort. Figure 5.2 further illustrates this relationship by demonstrating that as households experience a higher energy burden – defined as the percentage of their disposable income dedicated to residential energy services – the positive effect of Local Interventions on comfort levels tends to amplify. It depicts a noteworthy positive interaction suggesting that when these factors – energy burden and one of the local interventions – are considered together, their combined impact is more significant expected by simply adding their individual effects. This interaction is indicated by a beta coefficient of 0.10, with a p-value of 0.04, signifying statistical significance.

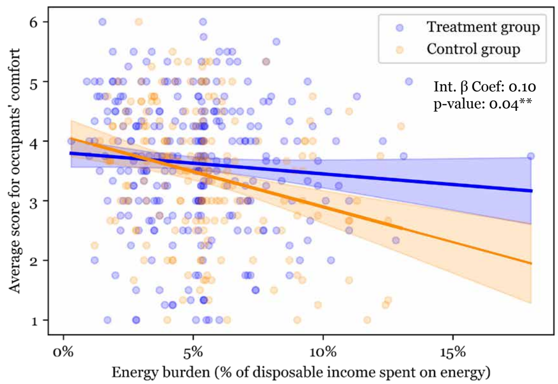

FIG. 5.2 Interaction effect between energy burden (the percentage of disposable income spent on residential energy services) and Local Interventions (aggregated) on Occupants' Comfort, illustrated with a 90% confidence interval shading

We also observed statistically significant increases in sustainable behaviour adoption among households classified under the Low-Income Low Energy Efficiency (LILEE) indicator when these households received support from (one of the) Local Interventions. LILEE serves as another measure of energy poverty. Unlike the energy burden, which is a continuous variable, LILEE categorises households as either energy poor or not. Figure 5.3 demonstrates the dynamics between this variable and the effects of the three interventions, both individually and collectively. Specifically, Basic Energy Coaching resulted in an interaction coefficient of 0.62 (p = 0.05),

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indicating a statistically significant positive effect. Comprehensive Energy Coaching showed a more pronounced effect, with an interaction coefficient of 0.72 (p = 0.08), though this was only marginally statistically significant. Similarly, the Fix Team intervention displayed a marginally significant positive impact, with an interaction coefficient of 0.56 (p = 0.06). When all local interventions were combined, the aggregate data indicated a robust interaction effect, with a statistically significant coefficient of 0.59 (p = 0.03).

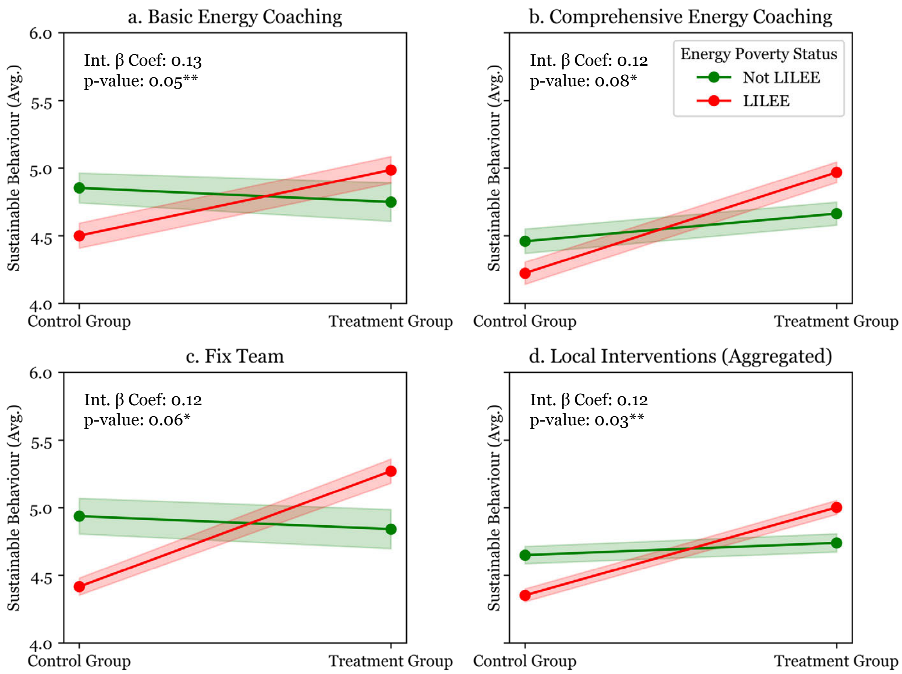

FIG. 5.3 Interaction effects between the Low-Income Low Energy Efficiency (LILEE) indicator and Local Interventions (individually and aggregated) regarding their impact on the adoption of Sustainable Behaviour, illustrated with a 90% confidence interval shading

In addition to the interaction effects related to energy poverty indicators, our analysis identified two significant interaction effects involving specific local interventions and covariates. As illustrated in Figure 5.4a, a highly significant negative interaction effect was observed between home ownership status and the effectiveness of the Comprehensive Energy Coaching intervention in reducing estimated energy bills (beta coefficient of -0.23, p-value < 0.01). This effect implies that the intervention was notably more effective for households that do not live in a dwelling owned by them (i.e., households that rent privately or socially) than owner-occupying households. Figure 5.4b reveals another significant negative interaction effect concerning household composition. Specifically, the interaction between being a couple with children and the effectiveness of the Fix Team intervention in alleviating financial concerns about energy bills was significant (beta coefficient of -0.13, p-value = 0.02). This suggests that the intervention was more effective in reducing financial stress for household types other than those consisting of couples with children.

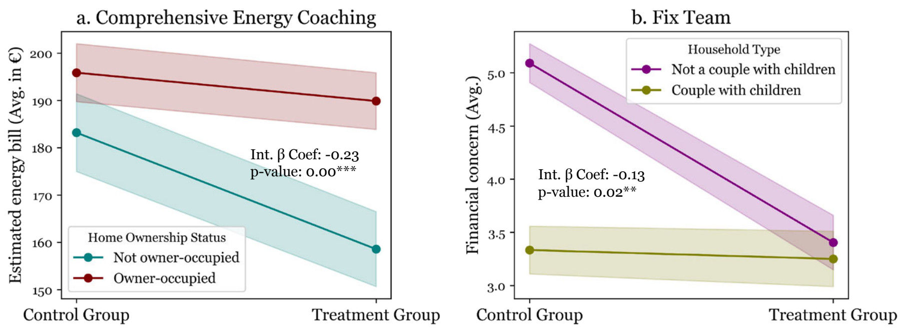

FIG. 5.4 Interaction effects of a.) owner-occupant status on the effectiveness of Comprehensive Energy Coaching in reducing Estimated Energy Bills, and b.) being a couple with children on the effectiveness of the Fix Team intervention in alleviating Financial Concerns regarding Energy Bills, both illustrated with a 90% confidence interval shading

5.6 Discussion

The main purpose of this analysis was to delve into the effectiveness of three local interventions – Basic Energy Coaching, Comprehensive Energy Coaching, and Fix Teams – in addressing energy poverty within the unique Dutch context, where a decentralised approach has granted significant policy discretion to municipalities.

We assessed whether these interventions fulfilled their aims by comparing outcomes related to perceived residential comfort, adoption of sustainable behaviours, estimated reductions in energy bills, and alleviation of financial concerns related to energy bills in both a control and a treatment group. Our results indicate varied outcomes, with the Fix Team and Comprehensive Energy Coaching interventions showing positive effects. A significant finding was the importance of strategically targeting these interventions at households in energy poverty. This discussion section will explore the broader implications of these results for the field of energy justice, evaluating the effectiveness of local interventions, comparing various intervention approaches, and examining the specific conditions under which these interventions prove most effective.

Despite our initial hypotheses predicting that all three interventions would positively impact the four criteria, based on existing literature, our analysis revealed a more complex outcome. On an individual level, only the Fix Team intervention, which primarily focused on shallow retrofitting, led to statistically significant improvements in residents' perceived comfort and their financial concerns regarding energy bills. While the Comprehensive Energy Coaching produced marginally significant improvements (at a confidence level under 90%) in perceived comfort, sustainable behaviour, and energy bill reductions, these were not as pronounced. When viewed collectively, however, the interventions as a whole did lead to significant improvements in both perceived comfort and energy bill reductions. The interaction effects observed in our study were particularly telling. Notably, all interventions had a more substantial impact on households experiencing energy poverty, defined either as those living on a low income in inefficient homes or those spending a significant portion of their income on energy.

The absence of marginally significant effects from the single-visit Basic Energy Coaching is surprising, given that prior studies, such as those by Ramsden (2020) and Baker et al. (2019), highlighted positive outcomes from interventions involving one or two home visits in terms of enhancing comfort levels and reducing energy bills. However, the fact that Comprehensive Energy Coaching and Fix Team interventions showed more substantial results *does* align with suggestions from previous studies (Bashir et al., 2013; Milne & Boardman, 2000) that the success of interventions is closely tied to the thoroughness of their design and implementation.

Moreover, the Fix Team intervention enhanced occupants' comfort and alleviated financial concerns regarding energy costs, yet unexpectedly it did not lead to significant reductions in energy bills. It was also the only intervention to exhibit a negative (albeit insignificant) beta coefficient for sustainable behaviour. This outcome may suggest a rebound effect, where households, feeling more comfortable and less concerned about energy costs post-intervention due to improved insulation, might increase their energy use for heating, thereby not reducing their overall energy expenditures (Berkhout et al., 2000). This would align with the findings of Barrella et al. (2023) that shallow retrofits notably influence those in 'hidden energy poverty' who were rationing energy pre-intervention. Alternatively, the enhanced perceptions of comfort and alleviated financial concerns regarding energy costs could be partially attributed to a psychological impact, akin to a ‘placebo’ effect, rather than a reflection of actual material changes, which is indeed sometimes observed in self-reporting (MacNaughton et al., 2016). To gain a deeper understanding of interrelationships and reasons behind specific behaviour, qualitative research, such as interviews, could be invaluable. For instance, exploring whether people adjust their temperature settings post-intervention due to increased awareness of environmental impact or out of financial concern would shed light on the nuanced motivations behind behavioural change. While such propositions warrant further investigation, it underscores the necessity of looking beyond changes in energy usage alone when evaluating local interventions and considering factors like perceived comfort and financial stress.

Another crucial contribution of this study is the interaction effects we found. They indicate that the effectiveness of the interventions under study notably depended on the energy poverty status of households. Local interventions were markedly more effective for those facing substantial energy burdens, defined as a high proportion of disposable income spent on domestic energy services, and for households classified as LILEE (Low Income, Low Energy Efficiency). These findings align with theoretical suggestions by Darby (1999) that local interventions would prove more effective when well-targeted at households in need, and are now supported quantitatively in this study. They also correspond with recent studies that emphasise the predictive value of high energy burdens in determining the urgency of assistance needed (Chen et al., 2024; Hatch & Graff, 2024). LILEE as an interacting effect suggests that local interventions could be particularly beneficial for households that ration energy in poorly insulated homes, supporting findings from Baker et al. (2019) and Barrella et al. (2023). This ties into the broader discussion of rebound *and* prebound effects (Sunikka-Blank & Galvin, 2012; Teli et al., 2015), which could have influenced the observed outcomes.

Our findings also reveal less straightforward interaction effects. First, the significant negative interaction between owner-occupancy and the effectiveness of the Comprehensive Energy Coaching intervention on estimated energy bill reductions could be due to generally higher responsiveness to energy-saving strategies when the occupants do not have the authority to make more permanent changes to the property, making them more reliant on behaviour-based interventions to manage energy consumption (Palm et al., 2020). If so, it is likely that these behavioural changes extend beyond those assessed in our study (see Appendix 13), as we do not observe an interaction effect on our composite Sustainable Behaviour effectiveness criterion. Secondly, the greater effectiveness of the Fix Team intervention in alleviating financial concerns in households other than those consisting of couples with children could be due to different financial pressures and priorities. Couples with children may have less flexibility in reducing energy costs, for example, because bigger family size necessitates higher utility usage (Brounen et al., 2012). Conversely, other household types, such as singles and childless couples, might see more significant financial relief from interventions that reduce energy bills, as their discretionary spending is less constrained by fixed costs such as club membership, childcare, and healthcare.

These insights underscore the importance of considering heterogeneity in designing, implementing, and evaluating energy poverty alleviation strategies. They resonate with broader calls for targeting policies at the most vulnerable and tailoring them to local communities' specific needs and contexts. This is particularly important as untargeted financial relief measures may raise energy prices when supply is already constrained by distorting the market and creating inefficiencies (Bajo-Buenestado, 2017), deter investments essential for energy efficiency improvement (Garcia & Stacchetti, 2009), contribute to inflation by boosting liquidity across the board (Dao et al., 2023), and most importantly fail to adequately assist the most vulnerable groups (Frilingou et al., 2023). Our findings highlight the need for more controlled experimental designs in future research to better delineate the complex interactions of local interventions, thereby enhancing their robustness and generalisability. This research could opt for a randomised design and more comprehensive sample sizes to overcome some of the limitations of this study. For instance, the significant reductions in energy bills noted in the aggregated intervention data compared to the single interventions could be more reflective of the broader sample size rather than the effectiveness. Nevertheless, adjustments for covariates and propensity score matching have mitigated some observational data challenges, as clearly shown in Appendix 14. Had we not adjusted for a range of household characteristics and dwelling features, we would have drawn flawed conclusions due to the non-randomness of our control and treatment groups. This highlights the importance of gathering detailed information about respondents, particularly in post-intervention analysis.

The indirect effects of interventions are outside the scope of this study but, although more challenging to track, present a compelling avenue for future research due to their more elusive nature. For example, recent literature suggests that energy coaching services could serve as potential user and process intermediaries towards broader sustainability goals (Broers et al., 2023; Hofman et al., 2023). While our analysis of single-visit Basic Energy Coaching did not directly influence the dependent variables, these coaches have in any respect already crossed the threshold and can therefore provide diverse forms of assistance to households. By gaining a better understanding of a household's situation and through personal interaction, they can positively influence long-term improvements in living conditions. This includes helping with eligibility checks for benefits, handling official letters, and providing other financial advice. They can also point residents towards more extensive support services (De Wilde, 2019), like the Fix Team under study in this paper. Therefore, these interventions may indirectly help to build trust within social networks and towards institutions (Grossmann et al., 2021).

5.7 Conclusions

This study provides insights into the effectiveness of energy coaching and shallow retrofitting services in mitigating energy poverty, focusing on three interventions: Basic Energy Coaching, Comprehensive Energy Coaching, and Fix Teams. The collective impact of these interventions significantly enhanced occupant comfort and reduced household energy bills. Notably, the Fix Team intervention stood out for its substantial impact on both comfort levels and financial relief regarding energy costs. The Comprehensive Energy Coaching also demonstrated promising, albeit marginally significant, effects on comfort levels and adoption of sustainable behaviour. However, the Basic Energy Coaching yielded no significant results. Additionally, the effectiveness of these interventions was particularly marked in households experiencing energy poverty, where improvements in comfort and adoption of sustainable practices were most significant.

Consequently, our research contributes to the field of energy poverty mitigation by offering a comprehensive comparative assessment of different local interventions within the unique decentralised Dutch context. The research is pioneering in integrating both perceived impact through survey data and actual living conditions and background characteristics of respondents via administrative microdata, which facilitates a more nuanced and accurate impact assessment. This dual-data approach allows researchers to move beyond merely confirming the presence of an impact to understanding for whom these interventions are most effective. This shift in focus could significantly refine future strategies and policies in the fight against energy poverty.

The findings underscore several key messages and takeaways. Firstly, local interventions prove to be effective, significantly enhancing household well-being at modest costs. Secondly, a more comprehensive approach involving multiple visits has been shown to significantly boost effectiveness compared to interventions involving only a single visit. Thirdly, the importance of targeted strategies is highlighted through interaction effects; interventions tailored to households in greater need – those experiencing energy poverty – yield more substantial benefits. Lastly, these interventions can be more effectively designed and implemented by acknowledging the diverse needs of local communities and developing tailored alleviation strategies that consider specific factors such as energy efficiency, household types, and ownership status.

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Hence, the policy implications are profound. While we clearly highlighted the necessity for policymakers to explore targeted and tailored interventions, the European energy crisis revealed that governments struggle to quickly identify in-need households due to missing or unreliable data. Therefore, improving data collection and sharing among key stakeholders like government, community centres, (local) faith-based organisations, and housing associations is crucial. Additionally, understanding the diverse aims and outcomes of interventions such as energy coaching and shallow retrofitting is essential. Policymakers must consider whether short-term building energy efficiency upgrades or changes in behavioural patterns are more pertinent to enhance well-being in their specific local contexts. Moreover, our results imply that more comprehensive designs of local interventions, which are more costly and require multiple visits and sustained engagement, are crucial for effectiveness. Policymakers should therefore prioritise these thorough approaches, recognising that the initial higher costs will be justified by the significant long-term benefits in terms of environmental sustainability and resident well-being.

Looking ahead, our findings prompt a call for more expansive future research into local interventions addressing energy poverty. To prepare for imminent crises and facilitate a more just energy transition, it is crucial to engage in comprehensive comparative studies similar to this one. Future research should incorporate detailed respondent information to accurately correct for disparities between control and treatment groups, particularly when utilising observational data, but also to improve understanding of the nuanced interaction dynamics that influence intervention effectiveness. Moreover, employing larger sample sizes and adopting randomised controlled designs would enhance the robustness of results. Additionally, longitudinal studies exploring these interventions' long-term effects could provide invaluable insights into their sustained efficacy and the enduring benefits they deliver.

In conclusion, this study highlights the potential of local interventions in energy poverty mitigation and household well-being. It establishes recommendations for policy-making that emphasise targeted and comprehensive approaches, tailored to the local context. The continued exploration and refinement of these strategies will be essential in shaping resilient energy systems that are both inclusive and equitable.

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6 Trade-offs in national relief responses to the energy crisis

This chapter is based on a co-authored manuscript accepted for publication:
Croon, T. M., & Sokołowski, J. (under review). Fiscal Responses to the European Energy Crisis: Trade-Offs in Targeting Household Relief Measures. Submitted to *Journal of European Social Policy*.

ABSTRACT

The 2021-2023 energy price shock compelled European governments to shield households while navigating four, often competing, objectives: delivering meaningful relief, containing fiscal costs and inflation, preserving energy conservation incentives, and maintaining public support. This study presents the first cross-national comparative analysis of how 18 EU member states managed these perceived trade-offs. By integrating Bruegel's Fiscal Tracker with uprated Eurostat Household Budget Survey microdata, we map every euro of support for 229 household-oriented interventions across four dimensions: benefit adequacy, targeting efficiency, environmental sustainability, and political salience. Initial responses favoured broad-based, highly visible measures that offered rapid but diffuse relief; over time, governments pivoted towards more targeted schemes, enhancing the distributive impact and environmental alignment of support. Nordic packages were sustainable yet largely inconspicuous, while Central and Eastern European schemes maximised visibility but were relatively regressive and blunted conservation signals. Western and Mediterranean European countries that combined tiered price caps with targeted transfers exemplified how 'targeting within universalism' can reconcile competing objectives. The four-dimensional evaluative framework developed herein underscores that the design of crisis relief is inherently political. It offers a transferable tool for assessing emergency measures and the evolving architecture of equitable climate and energy policy.

6.1 Introduction

When energy prices soar, societies face a critical dilemma: whom to protect, and how? The ripple effects of skyrocketing energy prices reach beyond markets, threatening households' financial security and political stability (Deese, 1979; Jacobs, 2016). The European energy crisis of the early 2020s sharply demonstrated this reality, propelled by a confluence of resurgent global demand following the Covid-19 pandemic, geopolitical upheaval triggered by Russia's invasion of Ukraine, and persistent infrastructure constraints (Emiliozzi et al., 2024). The resulting price spikes exacerbated financial burdens on already vulnerable households, particularly those with low incomes living in energy-inefficient dwellings, pushing millions of households into energy poverty (Guan et al., 2023). In response, European governments were compelled to swiftly deploy targeted household relief measures, navigating complex trade-offs between competing policy objectives.

Amid this crisis, European governments mobilised unprecedented fiscal packages to blunt the immediate shock, with VAT cuts, levy suspensions, and price caps that could be rolled out at speed and broadcast political resolve dominating the response (Natalini et al., 2020; Sgaravatti et al., 2024). However, experts and international organisations, including the OECD (Castle et al., 2023), IMF (Arregui et al., 2022), World Bank (Gencer & Akcura, 2022), and European Commission (Dombrovskis, 2023), cautioned against the unintended consequences of such measures. These included inflationary pressures, disproportionate benefits for higher-income households with greater energy consumption, market distortions, and disincentives for energy conservation and efficiency investments (Batlle et al., 2022; Cornago & Springford, 2023; Sgaravatti et al., 2024; Sokołowski & Sokołowski, 2023; Waddams, 2023).[48] At the same time, shifting towards narrowly targeted schemes has been criticised for the 'technocratic fallacy' of identifying the 'most deserving' households (Middlemiss, 2016) and the risks of excluding vulnerable populations due to administrative barriers, application complexities, stigma, and definitional ambiguities (Simcock, 2022).

These twin critiques crystallise the central design dilemma: cast a wide net to ensure no vulnerable household slips through, even if that inflates costs and weakens conservation signals, or focus support narrowly to stretch scarce funds and

48 IMF research (Ari et al., 2022) describes how fiscal measures by European governments to curb retail price pass-through effectively delayed key energy shock adjustments, sustaining higher global energy demand and prices.

preserve efficiency, knowing some in need may be left behind. Every choice forces governments to balance urgent political demands for visible relief against longer-term goals of fiscal discipline, market integrity and the clean-energy transition -perceived trade-offs that stand at the core of this paper.

Building on this dilemma, our study offers the first systematic, cross-national scorecard of how 18 European countries balanced four competing goals – effectiveness, efficiency, environmental sustainability and political salience – when shielding households during the 2021-23 energy-price shock. We combine Bruegel's real-time Fiscal Tracker (covering 229 household-oriented interventions) with uprated Eurostat Household Budget Survey micro-data to model how each euro of relief was allocated across the income distribution. For every country we compute the share of the energy-poverty gap closed (effectiveness), the proportion of funds reaching energy-poor households (efficiency), a budget-weighted sustainability score for each policy mix, and a composite salience index capturing reach, average impact and fiscal scale. The results reveal stark contrasts: 'tiered' price caps plus targeted top-ups (Greece, Netherlands) outperformed on both effectiveness and efficiency; Nordic packages were lean, efficient and green but largely invisible to voters; and Central and Eastern European schemes maximised visibility at the expense of leakage and conservation signals. Crucially, we show that hybrid 'targeting-within-universalism' packages can reconcile political salience with fiscal and environmental discipline.

Beyond these regional distinctions, we trace a broader evolution in policy trajectories. Governments initially relied on untargeted measures – particularly in Western Europe – reflecting administrative constraints and pressure for rapid, visible action. Yet such measures carried significant opportunity costs: the €190 billion spent on blanket VAT cuts in 2022 could have instead financed deep energy renovations for millions of homes across Europe. Over time, however, many pivoted towards more layered or hybrid approaches, combining universal entitlements with progressive top-ups and investment elements. These packages improved the distributional accuracy and enhanced targeting efficiency and environmental alignment. Critically, the capacity to implement such calibrated responses was shaped by pre-existing welfare architectures.

The remainder of the paper is organised as follows. Section 6.2 sets out the conceptual and normative foundations of targeting, drawing together welfare-state theory and relevant political economy debates. Section 6.3 details our data sources, variable construction and modelling strategy for allocating relief and measuring the four dimensions. Section 6.4 presents the comparative results, first tracking the evolution of policy mixes over time, then mapping cross-country performance and regional patterns. Section 6.5 discusses the political economy drivers behind these patterns, the institutional constraints that shaped what was feasible, and the implications for designing future relief that supports conservation efforts. Section 6.6 concludes, distilling policy lessons and outlining avenues for further research.

6.2 The political economy of targeting household energy relief measures

This section examines how targeted social assistance programmes balance benefit adequacy, targeting efficiency, environmental sustainability, and political salience. It begins by discussing the conceptual and normative foundations underpinning debates about allocating targeted versus universal forms of assistance, highlighting the inherent tensions between competing policy objectives. It then introduces the operational framework for evaluating targeting outcomes in practice.

6.2.1 Conceptual and normative foundations

Targeting, broadly defined, involves directing resources and policy benefits to specifically delineated groups (Devereux, 2016). While some targeting uses broad reference groups (e.g., students, the unemployed), other approaches use specific criteria such as age, income, or household composition (Van Lancker et al., 2015). The concept has been extensively debated in the context of welfare economics, where scholars such as Sen (1998) and Titmuss (1974) have argued that targeting is not only a technical issue but also a deeply political one.

The benefit adequacy and targeting efficiency of social assistance programmes are central concerns in both social policy and public economics. *Benefit adequacy* generally refers to a programme's ability to reach its intended beneficiaries and achieve its redistributive aims, while *targeting efficiency* concerns the cost-effectiveness of delivering that support, with an emphasis on minimising administrative burdens, leakage, and unintended distortions (Stiglitz & Rosengard, 2015). These two principles often sit in tension: a design that maximises coverage may raise costs or introduce inefficiencies, while a tightly targeted programme may save resources but fail to reach many of those in need. A longstanding debate centres on the trade-off between *universality* and *selectivity* (Jacques & Noël, 2021; Shaver, 1998). Selective approaches, typically involving means-testing, are favoured for their efficient use of public resources and potential to avoid market distortions (Coady et al., 2004; Simshauser, 2021), but face criticism for generating poverty traps, stigmatisation, and non-take-up among eligible households (Garfinkel, 1982; Van Oorschot, 2002). Moreover, it risks undermining broader support for welfare systems over time (Gelbach & Pritchett, 2002; Van Oorschot & Roosma, 2017). This reflects a fundamental policy dilemma: whether to prioritise targeting efficiency in resource allocation or benefit adequacy in ensuring that support reaches those in need.

Tensions between universality and selectivity in welfare design have long been recognised in theory and practice. Early contributions by Wilensky and Lebeaux (1958) contrasted universalist welfare models – administratively straightforward but fiscally demanding – with residualist approaches that are more cost-efficient yet risk excluding those in need. Musgrave (1959), while identifying redistribution as a core function of the state, raised normative questions regarding the scope and targeting of public transfers. Okun (1975) famously likened redistribution to a ‘leaky bucket’, arguing that some resources are inevitably lost through administrative costs, tax distortions, and behavioural disincentives to work or invest. He underscored the inevitable trade-offs between equity and efficiency, framing them as a delicate balancing act foundational to welfare economics. These debates evolved further during the 1980s with the rise of the ‘targeting orthodoxy’ in development economics, which championed narrowly targeted interventions as fiscally prudent and efficient ways to meet basic needs, particularly in resource-constrained environments (Besley & Kanbur, 1991; Chenery et al., 1974; Streeten et al., 1981). Some of these insights have since influenced welfare reforms in advanced economies, particularly under fiscal pressure, leading to greater use of means-testing (Van Gerven, 2022). More recently, algorithmic targeting has promised greater precision but also raised concerns about reinforcing structural exclusions, particularly in complex policy areas like energy poverty, where vulnerability is multidimensional and difficult to capture through traditional proxies (Dubois, 2012; Lausberg & Croon, 2023).

Another critical debate, specific to the targeting of household energy relief measures, revolves around the tension between short-term political imperatives and long-term environmental sustainability goals (Belaïd et al., 2023). Governments often face immense pressure during energy crises to provide immediate relief to households burdened by surging energy costs (Fabra, 2023; Guan et al., 2023). Broad subsidies, tax reductions, or price caps are administratively simple, politically popular, and effective in delivering rapid assistance across a broad electorate (Sirin et al., 2023). These measures tend to rank high on salience – defined here as the degree to which a policy response is publicly visible, emotionally resonant, and symbolically meaningful, particularly during crises when leaders must be seen to act in order to maintain public trust, demonstrate control, and avoid blame (Boin et al., 2017). However, they typically conflict with sustainability – a dimension concerned with long-term environmental objectives such as promoting energy conservation, reducing reliance on fossil fuels, and transitioning towards clean energy systems (De Bruin & Yakut, 2023; Gajdzik et al., 2024). Policies aligned with sustainability goals, such as retrofitting programmes or renewable energy incentives, offer a more structurally sound solution but require significant time until benefits are felt (Darvas & Wolff, 2022). This highlights a misalignment between immediate public demands and the time needed for long-term benefits.

TABLE 6.1 Dimensions of household energy relief, summarising normative aims, design logics, and empirical indicators of targeting performance

Dimension	Normative objectives	Design principles	Operational indicator
Benefit adequacy	Mitigate energy-related deprivation by reaching those with constrained consumption or income	Ensure inclusive eligibility criteria and calibrate benefit levels to the severity of need	Energy-related deprivation reduced among target households
Targeting efficiency	Maximise cost-effective-ness of relief by minimising leakage, price distortions, and inflationary pressures	Use means-testing or tiering to contain costs and avoid externalities	Share of total support received by target households
Environmental sustainability	Preserve incentives for energy conservation while supporting household transitions to cleaner energy use	Structure support to maintain marginal cost signals and promote low-carbon investments	Budget-weighted environmental score based on policy mix
Political salience	Enhance public visibility and the legitimacy of support measures across the population	Provide support that is timely, easily understood, and tangible	Composite of reach, average benefit, and overall fiscal scale

Note: Indicators are empirically derived from modelled allocations and coded policy instruments (see Section 6.3 and Appendix 15)

Targeting household energy relief involves balancing four distinct but interrelated objectives: benefit adequacy, targeting efficiency, environmental sustainability, and political salience. These dimensions reflect both instrumental and symbolic goals in policy design, as emphasised by Schneider and Ingram (1993). While these aims often pull in different directions, they are not mutually exclusive. As summarised in Table 6.1, each dimension can be translated into specific design principles and operational indicators, enabling structured assessment of trade-offs and complementarities in crisis relief. In practice, many governments combined logics, such as layering universal components with targeted top-ups, to reconcile competing demands within politically and administratively feasible packages.

6.2.2 Indicators of targeting outcomes

Designing targeted household energy relief measures involves balancing multiple, often conflicting, objectives. As outlined in Table 6.1, these include benefit adequacy, targeting efficiency, environmental sustainability, and political salience. This section outlines how each dimension can be operationalised through measurable indicators, serving as normative reference points and empirical criteria for evaluating the performance of relief policies.

Benefit adequacy refers to how relief measures reach their intended beneficiaries and mitigate hardship, particularly among vulnerable households. It is typically assessed through three interrelated metrics: ‘coverage’ (the proportion of the eligible population that receives support), ‘adequacy’ (whether the level of support is sufficient to meet basic energy needs), and ‘impact’ (the extent to which poverty or deprivation is reduced) (Barr, 2020; Devereux et al., 2017). This is particularly critical in the case of energy poverty, where suppressed consumption may obscure need, and the services affected – such as heating, lighting, or refrigeration – are essential for human well-being and social inclusion (Tirado Herrero, 2017). While incidence-based (or ‘headcount’) indicators capture whether households fall above or below a deprivation threshold, hence coverage, they say little about adequacy or impact. In contrast, intensity-based measures, such as the energy poverty gap operationalised by Croon et al. (2023), capture not only whether assistance reaches the intended households, but also how far it goes in reducing their shortfall relative to a normative baseline. As shown in Table 6.2, benefit adequacy corresponds to correct inclusion (cell A), where support reaches the intended group and meaningfully alleviates their deprivation. Conversely, exclusion errors (cell B) undermine benefit adequacy, as intended beneficiaries are neglected, while cell D represents correct exclusion and thus lies outside performance evaluation.

Targeting efficiency, by contrast, captures how precisely support is allocated to the intended population relative to its total cost. It centres on the concept of ‘leakage’, or the share of support going to households outside the target group, commonly referred to as ‘inclusion errors’ (Rosenow et al., 2013). Table 6.2 illustrates that these correspond to cell C – inclusion errors – in contrast to cell A, where support reaches the intended recipients. Distinctions between vertical efficiency (whether greater support flows to those with greater need) and horizontal efficiency (minimising inclusion errors) further sharpen this ratio. Other relevant indicators include the cost per beneficiary and administrative overheads, which help determine whether the programme's design and delivery mechanisms make optimal use of public funds (Hassel & Wegrich, 2022). In practice, targeted income transfers are widely regarded as the most cost-effective and administratively viable option (Arregui et al., 2022). While price-suppressing measures inherently create market distortions and inflationary spillovers, their targeting efficiency can be improved through means-testing or tiering, which help preserve incentives to reduce consumption (Simshauser, 2021). Means-tested renovation subsidies, such as those offered through France's *MaPrimeRénov'*, enhance structural resilience by enabling low-income households to invest in energy performance improvements they could not otherwise afford (Côté & Pons-Seres de Brauwer, 2023). In contrast, untargeted schemes such as Italy's *Superbonus 110%* allowed homeowners to claim more than 100% of renovation costs, overstretched the construction sector, incentivised fraud, and ultimately imposed unsustainable fiscal burdens (Padoan, 2023). These examples underscore the tension between addressing genuine need and containing unintended spillovers.

TABLE 6.2 Typology of targeting outcomes based on alignment between intended and actual beneficiaries

		Beneficiary	
		No	Yes
Target group	No	A. (Efficient exclusion)	B. (Inclusion error)
	Yes	C. (Exclusion error)	D. (Effective inclusion)

Environmental sustainability in household energy relief hinges on preserving incentives for conservation and supporting a transition away from fossil fuels. At the least sustainable end are untargeted fossil fuel subsidies – including broad price caps or tax reductions – which distort price signals, encourage overconsumption, and entrench carbon-intensive behaviours (Schwanitz et al., 2014). Slightly more sustainable are untargeted subsidies that suppress energy prices only for non-fossil fuels. For example, during the energy crisis, many European countries directed more support towards subsidising electricity rather than natural gas (Sgaravatti et al., 2023). Both approaches would be more sustainable if targeted at vulnerable groups, as this reduces the risk of subsidising unnecessary energy use (Galvin et al., 2024).[49] Alternatively, tiered price caps – such as those adopted in Germany, Austria, and the Netherlands – offer basic relief while preserving incentives for energy conservation above a defined threshold (Amores et al., 2023). The impact of price signals is evidenced by Germany's 23% drop in gas consumption during the second half of 2022 (Ruhnau et al., 2023). Lump-sum transfers are more sustainable, which enable households to meet essential needs without directly subsidising energy use, thereby avoiding distortions while providing flexibility (Arregui et al., 2022). At the most sustainable end are investment subsidies for improving dwellings' energy performance and deploying renewables, particularly when targeted at those unable to afford such upgrades independently (Farghali et al., 2023; Frilingou et al., 2023).

The final key dimension shaping targeting outcomes is salience, the extent to which relief measures are visible and tangible. Policies that lack salience may struggle to build or sustain public support, while those perceived as unfair, insufficient, or slow to deliver can provoke backlash or erode trust in institutions (Ibsen, 2024). Particularly in low-trust settings, salient delivery of broadly accessible measures designed to minimise administrative complexity can bolster legitimacy by demonstrating state responsiveness and reducing perceptions of exclusion or arbitrariness (Montes de Oca Leon et al., 2024). At the same time, overly complex eligibility criteria or bureaucratic inefficiencies risk delaying the delivery of relief measures, while a speedy response is another important element of public support for crisis relief (Knill et al., 2023). Evidence from a UK-based conjoint experiment during the energy crisis further shows that public support is shaped less by rhetorical framing than by the concrete design of relief measures – particularly their scale, inclusiveness, and fairness (Beiser-McGrath, 2024).

49 Bagnoli and Bertoméu-Sánchez (2022) for instance demonstrated that the implementation of the Spanish social tariff did not significantly raise the energy consumption among eligible households.

6.3 Materials and methods

6.3.1 Data sources and preparation

We utilised several key data sources for our analysis. Bruegel's Fiscal Tracker (Sgaravatti et al., 2023) served as a primary source, providing detailed information on provisional fiscal interventions implemented between 1 September 2021 and 15 January 2023 in response to the energy crisis while excluding structural measures like pre-existing social energy tariffs. Following the IMF's classification (Arregui et al., 2022), a distinction was made between price-suppressing policies (e.g., excise/VAT cuts, price caps) and income support (e.g., transfers, vouchers). After removing duplicates and firm-only measures, we identified 229 household-targeted interventions across 18 European countries. Using Bruegel's descriptions and official sources, we classified each measure as untargeted or means-tested, reviewed eligibility criteria, and recorded allocated funds. Since measures differed in duration and payment frequency, all fiscal envelopes were converted to annual-equivalent amounts before allocation.

In addition, we used the 2020 Household Budget Survey (HBS) from Eurostat (2023b), which offers detailed income and disaggregated energy expenditure data. We preferred HBS over EU-SILC for its item-level expenditure data, including disaggregated energy spending, crucial for modelling price-based support. Household energy expenditure is defined using COICOP 0451-0455 (electricity, gas, district heating, solid and liquid fuels), explicitly excluding utilities embedded in rent (COICOP 04.1), as the latter cannot be disentangled from housing costs and varies in coverage across countries. Nine EU countries were excluded due to missing HBS data.[50] The final dataset includes 179,549 households, ranging from 1,411 (Luxembourg) to 51,734 (Germany).

In the case of France, Eurostat did not field a new HBS in 2020; instead, the 2015 survey was uprated to 2020 using national price indices (Adera et al., 2025). We retain France because our energy poverty indicators are defined relative to national medians, which are robust to such uprating, but we interpret absolute expenditure levels for this case with caution. In addition, income variables

50 Austria, Cyprus, Czechia, Italy, Malta, Portugal, Romania, Slovenia, and Sweden.

in the HBS are not fully harmonised across countries and, in some cases, exhibit higher item non-response or reporting variability, particularly in smaller samples (e.g., Denmark), which may inflate the share of households classified as low-income.

To reflect the economic circumstances during the energy crisis, we updated all 2020 income and energy expenditure data to 2022 (see Appendix 16 for the full set of income- and energy-adjustment factors). Income was adjusted with Eurostat's 2022 EU-SILC, from which we computed the average relative change in each national income decile between 2020 and 2022. Energy expenditures were updated using Eurostat's Harmonised Index of Consumer Prices (HICP) (2024a), applying country-specific sub-indices separately for residential energy and transport fuels. Where price measures covered both households and firms, we used Eurostat's Simplified Energy Balances (2024b) to estimate each country's household share of total energy consumption.

To avoid potential double counting of policy effects already embedded in official price indices, all uprating was performed under constant statutory tax rates, isolating underlying market price changes from the impact of temporary VAT or excise cuts; the main results correspond to this constant-tax specification. We evaluate outcomes at 2022 price and income levels because this is the first full year in which elevated energy prices and most support measures overlapped, and Bruegel reports planned fiscal envelopes up to early 2023 rather than realised full-year amounts. Uprating to 2023 price levels would introduce a timing mismatch, so measures extending into 2023 are expressed as annual-equivalent values to ensure consistency with the 2022 expenditure baseline.

Both datasets are nationally representative. The HBS uses calibrated weights that closely align with national income and energy expenditure totals (<3-5% deviation), ensuring reliable population estimates. As with most surveys, high-income households are somewhat underrepresented, and energy expenditures may be understated due to recall bias, meaning our estimates likely reflect upper-bound impacts of fiscal support.[51]

Since crisis-related income transfers may already be embedded in observed household income, we conducted robustness checks using a counterfactual pre-transfer income definition, in which reported disposable income is adjusted to net

51 While recall bias in household surveys is generally associated with underestimation of expenditures (Crossley et al., 2013), evidence for energy use and spending is mixed, with both understatement and overstatement possible (Wu et al., 2020). This underscores the need for cautious interpretation and highlights the risks inherent in relying on survey data.

out simulated crisis-related transfers before computing energy poverty gaps. These checks assess the sensitivity of benefit adequacy and targeting results to potential double counting of income support. Reassuringly, this adjustment does not affect the qualitative cross-country patterns reported

Four limitations merit discussion. First, although Bruegel's database is comprehensive, it excludes structural measures predating the energy crisis – such as Hungary's regulated tariffs or the original scope of Belgium's social tariff – as well as firm-oriented interventions, including utility bailouts that could have had indirect effects on household energy affordability. While pre-existing social support systems may reduce the need for crisis-specific spending, we focus on discretionary fiscal responses. All included measures were cross-checked against national budgets and official sources. Second, the Bruegel dataset records budget allocations at the national level rather than verified disbursements. Some measures involved eligibility criteria and administrative procedures that may have limited take-up or delayed spending, meaning our modelling reflects intended fiscal envelopes rather than realised outlays. This limitation is especially relevant for indicators such as political salience, which combine fiscal scale with reach and visibility. Third, the microdata (HBS 2020) predates the energy crisis and had to be uprated to 2022 using decile-level changes in income and prices. While common in distributional analysis, this approach assumes constant consumption within income groups and does not account for behavioural adjustments in response to the crisis. Fourth, due to data availability, the analysis includes 18 EU countries, covering 82% of the EU-27 population. Countries with missing or incompatible household expenditure data were excluded.

6.3.2 Modelling household-level allocations

Using policy targeting criteria from Bruegel, we allocated the funds from all 229 household-oriented interventions to individual households, distinguishing between untargeted and targeted income support, and adjusting price support based on energy consumption levels.

For income support, the per-household transfer T_i combines untargeted and targeted components:

$$T_{i,c} = \frac{M_{u,c}}{N_c} + \sum_t \left(\frac{M_{t,c}}{N_{t,c}} \cdot g_{i,t} \right) \qquad [1]$$

Where $M_{u,c}$ and $M_{t,c}$ represent the untargeted and targeted funds in country c, N_c and $N_{t,c}$ are the total and targeted household counts, and $g_{i,t}$ indicates whether household i belongs to the targeted group t.

The per-household price subsidy S_i was allocated based on actual household energy spending. To reflect the greater relative burden of fixed energy costs for low-income households[52], total funds were first distributed across energy spending deciles, then allocated within each decile proportionally to spending, resulting in larger absolute subsidies for higher-spending households (Galvin et al., 2024; Meier et al., 2013). The allocation is formalised as:

$$S_{\mathrm{i,c}} = \sum_{\mathrm{d=1}}^{\mathrm{D}} e_{\mathrm{i,c}} \left(\frac{M_{\mathrm{p,c}} \cdot \alpha_{\mathrm{c}} \cdot S_{\mathrm{d,c}}}{E_{\mathrm{d,c}}} \right) h_{\mathrm{i,d,c}} \qquad [2]$$

where e_i is household-level energy spending, $M_{p,c}$ total price support in country c, α_c the household share of energy use (i.e., excluding firms), $s_{d,c}$ and $E_{d,c}$ the spending share and total for decile d, and $h_{i,d}$ indicates decile membership.

We define per-household energy bill coverage C_i as the share of 2022-2023[53] energy expenditure offset by combined income support and price subsidies:

$$C_{\mathrm{i,c}} = \frac{T_{\mathrm{i,c}} + S_{\mathrm{i,c}}}{e_{\mathrm{0,i,c}}} \qquad [3]$$

52 Low-income households were defined using the EU and OECD threshold of 60% of median after-tax income.

53 We considered two years of energy expenditure, as the support covered two fiscal years.

Where $e_{0,i}$ is household *i*'s pre-support energy spending (reported 2020 expenditure uprated to 2022 price levels), excluding pre-existing structural subsidies and the fiscal support measures analysed.

To assess the benefit adequacy of fiscal support, we apply two Eurostat-based, expenditure-oriented energy poverty indicators (2M and M/2). We adopt a multi-indicator approach to capture different forms of deprivation and a broader range of fiscal support impacts, as suggested by Best et al. (2021), Castaño-Rosa et al. (2019), and Thomson et al. (2017). The first captures overburden (i.e., excess energy spending relative to income), while the second measures underconsumption (i.e., inadequate consumption due to affordability constraints). Relying solely on overburden would overlook households that limit energy use to avoid costs. In our analysis, households are classified as energy poor if they exhibit a positive gap on either indicator, meaning their spending exceeds the overburden threshold or falls below the underconsumption threshold.

To assess the benefit adequacy of fiscal support, we apply Eurostat-based, expenditure-oriented indicators. We adopt a multi-indicator approach to capture different forms of deprivation and a broader range of fiscal support impacts, in line with Best et al. (2021), Castaño-Rosa et al. (2019), and Thomson et al. (2017). For domestic energy use, we therefore apply both an overburden indicator (2M), capturing excess expenditure relative to income, and an underconsumption indicator (M/2), reflecting constrained consumption due to affordability constraints, respectively. For transport fuels, however, we apply only the overburden indicator (2M), since low expenditure on private transport does not reliably signal deprivation: households may rely on public transport, live in dense urban areas, or simply choose not to own a car. By contrast, domestic energy is a universal need, making both under- and overspending informative in that domain.[54]

We apply both indicators only to low-income households, which effectively means-testing energy poverty to focus on where deprivation is most policy-relevant and affordability constraints are binding. To test the sensitivity of results, we also assessed alternative low-income thresholds (50% and 70% of the national median), finding that relative country rankings and trade-offs remain stable.

54 While underconsumption (M/2) is an informative indicator for domestic energy use in the 2020 HBS wave, reliance on this measure may become less straightforward over time as heating systems decarbonise. In contexts where a growing share of households no longer uses fossil fuels or has structurally lower heating needs (e.g., highly efficient buildings), low expenditure may increasingly reflect efficiency rather than deprivation. For the period under study, underconsumption continues to provide a meaningful signal of affordability-related limitations.

Following Croon et al. (2023), we compute the energy poverty gap for each household, which captures the depth of deprivation rather than whether a threshold is crossed. Incidence measures risk, misclassifying support as ineffective if hardship is reduced but not eliminated; intensity better reflects welfare improvements.

The overburden indicator (2M) flags households whose equivalised energy spending exceeds twice the median income share, with the gap defined as the excess. The underconsumption indicator (M/2) identifies those whose spending falls below half the median equivalised energy expenditure, with the gap defined as the shortfall to reach that level. Because both indicators are defined relative to national median expenditure shares, thresholds are recomputed after uprating incomes and prices to 2022 levels and then held constant when applying fiscal support so that outcomes are evaluated against that benchmark. Consequently, the incidence of energy poverty remains relatively stable under uprating, while the gap increases, reflecting a deepening of hardship among affected households. See Appendix 15 for country-level incidence and mean gaps before the crisis, under crisis conditions without support, and after fiscal support is applied.

The final energy poverty gap for household is the maximum of these two gaps:

$$\mathrm{G_i} = \max\left(\mathrm{y_i}\left(\frac{\mathrm{e_{eq,i}}}{\mathrm{y_{eq,i}}} - 2 \cdot \mathrm{median}\left(\frac{\mathrm{E_{eq}}}{\mathrm{Y_{eq}}}\right)\right), \frac{1}{2}\mathrm{median}\left(\mathrm{E_{eq}}\right) - \mathrm{e_{eq,i}}, 0\right) \quad [4]$$

where e_i is household i's equivalised annual energy spending (using OECD's scale), y_i its equivalised disposable income, and E and Y are sample-wide vectors of energy expenditure and income. The first term captures excess burden, the second underconsumption. Taking the maximum ensures the gap reflects the more severe deprivation, with zero assigned if neither applies.

6.3.3 Analytical framework

The total computed proportion of household-level support enables a macro-level comparison of these measures' benefit adequacy and targeting efficiency.

We define benefit adequacy (*BA*) as the share of the pre-intervention energy poverty gap[55] offset by support received:

$$BA_c = \frac{\sum_{i \in EP}(T_{\mathrm{i,c}}+S_{\mathrm{i,c}})}{\sum_{i \in EP} G_{\mathrm{i,c}}} \quad [5]$$

where *EP* is the set of energy poor households (with G_i>0). Higher values indicate greater success in reducing or preventing further deterioration of hardship intensity.

Targeting efficiency (*EFY*) is the share of total support reaching energy poor households:

$$EFY_c = \frac{\sum_{i \in EP}(T_{\mathrm{i,c}}+S_{\mathrm{i,c}})}{\sum_{i}(T_{\mathrm{i,c}}+S_{\mathrm{i,c}})} \quad [6]$$

Here, higher values indicate minimal misallocation and limited market distortions.

Both indicators use the same numerator, total support received by energy poor households, but different denominators: *BA* divides by the pre-support gap to measure how much need is met, while *EFY* divides by total support to measure how much support flows to the target group.

Sustainability (*SUS*) reflects the environmental alignment of each country's fiscal response. Drawing on the environmental criteria outlined in Section 6.2.2, each policy type is scored from 0 (least sustainable) to 7 (most sustainable), incorporating conservation incentives, fossil fuel reduction, support for long-term investments in energy efficiency or renewable technologies, and level of targeting (see Appendix 17). The country-level index is a budget-weighted average:

$$SUS_c = \sum_k \left(\frac{M_{k,c}}{M_{total,c}} \cdot s_k \right) \quad [7]$$

where $M_{k,c}$ is the amount allocated to policy type *k*, $M_{total,c}$ the total fiscal support for households, and s_k the sustainability score.

55 As with coverage, we accounted for energy poverty gaps over a two-year period to ensure comparability with the support spanning two fiscal years.

Salience (*SAL*) captures the extent to which the public experiences fiscal support in broad, perceptible, and politically meaningful ways. Building on recent political economy research (Beiser-McGrath, 2024; Belgioioso & Newman, 2025; Montes de Oca Leon et al., 2024; von Uexkull et al., 2024), we construct a composite indicator combining the reach, average impact, and fiscal scale of support measures:

$$SAL_c = R_c \cdot \overline{C}_c \cdot \theta_c \qquad [8]$$

where R_c denotes the share of households receiving any assistance in country c; C_c is the average proportion of energy expenditure covered across all households; and θ_c is the total household support spending as a share of GDP. Together, these components reflect how widely, tangibly, and visibly relief measures are delivered.

6.4 Results

This section examines the fiscal responses of eighteen European countries to the energy crisis across multiple dimensions, focusing on allocating targeted and untargeted measures, energy bill coverage across income groups, and prioritising four targeting dimensions: benefit adequacy, targeting efficiency, environmental sustainability, and salience. The evidence highlights significant national variation while revealing overarching trends, notably the dominance of untargeted measures in absolute terms and a broadly progressive orientation in household support.

Figure 6.1 presents the timeline of fiscal responses. The crisis response was initially characterised by broad, untargeted measures, with expenditures clustering into two notable peaks.[56] The first, in January 2022, involved a rapid deployment of untargeted price subsidies and universal transfers amounting to more than €131 billion. The second, in January 2023, featured a larger share of targeted instruments: only 2.8% of the first €100 billion (Sep 2021 - Jan 2022) was targeted, compared to 31.4% of the final €100 billion (Nov 2022 - Jan 2023). Although untargeted interventions remained the largest expenditure category overall, these figures indicate a notable pivot towards more targeted approaches in the later stages of the crisis.

56 Here, targeting refers not to energy poverty but to measures aimed at specific households and/or firms (i.e., with eligibility criteria), as classified by Bruegel, whereas 'untargeted' measures apply broadly without such screening.

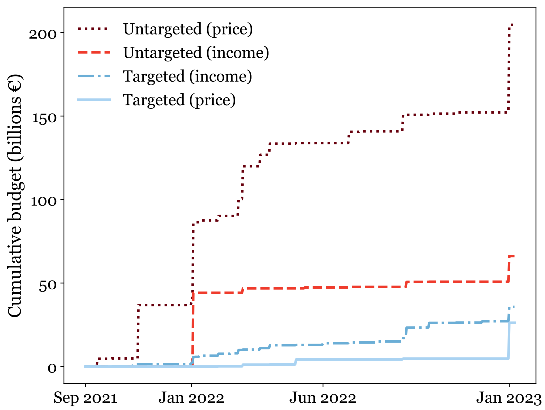

FIG. 6.1 Cumulative distribution of fiscal support provided (by eighteen European countries under study) to households across targeted and untargeted measures for price subsidies and income transfers

We find varying approaches to fiscal measures across countries, with some allocating significantly more support to low-income households than middle- and high-income groups. In contrast, others implemented minimal or largely universal assistance (Figure 6.2). Notably, all countries provided relatively greater support to low-income households, reflecting a broadly progressive orientation in energy bill coverage. The dashed trend line represents the average cross-country distribution pattern. Countries positioned above and to the left of the line provided more support to low-income households than would be expected given their overall level of assistance, whereas those below and to the right offered less support to low-income households relative to the average pattern. Most align closely with the trend line, indicating similar patterns in distributing support between different income brackets.

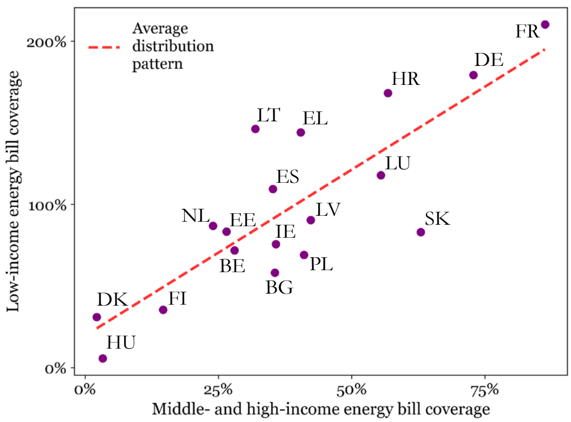

FIG. 6.2 Cross-country comparison of the extent to which fiscal support offsets baseline energy expenditures across income groups

Lithuania, Greece, and Croatia provided notably progressive support, exceeding the average low-income coverage expected at their levels of middle- and high-income assistance. Lithuania, in particular, deviated furthest above the trend line, covering nearly five times more of low-income households' energy bills than those of middle- and high-income groups. This reflects a response strongly focused on the most vulnerable: heating-aid eligibility was expanded to around 110,000 households and minimum-income benefits were increased, with pension uprating also contributing progressively given that pensioners in Lithuania are disproportionately concentrated in lower-income groups. On the other end of the spectrum, Slovakia, Bulgaria, and Poland fall furthest below the trend line, indicating less progressive responses relative to their overall spending. In Slovakia, the fiscal approach relied largely on universal price caps, with some small-scale transfers that were categorically targeted – such as to pensioners and parents – yet these groups are *not* predominantly low-income in Slovakia, resulting in limited redistribution towards the poorest households. Meanwhile, Hungary, Denmark, and Finland provided only limited support overall.

		Targeting Efficiency	Benefit Adequacy	Environmental Sustainability	Political Salience
BE	Belgium	0.25	1.53	0.73	0.54
BG	Bulgaria	0.19	1.38	0.47	0.39
DE	Germany	0.18	3.57	1.48	1.67
DK	Denmark	0.64	0.46	3.09	0.02
EE	Estonia	0.40	1.19	1.87	0.43
EL	Greece	0.33	3.19	1.99	1.69
ES	Spain	0.30	1.53	1.79	0.53
FI	Finland	0.23	0.29	3.46	0.04
FR	France	0.28	2.21	1.56	1.90
HR	Croatia	0.30	3.74	2.20	0.96
HU	Hungary	0.15	0.13	0.00	0.00
IE	Ireland	0.32	1.22	2.58	0.22
LT	Lithuania	0.45	2.56	2.82	1.17
LU	Luxembourg	0.24	1.92	2.09	0.75
LV	Latvia	0.28	1.68	3.19	0.76
NL	Netherlands	0.29	1.83	1.05	1.03
PL	Poland	0.23	0.95	1.51	2.46
SK	Slovakia	0.17	2.12	1.21	1.11

FIG. 6.3 Scores across targeting dimensions

Figure 6.3 compares countries' performance across the four targeting dimensions, each reflecting distinct policy objectives. Compared to Figure 6.2, high support for low-income households does not automatically translate into greater benefit adequacy. Much of France's support came through universal measures: a one-off €100 payment to 38 million people and a blanket electricity price cap under the *'bouclier tarifaire'*, which spread resources across all consumers rather than concentrating them on those with the greatest need. By contrast, Croatia covered a smaller share of low-income energy bills but achieved higher benefit adequacy (3.74 compared with 2.21 in France). This is largely because Croatia's main price intervention was structured as a tiered price cap. Households paid a lower regulated tariff for a defined block of essential consumption (€59/MWh below 2,500 kWh) and a higher tariff above that threshold (€88/MWh). This operational framework concentrated fiscal relief on basic energy needs while preserving stronger price signals for discretionary consumption.

These contrasts are further illuminated by the interplay between targeting efficiency and salience. Countries prioritising visibility and broad reach, such as France and Poland, achieved high salience scores but performed less on targeting efficiency. In Poland, VAT reductions, universal price caps, and categorical transfers under the *Solidarity Shield* reached a wide share of the population. Still, they channelled a substantial portion of resources towards households that were not in energy poverty. Meanwhile, Denmark and Finland represent the opposite end of the spectrum. Both implemented narrowly targeted, low-cost schemes: Denmark through its heat cheque and dedicated fund for gas boiler replacements, and Finland via temporary electricity tax deductions for households with exceptionally high bills. These approaches yielded high targeting efficiency and relatively strong sustainability scores, reflecting targeted allocation and limited reliance on price suppression. However, the overall fiscal envelope for household support in each case remained modest, and the scale of household-level compensation was limited. As a result, neither country saw a significant reduction in the energy poverty gap. Their interventions were far less visible to the general public, as reflected in low salience scores.

While many countries exhibited clear trade-offs across the four dimensions, a few achieved comparatively balanced performance. Greece stands out with one of the highest benefit adequacy scores in the sample, while also performing relatively well on targeting efficiency and political salience. This reflects the breadth and differentiation of its support scheme, which combined universal price subsidies with enhanced relief for households on the Social Residential Tariff, thereby concentrating assistance where affordability pressures were greatest. Lithuania similarly paired immediate support with longer-term structural investment. Its €1.12 billion energy independence package, amounting to roughly €1,000 per household, allocated

€677 million to building renovation and renewable energy deployment, particularly in multi-apartment housing, strengthening both social protection and future energy resilience.

Figure 6.4 highlights the distinct trade-offs that characterised regional responses to the European energy crisis. Nordic and Baltic countries performed strongly on both targeting efficiency and sustainability, reflecting their reliance on well-targeted, environmentally aligned measures. However, the limited scale of these interventions meant that their overall impact and public visibility remained low. By contrast, Western European countries tended to prioritise benefit adequacy and political salience, devoting larger fiscal envelopes to support and distributing relief across wider segments of the population. This approach provided more tangible short-term cushioning, but at the cost of weaker targeting efficiency and greater reliance on price-suppressing measures that risk reinforcing fossil fuel lock-in. Mediterranean countries showed relatively balanced but moderate performance across dimensions, reflecting constrained fiscal space and stronger reliance on tariff regulation and temporary compensation schemes. Finally, Central and Eastern European countries exhibited highly uneven profiles: some implemented large-scale but weakly targeted price interventions that scored poorly on both efficiency and sustainability, while others relied heavily on existing pre-existing regulated energy tariffs, resulting in limited incremental support and low salience. Overall, the regional averages in Figure 6.4 are shaped by a few standout national cases, underlining that while trade-offs between targeting precision, environmental ambition, and political visibility are common, they are not uniform – and, in some instances, can be partially reconciled through careful policy design.

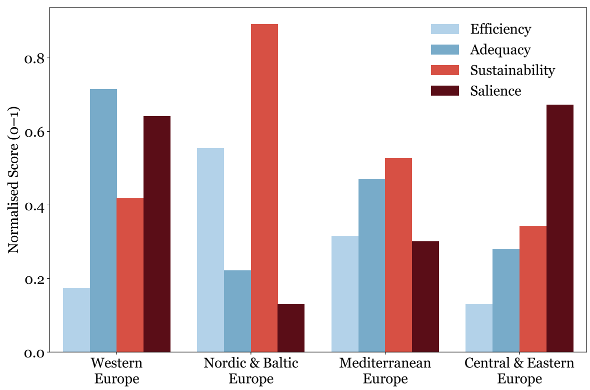

FIG. 6.4 Prioritisation of fiscal relief dimensions, with scores normalised and then averaged across European regions

6.5 Discussion

European governments confronted the 2021-23 energy-price shock with an inevitable four-way trade-off. Our scorecard shows that no country excelled on every axis, yet the tensions among them are not purely mechanical. Untargeted measures dominated total household relief, while they were associated with closing only a small share of the European energy poverty gap. To illustrate the scale of inefficiency: blanket VAT cuts alone cost governments €190 billion in 2022 – a sum sufficient to cover 70% of energy bills for every household below the median income. The pattern confirms a familiar dilemma: broad price measures maximise political visibility (salience) and quickly reduce hardship (benefit adequacy) but are costly and inflationary because they also subsidise high-income households (lower targeting efficiency) and distort price signals and conservation incentives (weaker environmental sustainability). Conversely, narrowly targeted schemes protect budgets and price signals, yet their limited reach reduces both salience and often fails to support all those in need adequately.

This comparative variation also unfolded over time. Untargeted instruments dominated the first wave – particularly in Western Europe – because of their administrative simplicity and political expediency. Targeted instruments, such as means-tested transfers, grew substantially in 2022-23 as fiscal pressure mounted and governments refined eligibility rules. This trajectory mirrors what Boin et al. (2017) call the 'learning phase' of crisis management, in which policymakers' initial, politically charged improvisation gives way to more strategic action as actors evaluate what succeeded, what failed, and how to adapt accordingly.

France's blanket *bouclier tarifaire* epitomised the early, salience-maximising strategy, extending its price cap to virtually all consumers but scattering resources thinly. Germany initially followed a similar trajectory, but its *Preisbremsen* in 2023 capped the price only for a baseline share of consumption (typically 80% of previous use) while allowing market prices to apply above that level. This tiered structure preserved a broad entitlement while restoring marginal price signals, marking a shift towards more calibrated targeting that delivered greater relief per euro spent, particularly for cost-constrained households. By contrast, Denmark and Finland pursued the opposite archetype: modest, tightly targeted schemes that scored high on targeting efficiency and sustainability but remained almost invisible to the wider electorate. Several other countries introduced broader but tiered price-suppression schemes, more closely attuned to energy poverty, by directing support towards households with low absolute consumption constrained by affordability concerns. These contrasts illustrate that countries such as Croatia, Greece, and Lithuania show that benefit adequacy and targeting efficiency need not be mutually exclusive; they combined broad relief with reinforced support for low-income groups, yielding comparatively deeper reductions in energy poverty at similar or lower expenditure levels.

Amid these complexities, a compelling case emerges for hybrid relief strategies akin to what Skocpol (1991) termed 'targeting within universalism': embedding progressive elements within broadly accessible programmes to retain political support while directing greater benefits to those in need. Structuring support around a basic entitlement, then layering targeted transfers or tapering benefits, allows governments to preserve salience while improving distributive equity. A complementary lesson is portfolio thinking: no single instrument resolves every tension, but a deliberate mix – universal yet shallow rebates, deep targeted transfers, and investment components – can offset weaknesses across the policy mix and align short-term relief with long-term goals.

These patterns are shaped by conscious policy choices and deeper institutional, cultural, and historical legacies that define what is administratively feasible, politically acceptable, and practically necessary. Regional contrasts illustrate this path dependence.

Firstly, the Nordic countries offer a clear example of how institutional, cultural, and historical factors shape distinctive fiscal responses to energy crises. Strong universalist welfare states with extensive social safety nets provide households with built-in protection against economic shocks (Esping-Andersen & Korpi, 1987), while governance systems grounded in long-term planning and high public trust enable a focus on sustainable, efficient measures over ad hoc relief (Strandberg, 2006). Longstanding commitments to energy efficiency and early integration of renewables – supplemented by Denmark's use of biogas and Finland's reliance on nuclear power – further reduced the need for large-scale fiscal intervention (Rüdiger & Åberg, 2024). By contrast, while similarly committed to environmental sustainability, the Baltic states pursued more extensive emergency relief, reflecting weaker welfare systems and greater exposure to the energy crisis. Latvia, Lithuania, and Estonia combined price caps, tariff reductions, and broad-based compensations with targeted measures (Blumberga et al., 2024). Although Greve et al. (2024) note a modest Nordic shift from the traditional universalist approach towards targeted support, their interventions remained far more restrained than the expansive aid packages seen in the Baltics.

Secondly, a key driver behind extensive fiscal relief measures implemented in Western Europe appears to have been political, particularly the fear of populist backlash (Osička & Černoch, 2022; von Homeyer et al., 2022). France's experience with the Yellow Vest movement underscored the political risks associated with surging energy prices (Sokołowski et al., 2023), while Germany's *Doppel-Wumms* package was shaped by mounting public pressure and rising approval ratings for the far-right AfD (Krebs & Weber, 2024). Additionally, historical dependencies on Russian natural gas, particularly in Germany, heightened the urgency of fiscal interventions (Halser & Paraschiv, 2022; Marquardt, 2024). In the Netherlands, the shock was especially pronounced because almost all residential heating relies on natural gas, historically supplied at low cost from the Groningen field. Its phase-out coincided with the crisis, resulting in the largest increase in domestic energy prices in the sample (Appendix 16) and a correspondingly sharp rise in the depth of energy poverty (Appendix 15). Straightforward and highly visible measures, such as energy price caps, reflect the imperative for governments to rapidly address public discontent in competitive political landscapes (Brännlund & Peterson, 2024; Mikulska & Finley, 2024).

Thirdly, Central and Eastern Europe experienced the severest price shocks during the energy crisis but had the least fiscal space to respond. These countries were particularly vulnerable due to their historical reliance on Russian fossil fuels (Harsem & Harald Claes, 2013) and traditionally lower housing standards (Csoknyai et al., 2016; Sokołowski & Bouzarovski, 2022), which made deterioration in energy affordability sharper (Appendices 15 and 16) and amplified public demand for immediate relief. However, limited financial resources restricted their ability to implement robust support measures or effectively compete in international LNG markets (Costantini et al., 2022). Consequently, the substantial Western European fiscal measures provoked frustration and prompted calls for European solidarity. This pressure contributed to the EU's eventual agreement on a bloc-wide energy price cap (Fabra, 2023; Nicoli & Zeitlin, 2024; Smeets, 2023). Notably, the cap included restrictive conditions that rendered its practical implementation unlikely (Gros, 2023), leaving individual member states to act independently (Schramm, 2023).

Finally, Mediterranean responses diverged sharply. Spain was able to capitalise on its recent renewable energy boom through the so-called *Iberian exception:* a temporary mechanism, approved by the EU, that effectively decoupled electricity prices from volatile gas markets and was financed via windfall taxes on non-gas producers (Bento et al., 2024; Hidalgo-Pérez et al., 2024). In contrast, Greece, despite enjoying similarly favourable conditions for wind and solar, has traditionally depended on lignite and coal (Vlassopoulos, 2020), with post-financial crisis austerity measures

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severely limiting its renewable energy investments (Angelopoulos et al., 2017), and therefore had to rely to shield households. The heterogeneity in income and expenditure adjustments between 2020 and 2022, which shaped both the scale of hardship and the fiscal effort required, is documented in Appendix 16.

Taken together, our findings speak directly to a growing literature highlighting the inherent tensions in designing not only crisis responses that balance immediate, tangible relief with long-term environmental sustainability, but also broader energy and climate policies that strive to align social equity with decarbonisation goals (Belaïd et al., 2023; Darvas & Wolff, 2022). This way, this study underscores that while targeting is often perceived as a purely technical exercise, it is, in fact, a value-driven and politically negotiated choice. Earlier work has examined the targeting efficiency of energy relief (Bardazzi et al., 2024; Mastropietro, 2022), but devoted less attention to the administrative and political constraints shaping what targeting rules are feasible. In principle, smart targeting in the energy sector can reconcile progressive and conservative priorities by reducing inequality, limiting emissions, and containing fiscal costs (Simshauser, 2023); in practice, our cases reveal the recurrent challenge of designing, funding, and legitimising such schemes at speed.

From a governance perspective, our detailed analysis of all measures suggests that countries with pre-existing administrative infrastructure, such as Belgium's extension of its social tariff for low-income households to also cover lower-middle-income groups, were better positioned to scale their policies efficiently. Others paired immediate relief with demand-side investment: Dutch 'fix teams' rolled out low-cost insulation in low-income neighbourhoods (Croon et al., 2025), while Greek energy communities installed rooftop PV for vulnerable households (Kanellou et al., 2023). These examples illustrate that effective response depends not only on institutional capacity, but also on institutional imagination.

Despite offering new comparative insights, the results should be interpreted in light of several methodological limitations. Notably, excluding pre-existing or firm-targeted structural policies means that countries with long-standing support mechanisms may appear to have responded less forcefully, despite high levels of household protection. This may partly account for the modest scores observed in Nordic countries, which were assessed based on direct household interventions despite having allocated substantial funds to utility liquidity, such as Finland's public energy company bailout at nearly 7 per cent of GDP and Denmark's sector-wide support at around 4 per cent of GDP (Sgaravatti et al., 2024). Conversely, among the measures included, some were introduced in response to broader cost-of-living pressures rather than the energy crisis specifically. As a result, not all recorded spending can be clearly attributed to energy-related hardship, which complicates the interpretation of the coverage and benefit adequacy metrics. Additionally, while both direct relief and green investments are treated as household-targeted support, only the former yields benefits felt immediately, which may overstate benefit adequacy and salience in the short term. Moreover, the static modelling approach, based on uprated 2020 data, limits the ability to capture behavioural changes or shifting household vulnerabilities over time. These caveats caution against overinterpreting cross-country rankings and underscore the need for future research to incorporate more behavioural, temporal, and institutional nuance.

Building on the insights of this study, future research should investigate the role of institutional capacity in enabling responsive, targeted, and environmentally aligned energy relief. A second avenue lies in unpacking the political dynamics behind fiscal decisions: comparative case studies that trace the interplay between public pressure, party ideology, and institutional legacies would enrich our understanding of how policy paths are chosen under crisis conditions. Third, expanding the analytical lens to include multidimensional and intersectional vulnerabilities, such as housing quality, health status, and geographic isolation, could offer a more granular view of who benefits from crisis interventions and who remains underserved. Lastly, the EU's Social Climate Fund, a funding instrument to support vulnerable households during the green transition, offers a timely opportunity for future comparative research. Assessing how countries design targeted spending strategies, by applying the framework developed in this study, could help determine whether these plans reflect the lessons of the energy crisis or risk repeating its shortcomings.

6.6 Conclusion

This study set out to explain how eighteen European countries balanced four competing policy objectives – benefit adequacy, targeting efficiency, environmental sustainability and political salience – when shielding households during the 2021-23 energy-price shock. By integrating Bruegel's Fiscal Tracker with uprated Household Budget Survey microdata and applying an original four-dimensional framework, it offers a systematic, cross-national comparison of relief strategies and the trade-offs they entail. A clear sign of evolving policy learning is the marked shift towards targeting. While only 3% of the first €100 billion was targeted, this rose more than tenfold in the final tranche, reflecting tighter fiscal constraints and improved administrative capacity.

The comparative results highlight overarching insights. First, benefit adequacy and targeting efficiency are not mutually exclusive but hinge on how assistance is delivered. Packages that layered stratified price relief with means-tested transfers achieved the greatest average reduction in the energy poverty gap per euro spent, while limiting leakage to higher-income households. Second, environmental sustainability need not be sacrificed on the altar of political visibility: when universal price caps were bounded by consumption thresholds or combined with investment components, such as fast-tracked energy efficiency upgrades or renewables deployment, sustainability scores remained above the sample median even where salience was high. Together, these findings confirm that the four objectives interact as a continuum rather than a set of binary choices, and that a country's position on this continuum is determined not by any single instrument but by the overall policy mix. In practice, hybrid packages that combine universal entitlements with targeted top-ups, alongside a portfolio approach coordinating complementary instruments, exemplify how mixed strategies can align these objectives in a mutually reinforcing way.

By rooting the analysis in these four dimensions, the paper deepens the political economy understanding of energy crisis relief. Energy prices are conspicuous and immediately felt; sharp increases therefore generate acute electoral pressure, prompting governments to deploy fiscal responses on a scale comparable to, and sometimes exceeding, pandemic-era interventions. Given these extraordinary stakes, relief design is more than a technocratic exercise: political contingency shapes who is assisted first, how widely benefits are distributed, and whether funds reinforce or undermine longer-term decarbonisation goals. By demonstrating that these four dimensions can be analysed concurrently, and that the trade-offs between them are neither inevitable nor fixed, this study demonstrates why a multidimensional lens is indispensable for judging whether the billions deployed in future price shocks will merely mute unrest or genuinely alleviate deprivation while preserving climate ambitions.

The synthesis presented here suggests that the policy problem posed by future energy or climate shocks is not simply 'whom to compensate', but 'how to sequence and combine' multiple design logics in real time. The four-dimensional framework developed in this paper offers a replicable tool for that task. Applied to forthcoming initiatives, it can help benchmark progress, identify emerging trade-offs early, and promote an evidence-based dialogue among finance, energy and social policy practitioners. In this way, the study aims to inform policy design while enriching scholarly debate on the multidimensional nature of social protection in the energy transition.

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PART III

Principles and governance

Institutional and normative logics in shaping just energy transitions

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7 Residual welfare and short-termism in UK household energy support

This chapter is based on a peer-reviewed article published as:
Croon, T. M., Elsinga, M. G., Hoekstra, J. S. C. M., Sunikka-Blank, M., & Galvin, R. (2026). For the Few, Not the Many: Tracing the Residualist and Compensatory Nature of British Energy Support. *Environmental Policy and Governance.*

ABSTRACT

Drawing on extensive documentary analysis, this article traces the evolution of British energy policy support since World War II. It analyses shifts in policy design through two interpretive lenses: eligibility (residualist vs universalist) and function (compensatory vs preventive). While the UK was once a global leader in preventive, relatively broad-based energy efficiency investments, since the 1980s it has moved increasingly towards reactive, narrowly targeted schemes, mostly delivered through energy supplier obligations and providing means-tested relief. Moments of crisis, such as the oil shocks of the 1970s and the recent energy price surge, prompted temporary shifts to universalism, but such measures have proved short-lived. While successive governments emphasised the many co-benefits of energy efficiency schemes, they remain inconsistently implemented and underfunded. We argue that the persistence of residualist-compensatory models is driven by political, institutional, and ideational factors. To make sense of these developments, we introduce a typology of four models – residualist compensatory, residualist-preventive, universalist-compensatory, and universalist-preventive – which is used to map key policy shifts and assess their implications. We conclude by explaining that a transition towards a universalist-preventive approach must be grounded in a rights-based framework.

7.1 Introduction

In the 1970s and 1980s, the UK was a global leader in energy efficiency, launching the world's first dedicated Energy Efficiency Office, nationwide awareness campaigns, and coordinated government support for households and industry (Leach, 1991; Mallaburn & Eyre, 2013). In stark contrast, the UK government today is one of the few high-income European countries without a comprehensive, universally accessible scheme for retrofitting grants or loans that goes beyond heating system replacement .[57] Instead, it relies on a fragmented patchwork of policies, mostly financed through consumer levies and limited to low-income households, despite an aging and relatively inefficient housing stock and the pressing challenges of climate change and the cost-of-living crisis (Figus et al., 2017; Roberts, 2008).

This article offers a comprehensive analysis of how this shift occurred, tracing the evolution of UK energy support policy from the energy crisis of the 1970s to the latest announced 2025 reforms. It argues that while the UK has increasingly moved towards a residualist and compensatory model, relying heavily on narrowly targeted, short-term assistance for a subset of 'deserving' households, often delivered through market-based instruments such as energy supplier obligations (Katris & Turner, 2021; Rosenow, 2012; Rosenow et al., 2013), this trajectory has not been linear or absolute. Elements of more universal, preventive, and investment-oriented support have persisted or re-emerged at various points, reflecting political, economic, and institutional tensions that continue to shape the policy landscape.

Against this background, fuel poverty emerged as an increasingly prominent reference point in UK household energy policy. The Warm Homes and Energy Conservation Act (2000), which established an official definition of fuel poverty as *"living on a lower income in a home which cannot be kept warm at reasonable cost"*, was a breakthrough in compelling the government to formulate concrete strategies for fuel poverty alleviation. However, it may also have contributed to framing the issue primarily as a technical challenge of energy inefficiency, sidelining structural factors such as income inequality and rising energy prices (Middlemiss, 2016). In doing so, it arguably marked the beginning of an austerity-driven governmentality in which state responsibility

57 Since devolution in 1999, energy policy has been largely devolved within the UK, leading to distinct approaches across the nations. While Scotland offers a broadly accessible scheme via '*Home Energy Scotland*', England lacks a comprehensive, universal energy efficiency programme, unlike France (*MaPrimeRénov'*), Germany (*KfW*), Italy ('*Superbonus*', though increasingly means-tested), Ireland (*Home Energy Grants*), the Netherlands (*ISDE*), and Spain (*PREE*).

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became increasingly confined to targeted retrofit measures and energy relief without looking at broader energy efficiency subsidies or tax reform (Galvin, 2024), especially after the Warm Front programme was scrapped in 2013 (Bridgen & Robinson, 2023; Sovacool, 2015). This trajectory has implications beyond the UK, given its early role in defining fuel poverty as a discrete policy concern, an issue now gaining recognition in Canada, the United States, and across continental Europe (Bednar & Reames, 2020; Kyprianou et al., 2019; Riva et al., 2021).

To make sense of these policy shifts, and contribute a novel, long-term perspective that integrates both energy efficiency and energy bill support, rarely addressed together in existing literature, this article adopts two interpretive lenses that help explain the underlying logic of change. The first traces a shift along a residualist-universalist spectrum, capturing changes in *who* is targeted by energy policy. Here, ‘residualisation’ refers to the retreat of the state from broad-based welfare provision towards narrowly targeted, means-tested assistance, offered only to those deemed most in need (Esping-Andersen, 1990; Wilensky & Lebeaux, 1958). The second perspective examines a movement from compensatory to preventive models of support, focusing on *how* and *when* help is delivered. While compensatory policies are reactive, offering relief after harm has occurred (e.g. energy bill rebates), preventive approaches aim to reduce vulnerability before crises emerge (e.g. housing insulation). This shift aligns with the broader paradigm of ‘social investment’, which treats welfare spending not merely as expenditure but as a long-term strategy to enhance capabilities, reducing future risks, promoting well-being, and enabling societal participation (Hemerijck, 2002). While both lenses are prominent in British energy discourse, the residual shift appears to have materialised, whereas the preventive turn remains largely rhetorical.

The remainder of this article is structured in three main sections. First, it lays out the theoretical framework underpinning the analysis, focusing on the dual shifts from universalist to residualist models of welfare, and from preventive to compensatory forms of government spending. Second, drawing on a wide range of policy documents and official sources, we trace the historical trajectory of UK energy support from the 1970s to the current reforms, highlighting key shifts, contradictions, and continuities in the policymaking landscape. Finally, we assess these developments through a typology of four ideal-typical approaches to energy support: residualist-compensatory, residualist-preventive, universalist-compensatory, and universalist-preventive. This typology provides a basis for critically examining the strengths and limitations of each model in addressing fuel poverty, enhancing energy efficiency, and balancing short-term relief with long-term resilience in the context of overlapping ecological, economic, and social crises.

7.2 Shifting governance objectives

This article adopts a theory-informed analytical framework to examine long-term shifts in the design of energy support policies. Rather than treating eligibility and policy function as merely descriptive attributes, the analysis draws on two well-established strands of policy and welfare state scholarship: debates on residualisation versus universalism, and work on compensatory versus preventive (or social investment) approaches to social policy (Bernard & Boucher, 2007; Esping-Andersen, 1990; Hemerijck, 2015). These strands address complementary questions of governance. The former concerns *who* is entitled to public support and on what basis, while the latter concerns *how* and *when* social risks are addressed: reactively through income or price compensation, or proactively through measures aimed at reducing future vulnerability.

Although these literatures have often developed in parallel, a growing body of research has shown that distributive scope and functional orientation are closely intertwined in processes of institutional change. Comparative studies of welfare reform demonstrate that shifts towards social investment are frequently accompanied by changes in eligibility design, while patterns of targeting and residualisation shape the feasibility and reach of preventive interventions (Andersson, 2020; Jacques & Noël, 2021; Morel et al., 2012). Rather than treating universalism, residualism, compensation, and prevention as isolated policy choices, this work highlights their co-evolution as part of broader transformations in governing logics, fiscal rationales, and conceptions of social responsibility.

Building on this literature, the two-dimensional framework developed here brings these perspectives together to analyse energy support policies and other instruments of environmental governance. Applied as a heuristic device, it captures both the distributive scope of interventions and their temporal orientation, enabling a systematic assessment of how these policies balance short-term affordability, long-term efficiency, and social equity across changing institutional and political contexts.

7.2.1 Residualist paradigm

Residualisation of social policy in Europe, and particularly in Britain, refers to a structural shift in welfare provision whereby universal or broad-based entitlements are increasingly replaced with selective, means-tested benefits that serve only those in acute 'need' or those deemed most 'deserving' (Hoekstra, 2009; Spicker, 2005). In contrast, universal welfare approaches provide entitlements broadly across a population, based primarily on

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citizenship or broad demographic categories (e.g., pensioners, the unemployed) rather than financial or other narrowly defined criteria or specific criteria such as age, income, or household composition (Van Lancker et al., 2015). Unlike 'targeting', which refers to the distributive direction of public spending (Jacques & Noël, 2021), residualisation represents a more fundamental shift in the logic of welfare states, redefining social protection as a last resort rather than a universal right.

Eligibility is treated here as a core analytical dimension because it captures how responsibility for social risks is allocated between the state, the market, and households. A shift towards residualism signals not merely narrower coverage, but a redefinition of social protection as conditional, temporary, and exceptional rather than a universal social right. In the context of energy policy, this distinction is particularly consequential, as eligibility rules determine whether affordability and efficiency are treated as collective infrastructure concerns or as individualised problems experienced only by a subset of 'deserving' households. As scholarship in environmental policy has long emphasised, such design choices are inherently normative: frameworks that prioritise efficiency without making distributional implications explicit risk obscuring questions of equity and responsibility (Aakre & Rübbelke, 2010). By foregrounding eligibility, the analysis makes these distributive assumptions visible rather than implicit.

Residualisation has been particularly pronounced in liberal welfare states such as the UK, where successive governments have moved away from Beveridgean principles of comprehensive welfare coverage towards a more conditional and minimalist model (Edmiston, 2017). Policies such as the replacement of universal child benefits with income-contingent payments and the tightening of eligibility for unemployment support illustrate this trend (Heins & Bennett, 2018; Ridge, 2013). In contrast, social-democratic welfare regimes such as Scandinavian countries have largely preserved more universalist approaches, maintaining broad-based entitlements and inclusive welfare structures that emphasise collective well-being and shared responsibility (Esping-Andersen, 1990; Frederiksen, 2018).[58] These cross-national differences highlight the extent to which residualisation is not only a product of fiscal constraint but also of political ideology and institutional legacies.

At a deeper level, residualisation signals a redefinition of the welfare state's role, moving away from principles of collective provision towards a more conditional and selective logic. It is closely associated with neoliberal modes of governance in which

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58 However, even in Nordic countries, universalist welfare policies have come under increasing pressure in recent decades (Johansson, 2001). The energy crisis and broader inflation shock in recent years again highlighted this, with Nordic governments introducing targeted measures for vulnerable households, though on a more modest scale than elsewhere (Croon & Sokołowski, 2025; Greve et al., 2024).

social protection is reimagined not as a shared right but as a cost to be minimised, a safety net activated only when market solutions fail (Clasen, 1999; Kaneko, 1998). In this context, state intervention is increasingly framed as a form of conditional relief, subject to individual conditions and behavioural obligations. Proponents often justify this model on the grounds of fiscal efficiency, ensuring that limited public resources are directed towards those most in need (MacLeavy, 2016). However, critics point to the broader social consequences of this shift, arguing that it introduces administrative burdens and reinforces stigma (Sen, 1998). It is also said to deepen inequalities, foster a moral hierarchy between those deemed self-reliant and those portrayed as dependent or failing, and erode the solidarity that underpins collective welfare provision (Van Oorschot & Roosma, 2017).

The residualist logic extends beyond the confines of traditional income support mechanism, such as unemployment benefits, family allowances, and sick leave entitlements, to increasingly shape sectoral domains like housing, health, and, as explored in this article, energy policy. In housing, for example, the retreat of the state from mass social housing has coincided with the rise of selective housing benefits and strict eligibility criteria (Elsinga & Wassenberg, 2014; Pearce & Vine, 2013). Especially in countries where social housing sectors have shrunk or been reoriented towards only the most economically vulnerable, this has resulted in spatial segregation and diminishing affordability across the housing system (Burrows, 1999; Hoekstra, 2017). In health care, too, residualisation is evident in areas like prescription charges, dental treatment, mental health services, and social care, where access is increasingly means-tested or only available to those in greatest need while others face rising costs, longer waits, or exclusion altogether (Bambra, 2005; Cummins, 2018; O'Brien, 1989).

Residualisation in the provision of energy services has followed a similar trajectory. Historically, energy provision in many advanced economies was managed through publicly owned utilities that ensured broad-based affordability and system-wide stability (Helm, 2003). However, following the liberalisation of energy markets in the 1990s and 2000s, particularly across Europe and North America, affordability concerns were increasingly reframed either as matters of overall market price levels or as individualised hardship, defined as fuel poverty or energy poverty (Boardman, 2010; Dubois, 2012). In response, several European countries introduced means-tested 'social tariffs' alongside market liberalisation, offering targeted support only to narrowly defined groups considered most in need.[59]

59 Notable examples include the introduction of social energy tariffs in Belgium (2004), Romania (2005), and France (2005), followed by Cyprus (2006), Italy (2008-2009), Spain (2009), Portugal (2010), and Greece (2010). In contrast, several Central and Eastern European countries continued to maintain broader household energy price regulations even after joining the EU.

Residual approaches are also evident in the domain of energy efficiency. In the United States, for instance, the *Weatherization Assistance Program* (WAP), established in 1976, has long operated on a residualist logic, providing retrofitting subsidies solely to low-income households (Fowlie et al., 2018; Hernández & Bird, 2010). More recently, similar patterns have emerged in the UK, where energy efficiency support has become increasingly selective, as this article explores in detail.

7.2.2 Preventive paradigm

Parallel to residualisation, the rise of the preventive paradigm, often discussed under the label of 'social investment', marks a significant evolution in contemporary governance arrangements (Hemerijck, 2015). In contrast to compensatory approaches, which provide relief after harm or disadvantage has occurred, preventive policies seek to address the root causes of vulnerability in advance (Morel et al., 2012). As such, they embody a shift from *repair* to *prepare*, and from passive income maintenance towards anticipatory forms of intervention that prioritise capacity building, resilience, and future-oriented policy design (Giddens, 1998; Hemerijck, 2017)

Initiatives such as accessible childcare and early childhood education, vocational training schemes, and active labour market policies exemplify this investment-oriented ethos. They do so by promising cognitive and emotional development during critical years, equipping individuals with skills aligned to evolving labour market demands, and intervening early in periods of joblessness to prevent long-term detachment from the workforce (Hemerijck, 2002; Jenson, 2009). These policies reflect a broader commitment to 'life course thinking', which emphasises timely interventions to prevent the accumulation of disadvantage across an individual's lifespan (Esping-Andersen, 2002).

Beyond social policy, the preventive paradigm also resonates with broader debates in sustainability and environmental governance, where long-termism, anticipation, and upstream intervention are widely recognised as core governance principles. Research highlights that sustainability-oriented governance requires public administrations to move beyond short-term problem solving towards anticipatory and reflexive modes of action that address structural causes rather than symptoms (Bornemann & Christen, 2018). At the same time, such approaches are often politically and institutionally challenging, as they involve short-term costs while their benefits accrue only over longer time horizons (Teng et al., 2013). From this perspective, preventive social policies can be understood as part of a wider shift towards governance arrangements that prioritise long-term societal resilience.

Empirically, countries differ markedly in how this preventive orientation is institutionalised. Scandinavian welfare states such as Sweden, Denmark, and Finland have embedded service-oriented preventive measures within largely universal social protection systems, whereas countries like the UK and Germany have tended to layer more selective and fragmented preventive initiatives onto increasingly residual welfare arrangements (Hemerijck & Vandenbroucke, 2012). These differences underscore that preventive governance is not value-neutral: its effectiveness and distributive consequences depend strongly on how it is combined with eligibility rules and broader institutional contexts.

Within the preventive paradigm, two distinct normative rationales often underpin the push for early and proactive interventions: a 'productivist' logic centred on economic efficiency and labour market performance, and a justice- or capability-based perspective that emphasises individual dignity, autonomy, and well-being (Laruffa, 2020; Morel & Palme, 2017). From the productivist standpoint, social investment policies reconceptualise welfare from being a cost or burden to a productive factor, and they are expected to yield returns through higher employment, productivity, and reduced welfare dependency (Midgley, 1999; Smyth & Deeming, 2016). In contrast, capability-based approaches, drawing on thinkers like Sen (1999) and Nussbaum (2000), frame some of these same interventions as intrinsic goods, means of expanding people's real freedoms and enabling them to flourish on their own terms (see e.g., Laruffa, 2018). These perspectives are not necessarily in conflict; in many cases, policies justified on economic grounds can also support broader social and ethical aims. Yet the emphasis matters: a productivist lens tends to prioritise those deemed 'economically active', potentially sidelining individuals whose contributions are less visible in market terms, such as carers, disabled people, or the long-term unemployed. As critics warn, this productivist orientation can risk reinforcing existing inequalities by overlooking or undervaluing those less able to engage in paid employment (Cantillon & Van Lancker, 2013).

While traditional applications of the social investment paradigm primarily focus on human capital, education, and employment, it can also be extended to address the domains introduced in Section 7.2.1. In housing provision, models like *Housing First*, as pioneered in Finland, exemplify preventive investment by addressing homelessness through immediate access to stable housing, on the premise that a secure home is a prerequisite for tackling other forms of social and economic exclusion (Baker et al., 2020). This approach has demonstrated that securing housing upfront not only improves individual outcomes in health, employment, and well-being but also reduces long-term public expenditure by minimising reliance on emergency and crisis services (Busch-Geertsema, 2013; Haffner & Elsinga, 2018; Woodhall-Melnik & Dunn, 2016). Similarly, preventive care is emphasised in the health sector – arguably even more prominently due to the substantial public expenditure associated with healthcare in welfare states – through early interventions such as lifestyle education, routine screenings, and vaccinations (Eisner et al., 2011). These measures not only reduce the onset of chronic illness and help lower long-term healthcare costs, but also improve individuals' capabilities by supporting healthier, more autonomous lives (Maciosek et al., 2010; Mitchell et al., 2017; Warner, 1979).

In the context of energy services, the preventive paradigm represents a strategic shift from short-term compensatory measures towards structural, long-term solutions. Reactive interventions, such as direct energy bill subsidies, typically fail to address underlying structural issues, whereas preventive approaches based on energy efficiency prioritise long-term solutions (Sommestad, 2011; Zimmermann & Gengnagel, 2023). Galvin et al. (2024), analysing the elasticity of heating expenditure in England, demonstrate that energy efficiency upgrades offer the most substantial and lasting relief from fuel poverty, outperforming direct income support. From a fiscal standpoint, this approach is also far more cost-effective. Rüdinger (2023) highlights the opportunity costs of compensation: reallocating just a quarter of the €45 billion France spent in 2023 on its energy 'tariff shield' could increase funding for energy retrofits fivefold. Beyond economic logic, energy efficiency is also framed as a means of expanding individual capabilities. Day et al. (2016), drawing on a capabilities-based perspective, argue that structural interventions like retrofitting not only improve thermal comfort and health but also enable fuller social participation and restore a sense of dignity. However, unlike other areas of social investment, energy efficiency measures are typically embedded in dwellings rather than individuals, complicating efforts to target and sustain preventive support, since benefits do not follow people as they move and may even end up capitalising landlords rather than empowering vulnerable tenants (Croon et al., 2024; Fernández et al., 2024).

Combining eligibility and function as analytical dimensions offers several advantages for comparative policy analysis. It enables policies to be assessed not only in terms of whom they target, but also in terms of how they address social risks over time, thereby revealing hybrid configurations, such as targeted preventive interventions or universal compensatory schemes, that may be obscured in one-dimensional typologies (Howlett & Rayner, 2007; Jacques & Noël, 2021). At the same time, applying this framework involves interpretive challenges. Eligibility and policy function are best understood as gradational rather than binary categories, and many interventions combine preventive and compensatory elements to varying degrees, making precise classification inherently nuanced and context-dependent (Bouma et al., 2019; Suykens et al., 2016). For this reason, the framework is applied here as a heuristic rather than a normative ranking device, with classifications interpreted contextually and comparatively rather than mechanically.

7.3 Analytical approach and methodology

This article adopts a qualitative, interpretive approach to trace the evolution of UK energy support policy, focusing on the shifting logics of eligibility and policy function. The two-dimensional framework introduced in Section 7.2 is used as an organising lens throughout the documentary analysis, structuring how policy instruments are compared and positioned over time. Each policy is systematically analysed and categorised along the two analytical dimensions explored above: eligibility coverage, ranging from residual (targeted and conditional) to universal (broad-based), and primary function, distinguishing between compensation (financial support to offset high fuel costs) and prevention (energy efficiency improvements and energy-demand reduction incentives). In practice, rather than from policy framing alone, eligibility is inferred from formal access rules, while function is inferred from the dominant mechanism of intervention.

This analysis is based on a structured review of documentary sources, including legislative texts, consultation papers, parliamentary briefings, budget announcements, White and Green Papers, government impact assessments, and evaluations by relevant governmental bodies and external organisations. In total, the analysis examines 19 distinct UK domestic energy support policies and programmes, drawing on 97 documentary sources. The typological mapping presented in Figure 7.1 focuses on 16 schemes that were operational at some point from 2010 onwards, allowing for direct comparison of contemporary policy design logics; where schemes were substantially reformed, these changes are reflected through multiple positions on the typology (see Appendices 18 and 19). The analysis combined deductive coding based on predefined eligibility and function categories with inductive interpretive judgement in positioning schemes along the scales.

Crucially, the two analytical dimensions are not conceived as binary categories, but as continuous spectrums along which policies can exhibit hybrid characteristics. For instance, a scheme may offer universal access to basic energy-efficiency vouchers while reserving fully funded retrofits for low-income households. Similarly, not all compensatory measures are equally direct: a lumpsum transfer to a vulnerable group is less responsive to actual energy needs than one calibrated to expected energy bills or triggered by freezing temperatures. As such, and given the political incentive for governments to frame even narrowly targeted interventions as broad, game-changing solutions, classification required a nuanced interpretive process, grounded in triangulation across multiple sources (Roe, 1998). Where political statements diverged from operational rules and mechanisms documented in legislation, implementation guidance, and evaluations, the latter were prioritised when positioning schemes along the scales.

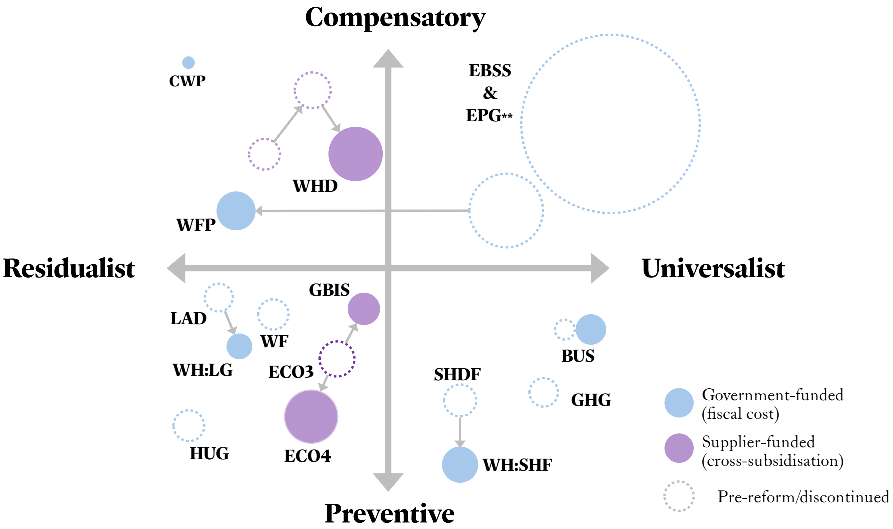

FIG. 7.1 Shifts in the design of UK energy support schemes* since 2010 along the residualist-universalist and compensation-prevention axes, with arrows indicating directional change from pre-reform to post-reform positions, circle size showing relative annual expenditure, fill status distinguishing active or reformed from discontinued schemes, and colour differentiating funding sources with purple for general taxation and blue for supplier obligations passed on to consumers (see Appendices 18 and 19 for substantiation)

** BUS (Boiler Upgrade Scheme), CWP (Cold Weather Payment), EBSS (Energy Bills Support Scheme), ECO4 (Energy Company Obligation, Phase 4), EPG (Energy Price Guarantee), GBIS (Great British Insulation Scheme), HUG (Home Upgrade Grant), LAD (Local Authority Delivery), SHDF (Social Housing Decarbonisation Fund), WF (Warm Front) WFP (Winter Fuel Payment), WHD (Warm Home Discount), WH: LG (Warm Homes: Local Grant), WH:SHF (Warm Homes: Social Housing Fund)*
*** This circle represents an annual cost of approximately £11.7 billion, equivalent to one year of either the Energy Bills Support Scheme or the Energy Price Guarantee (see Appendix for substantiation)*

While the article traces the broader historical trajectory of UK energy support policy from the 1970s energy crises onward, the typological mapping itself focuses on more recent developments. Specifically, it includes policies that have been operational since the enactment of the Warm Homes and Energy Conservation Act (2000). Where schemes have evolved significantly, such as through reforms to eligibility or funding, these shifts are reflected in their changing position on the typology. A visual mapping (Figure 7.1) illustrates this evolution: arrows in the figure indicate direction of change; circle size reflects relative expenditure; filled versus unfilled circles distinguish between active, reformed, and discontinued schemes; and colour differentiates between policies funded through general taxation and those financed via energy supplier obligations, which pass costs on to consumers. The mapping is intended not as an exhaustive inventory, but as a focused analytical tool to examine shifts in design logic, targeting scope, and strategic orientation over the past two decades. To support transparency, the appendix provides a codebook (Appendix 18) and scheme-by-scheme substantiation (Appendix 19) alongside the figure's placements.

7.4 Mapping the shifts in UK energy support policy

This section examines the evolution of British energy support policy over recent decades, using a two-dimensional framework that considers: (1) the extent to which policies are residual (targeted and conditional) as opposed to universal (broad-based), and (2) the degree to which they emphasise compensation (reactive financial support to alleviate high energy costs) versus prevention (proactive measures to improve energy efficiency and reduce demand).

7.4.1 Universalism and residualism in flux (1948-2008)

While the foundational Beveridge Report outlined a universalist, contributory vision for the British welfare state, it also recognised that some individuals would be excluded from insurance benefits, recommending a residual safety net that materialised in 1948 as National Assistance (Walker, 2011). The scheme offered limited, discretionary relief, including for heating costs, but was criticised for inconsistency, stigma, and reliance on caseworker judgment, amid growing awareness of poor housing conditions across the country and the vulnerability of older, disabled, and chronically ill people in cold homes. In 1966, the Supplementary Benefit system was introduced, formally incorporating Heating Additions for these claimants. Over time, categories like 'ordinary' and 'discretionary' heating additions were introduced, and the amount of money was regularly updated to respond to inflation and rising energy costs, especially during the oil crises (Lowe, 1993).

The oil crises of the 1970s were a seismic moment for UK energy policy, triggering an unprecedented shift in governmental logic from residual, discretionary relief to more universalist and preventive approaches. As oil prices quadrupled and coal strikes compounded the crisis, energy insecurity became a national concern affecting all households, not just the vulnerable.[60] In response, the UK adopted a broad-based approach to managing energy demand and curbing energy waste at its source, marking what some view as a brief but golden era of energy efficiency policy grounded in long-term investment logic (Schumacher, 1985). Government interventions included public awareness campaigns, mandatory reductions in speed limits, temperature caps in non-domestic buildings, stricter building regulations, industrial energy surveys, and large-scale retrofit programmes (Mallaburn & Eyre, 2013). A key example of this shift was the Home Insulation Scheme (HIS), launched in 1978, which marked a major turning point as the first nationally coordinated retrofit programme backed by significant public funding, offering material energy efficiency improvements – primarily loft insulation and draught-proofing – with full grants for low-income households and partial subsidies available to all, hence blending targeted and universalist elements (Leach, 1991).[61]

Following the broad-based urgency of the 1970s, the 1980s witnessed a clear residualisation of UK energy support. The HIS was gradually narrowed in its focus: by the late 1980s, the broadly accessible partial subsidies were eliminated, and eligibility was restricted *"solely for those on a low income and without capital"* (Boardman, 1991b, p. 69). This shift reflected both fiscal restraint and a political reorientation under Thatcher's Conservative government, which dismantled Heating Additions in 1987, causing Britain's poorest households to lose an estimated £100 million in annual support (Boardman, 1991a). Although the government did not formally recognise fuel poverty as a distinct welfare category, the introduction of the Cold Weather Payment (1988) signalled an implicit acknowledgment of the issue. This scheme, triggered only when sub-zero temperatures were sustained for seven consecutive days, offered £25 to recipients of means-tested benefits, setting an early precedent for highly conditional energy bill support. The trend towards residual interventions was cemented in the 1990s: in 1991, the HIS was replaced by the Home Energy Efficiency Scheme (HEES), which was limited to basic insulation measures and targeted only poorer households (Boardman, 1991b; Mallaburn & Eyre, 2013). This was followed in 1994 by the Energy Efficiency Standards of Performance (EESoP), the first energy supplier obligation to support low-income households with energy efficiency upgrades, though at a much smaller scale than later supplier-led schemes introduced in the 2000s (Rosenow et al., 2013).

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60 While the oil crises affected the population broadly, this period also revealed stark inequalities in household experiences, largely determined by income levels and the energy efficiency of their homes. Isherwood and Hancock (1979) were the first to attempt a formal quantification of what be known as 'fuel poverty', a concept that gained significant political and academic attention in subsequent years (Boardman, 1991b; Bradshaw & Hutton, 1983).

61 Alongside the HIS, *Community Insulation Projects* (CIPs) emerged in the late 1970s as locally delivered schemes employing young and unemployed people to insulate low-income homes, funded through job creation programmes (Boardman, 1993; Williams, 1983).

Blair's Labour government significantly reshaped energy support policies, recognising fuel poverty for the first time as a distinct and urgent policy issue and adopting a mix of universalist and targeted approaches. The Winter Fuel Payment, directly introduced upon taking office in 1997, exemplified its compensatory logic: a politically popular, universalist scheme offering £200 annually to all pensioners to help cover winter heating costs (Ginn, 2008). Building on this momentum, the Warm Homes and Energy Conservation Act (2000) legally defined fuel poverty and placed a statutory duty on future governments to implement strategies aimed at its eradication. As the flagship policy, the Warm Front programme (2000-2013) provided grants to low-income households for insulation, draught-proofing, and heating system replacements, explicitly aligning social welfare with emerging environmental and climate goals. Initially well-funded, Warm Front assisted 2.3 million households that saved an average of £1,895 per year in potential energy cost reductions (Sovacool, 2015), but scope narrowed over time due to budget cuts. In sum, the Blair government adopted the most fiscally ambitious model to date. While earlier decades saw shifts between residual and universalist approaches, this administration pursued a deliberately mixed strategy by pairing the rather universalist, compensatory Winter Fuel Payment with the more residual, preventive Warm Front scheme. Table 7.1 summarises the key policy instruments introduced since 2000, highlighting their target groups and core mechanisms.

TABLE 7.1 Key characteristics of British energy efficiency and energy bill support policies since 2000

Year(s)	Policy	Target group(s)	Key measures
1988-ongoing	Cold Weather Payment (CWP)	Low-income individuals on certain income-related benefits	Automatic £25 payment per week (when ≤0°C for 7 consecutive days)
1997-ongoing	Winter Fuel Payment (WFP)	Pensioner households (2024: only low-income pensioners)	Automatic tax-free payment (£200, since 2003 £300 for over-80s)
2000-2013	Warm Front Scheme (WFS)	Low-income homeowners and private renters on benefits	Government-funded grants for insulation and heating system repairs
2008-2012	Carbon Emissions Reduction Target (CERT)	All households (at least 40% of saving had to benefit low-income, elderly, disabled, and families with young children)	Supplier obligation funding insulation (loft, cavity wall), LED, glazing improvements, and heating upgrades
2008-2012	Community Energy Saving Programme (CESP	Low-income households in the most deprived areas (bottom 10% per Indices of Multiple Deprivation)	Area-based supplier obligation funding whole-house retrofits (solid wall insulation, heating system upgrades, glazing improvements)
2011-ongoing	Warm Homes Discount (WHD)	Low-income pensioners and certain income-related benefit recipients (2022: additional high-cost-dwelling criterion)	Annual rebate on electricity bills (initially £140, since 2022 £150), funded via a levy on energy companies

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TABLE 7.1 Key characteristics of British energy efficiency and energy bill support policies since 2000

Year(s)	Policy	Target group(s)	Key measures
2013-ongoing	Energy Company Obligation (ECO)	Low-income and vulnerable households (2022: increased focus on worst-rated homes in low-income areas)	Supplier obligation to fund insulation (loft, cavity, solid wall), boiler replacements, heating controls, and heat pumps
2017-ongoing	Energy Price Cap (Ofgem)	Consumers on standard variable tariffs (default)	Caps on unit rates gas/electricity, updated by Ofgem
2020-2021	Green Homes Grant (GHG)	Homeowners and private landlords	Vouchers for insulation and heat pumps/ solar thermal
2020-2025	Local Authority Delivery (LAD)	Low-income households (in homes with EPC bands E-G)	Council-led, small-scale improvements (basic insulation, draught-proofing)
2021-2025	Social Housing Decarbonisation Fund (SHDF)	Social housing providers and tenants (EPC bands D-G)	Grants supporting targeted retrofits (insulation, glazing, heat pumps)
2021-2025	Home Upgrade Grant (HUG)	Low-income, rural/off-grid households (EPC bands D-G)	Grants covering insulation and installing low-carbon heating
2022-2023	Energy Bills Support Scheme (EBSS)	All domestic electricity customers	Monthly discounts totalling £400 across 6 months, applied automatically to electricity bills
2022-2024	Energy Price Guarantee (EPG)	All domestic energy consumers	Government subsidy limiting average household energy bills (unit rates capped, overriding the Ofgem price cap temporarily)
2022-ongoing	Boiler Upgrade Scheme (BUS)	Homeowners and small landlords	Vouchers towards air-source or ground-source heat pumps or biomass boilers
2023-ongoing	Great British Insulation Scheme (GBIS)	Low-income households or dwellings in areas with council Tax bands A–D and EPC ≤ D)	Free/subsidised basic insulation measures (loft, cavity wall, roof) funded by energy suppliers
2025-	Warm Homes Plan (Local Grant)	Extension of LAD, through broader local criteria (income and deprivation metrics)	Direct grants for comprehensive upgrades (high-quality insulation, glazing, efficient heating systems)
2025-	Warm Homes Plan (Social Housing Fund)	Social housing providers (replaces SHDF, same eligibility)	Expanded grants supporting systematic, whole-stock retrofits (comprehensive insulation, glazing, low-carbon heating upgrades)
2018-2023 (2025-)	Minimum Energy Efficiency Standards	Private and social landlords renting worst-rated homes	Legal requirement raising minimum EPC ratings (targeting EPC band C)

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7.4.2 Austerity and supplier obligations (2008-2020)

The late 2000s saw sharp increases in energy prices alongside significant spending constraints resulting from the 2008 financial crisis, prompting significant policy shifts. With the Winter Fuel Payment and Warm Front increasingly costly but still inadequate to resolve persistent fuel poverty (Dresner & Ekins, 2006), Brown's Labour government decided to supplement these schemes, while scaling back Warm Front, with targeted, supplier-funded initiatives (Guertler, 2012; Rosenow, 2012). These included the Carbon Emissions Reduction Target (CERT) and Community Energy Saving Programme (CESP), operating between 2008 and 2012, which required energy suppliers to offer subsidised or free insulation, prioritising low-income households and deprived areas. Furthermore, the Energy Act 2010, enacted shortly before Labour left office, mandated a supplier-funded bill support scheme. This was later implemented by Cameron's coalition government as the Warm Home Discount (WHD), initially providing a £140 rebate directly reducing bills for low-income pensioners and households on certain benefits. This marked a notable transition from broadly targeted, government-funded programmes to narrowly targeted, supplier-funded schemes.

The subsequent replacement of Warm Front by the Energy Company Obligation (ECO) further intensified this trend towards residualisation, with narrower targeting and the transfer of both costs and responsibilities onto energy suppliers. Although ECO aimed to prioritise low-income and vulnerable households, it drew criticism due to the regressive impacts of increased energy prices resulting from supplier obligations (Rosenow et al., 2013). Critics also highlighted ECO's limited scope, focusing exclusively on smaller-scale energy efficiency improvements (Bergman & Foxon, 2020). While ECO was not the first scheme to involve energy suppliers in preventive measures, it marked a significant turning point: for the first time since the 1970s, all major government-backed preventive energy efficiency efforts were delivered solely through supplier obligations. This shift away from publicly funded, more universalist approaches led to a marked reduction in insulation projects, significantly slowing energy efficiency improvements, generating uncertainty, and reducing long-term investment and skill development within the sector (Adam et al., 2022).

In 2015, Cameron's Conservative government revised the British fuel poverty strategy, introducing a formal target to upgrade all fuel-poor homes to at least Energy Efficiency Band C by 2030 (DECC, 2015). Although this rhetorically prioritised prevention through energy efficiency, critics argued that actual financial commitment and implementation did not match government ambitions (Hamilton et al., 2015; Kearns et al., 2023). Funding remained heavily constrained, and ECO, positioned as the primary delivery mechanism, suffered repeated budget reductions and eligibility tightening, ultimately limiting its effectiveness and narrowing its reach. This had the effect that despite a stated preventive agenda – even coining it the UK's 'Green Deal' – substantive policy remained predominantly reactive and inadequately resourced (Middlemiss & Gillard, 2015; Owen et al., 2023). The 2019 introduction of Ofgem's Energy Price Cap further illustrated the continued reliance on compensatory approaches, attempting short-term mitigation of affordability pressures rather than investing systematically in preventive solutions (Ioannidou & Mantzari, 2019). Although the cap aimed to curb excessive charges from energy suppliers, analysts argued it was at best a stop-gap measure, only mitigating short-term affordability issues (Hardy et al., 2019).

7.4.3 Universal energy bill support and preventive ambitions (2020 onwards)

In 2020, Johnson's Conservative government positioned the Green Homes Grant (GHG) and Local Authority Delivery (LAD) schemes as key to a post-pandemic 'green recovery', simultaneously addressing fuel poverty, boosting the economy, and accelerating decarbonisation (Putnam & Brown, 2021). The GHG was intended to be broad-based and accessible to all homeowners and residential landlords in England, offering vouchers covering up to two-thirds of energy-efficiency upgrades and full funding for low-income households, but administrative hurdles and low uptake resulted in only £314 million of the £1.5 billion budget being spent before the scheme's early closure in 2021 (Carter & Pearson, 2022; National Audit Office, 2021). LAD continued to provide funding at a reduced scale directly to local authorities to deliver small-scale energy efficiency upgrades specifically for low-income and vulnerable households following GHG's termination (Georgiadou et al., 2024). The 2021 fuel poverty strategy deepened alignment with decarbonisation, launching further targeted residual programmes: the Social Housing Decarbonisation Fund (SHDF), was aimed exclusively at social housing residents, and the Home Upgrade Grant (HUG), narrowly focused on low-income households off the gas grid. However, reliant on competitive bidding processes and insufficiently scaled, these have so far not delivered the extensive improvements needed (McCarthy et al., 2024).

In response to the global energy crisis triggered by the Russian invasion of Ukraine, the UK government implemented two of the most universal energy affordability measures in its history: the Energy Bills Support Scheme (EBSS) and the Energy Price Guarantee (EPG). EBSS provided a flat-rate, automatic discount of £400 on electricity bills to all domestic electricity customers across Great Britain during winter 2022-23, regardless of income, energy usage, or need (Fawcett et al., 2024). Similarly, the EPG, introduced in October 2022, effectively capped the price of energy per unit, with the government covering the difference between the market rate and the capped rate, thereby limiting average household energy bills (Hick & Collins, 2023). These measures marked a radical return to universalism and compensatory logic, reflecting the scale and urgency of the affordability crisis. However, both schemes were costly, together costing almost £35 billion (National Audit Office, 2024), highlighting the tension between emergency universalism and long-term fiscal sustainability.

The subsequent introduction of the Boiler Upgrade Scheme (BUS) in 2022 and Great British Insulation Scheme (GBIS) in 2023 represent new incremental preventive measures. The BUS provides universal grants (£5,000-£7,500) to all homeowners in England and Wales to replace fossil fuel heating with low-carbon systems, but uptake remains modest (around 100,000 in 2024, significantly below the government's target of 600,000 a year by 2028) due to limited homeowner awareness, high remaining costs, and limited installer capacity (Lamb & Elmes, 2024). Likewise, the GBIS' overall impact remains limited, also due to the incremental nature of its insulation interventions, but its targeting is noteworthy, combining support for low-income and vulnerable households with assistance extended to a broader range of households in energy-inefficient homes and lower council tax bands (Holligan, 2024).

Thus, despite these five new initiatives (LAD, SHDF, HUG, BUS, and GBIS) signalling strategic realignment towards proactive preventive measures, funding remains limited and fragmented, while delivery continues to lag behind stated policy objectives. Figure 7.1 visualises this ongoing shift, mapping changes in scheme design since 2010 along universalist/residualist and compensatory/preventive axes, alongside their funding sources and relative expenditure.

Looking ahead, the February 2025 fuel poverty strategy published by Starmer's Labour government indicates both continuity and change in British fuel poverty policy. A significant step forward is the reinstatement of energy efficiency standards, particularly the Minimum Energy Efficiency Standard (MEES) for private landlords, with a revised compliance target of 2030, reinforcing preventive policy ambitions. Nevertheless, the strategy continues to emphasise residualisation, maintaining targeted support specifically for households most in need. Although the government has announced more funding for energy efficiency measures as part of its Warm Homes Plan, this remains modest compared to international benchmarks, highlighting ongoing limitations in scale and ambition. Recognising persistent gaps in current targeting approaches, given only about 63% of fuel-poor households currently receive support through conventional means-tested criteria, the strategy commits to exploring innovative methods of verifying eligibility, such as data-sharing between government agencies and health sector referrals.

7.5 Discussion

This section reflects on the broader implications of the British evolving energy support landscape. It examines the dominant policy trajectories, the structural and political factors shaping them, and assesses the strengths and limitations of the four identified support typologies.

7.5.1 British energy support: residual by default, preventive in promise

A dominant trend in British energy support policy has been a steady shift from universalism towards residualisation, typically justified by fiscal constraints and concerns over efficiency. This shift is also reflected in the evolving funding model, with support increasingly delivered through obligations on energy suppliers rather than direct government expenditure. However, major energy crises have disrupted this trajectory at key points. In response to the oil shocks of the 1970s, for example, the government briefly embraced universalist measures, notably through the Home Insulation Scheme, which adopted a two-tier approach by offering full funding for low-income households and partial subsidies for the wider population. Similarly, the energy crisis of the 2020s prompted a temporary reversion to universalist logic, following decades of residualisation since the 1980s, briefly interrupted only by the broadly distributed Winter Fuel Payment. As Blyth (2013) argues, while fiscal discipline is typically upheld in liberal political economies, crises create political space for deficit spending, allowing governments to temporarily reverse course and adopt more universalist measures.

The function of support, and the balance between compensatory and preventive approaches, has also shifted significantly, driven by a range of factors. In the post-war period, energy support followed a classically compensatory model, typically delivered through means-tested income supplements or emergency payments. This model was briefly disrupted by the 1970s energy crises, prompting a preventive turn primarily motivated by energy security concerns (Mallaburn & Eyre, 2013). Britain responded by pioneering large-scale energy efficiency measures through the Home Insulation Scheme. However, this preventive momentum gradually declined in the following decades until a mixed approach under Blair emerged. The Warm Front programme reflected a preventive logic, framed not only by energy security but increasingly by the imperative of climate change mitigation, signalling a shift in policy rationale (Kern et al., 2017). Meanwhile, the Winter Fuel Payment was politically framed as a compensatory energy support measure targeting elderly households perceived as most vulnerable (Walker & Day, 2012), though in practice it functioned as a universal lump-sum transfer until it became means-tested in mid-2024.[62]

The Warm Front programme experienced progressive reductions in funding and scope, and by the 2010s, energy efficiency policy in the UK had become increasingly fragmented, reliant on supplier obligations, and limited in resources (Webb, 2018). Although successive Conservative-led governments (2010-2024) promoted initiatives under banners such as the 'Green Deal' and 'green recovery', these programmes were generally characterised by low participation rates (Carter & Pearson, 2022). The 2020s energy crisis prompted a temporary return to compensatory logic through large-scale, short-lived compensatory schemes, mirroring trends in 'frugal' EU countries like Germany and the Netherlands, which spent billions to curb energy prices (Croon & Sokołowski, 2025). Further research is needed to explain why public spending far exceeded that of the more interventionist 1970s, though it may reflect institutional learning about the political instability that energy crises tend to provoke (Carlisle et al., 2017; Jacobs, 2016). Moreover, Labour's 2025 strategy signals renewed preventive ambition, particularly through minimum energy performance standards in the rental sector which is a policy lever shown to effectively accelerate retrofit activity (Müller et al., 2024), yet the scale of public investment remains modest and tightly targeted. Thus, while prevention continues to feature prominently in UK energy discourse, it remains more of a rhetorical commitment than a governing principle and is effectively overshadowed by fiscal commitment to short-term compensatory measures.

Overall, analysing eligibility and policy function as separate but related dimensions proved analytically useful in tracing how residualisation and compensatory support have tended to co-evolve in British energy policy, though primarily at the level of governing logics rather than detailed distributive outcomes. These patterns, and the inherent tensions involved, would have been less visible through a one-dimensional analytical lens.

62 Interestingly, despite it being a lump-sum transfer, Beatty et al. (2014) found that its framing as an energy support measure did lead many recipients to use the Winter Fuel Payment primarily for energy costs.

7.5.2 Structural political economy constraints

A key reason for the persistence of residualism and the limited materialisation of preventive energy policy lies in political and cognitive dynamics. For instance, while capped and means-tested schemes are often framed as technocratic tools, they also serve as political instruments for ‘selling restraint’, enabling both conservative and at times even more so progressive governments to signal fiscal discipline and responsible stewardship of taxpayer money (Whiteside et al., 2021). Moreover, compensatory schemes, particularly those narrowly targeted at visibly vulnerable groups, generate immediate, tangible benefits that are easier for politicians to frame as moral imperatives (Graham, 2010) . At the cognitive level, politicians may have a bias towards crisis management, and are more likely to respond to visible, pressing issues such as rising energy bills than to invest in solutions for abstract or long-term problems like energy inefficiency in homes (Carlisle et al., 2017). Preventive strategies, such as large-scale retrofitting, lack this sense of narrative urgency, as their benefits are diffuse, long-term, and often invisible to the public (Bevan et al., 2020; Stern, 2015). This creates a ‘structural myopia’ within political systems governed by short electoral cycles, incentivising short-term relief over long-term resilience. As Ferrera (2017) notes, preventive strategies may offer greater social returns over time, but they require upfront investment and political patience, qualities often lacking in a political culture shaped by electoral volatility and the pursuit of immediate voter appeal (Goodwin, 2023).

Moreover, institutional factors deeply entrench these policy logics. The UK’s energy support mechanisms have evolved through incremental layering over several decades, with each new scheme typically building on, and rarely replacing, what came before (Kern et al., 2017; Thelen, 2004). Energy supplier obligations exemplify this dynamic: introduced by the Conservative government in the 1990s, revived by the Brown administration in the aftermath of the global financial crisis, significantly expanded under Cameron’s austerity politics, and still maintained by the current Labour administration. Though shaped by government targets, these schemes are delivered by suppliers with considerable discretion, and have generally produced fragmented, means-tested support, as market intermediaries have limited incentive to implement broad, preventive interventions (Moser, 2017; Rohde, 2015). Fundamentally designed for means-tested interventions, they embed residualist logics that are difficult to unwind (Owen et al., 2023). Universalist prevention requires advanced levels of bureaucratic coordination, planning, and regulatory oversight that the UK’s hollowed-out post-austerity government increasingly lacks (Bergman & Foxon, 2020).

Finally, ideational frameworks, aligned with a constructivist understanding of political economy, reinforce this pattern by shaping not only how policies are evaluated, but also which are deemed legitimate or politically viable in the first place (Blyth, 2002). Dominant assessment tools in HM Treasury and policy evaluation bodies prioritise short-term cost-effectiveness, often using narrow cost-benefit metrics such as projected energy savings or productivity gains that undervalue the broader, cross-sectoral benefits of preventive investment in energy efficiency: improved mental health, reduced strain on the NHS, enhanced educational outcomes for children, greater energy security, and progress towards climate goals (Jennings et al., 2020; MacNaughton et al., 2018). This reflects what the literature refers to as a 'fiscal lens', which reduces complex, long-term investments to short-run budgetary calculations (Hemerijck & Matsaganis, 2024; Morel et al., 2012; Sloman, 2024). Therefore, while emphasising co-benefits is important for building support, ensuring the long-term political durability of universal approaches requires grounding them not just instrumentally, but in a rights-based justification (Hesselman, 2022; Walker, 2015). This approach reduces the likelihood of governments cutting or diverting funds if the stated co-benefits take time to materialise or are difficult to quantify.

7.5.3 Weighing the trade-offs of four energy support typologies

As British energy support policy remains an outlier among high-income European countries in lacking a structural, universal energy efficiency programme, the question arises: what exactly is lost in this policy gap? What are the comparative strengths and weaknesses of universal prevention versus other typologies – residualist-compensatory, residualist-preventive, and universalist-compensatory – and how might their effectiveness vary by context? This subsection offers a higher-level comparative discussion of these four ideal-typical approaches.

The core rationale for universalist-preventive approaches lies in their potential to drive systemic decarbonisation, especially in contexts where energy inefficiency is widespread (Figus et al., 2017). By providing incentives to the so-called 'middle majority', households neither affluent nor poor, yet often lacking the means or motivation to retrofit, such schemes promise the greatest emissions reductions across the board (Katris & Turner, 2021). Furthermore, broad adoption of these incentives can drive economies of scale and predictable demand, thereby lowering long-term costs of retrofits (Michelsen et al., 2015). At the same time, their political appeal increases the likelihood that such schemes will endure through political cycles. However, retrofitting is capital-intensive, and blanket coverage risks subsidising wealthier households who could otherwise afford upgrades, potentially diverting scarce resources away from those in greatest need (Figus et al., 2017). If poorly designed, such schemes can produce limited impact, as seen with the Green Homes Grant. In Italy, the *Superbonus 110%* initially offered universal tax credits that exceeded the cost of renovations, which drove up prices, encouraged fraudulent claims, and contributed significantly to national debt (Padoan, 2023). Without appropriate safeguards, universal subsidies risk exacerbating inequalities by delivering renovation-induced premiums to already wealthy property owners (Fernández et al., 2024). To counter these effects, especially in the rental sector, policy design should include rent controls and protections against 'renovictions' (Busà, 2024).

Residualist-preventive models, by contrast, prioritise those most in need. Croon et al. (2025) demonstrate that even if energy conservation interventions benefit everyone, they provide significantly greater welfare gains for those experiencing fuel poverty, therefore representing the greatest value for money. Under fiscal constraint, they could therefore offer a defensible and pragmatic political route: especially if skilled workforce and implementation capacity is limited, it may seem fair to begin with households facing the greatest hardship. Moreover, it is an approach that makes more sense in a context where the energy efficiency of the housing stock varies greatly (Rosenow et al., 2017). However, this approach also comes with trade-offs. Means-testing adds bureaucratic complexity, often delaying delivery and deterring take-up, particularly where there is low institutional trust. Many households just above eligibility thresholds remain unsupported, despite facing similar vulnerabilities. Targeting energy efficiency schemes can also reinforce stigma, whereby people may feel 'embarrassed' or 'ashamed' to be singled out for help, reinforcing perceptions of dependency or failure (Reid et al., 2015). Another challenge lies in the fact that such interventions are embedded in dwellings rather than individuals, meaning their benefits do not necessarily follow vulnerable households over time, particularly as people move or tenancies change. Moreover, by limiting intervention to a narrow subset of the population, residualist-preventive strategies miss the opportunity to drive broader market transformation or shift aggregate energy demand. Nonetheless, residualist-preventive strategies may be well-suited to specific contexts, such as during an energy crisis that demands swift action, or when a social housing provider seeks to offer interim relief to vulnerable tenants ahead of a full retrofit (Croon et al., 2025).

Residualist-compensatory approaches offer notable strengths. During periods of constrained energy supply, they avoid inflating energy prices by refraining from subsidising excessive demand (Bajo-Buenestado, 2017; Dao et al., 2023), while preserving incentives for conservation and efficiency investments (Garcia & Stacchetti, 2009). When costs are recovered through progressive taxation, such models can also enhance redistribution, directing resources from higher- to lower-income households (Arregui et al., 2022). As Hick and Collins (2023) observe, targeted one-off payments via social security, so-called 'passporting', produced more progressive outcomes than universal measures like across-the-board energy bill credits or tax rebates, by directing greater support to households on the lowest incomes. However, while administratively simpler, using means-tested benefit eligibility inevitably excludes many vulnerable or struggling households, one of the central criticisms raised by Simcock (2022). This may be especially problematic in the case of fuel poverty, where dwelling quality and energy efficiency vary widely even among low-income groups, meaning that income alone may not reflect the severity of need. In this light, Starmer administration's new commitment to developing more refined eligibility frameworks is a welcome shift. Drawing on data and criteria from healthcare and local government, and incorporating wider deprivation indicators beyond income, could improve coverage (Koďousková et al., 2023). Palmer et al. (2023) also stress that using information already available to energy suppliers, such as prepayment meter status or registration on the Priority Services Register, could further support more effective and timely targeting.

Universalist-compensatory approaches, by contrast, offer distinct advantages in terms of speed, simplicity, and political viability. Their administrative ease enables rapid deployment during crises, as seen in schemes across Europe (Croon & Sokołowski, 2025), which required limited infrastructure and reached households swiftly. Universality also minimises the risk of exclusion, especially in contexts where means-testing mechanisms are fragmented or distrusted, while ensuring that lower-middle-income households also receive support (Poppe et al., 2024).[63] Moreover, in times of geopolitical or economic instability, the broad and visible nature of universal support can help pre-empt political backlash and show that government is attuned to everyday hardship (Grin, 2025). However, the drawbacks of this model are not insignificant. By insulating all consumers from price signals and limiting the competitive advantage of renewable energy, price caps on fossil fuels risk net zero ambitions (Caine, 2023). Universality also entails considerable fiscal costs and can have regressive effects, as higher-income households, who typically consume significantly more energy, stand to receive greater financial benefits from a universal price cap unless these are explicitly offset through progressive taxation (Galvin et al., 2024; Schulte & Heindl, 2017).

63 However, as Palmer et al. (2023) note, broad coverage does not guarantee adequacy: while EBSS successfully reduced electricity disconnections, it had limited impact on gas disconnections, highlighting the challenges of calibrating universal schemes to diverse household needs.

Of course, these typologies are not mutually exclusive, and hybrid models offer promising pathways. One example is large-scale, broad-based retrofitting of social housing, a form of ‘targeting within universalism’. This approach captures the economies of scale and demand predictability of universal schemes, while concentrating benefits in the housing segment most affected by fuel poverty, thus maximising social impact (Croon et al., 2024). Other hybrid strategies include Germany’s nearly fare-free public transport initiative during the energy crisis – nominally universal, but with disproportionate benefits for lower-income households (Rozynek, 2024) – and targeted public investment in grid infrastructure in areas facing frequent outages, often rural and lower-income (Lin et al., 2022).

The trade-offs identified across these four typologies also have implications beyond the UK case and beyond high-income settings. In low- and middle-income countries, universal energy subsidies have historically served as a key mechanism for managing affordability and political legitimacy (Skovgaard & Van Asselt, 2018), and reform efforts that simply withdraw or narrowly target such compensation have repeatedly proven politically fragile (Rentschler & Bazilian, 2016). While immediate needs are often even more acute in these contexts, making preventive and long-term policy logics more difficult to sustain, the analysis points to the importance of understanding subsidy reform not only as a technical exercise but as a political economy process shaped by how alternative forms of protection are perceived and sequenced.

7.6 Conclusion

The trajectory of British energy support policy over the past five decades reveals a complex interplay between changing political priorities, bureaucratic path dependencies, budgetary pressures, and reactive policymaking in times of crisis. Once a global leader in universalist, preventive energy policy, the UK has gradually shifted towards residualist, compensatory models that target narrowly defined 'deserving' groups through means-tested benefits and supplier obligations.

However, moments of crisis – most notably the oil shocks of the 1970s and the energy crisis of the early 2020s – have temporarily reversed this trend, prompting more universalist measures, such interventions have largely proven short-lived and reactive. Recent energy efficiency schemes have tended to suffer from fragmented funding, low uptake, and narrow eligibility. Despite its rhetorical commitments, the UK's preventive approach to energy efficiency remains underdeveloped, making it one of the few high-income European countries without a comprehensive scheme that goes beyond heating system replacement and leaving three million households in fuel poverty. To that end, embedding energy efficiency as a right rather than a discretionary benefit could offer a path to overcoming the political short-termism, institutional fragmentation, and narrow cost-benefit framing that have long constrained the UK's energy support policy.

The typological framework used in this article – residualist-compensatory, residualist-preventive, universalist-compensatory, and universalist-preventive – highlights the trade-offs embedded in each policy model. While residualist-compensatory models may minimise public spending and maintain conservation incentives, they tend to exclude households in need of support. Universalist-compensatory approaches, though broadly popular and administratively efficient, entail high fiscal costs, risk regressive distributional effects, and run counter to climate objectives. Preventive interventions, particularly those grounded in a universalist logic, offer the greatest long-term return in terms of decarbonisation, cost-of-living, and various co-benefits, but require significant upfront investment, political patience, and strong institutional coordination.

Beyond the UK case, this analytical framework offers a systematic way to compare energy support regimes across different institutional contexts by shifting attention from individual policy instruments to the governing logics that underpin them. By distinguishing eligibility design from policy function, the framework helps to clarify why certain policy configurations persist despite their economic or environmental shortcomings, why reform efforts often prove politically fragile, and how tensions between short-term affordability and long-term objectives are managed differently across contexts. As such, it provides a transparent and transferable basis for comparative research on energy policy and subsidy reform in both high-income and lower-income settings, while recognising that the effectiveness and political durability of any given typology remain strongly conditioned by institutional, fiscal, and socio-political context.

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8 Integration of social dimensions in EU climate and energy legislation

This chapter is based on a manuscript currently under review:
Croon, T. M. (under review). The Climate-Social Nexus in the European Green Deal: Layered Reforms of Paradigm Shift?. *Journal of European Public Policy*.

ABSTRACT

This paper applies Peter Hall's three-orders framework to assess the depth of integration between climate and social objectives in EU policy, tracing developments from the 1990s through the European Green Deal (EGD). Building on a systematic content analysis of key legislative texts and preparatory documents, from early market-liberalisation measures and the 2003-2009 directives, through procedural energy-poverty safeguards (2009-2019), to the redistributive instruments of the Just Transition Fund and Social Climate Fund (2019-), it distinguishes between first-order (instrument tweaks), second-order (recalibrations within an existing paradigm) and third-order (paradigm shifts) change. Findings reveal that although the EGD embeds significant second-order reforms, particularly the financing of redistributive instruments through carbon revenue spending, it builds upon rather than replaces the established logic of market primacy. True third-order change, whereby equity and redistribution are repositioned as core policy goals supplanting market-based logic, has not yet occurred. The paper concludes that the EU's climate-social nexus represents a cumulative, hybrid trajectory: incremental learning and punctuated political pressures have produced deeper redistributive mechanisms, but the absence of a universal-rights approach to affordable clean energy and mobility points to evolution rather than revolution in EU governance.

8.1 Introduction

The European Commission's 2019-2024 mandate launched one of the most ambitious climate agendas in global history through the European Green Deal (EGD). This initiative targets a wide range of sectors, including energy, transport, and agriculture, and includes the Fit for 55 package, which sets a 55% reduction in greenhouse gas emissions by 2030 (compared to 1990 levels) as a milestone on the path to climate neutrality by 2050 (European Parliament and Council, 2021). Beyond its environmental objectives, the Commission has emphasised the importance of a 'just transition' that ensures 'no one is left behind', hinting at a stronger alignment between climate and social policy objectives (Oberthür & von Homeyer, 2022; Sarkki et al., 2022).

The existing literature has explored aspects of this novel alignment (Filipović et al., 2022; Graziano, 2023; Sabato & Theodoropoulou, 2023), but consensus remains elusive on whether it signifies a paradigm shift from separate climate and social agendas to an integrated framework. Zimmermann and Gengnagel (2023) offer valuable insights into the tensions and continuities between productive and protective social policies through their analysis of the EGD's new social policy instruments but stop short of assessing whether these changes amount to a paradigm shift. Meanwhile, Sabato and Mandelli (2023, p. 24) are more convinced that *"the EU is still far from a true paradigm shift"*, yet their claim lacks substantiation through a systematic application of policy paradigm analysis.

Furthermore, recent studies applying paradigm frameworks have predominantly focused on responses to the energy crisis rather than the EGD. For example, an analysis of the UK's policy response suggests reinforcement of entrenched neoliberal approaches, with escalating state intervention exposing inherent contradictions and socio-ecological limitations of this paradigm (Fearn, 2023). Similarly, research into EU energy policy during the crisis underscores increased state and EU coordination, securitisation of energy policy, and accelerated decarbonisation efforts, albeit without adequately addressing the social dimension (Osička & Černoch, 2022).

Despite these valuable contributions, a thorough assessment of whether the EU's perceived integration of climate and social objectives constitutes a meaningful policy paradigm shift remains absent. Moreover, understanding the depth of change requires tracing not only the EGD, but also the longer evolution of EU energy and climate policy since the 1990s, when market liberalisation and early environmental concerns first shaped the policy landscape. This is critical, as it allows insights into the EU's socioeconomic trajectory during a period of profound transformation, where historically such transitions have exacerbated inequalities by disproportionately benefiting some groups while disadvantaging others (Acemoglu & Robinson, 2012; Milanovic, 2016).

This paper addresses this gap by systematically applying Hall's (1993) policy paradigm theory to selected EGD legislation. Hall's framework, one of the defining theories in policy dynamics, enables analysis not only of profound paradigm shifts but also of more incremental changes, making it particularly suitable for examining EU policymaking, which is characterised by consensual, expert-driven negotiations. Hall's framework has been applied across various EU policy domains, including monetary policy (Diessner, 2017), development policy (Delputte & Orbie, 2020), and science, technology, and innovation policy (Dabić, 2024). Extending this analytical lens to the EGD, this paper systematically evaluates whether recent policy shifts represent mere instrumental adjustments (first-order change), substantial recalibrations within established paradigms (second-order change), or fundamental realignments of policy objectives (third-order change). By doing so, this paper provides critical insights into the depth and implications of the EGD's climate-social policy integration.

The remainder of this paper unfolds as follows: Section 8.2 presents the theoretical framework, elaborating on Hall's three orders of policy change and detailing how this conceptual lens applies specifically to the EU's climate-social policy nexus. Section 8.3 outlines the analytical framework and methodology, describing the legislative texts selected for analysis and explaining how they are systematically evaluated through thematic coding aligned with Hall's framework. Section 8.4 provides an empirical assessment, highlighting policy shifts and continuities revealed through this analytical approach. Finally, Section 8.5 discusses the broader implications of these findings.

8.2 Theoretical framework: policy dynamics

A policy paradigm is the overarching framework of ideas, assumptions, and problem definitions that shape how policymakers define and prioritise issues, identify solutions, and assess their impact (Hall, 1993). Embedded in institutional structures and political discourse, paradigms seem resistant to change, as evidenced by extensive research highlighting path dependency, institutional inertia, and the role of entrenched interests in preserving existing policy frameworks (Mahoney & Thelen, 2009; Pierson, 2000). When shifts do occur, they unfold within institutional, political, and ideological constraints, prompting ongoing debate on the mechanisms driving such transformations (Clemens & Cook, 1999).

Peter Hall's constructivist approach views policy change as an incremental learning process within established paradigms, where policy communities adapt through social learning until persistent failures prompt more fundamental shifts in both problem definition and policy instruments, driven primarily by evolving ideas and norms (Considine, 2005; Hall, 1993). Policy communities are networks of diverse actors with politicians and civil servants themselves forming just one group, though retaining ultimate decision-making authority, within a broader community of technical and scientific experts, academics and researchers, think tanks, interest groups and media actors who collectively engage in social learning, interact, debate and influence policy changes (Pemberton, 2000).

This perspective stands in contrast to punctuated equilibrium theory (Baumgartner & Jones, 2010), which holds that paradigms persist through bureaucratic inertia and path dependency but shift abruptly when external shocks break the equilibrium – often triggered by crises or political disruptions – rather than evolving through the incremental, cumulative learning Hall describes. Meanwhile, the advocacy coalition framework (Sabatier, 1988) and discursive institutionalist approach (Schmidt, 2008) focus on the political contestation of ideas, assessing paradigm shifts as the result of long-term struggles between coalitions that seek to influence policy through discourse rather than Hall's focus on the learning of bureaucratic and expert elites. Lastly, according to the multiple streams theory, change can be orchestrated by strategic policy entrepreneurs (Kingdon, 1984).

While these alternative frameworks offer valuable insights, Hall's model is more suitable for understanding institutional environments where paradigm shifts unfold gradually rather than abruptly and are likely to emerge through internal learning rather than external contestation.[64]

Hall's (1993) model provides a useful framework for understanding how policies evolve, which he initially developed to explain shifts in British economic policymaking, particularly the transition from Keynesianism to monetarism. He distinguished between first-order, second-order, and third-order changes, which vary in depth and significance. The key distinction is that while first- and second-order changes occur within an existing paradigm, a third-order change represents a paradigm shift in which the underlying goals, assumptions, and problem definitions governing a policy domain are fundamentally restructured.

8.2.1 Three orders of policy change

First-order change: adjusting the instruments

According to Hall (1993, pp. 279-281), first-order change involves minor, often technical alterations to existing policy instruments, without questioning the fundamental goals or rationale of the policy area. In practical terms, policymakers might adjust funding allocations, tweak eligibility criteria, or introduce small-scale regulatory amendments; Hall's example being tax band adjustments. Although these changes can have immediate and tangible effects in people's lives, as the expanding of a programme will cover people previously excluded, they remain incremental and occur within the existing framework of ideas about what the problem is and how it should be solved.

A key feature of first-order change is that it usually reflects a process of continuous monitoring and routine adaptation through 'trial and error' (Lindblom, 1979), rather than an attempt to reassess the core assumptions of a policy domain. For instance, governments might raise or lower subsidies or feed-in-tariffs for

64 While recent events like the energy crisis undoubtedly represent external shocks influencing EU policymaking, this paper argues they primarily accelerated existing trajectories in this context rather than triggering a paradigm shift. Additionally, external advocacy coalitions, such as those championing energy justice and the right to energy, have notably impacted EU policy developments. However, in Hall's framework, such advocacy groups are conceptualised as part of the broader Brussels-based 'policy community', contributing to internal social learning processes rather than constituting purely external contestation.

renewable energy (RE) in response to short-term budgetary pressures, or in search of a certain optimum (Andor & Voss, 2016; Lustick, 1980), while still pursuing the same overarching objective of incentivising RE adoption through market-based mechanisms. Such incremental fine-tuning may address immediate concerns but does not imply any radical rethinking of policy objectives or the broader paradigm itself.

Second-order change: recalibrating the framework

Second-order change goes beyond incremental adjustments by altering the instruments through which a policy goal is pursued, even though the overarching objectives and assumptions remain largely intact. Hall's examples include monetary control reforms, target adjustments, and cash limits that aimed to reinforce fiscal discipline in Britain throughout the 1970s and early 1980s while preserving elements of Keynesian demand management and spending strategies (Oliver & Pemberton, 2004).

To further illustrate, and continuing with the earlier example of RE policy, a second-order change might entail shifting from subsidies or guaranteed feed-in tariffs to Renewable Portfolio Standards (RPS), which require utilities and energy suppliers to meet mandatory renewable energy quotas (Barbose et al., 2016; Joshi, 2021). Such more substantial recalibrations typically happen when policy communities collectively learn the first-order adjustments have proved insufficient, and new tools are needed to better address emerging issues without challenging the underlying market-oriented logic (Buch-Hansen & Carstensen, 2021). Consequently, despite being more substantial than first-order adaptations, second-order changes remain within the confines of the established paradigm.

Third-order change: the paradigm shift

Third-order change, often termed a paradigm shift, involves the most profound form of transformation. It is not simply a matter of revising instruments but of questioning and altering the foundational goals, assumptions, and problem definitions that underpin a policy domain (Hall, 1993). In Hall's seminal example, Britain's transition from Keynesian demand management to monetarism was not just about new fiscal or monetary levers; rather, it reflected an entirely different view of how economies function and what role the state should play (Sterling & Laybourn-Langton, 2017).

Returning to the RE policy context, a third-order change could entail moving away from market-based mechanisms like subsidies, feed-in tariffs, or RPS, and adopting a fundamentally different approach, such as direct state ownership of energy infrastructure or full nationalisation (Fearn, 2023). Alternatively, third-order change may involve reordering priorities towards guaranteeing universal access to basic services, reshaping climate policy not merely through ownership structures but through embedding social rights at the heart of decarbonisation strategies. Rather than merely incentivising private investment, such a shift would represent a fundamental rethinking of the ownership and structure of the energy sector.

Despite the analytical clarity of having three orders of policy change, Hall's typology has been critiqued for inadequately accounting for the uneven scale of transitions between the different orders. Blyth (2012), for instance, argues that incremental learning effectively explains first- and second-order changes but insufficiently accounts for the complexity of third-order shifts. Similarly, Oliver and Pemberton (2004) highlight intermediate stages within paradigm shifts that Hall's typology does not fully acknowledge. Coleman et al. (1996) further suggest that failed incremental changes and associated feedback loops among policy stakeholders gradually culminate in more substantial paradigm shifts, again highlighting the critical role played by intermediate stages. Carstensen (2011) and Wilder and Howlett (2014) emphasise that these intermediate stages often involve actors engaging in ideational 'bricolage', selectively combining elements of old and new paradigms as they respond pragmatically to emerging anomalies or failures. Together, these critiques suggest that understanding third-order change requires greater clarity about intermediate mechanisms and stages that cumulatively facilitate paradigm shifts.

Consequently, this study conceptualises Hall's three orders of change not strictly as discrete categories, but rather as a flexible continuum, exploring the intermediate stages of policy transformation that Hall leaves largely implicit. These intermediate steps are discussed in detail in the subsequent section, enabling a deeper understanding of how incremental changes cumulatively contribute to substantial policy paradigm shifts.

8.2.2 Applying Hallian framework to the EU's climate-social policy nexus

Peter Hall's three orders of policy change offer a versatile framework that can be applied across diverse policy areas, including climate and social policy. In the environmental policy sphere, paradigms often revolve around competing views on the roles of markets, states, and civil society in driving sustainability outcomes (Geels et al., 2016). Social policy paradigms, meanwhile, can vary in how they conceptualise inequality, justice, welfare rights, and society's obligations towards vulnerable groups (Dean, 2007). The intersection, termed the 'climate-social policy nexus', highlights the extent to which environmental objectives integrate social considerations, particularly regarding fairness and equity in transitioning to a low-carbon economy.

The European Green Deal (EGD), with its explicit emphasis on achieving a 'just transition', makes the integration of environmental and social policy particularly relevant within the EU. Applying Hall's framework helps clarify the extent and depth of this integration. At the one end of the spectrum, as illustrated in Figure 8.1, first-order changes involve modest adjustments to an otherwise environmentally driven policy approach. These typically begin with recognising the social impacts of climate policies, as impact evaluations reveal that focusing on environmental goals in isolation leads to suboptimal outcomes (Smit & Pilifosova, 2003). This recognition may then lead to minor policy adaptations or add-ons, often outside the core energy and climate policy frameworks, such as protections against utility disconnections due to arrears or slight expansions of welfare programmes (Oppenheim, 2016). A prominent example includes the widespread lump-sum transfers implemented during the energy crisis to support low-income households, frequently framed as 'energy allowances' (Croon et al., 2024). These incremental responses acknowledge inequities in the climate and energy domains but make only limited adjustments to existing policy frameworks.

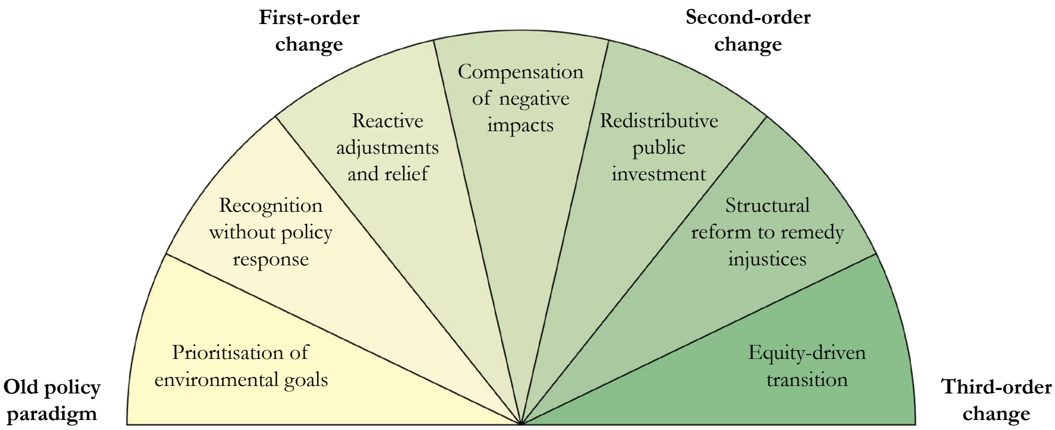

FIG. 8.1 An illustration of the continuum of social policy integration into climate policy, based on Hall's (1993) conceptual framework, ranging from incremental adjustments to paradigm shifts

Midway along the arc, a second-order shift would then move beyond minor adjustments that merely mitigate symptoms through the introduction of new instruments, such as structural public funds that direct investments in sustainable technologies towards those disproportionately affected by climate policies and climate impacts. Rather than relying on short-term relief measures, these mechanisms embed redistributive principles into climate mitigation and adaptation spending. Examples include priority programmes offering means-tested retrofit grants and electric vehicle subsidies for lower-income households to adopt a more sustainable lifestyle and increase access to suitable transport options, addressing the regressive nature of past subsidy schemes that largely benefited affluent homeowners installing solar panels or electric vehicles (Caulfield et al., 2022; Fernández et al., 2024). A second-order shift seeks to correct these imbalances by ensuring that public investment in climate action actively reduces, rather than exacerbates, social inequalities (Muehlegger & Rapson, 2022).

A third-order shift, by contrast, would embody a deeper transformation: instead of treating social policy as a secondary add-on to environmental objectives, it would place equity and redistribution at the core of climate action, reordering institutional priorities and decision-making processes. This could take the form of ensuring universal basic services for energy and mobility, ensuring guaranteed minimum levels of affordable access to electricity, heat and public transport, through structural interventions in public and private infrastructure (Coote, 2022; Klenert et al., 2018). Democratic control of energy systems through cooperatives would prioritise collective ownership (Kunze & Becker, 2015), while job guarantees in green sectors would ensure stable employment for workers transitioning out of fossil fuel industries (Tcherneva, 2020). Finally, climate reparations and just transition funds would direct substantial investment towards historically marginalised regions and communities most affected by both past industrial decline and present climate risks (McCauley & Heffron, 2018).

As shown in Figure 8.1, the final wedges on the spectrum mark such fundamental redefinition of what climate governance should achieve: an ‘equity-driven transition’ that positions social justice as a principal pillar of sustainability instead of an afterthought. Rather than serving as a definitive blueprint, this figure offers an illustrative framework for understanding the flexible continuum of policy change, highlighting how Hall’s orders of change can help conceptualise varying degrees of climate-social policy integration.

8.3 Analytical framework and regulatory review

This study employs a qualitative research design, drawing primarily on EU legislative texts to identify policy paradigms through ‘revealed ideas’ by examining the priorities and assumptions embedded in regulations and policy instruments. Rather than assessing the cognitive and normative beliefs of policymakers through interviews or discourse analysis, this approach infers dominant policy logics from proposed and enacted legislation, reflecting how paradigms shape actual policy outcomes. While Daigneault (2013) critiques this method, arguing that ideas should be studied independently of policy outputs, Princen and ’t Hart (2014) counter that policy instruments are not merely material constructs but operationalise underlying ideational frameworks. Given the multi-layered and expert-driven nature of EU policymaking, where ideological shifts are often mediated through technical negotiations and compromise, regulatory texts provide one of the most tangible and systematic ways to trace paradigm change.[65]

8.3.1 Selection of legislative texts

The EGD encompasses a broad suite of legislative initiatives spanning energy, transport, industry, and biodiversity. Given this extensive scope, our analysis focuses on a subset of key legislative instruments that engage most directly with the climate-social policy nexus, particularly in relation to energy affordability, vulnerability protections, and redistributive funding mechanisms. Most include explicit reference to energy and transport poverty, which remains the EU’s most well-defined social objective within climate policy (Vandyck et al., 2023). Rather than assessing the EGD in isolation, we systematically compare its legislative output to earlier regulatory frameworks, allowing us to trace continuities and breaks in policy logic, priorities, and mechanisms. This comparative approach is particularly suited to capturing how elements may be layered onto existing frameworks without necessarily displacing them.

65 EU policymaking operates within a multi-institutional framework where policy proposals emerge from the European Commission, are debated and amended by the European Parliament and the Council, and often require input from regulatory agencies, expert groups, and stakeholder consultations (Klüver et al., 2015). This process, shaped by negotiation and technical expertise, means that paradigm shifts tend to unfold incrementally rather than through abrupt ideological change (see Bauer & Becker, 2014; Schmidt, 2006, for a more comprehensive discussion).

This approach is particularly suited to the amending nature of the EGD, which primarily revises existing directives and regulations rather than introducing entirely new legislation. Since these revisions build upon established policy frameworks, they provide a structured basis for assessing whether changes remain within the existing paradigm (first- or second-order change) or reflect a deeper redefinition of goals and assumptions (third-order change).

Table 8.1 presents the key legislative texts analysed in this study alongside their predecessor frameworks, illustrating how the EGD builds on prior regulations while introducing new redistributive instruments such as the Just Transition Fund and Social Climate Fund.

TABLE 8.1 Legislative texts and their predecessor frameworks analysed in this study66

Legislative framework (EGD)	Predecessor framework
Gas Market Directive (EU/2024/1788), Gas Market Regulation (EU/2024/1789)	Gas Directive (EC/98/30, EC/2003/55, EU/2009/73), Gas Regulation (EC/1775/2005, EU/715/2009)
Electricity Market Design Directive (EU/2024/1711), Electricity Market Design Regulation (EU/2024/1747)	Electricity Directive (EC/96/92, EC/2003/54, EC/2009/72, EU/2019/944), Electricity Regulation (EU/2003/1228, EU/2009/714, EU/2019/943)
Energy Efficiency Directive (EU/2023/955)	SAVE Directive (EC/1993/76), Energy Services Directive (EC/2006/32), Energy Efficiency Directive (EU/2012/27, EU/2018/2002)
Renewable Energy Directive (EU/2023/2413)	Renewable Energy Directive (EC/2001/77, EU/2009/28, EU/2018/2001)
Energy Performance of Buildings Directive (EU/2024/1275)	Energy Performance of Buildings Directive (EC/2002/91, EU/2010/31, EU/2018/844)
Emissions Trading System Directive (EU/2023/959)	Emissions Trading System Directive (EC/2003/87, EU/2009/29, EU/2018/410), Effort Sharing Regulation (EU/2023/857, EU/2018/842)
Just Transition Fund Regulation (EU/2021/1056)	*New regulation, no direct predecessor*
Social Climate Fund Regulation (EU/2023/955)	*New regulation, no direct predecessor*

In addition to final legislative texts, we examine Commission proposals, impact assessments, position statements, and trilogue documents, as these materials often contain clearer articulations of policy rationales before being diluted through political bargaining. Given that the Commission frequently acts as a policy

66 The Governance Regulation (EU/2018/1999) remains a foundational framework for National Energy and Climate Plans (NECPs) and reporting obligations relevant to social objectives but was not substantially revised under the European Green Deal.

entrepreneur within the EU's multi-level governance structure, these documents offer insights into the ideational shifts that may not be immediately visible in final legislation, particularly in areas where Member States or the Council have resisted change. By analysing both legislative texts and their preparatory materials, we gain a more precise understanding of how and where paradigm shifts may be emerging within the EU's evolving climate-social policy landscape.

8.3.2 Analytical strategy

To assess the degree of alignment in EU climate-social policy, this study applies a qualitative content analysis of legislative texts, using Hall's three orders of change framework to evaluate whether the EGD introduce incremental adjustments (first-order change), significant recalibrations (second-order change), or a fundamental redefinition of policy objectives (third-order change). However, rather than applying it as a rigid stepwise model, this study conceptualises legislative evolution as a continuum, where incremental modifications may accumulate into broader paradigm shifts over time (see Figure 8.1).

This is explored through several interrelated dimensions, starting with how legislative texts define and prioritise inequality and vulnerability in the context of climate and energy policy. This includes assessing whether social risks linked to the climate transition, such as energy and transport poverty, are clearly conceptualised and addressed, and whether they are framed as market failures requiring limited intervention, as structural inequalities necessitating targeted redistributive mechanisms, or as broader governance challenges that call for a reconfiguration of economic and social contracts (Gough, 2021). The study also examines the extent to which new legislation strengthens legal protections for affected populations, evaluating whether policies enhance consumer rights and access to essential services. It also evaluates to what extent funding and support mechanisms introduce novel financial provisions and to what extent these are incremental adjustments or signal a more structural integration of climate and social objectives.

Beyond substantive policy content, the analysis examines how governance structures shape the participation of social actors in decision-making. This includes assessing whether legislative changes introduce new mechanisms that expand the role of vulnerable groups, social partners, and civil society organisations or whether governance remains predominantly technocratic and top-down. A key consideration is whether participation is institutionalised through procedural mechanisms that provide structured input opportunities or remains limited to non-binding

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consultations (Newell et al., 2024). Additionally, the study evaluates whether policies promote decentralised governance models, such as energy cooperatives and local energy communities, as a means of increasing stakeholder involvement in climate and energy policymaking (Sokołowski et al., 2020; Walker et al., 2010).

Finally, the study examines the underlying assumptions guiding interventions, particularly the balance between market-based and state-led approaches to delivering social and climate objectives, and the extent to which a rights-oriented framework is incorporated. This includes assessing whether policies primarily rely on market mechanisms and private sector incentives to deliver equitable outcomes, with the state intervening in a reactive or corrective capacity, or whether they reflect a more proactive role for public institutions in shaping distributive outcomes. Additionally, the analysis considers whether social objectives are embedded as core components of climate governance or treated as secondary concerns addressed through compensatory mechanisms. This distinction is crucial in evaluating whether the EGD represents an incremental adjustment within existing policy paradigms or signals a more structural reconfiguration of the relationship between social and environmental policy.

By applying this multi-layered analytical strategy, the study provides a systematic account of how and where paradigm shifts may be emerging in EU climate-social policymaking, capturing both the substance of legislative change and the evolving policy rationale that underpins it.

8.4 Policy shifts and continuities

The evolution of EU climate and energy policy reflects a gradual but significant shift from market-driven approaches with primarily environmental objectives towards greater integration of social considerations. This section traces key developments in the climate-social nexus.

8.4.1 From market efficiency to environmental considerations (1993-2006)

The early development of EU climate and energy policy was largely shaped by economic and market priorities, with environmental objectives gradually gaining prominence and social considerations remaining marginal.

The 1990s marked the beginning of energy market liberalisation, notably through the First Energy Package. The 1996 Electricity Directive aimed to create a competitive internal electricity market by mandating third-party access and unbundling vertically integrated utilities.[67] Social protection was marginal to its objectives: references to consumer and environmental concerns appeared only in recitals, particularly Recital 13, where it states that 'some Member States' expressed the view that *"free competition, left to itself, cannot necessarily guarantee"* objectives such as consumer and environmental protection (European Parliament and Council, 1996, p. 20). To address these concerns, Member States were permitted – but not required – to impose public service obligations (PSOs) concerning security of supply, quality, pricing, and environmental protection, as set out in Article 3(2) of both the 1996 Electricity Directive and the 1998 Gas Directive, which similarly extended similar market-based principles to the natural gas sector. The language is permissive (using the purely discretionary 'may'), reflecting the minimalist and optional nature of social protection.

67 Unbundling vertically integrated utilities means breaking up companies or state-owned enterprises that previously controlled the entire supply chain – generation, transmission, distribution, and retail – into distinct entities, promoting competition in some segments while keeping transmission infrastructure under state control (see, e.g., Jamasb & Pollitt, 2005).

Environmental concerns initially remained secondary to economic and market priorities. A notable early exception was the 1993 SAVE Directive, which aimed to reduce carbon emissions through demand-side energy efficiency measures like building certification schemes. Although primarily an environmental measure, its preamble linked energy efficiency to *"economic and social cohesion"* (European Parliament and Council, 1993, p. 29). By the early 2000s, environmental priorities were becoming better anchored. Examples are the 2001 Renewable Electricity Directive and 2002 Energy Performance of Buildings Directive (EPBD), which primarily focused on environmental goals but briefly mentioned socio-economic co-benefits such as local employment and affordable housing in their Recitals. The introduction of the EU's Emissions Trading System (ETS) in 2003 (launched in 2005) became the most symbolic instance of aligning environmental objectives with market principles. However, social considerations remained absent: the ETS focused solely on environmental effectiveness and economic efficiency, overlooking potential distributive impacts on vulnerable groups. Thus, even as environmental objectives became structurally embedded, social dimensions remained marginal.

A more substantive, albeit still limited, social emphasis emerged with the Second Energy Package adopted in 2003. For the first time, the recast Electricity Directive introduced a binding obligation on Member States: Article 3(5) stated that Member States 'shall' adopt measures to protect vulnerable customers. However, crucially, the concept of vulnerability remained undefined at EU level, and the Directive left wide discretion to Member States regarding the form, scope, and strength of protective measures. It did not establish an enforcement mechanism, relying solely on Member State reporting under general internal market obligations, without specific scrutiny or penalties for insufficient protection. The recast Gas Directive mirrored these provisions in Article 3(3), but again without harmonised definitions or strong oversight. Hence, while the Second Energy Package marked a shift from optional to mandatory consideration of vulnerable consumers, it ultimately fell short of establishing robust EU-level scrutiny, leaving the scope and enforcement of social protections largely to the discretion of national policymakers.

Despite the increasing prominence of environmental priorities during this period, social considerations remained peripheral. References to social goals were extremely light, confined to recitals or optional PSOs, without harmonised definitions or binding social standards. Affordability was framed narrowly in terms of maintaining reasonable prices, without addressing distributional issues or social vulnerability.

8.4.2 Social adjustments within existing frameworks (2006-2019)

The period from 2006 onwards saw the consolidation of environmental objectives as binding elements of EU energy and climate legislation, while social considerations began to receive more structured, though still limited, recognition.

Building on earlier discussions about PSOs, the 2006 Energy Services Directive for the first time explicitly allowed Member States to introduce *"tariff structures with a social aim"* to protect vulnerable consumers from excessive energy costs (European Parliament and Council, 2006, p. 71).[68] Its inclusion responded to ongoing legal tensions between the European Commission and several Member States over the permissible scope of PSOs: while the Commission sought to ensure that PSOs did not distort competition within the internal energy market, Member States, particularly France and Italy, argued for broader interpretations that included social pricing measures. By formally allowing tariff structures with a social dimension, the Directive acknowledged these pressures without fundamentally altering the market-liberalisation paradigm or imposing binding social obligations at EU level.

In the aftermath of the 2008 global financial crisis (GFC), the Third Energy Package introduced the concept of 'energy poverty' into EU law but confined to the recitals rather than operative provisions. Recital 45 of the Electricity Directive referred to energy poverty as a 'emerging problem' affecting an increasing number of consumers, encouraging Member States that they 'should' (non-binding language without legal obligation) take appropriate measures to address it. Compared to the 2003 Directives, the 2009 Electricity and Gas Directives maintained largely similar legal frameworks regarding the protection of vulnerable customers. In both cases, Member States were still required to 'take appropriate measures' to protect vulnerable consumers, but retained full discretion over the definition of vulnerability, the identification of energy poverty, and the design of protection mechanisms. The Directives explicitly positioned general social policy tools, such as welfare benefits and social security schemes, as the primary means to address affordability issues, keeping redistribution mechanisms outside the core energy market framework and reinforcing the assumption that competition would drive consumer benefits.

68 Social energy tariffs had by then already emerged in Belgium (2004), Romania (2005), and France (2005), followed by Cyprus (2006), Italy (2008-2009), Spain (2009), Portugal (2010), and Greece (2010). Meanwhile, several Central and Eastern European countries maintained broader household energy price regulation after joining the EU.

Meanwhile, environmental objectives were increasingly consolidated during this period. The 2009 Renewable Energy Directive (RED) legally bound Member States to achieve national renewable energy targets by 2020 (Article 3), supported by monitoring mechanisms and potential infringement procedures, but made only vague references to co-benefits such as social cohesion and local employment (Recital 4), alongside diffuse concerns about biofuels and food prices, which the Commission was tasked to monitor without immediate corrective measures. The 2009 revision of the EU ETS provided the clearest example of strengthened environmental ambition combined with the neglect of social dimensions: it expanded auctioning and tightened the emissions cap without properly acknowledging or addressing the regressive impacts of carbon pricing on households. While energy-intensive industries continued to benefit from free allowances to mitigate carbon leakage risks, the power sector was fully exposed to carbon pricing, and households faced higher energy costs without protection. The Directive encouraged ('should') Member States to allocate at least 50 per cent of auctioning revenues to climate action, but merely permitted ('may') their use for social measures supporting low- and middle-income households, treating the mitigation of regressive impacts as an entirely optional and peripheral objective.

Similarly, the 2010 EPBD recast strengthened energy efficiency goals but only briefly referred to co-benefits for low-income households in recitals. The 2012 Energy Efficiency Directive (EED) introduced binding national savings targets and mandatory energy efficiency schemes, yet only allowed Member States, under Article 7(7)(a), to optionally include social aims in saving obligations, such as prioritising measures for households affected by energy poverty, through explicitly permissive ('may') language.

The 2015 Energy Union Strategy positioned affordability and consumer protection as central concerns, explicitly recognising energy poverty as a multifaceted issue linked to inefficient housing and low incomes, which *"can only be tackled by a combination of measures"* (European Commission, 2015, p. 12). However, it again framed social protections as complementary rather than integral to EU energy policy, urging Member States to rely on existing welfare systems and targeted market interventions. The strategy remained rooted in market logic, prioritising competition and consumer choice. Its five pillars – security of supply, integrated energy market, energy efficiency, decarbonisation, and research and innovation – did not explicitly include affordability or energy poverty. The 'security of supply' pillar referred to 'solidarity and trust', yet this applied primarily to cross-border gas supply during crises, not to protecting households.

Following the launch of the Energy Union Strategy and the Paris Agreement that same year, the EU introduced a series of legislative revisions that cautiously expanded social considerations within energy and climate governance, although largely at a procedural level.

The 2018 EPBD revision required Member States, for the first time, to incorporate in their Long-Term Renovation Strategies an outline of relevant national actions contributing to the alleviation of energy poverty in Article 2a(1d). However, no harmonised definition of energy poverty was introduced, and the obligation was procedural: Member States 'shall' include outlines, but the depth, scope, and enforcement of measures remained fully at their discretion. The 2018 Governance Regulation further required Member States to assess the number of households affected by energy poverty and, where a significant number was identified, to include indicative targets and objectives for its reduction within their National Energy and Climate Plans (NECPs) and progress reports (Article 24). While Member States 'shall' conduct such assessments and include targets if applicable, the definition of what constituted a 'significant' level of energy poverty was left entirely to national interpretation, and the targets remained indicative rather than binding. Building on this, the 2018 EED revision further embedded social considerations procedurally. Article 7(11) required Member States to 'take into account' the need to alleviate energy poverty when designing energy efficiency obligation schemes, to 'prioritise', where appropriate, measures for vulnerable households, and to report on outcomes within NECPs. Yet the binding force remained limited: while 'shall take into account' imposed a duty to *consider*, 'to the extent appropriate' left the prioritisation of vulnerable households largely optional.[69]

Beyond energy poverty, the 2018 RED II recast modestly extended social dimensions by requiring Member States to ensure that renewable self-consumption and participation in renewable energy communities were accessible to all consumers, including low-income and vulnerable households (Articles 21(6a) and 22(4f)), though without mandating prioritisation or targeted support. The 2018 revision of the ETS Directive significantly strengthened environmental ambitions by tightening the annual cap, creating a Market Stability Reserve (MSR), and cutting off almost all free allowances for the power sector. However, it still did not acknowledge, let alone address, the regressive impact of rising electricity prices on households. While it introduced 'just transition' principles in a traditional labour union sense, it merely encouraged Member States to use auction revenues for social measures like job

69 Subsequently, only a few NECPs included substantive energy poverty measurement, reflecting how the 'to the extent appropriate' language effectively diluted the binding force of Article 7(11).

training in carbon-intensive regions (Recital 13, Article 10(3)). Social objectives remained optional, without binding allocation rules. The new Modernisation Fund (MF) introduced a redistributive mechanism aimed at supporting clean energy and energy efficiency investments in lower-income Member States (Article 10d), reflecting intra-Union cohesion and solidarity objectives rather than domestic social policy objectives, with the fund having primarily environmental goals. Finally, the 2019 Electricity Directive marginally strengthened consumer protections by requiring Member States not only to protect but also to define ‘vulnerable customers’ (Article 28), thereby adding modest procedural reinforcement, though without substantially limiting national discretion.

Overall, while this period witnessed some social adjustments across multiple instruments, binding obligations remained weak. Social protections or investments were framed primarily through procedural requirements (monitoring, reporting) rather than substantive guarantees, reinforcing the primacy of market liberalisation and decarbonisation objectives in EU energy law.

8.4.3 Emergence of redistributive decarbonisation (2019-)

By the late 2010s, the EU’s climate and energy policy began to integrate social considerations more systematically, reflecting a gradual shift from procedural accommodation towards the structural embedding of redistributive elements. Although environmental and market-based objectives remained dominant, social dimensions became increasingly layered into the governance framework.

The launch of the European Green Deal (EGD) in 2019 marked a turning point. It framed the energy transition as requiring social fairness to succeed, explicitly stating that it must *“leave no one behind”* (European Commission, 2019, p. 16). This ambition materialised through the Just Transition Mechanism (JTM) in 2020, with the Just Transition Fund (JTF), established in 2021, as its central pillar. For the first time, a dedicated financial instrument was introduced to mitigate the socio-economic impacts of decarbonisation, with a single specific objective of ‘enabling regions and people’ towards climate neutrality (Article 2). JTF support is conditional on the preparation of national Territorial Just Transition Plans, setting out the most affected regions and the measures needed to foster economic diversification, worker reskilling, and social inclusion (Article 11). Unlike previous periods, where social objectives were merely encouraged or required to be reported on, the JTF strictly limits eligible support to activities explicitly listed in the Regulation and directly linked to the specific objective (Article 8). However, the JTF’s modest scale

(€17.5 billion), limited consultation of regional stakeholders, high administrative burden, and broad scope across multiple objectives has raised concerns about its ultimate impact (Cameron et al., 2020).

Moreover, the 2023 EED revision strengthened the procedural integration of social objectives, by providing the first EU-level definition of energy poverty in Article 2(52)).[70] It also slightly reinforced reporting requirements under National Energy and Climate Plans (Article 31). However, enforcement remained largely procedural, relying on monitoring and reporting without substantive minimum standards at EU level.

A profound shift came with the 2023 ETS revision, which marked a turning point in the integration of social compensation mechanisms into the EU's core decarbonisation instrument. Most notably, the Directive established a second carbon market, ETS2, extending emissions trading to heating and transport fuels from 2027 onwards. Recognising potential affordability risks this posed for households, the Directive introduced temporary safeguards, including a possible one-year postponement of ETS2's launch in the event of exceptionally high energy prices, and a price stability mechanism to contain excessive cost surges.[71] Moreover, beyond these short-term protective measures, the Recitals embedded social fairness structurally and for the first time by explicitly recognising *"the transition has a particular impact on disadvantaged and vulnerable groups"* and the need for *"effective social compensation, especially in view of the existing levels of energy poverty"* (European Parliament and Council, 2023, pp. 134, 152). Most importantly, it established a dedicated redistributive mechanism: approximately 25% of ETS2 revenues, capped at €65 billion, are earmarked for the newly created Social Climate Fund (Article 30d), moving beyond earlier reforms that merely encouraged the use of auction revenues for social purposes.

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70 It defines energy poverty as "*a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes*" (European Parliament and Council, 2023a, p. 31).

71 The price stability mechanism allows for the release of additional allowances if the average carbon price for heating and transport fuels exceeds €45 per tonne in real terms. However, the release of additional allowances is subject to a time lag and volume caps under the Market Stability Reserve rules (Article 30h), with no further release permitted for 12 months after activation. As a result, the mechanism may not fully prevent sustained periods of high prices.

The Social Climate Fund (SCF) represents the EU's most direct effort to mitigate the regressive effects of carbon pricing on households. It targets vulnerable households, vulnerable micro-enterprises and vulnerable transport users (Article 1).[72] Member States are required to prepare Social Climate Plans (SCPs), outlining how they will support these groups, and allocations are distributed largely based on GDP per capita, reflecting intra-Union solidarity principles. Eligible actions are restricted to structural investments, such as building renovations, clean heating systems, and sustainable mobility, with only a limited share (maximum 37.5%) permitted for temporary direct income support (Article 8(2)). Enforcement is linked to performance-based conditionality: the Commission's approval of Social Climate Plans is required before disbursement (Article 15), with funding conditional on the achievement of milestones and targets (Article 7(2)) and subject to suspension for non-compliance (Article 18), following a model similar to the Recovery and Resilience Facility (RRF). However, the SCF's ability to shield households remains uncertain. Although Member States must provide 25% co-financing, bringing potential funding to €86.7 billion, allocations are capped and do not adjust if carbon prices rise faster than expected. External forecasts, such as BloombergNEF's estimate of €149 per tonne by 2030 – potentially adding €0.30 per litre to petrol – suggest that prices could surge despite the safeguards (Chang & Coker, 2025). As a result, the SCF's effectiveness will ultimately depend on whether Member States choose to top up support from their own ETS2 revenues.

Beyond carbon pricing, the EGD increasingly embedded social considerations into other directives as well. Compared to 2018, the REDIII revision shifts from being descriptive (no binding duty) to using binding obligations ('shall') that require Member States to ensure a just transition, promote workforce reskilling, strengthen public participation, and address energy poverty as integral parts of renewable energy policy, with compliance overseen through NECP reporting. Nevertheless, the absence of binding quantitative standards limits the prospects for strong judicial or administrative enforcement. Similarly, the 2024 EPBD revision states that Member States *"shall introduce effective safeguards, to protect in particular vulnerable households, including by providing rent support or by imposing caps on rent increases"* (European Parliament and Council, 2024, p. 68), particularly when landlords receive public subsidies for renovations, a shift from the 2018 directive that only encouraged 'consideration' of split incentives. Yet despite the use of binding language, enforcement remains largely procedural, relying on Member State reporting under the Governance Regulation, with infringement procedures theoretically possible but practically unlikely due to the vague and flexible formulation of social safeguard obligations.

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72 Defined as households and individuals experiencing energy or transport poverty or bearing disproportionate energy or transport costs relative to income (Articles 2(10), (12)), and micro-enterprises significantly affected by price impacts and lacking the means to invest in sustainable alternatives (Article 2(11)).

TABLE 8.2 Incorporation of social and equity measures in climate and energy policies under the European Green Deal (EGD)

Instrument	Definition and Priorities	Protections and Legal Standards	
2021 Just Transition fund (EU) 2021/1056	• Supports clean energy, reskilling, economic diversification in carbon-intensive territories (Art. 2, 8).	• Member States must promote gender equality and prevent discrimination (Art. 5(1)).	
2023 Energy Efficiency Directive (EU) 2023/1791	• Defines energy poverty (Art. 2(49)).	• Member States must prioritise energy savings among vulnerable, energy-poor, and social housing occupants (Art. 8(3)). • Member States must ensure access to independent dispute resolution for heating, cooling, and hot water services (Art. 15(2)).	
2023 Renewable Energy Directive (REDIII) (EU) 2023/2413	• Renewable policies must contribute to just transition, address energy poverty, promote reskilling (Art. 3(4), 22(7)).	• Member States shall promote participation of vulnerable and energy-poor consumers in renewable energy communities (Arts. 18, 22(7)).	
2023 Emissions Trading System Directive (ETS2) (EU) 2023/959	• Recognises impact of carbon pricing on low-income households (Recitals 43, 134).	• Launch of ETS2 can be delayed by one year if energy prices spike (Art. 30h).	
2023 Social Climate Fund Regulation (EU) 2023/955	• First 'narrative' EU definition of transport poverty (Art. 2(19)) • Allows national definitions for energy and transport poverty.	• Member States must target support to vulnerable households, micro-enterprises, and transport users (Art. 1). • Temporary income support capped at 37.5% of SCF funding (Art. 8(2)).	
2024 Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275	• Requires Member States to define, measure, and set national targets to reduce energy poverty (Art. 3).	• Member States must introduce safeguards against excessive rent increases post-renovation (Art. 15).	
2024 Electricity Market Design Directive (EU) 2024/1711	• Vulnerable customers must have access to energy-sharing schemes and public schemes (Art. 15(2)).	• Member States must ensure protection against disconnection for vulnerable customers (Art. 28). • Mandatory Supplier of Last Resort regime (Art. 27a as amended). • Regulated retail prices allowed during crises (Art. 5(1)). • Permanent regulated prices allowed for vulnerable groups (Art. 5(2)).	
2024 Gas Market Directive (EU) 2024/1788	• Member States must protect vulnerable and energy-poor customers during gas market transition (Art. 3).	• Member States must protect vulnerable and energy-poor customers against disconnection at critical times (Art. 3(5)). • Member States must ensure a Supplier of Last Resort is available (Art. 28). • Member States may regulate gas prices during declared crises (Art. 67).	

Monitoring and Enforcement Mechanisms	Representation and Consultation	Funding and Support Mechanisms
• Commission approves and monitors Territorial Just Transition Plans; funding can be suspended for non-compliance. (Art. 10–11).	• Member States must consult local authorities, social partners, civil society (Art. 11(1)).	• €17.5 billion (2021–2027) funded by MFF and NGEU. Conditional on approved Territorial Plans (Art. 8).
• Member States must report via NECPs (Art. 31). • Commission monitors implementation and may recommend corrective action (Art. 32(2)).	• Member States must establish networks of experts and one-stop shops accessible to vulnerable households (Art. 25, 26).	
• Member States must report via NECPs (Art. 17). • Commission monitors and may recommend corrective action (Art. 18).	• Member States must promote participation of citizens, energy-poor, and vulnerable groups in renewable energy communities (Art. 18, 22(7)).	
• Commission must monitor ETS2 market functioning. • Commission may suspend auctions if instability thresholds are met (Art. 30h).		• Approx. 25% of ETS2 revenues earmarked for the Social Climate Fund (Art. 30d).
• Social Climate Plans must be approved by the Commission (Art. 9–10). • Funding conditional on achieving milestones and targets (Arts. 7(2), 18).	• Member States must consult public and civil society organisations when drafting Social Climate Plans (Art. 7).	• Up to €86.7 billion (2026–2032), combining ETS2 revenues and mandatory 25% national co-financing (Arts. 4–5).
• National Building Renovation Plans subject to Commission review and possible recommendations	• Member States must consult social partners, civil society, and vulnerable groups during Plan preparation (Art. 3(7)).	• Financial support must prioritise energy-poor households; advisory services must be available (Arts. 16, 26).
• Enforcement by National Regulatory Authorities; coordination by ACER (Art. 59 of Dir. 2019/944 as amended).		
• National regulators must monitor markets; Commission must be notified of crisis interventions (Arts. 66–67).		

The EU's response to the 2021–2022 energy price crisis reinforced the trend towards stronger consumer protections while maintaining a market-based framework. The 2024 Electricity and Gas Market Directives and Regulations mark a notable departure from earlier liberalisation policies by introducing, for the first time, binding obligations ('*shall* ensure full protection') to prevent disconnections of vulnerable customers and customers affected by energy poverty. Both Directives require suppliers not to disconnect customers pending complaint resolution, establishing a new procedural safeguard absent from earlier frameworks. They also require Member States to establish a 'Supplier of Last Resort' regime, shifting from the previously optional model to a mandatory obligation in electricity markets, and a more flexible mandatory requirement in gas markets, allowing national adaptations. Moreover, in terms of price interventions, both Directives substantially expand the scope for regulated prices: while earlier frameworks permitted them only exceptionally, the 2024 reforms allow regulated prices below cost during a declared 'price crisis', covering up to 80% of median household consumption. Outside crises, the Electricity Directive permits Member States to maintain regulated prices for vulnerable and energy poor households indefinitely, whereas the Gas Directive limits such measures to temporary interventions. The phase-out of fossil fuels seems to sharpen tensions between social and environmental objectives, resulting in more constrained and transitional pricing protections. Together, these changes signal a recalibration of market principles towards a more socially resilient internal energy market.

While these developments mark a significant deepening of social protections within EU energy law, they remain layered onto a market-based framework rather than transforming it. Social objectives are increasingly proceduralised and supported through targeted redistributive mechanisms, yet without establishing universal rights to affordable energy.

8.5 Discussion

The evolution traced in Section 8.4 reflects a clear departure from the early phase of EU climate and energy governance, which prioritised market liberalisation. Early adjustments were primarily first-order changes, consisting largely of procedural recognition of social vulnerabilities. In contrast, the launch of the EGD in 2019 marked a qualitative reorientation towards redistributive instruments, notably the JTF and the SCF, reflecting clear elements of second-order change. However, despite these substantial recalibrations, the EGD does not represent a full third-order paradigm shift. Redistributive mechanisms have been layered onto, rather than replacing, the underlying liberalised market framework (Kern & Howlett, 2009). Equity has not yet been placed at the core of energy and climate governance through a fundamental reordering of institutional priorities. Achieving a true third-order shift would require recognising access to affordable clean energy and sustainable mobility, such as public transport, as fundamental social rights, structurally guaranteed through reforms to public and private infrastructure (Hesselman, 2022; Sheller, 2018). The absence of such a rights-based framework remains the key barrier to a paradigmatic transformation.

Still, the gradual evolution prompts a key question: were the two observed phases of policy change primarily driven by Hallian policy learning, or do alternative theoretical frameworks – Punctuated Equilibrium (PE), Advocacy Coalition Framework (ACF), and Discursive Institutionalism (DI) – offer stronger explanations?

The early post-GFC reforms (2008-2010) and the Energy Union strategy (2015) mostly addressed distributional inequities through minor technical adjustments and incremental procedural safeguards, such as defining vulnerable consumers and encouraging disconnection protections. These first-order changes align with Hall's social learning model, as they responded to accumulating policy 'anomalies': rising energy prices, persistent energy poverty, and market failures that challenged the assumption that competition alone ensured affordability (Bouzarovski & Petrova, 2015; Kern et al., 2015). Facing mounting evidence of this, the Commission promoted targeted welfare-based measures as pragmatic refinements rather than ideological shifts, ensuring that social protections remained compatible with market-liberal objectives.

While this Hallian perspective captures key dynamics, broader frameworks help illuminate deeper political and discursive forces. PE theorists would emphasise how the 2008 GFC, as a major external shock, reinforced austerity imperatives, prompting largely superficial social protections designed to contain political instability while keeping the market-liberal energy policy paradigm intact (Burns et al., 2019). ACF analysis underscores the role of advocacy coalitions, with Poland and other coal-dependent states leveraging their bargaining power to secure compensatory measures, such as allocations from ETS revenues (Olgun, 2017; Skjærseth, 2021). Meanwhile, DI highlights the gradual reframing of energy as an essential service, with the emergence of 'energy poverty' as a distinct policy problem reshaping discourse and legitimising stronger consumer protections within a still-liberalised policy framework (Bouzarovski et al., 2012).

Against this backdrop, the EGD marked a more substantial shift from reactive to embedded redistributive mechanisms, representing a second-order change that cannot be reduced to Hallian policy learning alone, even if aspects of adaptive refinement are observable. With carbon pricing becoming more ambitious and generating higher revenues, previous attempts to encourage Member States to allocate part of these funds to social support measures had yielded mixed results (Löfgren et al., 2018), prompting the Commission to institutionalise revenue recycling for vulnerable regions and households through new instruments like the JTF and SCF. Similarly, disconnection bans and other social protections, once voluntary and limited, became mandatory in the EGD as policy learning highlighted their necessity (Haber, 2018).

Yet the deeper drivers behind the EGD's social turn are better captured when alternative frameworks are also considered. PE theorists, for instance, would highlight how the shock of the 2018 Yellow Vest protests in France underscored the political fragility of carbon pricing, likely influencing the establishment of the SCF as a way to pre-empt social backlash against ETS2 (Driscoll, 2023).[73] Similarly, the affordability revisions in the new electricity and gas directives are deeply tied to the 2021-2022 energy crisis, which mainstreamed once-unthinkable measures in a liberalised energy market, such as price caps (Pollitt et al., 2024). This underscores the punctuated nature of policy shifts, where crises trigger abrupt departures from established paradigms. Meanwhile, ACF offers an alternative account, attributing the growing climate-social nexus within the EGD to shifting coalition dynamics. The FridaysForFuture movement and mass mobilisation around equitable climate action in 2018, coupled with the 'green wave' of the 2019 European elections, empowered progressive and social-democratic actors to embed redistributive mechanisms into

73 Kyriazi and Miró (2022) similarly argue that the Yellow Vest protests played a crucial role in elevating social justice concerns within EU climate policy, but from a Multiple Streams Framework (MSF) perspective, show how problem recognition, political dynamics, and policy entrepreneurs interacted to institutionalise mechanisms like the JTF.

EU climate governance (Pollex, 2025). Lastly, DI provides an additional explanatory layer, focusing on the increasing discursive power of concepts like 'just transition' (Bartenstein, 2024), as well as the reframing of energy poverty and energy citizenship as matters of social rights and procedural fairness rather than merely market failures (Held et al., 2024; Hesselman et al., 2021).

Therefore, while our continuum model based on Hall captures the gradual evolution of the EU's climate-social nexus to a large extent, it is essential to also recognise the critical junctures and dynamics that defined this trajectory. This is particularly true for the EGD, which was not merely the culmination of decades of incremental layering, but the product of a confluence of external pressures, shifting alliances, and evolving public discourse that catalysed a more decisive recalibration. Unlike the earlier post-GFC adjustment, where technical refinements were deemed sufficient, this climate policy transformation required more explicit political legitimation than before, which led to the linking of climate goals to a broader vision of social equity. As such, the EU's trajectory cannot be fully explained by Hallian social learning, nor by models emphasising exogenous shocks, coalition dynamics, or ideational shifts in isolation, Instead, it reflects a hybrid dynamic in which incremental changes generate the conditions for larger shifts, and these shifts, in turn, reshape the space for further incrementalism. Recognising this interplay between layered evolution and breakthrough moments is critical to understanding how the EU's climate-social nexus continues to evolve.

This complex interplay also makes it inherently difficult to draw definitive conclusions about whether the EU is undergoing a full paradigmatic transformation. While this study systematically analysed legislative texts to trace policy change, complementary approaches – such as examining political narratives, institutional bargaining processes, and stakeholder mobilisation – are needed to capture the full dynamics at play. Moreover, the multi-level governance structure of the EU, combined with the limits of shared competences, constrains systemic change in key domains such as social protection, welfare, and housing policy, where authority remains largely at national or sub-national levels. The realisation of transformative change thus depends not only on EU-level reforms but also on how Member States implement and expand these provisions, a process that varies significantly and ultimately shapes the impact of redistributive mechanisms such as the JTF and SCF. A final limitation of this study is its necessary focus; while 37 legislative acts, including both EGD-era legislation and their predecessor frameworks, were systemically analysed, broader funding instruments like the RRF fell outside its scope despite funding energy and climate measures. Additionally, some relevant strategies, such as the European Commission's Affordable Energy Action Plan, were published after this analysis was conducted.

Taken together, the evidence suggests that while the EGD has introduced significant second-order changes, it stops short of a full paradigmatic reordering of EU climate-social governance. Social safeguards have been embedded more deeply into climate and energy policy than ever before, yet they remain layered onto a fundamentally liberalised framework rather than displacing it. The EU's trajectory thus reflects evolution rather than revolution, an incremental but cumulative reshaping of the climate-social nexus. As implementation proceeds, continued scrutiny will be crucial to determine whether these reforms merely refine the existing paradigm or progressively lay the foundation for a more fundamental realignment of EU governance structures.

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9 Negotiating justice in revenue recycling of U.S. cap-and-trade initiatives

This chapter is based on a co-authored manuscript currently under review:
Croon, T. M., & Hernández, D. (under review). The (re)distribution of carbon pricing revenues: Embedding equity provisions in U.S. state-level cap-and-trade schemes. *Climate Policy*.

ABSTRACT

Carbon pricing programmes increasingly promise not only emissions reductions but also more equitable distribution of climate policy benefits. This article examines how equity is embedded in the revenue recycling of three U.S. cap-and-trade schemes: New York's participation in Regional Greenhouse Gas Initiative (RGGI), a power-sector programme across northeastern states; California's AB 32 system, an economy-wide programme funding the Greenhouse Gas Reduction Fund; and Washington's Climate Commitment Act, a recently adopted economy-wide cap-and-invest programme with explicit equity mandates. Using the Environmental Justice (EJ) framework – recognition, procedural, distributive, and restorative – we analyse legislative and administrative records, harmonised spending data, and 35 semi-structured interviews with policymakers, community representatives, and experts. We find convergence in form but divergence in substance. All three employ equity screening tools and statutory floors (at least 35% of investments to disadvantaged or overburdened communities, with an additional 10% for tribal governments in Washington), yet they differ markedly in how equity is operationalised. Key points of variation include the enforceability of benefit definitions, the degree of structured participation in investment decisions, the architecture protecting revenues from fiscal diversion, and the balance between universal and targeted spending. Their

trajectories also differ: New York retrofitted equity onto a technocratic model, California integrated it through conflict and codification, and Washington embedded equity by design. Recent political contestation, most notably the failed 2024 attempt to repeal Washington's scheme in a statewide referendum, suggests that programmes which prove durable share three traits: place-based benefits, institutionalised community authority, and spending patterns that are targeted to need while remaining legible to the wider public.

9.1 Introduction

Carbon pricing has moved from textbook model to governing practice, expanding globally over the past decade in response to escalating climate risks (Dobbeling-Hildebrandt et al., 2024). However, across these jurisdictions, political backlash over affordability concerns underscores a persistent tension: while cap-and-trade is widely regarded as a cost-effective mitigation tool, public resistance intensifies when it is perceived to exacerbate energy insecurity and leave pollution hotspots unaddressed (Douenne & Fabre, 2022; Hernández, 2013). In the U.S., environmental justice (EJ) critiques of cap-and-trade also focus on whether programmes address disparities in local co-pollutant exposure and give affected communities a meaningful role in policy design and oversight (Cushing et al., 2018; Klinsky, 2015; London et al., 2013).

Rather than revisiting the instrument-choice debate, this article centres on revenue recycling – the allocation of auction proceeds to households and public goods – as a key governance tool for better aligning cap-and-trade with environmental justice principles (Aldy & Stavins, 2012). We interpret revenue recycling decisions through an Environmental Justice (EJ) lens encompassing recognitional, procedural, distributive, and restorative dimensions (Schlosberg, 2007; Van Ness et al., 2022): asking who is prioritised and heard, how decisions are made and by whom, who benefits in the near term, and what historical or ongoing harms are addressed. Prior work argues for a practical pathway: strengthen these EJ dimensions and embed programme safeguards to bridge efficiency and equity (Kaswan, 2011); use auction revenues for compensatory investments unavailable under command-and-control (Stavins, 2008); and structure spending to local context to build durable public support (Raymond, 2019).

We examine three state-level programmes that now anchor U.S. practice yet follow distinct equity paths: New York's participation in the Regional Greenhouse Gas Initiative (RGGI), California's cap-and-trade under AB 32, and Washington's Climate Commitment Act (CCA). Despite a growing literature on carbon pricing distributional effects, we lack a comparative account of how equity provisions are operationalised in spending and what those choices imply for justice outcomes and political durability. We ask: (1) how do states define and identify disadvantaged or overburdened communities? (2) how are auction revenues allocated across sectors and geographies, and with what equity criteria? (3) what statutory and procedural mechanisms structure community authority, transparency, and accountability – and how do politics shape their use? The analysis draws on legislative and administrative documents, harmonised spending data, records of formal stakeholder consultations, and semi-structured interviews with policymakers, community representatives, and independent experts.

We find convergence in form but divergence in substance. New York retrofitted equity onto a technocratic foundation; California integrated equity through conflict and codification; Washington embedded equity by design though EJ oversight remains largely advisory. Across cases, the decisive levers are consistent: clear EJ screening tools, enforceable benefit definitions, budget rules that protect equity commitments, and structured community authority over investment decisions. Section 9.2 introduces the EJ framework and its application to revenue recycling; Section 9.3 outlines programme backgrounds; Section 9.4 details methods and data; Section 9.5 presents comparative findings; Section 9.6 discusses implications for designing carbon markets that cut emissions while advancing justice.

9.2 Justice in carbon pricing revenue recycling

Environmental justice (EJ) is commonly framed around three mutually reinforcing tenets: recognitional justice, procedural justice, and distributive justice (Schlosberg, 2007; Walker, 2012). Recognitional justice entails acknowledging that certain groups face greater environmental and social burdens, understanding the sources of these vulnerabilities, and respecting and valuing their experiences, identities, and contributions. Procedural justice emphasises fair, transparent, and inclusive decision-making processes that give affected communities a meaningful role in shaping environmental policies. Distributive justice concerns the equitable sharing of environmental benefits and the fair allocation of burdens across all communities. In climate governance, a fourth, increasingly emphasised tenet – restorative justice – focuses on repairing past and ongoing environmental and social harms by directing mitigation and adaptation investments towards returning resources, restoring ecosystems, addressing health impacts, and building long-term capacity in the communities most affected (Schlosberg & Collins, 2014; Van Ness et al., 2022). While this framework draws primarily on a political-theoretical strand of EJ scholarship, it overlaps substantially with wider environmental justice and energy justice literatures emphasising lived experience, power, and structural inequality.[74]

The uneven impacts of climate change bring EJ concerns to the forefront, as already disadvantaged communities that have contributed least to the problem, whether in the Global South or within industrialised nations, are often hit hardest by extreme weather, rising seas, and other climate harms (Morello Frosch et al., 2018). This 'climate gap' has fuelled calls to address climate change in tandem with social justice objectives. At the global level, distributive justice debates focus on how to share the burdens of emissions reduction and adaptation, as poorer countries, having contributed far less to the problem yet lacking the resources to meet either mitigation or adaptation costs, argue that wealthier, high-emitting nations should

74 Environmental justice scholarship encompasses multiple, partially overlapping traditions. The framework used here builds on political-theoretical work that systematizes justice claims into recognitional, procedural, distributive, and restorative dimensions (e.g., Schlosberg, 2007), and is widely applied in comparative policy analysis. It complements, rather than replaces, U.S. movement-based and public health-oriented EJ scholarship, particularly the work of Robert D. Bullard and others emphasising racialized exposure, community power, and civil rights (e.g., Bullard, 1990; Bullard et al., 2007; Wilson, 2009). It also aligns closely with energy justice scholarship, which similarly foregrounds recognition, participation, and distribution in energy systems (e.g., Hernández, 2015; Sovacool et al., 2016). This integrative framing enables comparative analysis of equity design in carbon pricing while remaining attentive to justice concerns rooted in lived experience and structural inequality.

shoulder a proportionally greater responsibility (Klinsky & Dowlatabadi, 2009). Intergenerational justice is also at stake, as choices made now will lock in climatic and social trajectories for future generations (Page, 1999; Schuppert, 2011).

Market-based climate policies like cap-and-trade, which sets an emissions cap and allows companies to trade pollution permits, have been criticised by EJ advocates for potentially conflicting with these principles. A key concern is distributive justice: such systems can create localized pollution 'hotspots' if facilities in already overburdened areas buy allowances rather than reduce their own emissions (Cushing et al., 2018). Without safeguards, nearby communities may see little air quality improvement even as overall GHG goals are met. Carbon pricing can also raise energy and fuel costs, disproportionately affecting lower-income households unless revenues or rebates offset the burden (Hernández & Laird, 2025; Metcalf & Weisbach, 2009). Procedural gaps are common, as affected communities often have limited influence over market design (Page, 2012). Some also object on ethical grounds, arguing that treating clean air and the atmosphere as tradeable commodities 'commodifies nature' and fails to respect its intrinsic value (Caney, 2010). In summary, left unchecked, a cap-and-trade system might achieve cost-efficient carbon reductions on paper while undermining environmental justice on the ground.

Despite these challenges, many scholars and policymakers argue that it is both possible and necessary to reconcile cap-and-trade with environmental justice. Rather than abandon market mechanisms, they call for targeted design adjustments to align them with justice tenets (Kaswan, 2011). For example, hybrid policy approaches that combine cap-and-trade with direct regulations can limit unintended impacts, while restricting or eliminating offsets, which may bypass local air quality improvements, helps ensure that emission reductions occur where they are most needed (Carlson, 2012; Fischer, 2003). Such measures aim to prevent pollution shifting.

Another key strategy is equitable revenue use. Cap-and-trade auctions can generate substantial public revenue, and directing those funds towards disadvantaged areas can transform the programme into an instrument for advancing environmental justice. Stavins (2008) argues that this feature gives cap-and-trade greater justice potential than command-and-control regulation, as its lower cost burden can be paired with compensatory investments funded by auction proceeds, an option unavailable under most traditional regulatory approaches. Building on this, Moghavem (2018) frames revenue allocation as a vehicle for Rawlsian justice, emphasising targeted investments in climate resilience, housing, and public health. Raymond (2019) further contends that auction revenue spending is not only a mechanism for delivering equity outcomes but also a political strategy to bolster and sustain public support for carbon pricing. One proposed approach is the cap-and-dividend model, which returns permit revenues to citizens as equal per-capita payments (Boyce, 2018). Yet, while often praised for progressive distributional outcomes and political appeal, universal rebates do little to strengthen mitigation efforts, and their long-term impact on support is limited, with low awareness and partisan identity reducing their influence (Mildenberger et al., 2022). Therefore, others argue that revenues have greater impact when used to 'cushion' the regressive effects of higher prices on vulnerable groups, or, better still, to invest in green solutions that build resilience and opportunity in the communities that need it most (Carattini et al., 2019; Muth, 2024; Woerner et al., 2024).

Equitable outcomes require not only fair distribution of benefits but also transparent rules, accountable processes, and meaningful community participation. Clear reporting requirements, accessible public information, and well-designed feedback channels help ensure that decision-makers remain answerable to affected communities and that policy impacts can be monitored and adjusted in real time (Fung, 2015; Newig et al., 2018). Equally important is giving EJ communities a genuine seat at the table in programme design, oversight, and implementation. Involving community representatives brings essential local knowledge and priorities, such as identifying pollution hot spots or setting criteria for project funding, that can shape more responsive and effective policies (Dobbin & Lubell, 2021). These procedural justice measures strengthen legitimacy and build trust: policies developed with communities, rather than for them, are far more likely to deliver equitable outcomes and sustain public support (Clark, 2018; Tyler, 2006).

However, ensuring that revenues are directed to EJ communities, and that local residents are meaningfully involved in governance, first requires recognitional justice: accurately identifying who these communities are and valuing their lived experiences (van Uffelen, 2022). This identification must go beyond narrow income metrics to incorporate a diverse set of multidimensional indicators, such as cumulative pollution burdens, climate vulnerability, health disparities, and socio-economic marginalisation (Cohen et al., 2023). Critically, these metrics should be co-designed with the communities themselves to reflect their own understandings of vulnerability and resilience (Whyte, 2018). Only when all voices and experiences are equally acknowledged can procedural and distributive measures achieve their intended outcomes, ensuring that carbon pricing revenue recycling both addresses historic inequities and supports transformative, community-driven climate solutions.

In sum, environmental justice principles offer a useful framework for analysing and refining cap-and-trade systems. Table 9.1 summarises applied lessons for incorporating EJ considerations into carbon pricing, from equitable revenue recycling to inclusive governance. Embedding such design features can enable carbon markets to achieve emissions reductions while also addressing distributional concerns, enhancing public trust, and generating health and resilience co-benefits (Boyce, 2018). The evolution of climate policy illustrates that 'bending the carbon curve' and 'closing the equity gap' are interconnected objectives (Morello Frosch et al., 2018).

TABLE 9.1 Operationalising environmental justice principles in carbon pricing revenue recycling

	Recognition justice	Procedural justice	Distributive justice	Restorative justice
Principles and objectives	Acknowledge intersectional and cumulative disadvantage	Commit to transparency and public accountability	Prioritise frontline communities	Commit to repair of historical environmental and racial injustices
Targeting and co-design mechanisms	Use indicators to identify frontline communities	Provide structured opportunities for meaningful community participation	Apply geographic targeting based on exposure, vulnerability, and need	Enable community ownership and self-determination
Delivery and accountability	Respect community-defined needs and values in programme design	Maintain accessible channels for feedback, appeal, and adaptive revision	Balance allocations across essential sectors with clear eligibility rules	Invest for intergenerational equity and long-term resilience

9.3 Background

Cap-and-trade programmes in the U.S. have developed primarily at the state level, emerging in the mid-2000s in response to stalled federal climate action and deepening political polarisation (Bang et al., 2017). While California and the Regional Greenhouse Gas Initiative (RGGI) were the first to operationalise such programmes, Washington's Climate Commitment Act (CCA), which launched in 2023, represents a newer generation and features more explicit statutory equity provisions. Table 9.2 summarises key design features across the three programmes.

The Regional Greenhouse Gas Initiative (RGGI) began with a 2005 memorandum of understanding among Northeastern and Mid-Atlantic states and entered compliance in January 2009, placing a CO_2 cap on fossil-fuel power plants larger than 25 MW (Yan, 2021). The current design, set by the 2017 Model Rule, targets a 30 percent reduction in power-sector emissions below the 2020 cap by 2030. Auction proceeds fund energy efficiency, renewable energy, and other consumer-benefit programmes, with at least 25 percent allocated to 'consumer benefit' or 'strategic energy purpose' (Holliman & Collins, 2023). Several states, including New York, auction nearly all allowances (Ruth et al., 2008). In New York, early use of RGGI revenues lacked statutory equity requirements, a gap addressed with the Climate Leadership and

Community Protection Act (CLCPA) in 2019, which introduced binding emissions targets and equity spending floors (Salter, 2023). This combination of long-standing programme participation and newly embedded equity mandates, along with the state's detailed investment reporting, makes New York a particularly strong lens for examining how equity provisions shape cap-and-trade implementation. Accordingly, it serves here as the representative RGGI case for comparison with California and Washington.

California's cap-and-trade programme was created around the same time under the Global Warming Solutions Act of 2006 (AB 32), committing the state to return to 1990-level greenhouse gas (GHG) emissions by 2020 and authorising market-based mechanisms (Holliman & Collins, 2023). Operational since 2013, the programme sets a declining emissions cap across electricity, industry, transportation fuels, and natural gas suppliers. A substantial portion of auction revenue – around 40 percent in recent years – funds the California Climate Credit, a semi-annual utility rebate administered by the California Public Utilities Commission (CPUC), while the remainder goes to the Greenhouse Gas Reduction Fund (GGRF). Continuous appropriations established by Senate Bill 862 (2014) earmark fixed shares for high-speed rail, affordable housing, and transit projects. Since its launch, California has raised more than $30 billion, and cap-and-trade has evolved into a central fiscal tool for advancing the state's broader climate and social objectives (Bang et al., 2017).

Finally, Washington's Climate Commitment Act (CCA), signed in 2021 after years of failed carbon-pricing efforts, including two high-profile ballot initiatives (Artime et al., 2025), was passed alongside the Healthy Environment for All (HEAL) Act. It embeds some of the strongest statutory equity provisions in U.S. climate policy, requiring that at least 35 percent of investments benefit overburdened communities and 10 percent support tribal-led projects. Unlike California's universal Climate Credit, Washington provides targeted affordability relief through the Families Clean Energy Credit, a one-time utility rebate for low- and moderate-income households. It also differs in its fiscal architecture: most allocations are made through discretionary legislative appropriations rather than fixed statutory earmarks, allowing greater annual flexibility but less guaranteed continuity for specific programmes. Revenues are administered primarily by the Department of Ecology through three accounts: the Climate Commitment Account, the Carbon Emissions Reduction Account, and the Natural Climate Solutions Account, which fund clean transportation, building decarbonisation, and ecological restoration.[75] In 2024, a repeal measure (Initiative 2117) was decisively rejected by voters, preserving the programme.

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75 The Climate Commitment Account funds cross-sector programmes including infrastructure and resilience; the Carbon Emissions Reduction Account supports emissions reduction in buildings, transport, and industry; and the Natural Climate Solutions Account focuses on forest health, wetlands, and land-based carbon sequestration.

TABLE 9.2 Comparative overview of design and implementation features of U.S. state-level cap-and-trade programmes

	New York (RGGI)	California (AB 32)	Washington (CCA)
Year operation-alised	2009	2013 *	2023
Legal authority	RGGI MoU (multi-state)**; Climate Leadership and Community Protection Act (CLCPA, 2019)	AB 32, Health & Safety Code §39719	Climate Commitment Act (CCA); HEAL Act
Sectoral coverage	Power generation only (14% of emissions)	Agriculture, transport, buildings, industry, power, extractives, forestry (76% of emissions)	Transport, buildings, industry, power, extractives (71% of emissions)
Carbon price (ICAP, average Jan 23-Jul 25)	\$20.28 per MtCO_2e	\$34.36 per MtCO_2e	\$53.10 per MtCO_2e
Administering agencies	New York State Energy Research and Development Authority (NYSERDA), Dept. of Environmental Conservation (DEC)	California Air Resources Board (CARB), Public Utilities Commission (CPUC), Greenhouse Gas Reduction Fund (GGRF)	Dept. of Ecology (DoE), Office of Financial Management (OFM)
Annual appropriations (FY24-25)	\$437 million	\$6 billion	\$2.3 billion (half of 23–25 biennium)
Revenue allocation	Centralised grants for energy efficiency and clean energy via NYSERDA; no rebates	70+ GGRF programmes; universal utility rebate (Climate Credit via CPUC)	3 statutory accounts; targeted rebate (Families Clean Energy Credit)
Equity spending floor	≥35% must benefit disadvantaged communities (DACs)	≥35% must benefit DACs *and* be located within them	≥35% must benefit overburdened communities + 10% to Tribes
Equity screening tool	Disadvantaged Communities Criteria	CalEnviroScreen 4.0	Environmental Health Disparities (EHD) Map
Statutory oversight	Climate Justice Working Group (CJWG)	Environmental Justice Advisory Committee (EJAC)	Environmental Justice Council; tribal consultation

** Although California's Cap and Trade programme officially launched in 2013, its framework was established in 2006 by the Global Warming Solutions Act (AB 32). Between 2006 and 2012, the California Air Resources Board (CARB) developed programme rules, set emissions caps, and initiated early action credits.*

*** RGGI member states include Connecticut (CT), Delaware (DE), Maine (ME), Maryland (MD), Massachusetts (MA), New Hampshire (NH), New Jersey (NJ), New York (NY), Rhode Island (RI), Vermont (VT), and Virginia (VA). Pennsylvania (PA) has considered joining but faces ongoing legal and political barriers.*

These differences in scope, statutory design, and equity mandates inform both the kinds of investments made and the ways in which equity is operationalised. The following section outlines the data sources, coding strategies, and analytical framework used to examine these dynamics across the three cases.

9.4 Methods

This study employs a qualitative, comparative design to understand how equity provisions are designed and implemented across three U.S. state-level cap-and-trade programmes: New York's participation in the Regional Greenhouse Gas Initiative (RGGI), California's cap-and-trade under AB 32, and Washington's Climate Commitment Act (CCA). Within RGGI, New York was selected for in-depth analysis due to its early adoption, the integration of binding equity requirements through the CLCPA, and the availability of comprehensive investment data. Oregon's Climate Protection Program (CPP), reinstated in late 2024 and launched in January 2025, was excluded due to its very recent rollout and the absence of mature revenue allocation or equity reporting.

The analysis draws on two main sources of evidence: 1) systematic review of policy and programme documents, and 2) semi-structured interviews with actors directly involved in, or affected by, the programmes.

Document Analysis

Document collection began with primary legislative and regulatory texts, including California's AB 32 and amendments, Washington's SB 5126 and the HEAL Act, and the RGGI Memorandum of Understanding and subsequent model rule revisions, alongside state-specific statutes such as New York's Climate Leadership and Community Protection Act (CLCPA). Administrative materials from implementing agencies, such as investment plans, auction reports, and annual evaluations, were reviewed alongside technical documentation for the three equity-screening tools (summarised in Appendix 20).

State-reported spending data were extracted from budgetary and programme reports and reclassified into a common set of categories (e.g., utility bill credits; transit and mobility; building decarbonisation; zero-emission vehicle deployment; nature-based solutions; workforce development and research; and administration or fund transfers) to enable cross-case comparison. Decisions in cases of divergent reporting formats were documented in an audit trail to ensure transparency and replicability (Carcary, 2020), and the harmonised dataset is presented in Appendix 21.

To capture debates and perspectives not reflected in official documentation, the evidence base was expanded to include public hearing records, workshop proceedings, written stakeholder submissions; position statements from community-based organisations, tribal governments, environmental groups, and industry associations; and coverage in reputable news media that documented political developments, stakeholder responses, and public discourse. Independent evaluations, academic studies, and NGO reports provided further context and enabled triangulation of official claims.

Semi-Structured Interviews

The second main source of evidence comprised approximately thirty-five semi-structured interviews: twenty-five from a broader project on state climate finance and ten conducted specifically for this substudy. The latter ten were purposively sampled to capture perspectives from government officials involved in programme design and administration (four interviews), community and EJ advocates (three interviews), and researchers and other subject-matter experts (three interviews). Interviews, which lasted between 45-90 minutes, followed a semi-structured guide aligned with the study's thematic focus on targeting tools, revenue allocation, equity provisions, and governance processes. With informed consent, sessions were recorded, transcribed, anonymised where requested, and coded in ATLAS.ti using the same framework as the documents to facilitate triangulation (Denzin, 2012). A subset of transcripts and documents was double-coded to check consistency; discrepancies informed refinements to code definitions (Campbell et al., 2013).

The design prioritises detailed, context-rich analysis within a small number of cases over a broader but more superficial survey. As with most qualitative designs, this approach entails limitations, including uneven administrative reporting across states, potential informant bias, and the evolving nature of the programmes. These were mitigated through systematic triangulation of sources, a transparent harmonisation protocol for spending categories, and process tracing of stakeholder engagement to connect official narratives with observed practices (Bennett & Checkel, 2015; Hoefer, 2011).

Analysis was guided by themes corresponding to the study's research focus: (1) criteria and tools for defining disadvantaged or overburdened communities; (2) revenue allocation patterns across spending categories; (3) statutory and procedural mechanisms for ensuring equity; and (4) political and institutional dynamics shaping implementation. Using ATLAS.ti, a mixed deductive-inductive coding process began with an initial codebook derived from these themes, aligned with the four justice tenets introduced in Table 9.1 – recognition (problem framing and identification of affected groups), procedural (participation rules and governance structures), distributive (targeting rules and spending flows), and restorative (measures addressing historic harms) – and was refined iteratively to capture emergent patterns such as tensions between geographic benefit and direct expenditure or the role of administrative burden in shaping access to funds (Fereday & Muir-Cochrane, 2006).

9.5 Findings

This section presents the empirical findings of the comparative analysis of three U.S. state-level cap-and-trade programmes. It first provides an overview of core programme features, specifically how disadvantaged or overburdened communities are defined and how revenues are allocated, before turning to an environmental justice analysis of how equity commitments are institutionalised, contested, and implemented in practice.

9.5.1 Defining disadvantage

A first and foundational equity decision across all three programmes concerns how disadvantaged or overburdened communities are identified for the purpose of targeting cap-and-trade revenues. While New York, California, and Washington all rely on composite screening tools that combine environmental and socio-economic indicators, they differ markedly in the weighting and conceptual logic underpinning these frameworks.

Figure 9.1 compares the screening frameworks used to determine which census tracts qualify under each state's statutory equity mandate. New York's *Disadvantaged Communities Criteria* (2023) balance environmental, social, and climate risk factors, uniquely including projected flood and heat exposure alongside redlining, racial demographics, and housing inequities. California's *CalEnviroScreen 4.0* (2021) follows a cumulative-exposure logic: pollution and health vulnerability make up over half the score. Proposition 209 bars explicit use of race or ethnicity, so it relies on indicators based on sensitive populations and socioeconomic factors along with environmental exposures to determine disproportionate burden. Washington's *Environmental Health Disparities Map* (2023) assigns two-thirds of its score to pollution exposure, hazardous site proximity, and health outcomes, giving less weight to socio-economic indicators; compared to New York and California, it foregrounds environmental harms over structural disadvantage.

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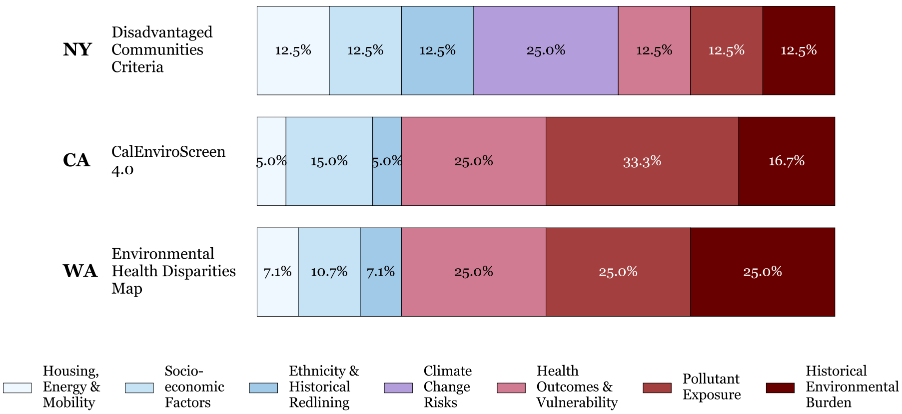

FIG. 9.1 Author's categorisation of indicator weightings in disadvantaged-community screening tools for New York, California, and Washington; underlying indicators and sources in Appendix 20

9.5.2 Revenue allocation patterns

Although all three programmes have statutory equity targets, investment priorities differ sharply. Figure 9.2 compares how revenues are spent across major spending categories, combining recent annual allocations with cumulative spending where available.

In New York, NYSERDA has historically directed RGGI proceeds towards clean energy and building decarbonisation, reflecting the programme's power-sector scope. Since the CLCPA (2019), nearly two-thirds of funds have supported initiatives like NY-Sun and Renewable Heat NY, with recent growth in EV incentives such as the Drive Clean Rebate. Workforce development programmes (e.g., Green Jobs – Green New York) remain significant. Administrative costs are relatively high due to transfers to the general fund and overhead, while spending on resilience, transit, or affordable housing is minimal, and no funds have supported utility bill assistance.

In California, a large share of proceeds funds the universal California Climate Credit, a semi-annual utility rebate (~$200/year for dual-service households). The remainder flows through the Greenhouse Gas Reduction Fund (GGRF), governed by earmarks including 40 percent for transit and 20 percent for affordable housing. These have financed major public transport, high-speed rail, and housing projects, as well as zero-emission vehicle deployment and climate resilience via CAL FIRE. Building decarbonisation plays a smaller role than in New York. Administrative costs are low, and – until recently – revenues were not used to offset general budget gaps; Governor Newsom's 2025-26 proposal to reallocate $1.5 billion to CAL FIRE marks a potential shift.

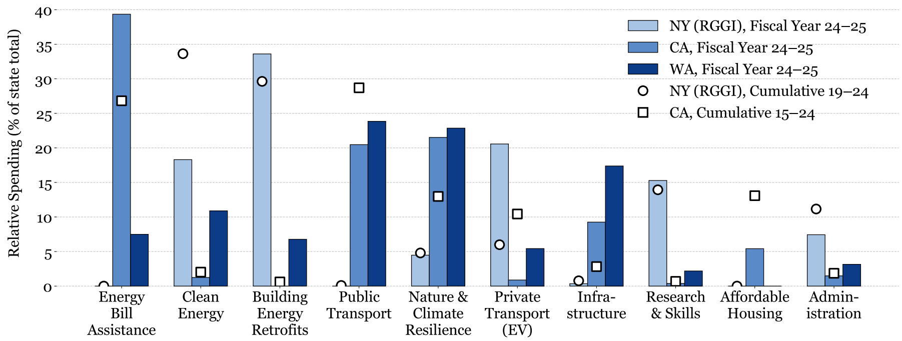

FIG. 9.2 Relative allocation of cap-and-trade revenues by category in New York, California, and Washington, with bars for Fiscal Year 2024-2025 and markers for cumulative totals since 2015 (CA) and 2019 (NY); see Appendix 21 for sources and underlying dollar amounts

The Fiscal Year 2024-25 spans July 2024-June 2025 (CA/WA) and April 2024-March 2025 (NY). The cumulative totals cover 2015-2024 (CA) and 2019-2024 (NY), Washington is only in its first biennium. Statutory earmarks direct 40% of GGRF revenues to transit and 20% to affordable housing. These proportions appear lower in Figure 9.2 due to the inclusion of non-GGRF spending (notably the California Climate Credit) and timing-related variation in annual GGRF disbursements, including funds that are delayed, withheld, or reallocated.

In Washington, CCA revenues flow through three accounts: the Carbon Emissions Reduction Account, Climate Commitment Account, and Natural Climate Solutions Account. Early spending emphasises public transport electrification, zero-emission vehicles, and infrastructure upgrades, including the $46.6 million all-electric Kitsap Transit ferry. The state has no universal rebate but earmarks over $200 million for targeted affordability and decarbonisation measures, including the $150 million Families Clean Energy Credit for low- and moderate-income households. The NCSA funds forest health, wetland restoration, and tribal climate resilience. Administrative costs are modest, and statutory rules restrict non-climate transfers.

9.5.3 Equity governance mechanisms

Beyond differences in targeting tools and spending patterns, the three programmes have converged on a broadly similar set of equity governance mechanisms. The key differences are more about their institutional strength: where authority is located (advisory versus binding), how 'benefit' is defined and verified, and whether accountability is anchored in enforceable geographic constraints or more flexible programmatic interpretations. Table 9.3 summarises these arrangements.

TABLE 9.3 Relative allocation of cap-and-trade revenues by category in New York, California, and Washington, with bars for Fiscal Year 2024-2025 and markers for cumulative totals since 2015 (CA) and 2019 (NY); see Appendix 21 for sources and underlying dollar amounts

	New York (RGGI)	California (AB 32)	Washington (CCA)
Recognitional (Defining & prioritising disadvantaged groups)	• Initially no EJ targeting • CLCPA (2019) created community-led process (CJWG) to define 'disadvantaged communities' using environmental, social, and climate-risk indicators	• EJ concerns initially marginalised; early breakdown of advisory structure triggered reform • CalEnviroScreen (2013) developed to identify high-burden, cumulative-impact communities for statutory investment targeting	• Embedded from the outset through HEAL Act • EHD Map defines overburdened communities • Tribal nations recognised separately from census-based screening
Procedural (Participation & decision-making structures)	• Historically technocratic, expert-driven governance with limited community input • CJWG holds formal authority over criteria-setting, but limited influence over investment decisions	• Conflict-driven reforms strengthened procedural inclusion • Environmental Justice Advisory Committee and community-led programmes (e.g. Transformative Climate Communities) institutionalise participation beyond consultation	• Environmental Justice Council and formal tribal consultation embedded in statute • Accelerated implementation timeline concentrated decision-making authority within agencies despite advisory structures
Distributive (Allocation of benefits* & burdens)	• ≥35% of climate investments must benefit disadvantaged communities • No binding requirement for expenditures to be geographically located within those communities • Equity delivered primarily through programme design rather than place-based spending	• ≥35% of investments must be both located in and benefit disadvantaged communities • Clear, enforceable geographic equity constraint strengthens distributive accountability • Parallel universal rebate track operates outside equity accounting, diluting overall progressivity	• Strongest statutory allocation: ≥35% to overburdened communities plus 10% tribal set-aside • Discretionary budgeting enables rapid deployment but reduces predictability and long-term equity guarantees • Targeted low-income energy bill rebate improves progressivity
Restorative (Addressing past injustices & harm)	• No explicit restorative initiatives to date; equity focus mainly forward-looking	• Partial restorative logic through place-based, community-defined investments, though no formal reparative mandate	• Tribal funding reflects partial restorative intent • Most investments focus on future adaptation rather than repair of historical harms

** Benefit' is defined statutorily and does not always imply in situ expenditure*

All three states formally recognise disadvantaged or overburdened communities, though the timing, scope, and authority of this recognition differ. In New York, equity targeting was introduced through the Climate Leadership and Community Protection Act (2019), which established the Climate Justice Working Group to define disadvantaged communities. Interviewees emphasised that the Working Group held genuine deliberative authority over criteria-setting, though this authority has not extended to investment decisions. In California, recognition emerged earlier and more contentiously, culminating in the statutory adoption of CalEnviroScreen following the resignation of the first Environmental Justice Advisory Committee and subsequent litigation over cumulative pollution impacts. Washington embedded recognitional equity from the outset through the HEAL Act and the Environmental Health Disparities Map, while also recognising tribal nations separately from census-based screening.

Procedural equity mechanisms likewise differ in strength. New York's governance remains largely agency-centred, with limited opportunities for communities to shape investment decisions beyond eligibility definition, and interviewees highlighted administrative barriers that often require community-based organisations to rely on intermediaries. California has gone furthest in institutionalising participation beyond consultation, most notably through the Transformative Climate Communities programme, which requires community-developed investment plans. However, interviewees also noted that procedural and administrative complexity across more than 70 programmes can privilege well-resourced applicants. Washington embeds procedural equity through statutory advisory bodies and formal tribal consultation, though these bodies have limited binding authority.

Distributive equity is anchored in statutory spending floors across all three programmes, but legal definitions vary. New York requires that at least 35 percent of investments deliver benefits to disadvantaged communities without a binding geographic requirement, allowing indirect or programmatic benefits to qualify. California applies a stricter standard, requiring projects to be both located in and demonstrably beneficial to disadvantaged communities. Washington combines a 35 percent allocation to overburdened communities with an additional 10 percent tribal set-aside, while relying more heavily on discretionary budgeting.

Across cases, restorative justice remains the least explicitly operationalised dimension, with equity provisions oriented primarily towards forward-looking mitigation and adaptation rather than repair of historic harms.

9.5.4 Political and institutional dynamics

Although the three programmes now rely on broadly similar equity governance mechanisms, their implementation trajectories diverge in ways that reflect distinct political histories, institutional legacies, and coalition dynamics. Interviewees consistently emphasised that equity outcomes are shaped not only by statutory design but by how governance arrangements are contested, sequenced, and defended under political and administrative pressure.

A first source of divergence lies in sequencing and institutional legacy. In New York, equity provisions were layered onto a cap-and-trade scheme originally designed as a technocratic instrument for cost-effective emissions reductions in the power sector. As a result, equity objectives had to be reconciled with established administrative routines, budgetary practices, and performance metrics that were not designed to deliver place-based or participatory outcomes. Interviewees described this as producing a persistent tension between new equity mandates and legacy programme logics, with equity often competing against long-standing efficiency and decarbonisation priorities. Support within the environmental justice community has therefore remained partial and conditional: some organisations endorse the programme only subject to stringent safeguards, such as banning allowance trading in overburdened areas and requiring that funds be spent within disadvantaged communities in ways that directly benefit local residents, while others reject carbon trading altogether, doubting the state's capacity to deliver on equity promises.

California followed a different pathway. While its cap-and-trade programme also began without robust equity safeguards, sustained contestation by environmental justice organisations prompted successive institutional reforms that gradually embedded equity into programme rules, advisory structures, and funding criteria. These reforms – most notably CalEnviroScreen, statutory geographic requirements, and programmes such as Transformative Climate Communities (TCC), described by interviewees as *"real power-sharing, not just consultation"* – have positioned California as a reference point for federal equity initiatives. Washington represents a third model: equity mandates were incorporated at the point of programme creation, drawing explicitly on lessons from earlier state experiences and from failed carbon-pricing initiatives. This front-loaded design enabled strong statutory commitments but compressed implementation timelines, limiting the extent to which participatory bodies could shape early investment decisions.

Political contestation and coalition-building further shaped how equity provisions were interpreted and defended. In California, early exclusion of environmental justice actors culminated in the resignation of the first Environmental Justice Advisory Committee and litigation against CARB over failure to assess cumulative co-pollutant impacts.

Interviewees consistently framed these conflicts as pivotal, triggering reforms that strengthened procedural inclusion and narrowed redistributive discretion through enforceable geographic requirements. In New York, equity reforms emerged through a more incremental process driven by sustained advocacy and broader climate mobilisation around the CLCPA. Yet disagreement persists over what constitutes a meaningful 'benefit'. Interviewees noted ongoing disputes over whether reductions in pollution outside a community qualify as equity if exposure falls locally, or whether spending within a community without delivering jobs, services, or ownership can meaningfully advance justice. Advocates repeatedly stressed that spending without participatory inclusion does not automatically yield equity, calling instead for in situ investment through mutual aid, cooperatives, land trusts, and other structures viewed as *"naturally more participatory"*. Washington's experience underscores the importance of coalition politics: the CCA was advanced by a broad alliance of EJ organisations, tribal governments, labour unions, and progressive lawmakers, whose coordinated support proved decisive not only in passing the legislation but also in defending it against repeal.

Administrative capacity and implementation constraints mediate how statutory equity commitments translate into practice. California's climate finance architecture is expansive but fragmented, spanning dozens of agencies and more than 70 programmes. While this scale enables large and diverse investments, interviewees emphasised that it also generates complex application and reporting requirements that tend to privilege well-resourced actors. Smaller community-based organisations frequently rely on intermediaries or professional consultants to access funds, potentially diluting participatory intent. New York's more centralised administration through NYSERDA reduces fragmentation but reinforces legacy programme priorities, with equity objectives filtered through established administrative frameworks. Washington's model emphasises administrative simplicity and early disbursement, with centralised authority and upfront funding intended to lower barriers to participation; however, interviewees noted that the accelerated rollout – agencies had roughly 18 months to establish auctions, define investment criteria, and begin disbursing funds – concentrated decision-making power within agencies and limited the early influence of advisory bodies.

Differences in budget architecture and fiscal protection further shape equity durability. California relies heavily on statutory earmarks that provide multi-year funding certainty for large programmes such as transit and affordable housing but reduce flexibility to respond to evolving community priorities. As one interviewee noted, the process is skewed towards *"owner-class"* beneficiaries, as many programmes prioritise decarbonisation of large-scale sectors such as industrial facilities and freight fleets, yet another emphasised their near-term economic spillovers:

"While the project itself won't be operational for a while, there's a lot of stuff going into it now that's providing a benefit to the community – the workers, the small businesses in that area that those workers are frequenting. It's a trickle effect in that community."

At the same time, equity integration is weakest in the California Climate Credit, a universal utility rebate that operates outside CARB's coordinated equity tracking. Providing roughly $200 annually per household regardless of need, it offers modest relief around utility bills but limited protection against energy insecurity and remains excluded from statutory equity accounting. As one official put it, it is *"helpful, but not particularly meaningful or targeted"*. Interviewees also flagged recent proposals to repurpose cap-and-trade revenues towards broader budget priorities as evidence that climate revenues remain vulnerable to fiscal reallocation, raising concerns about the long-term credibility of equity commitments. Similar concerns were raised in New York, where RGGI revenues have historically been subject to transfers to the general budget.

Washington's Climate Commitment Act faced the most direct fiscal challenge: a 2023 ballot initiative sought to repeal the programme entirely. Interviewees emphasised that statutory protections alone proved insufficient; political survival depended on making equity investments visible and locally salient. In the months leading up to the vote on Initiative 2117, supporters deliberately reframed the programme around immediate, place-based benefits, particularly improvements in air quality, job creation, and transit upgrades. As one official recalled:

"We had to show people that these funds weren't just disappearing into bureaucracy – that they were doing real work, right in their neighbourhoods."

This strategy proved critical to defeating the initiative and preserving the program, illustrating that the political durability of equity-oriented climate policy may hinge less on formal targets than on communities' lived experience of benefit or loss.

At the same time, interviewees cautioned that exceeding statutory equity thresholds does not automatically translate into substantive improvements for frontline communities. In Washington, early disbursements surpassed minimum allocation requirements, yet stakeholders questioned whether investments sufficiently addressed pressing needs such as building energy retrofits with direct affordability co-benefits. Several pointed to high-profile infrastructure projects whose emissions reductions are clear but whose relevance to overburdened communities is less direct. As one interviewee asked, *"Should those funds maybe come from other revenue streams – not those specifically dedicated to climate or frontline communities?"*

These reflections underscore that even where distributive targets are met, disagreements persist over the appropriate use of equity-designated funds and the balance between system-level decarbonisation and place-based community benefit. Equity delivery is therefore shaped by how governance mechanisms are activated, defended, and adapted under political pressure. These variations help explain why programmes that appear similar on paper generate divergent equity outcomes in practice, a pattern examined further in the Discussion.

9.6 Discussion

Equity provisions across the three programmes followed markedly different trajectories: retrofitted in New York, conflict-driven in California, and design-embedded in Washington. These trajectories reflect differences in historical formation, governance culture, statutory design, and the mobilisation of advocacy networks, factors repeatedly identified in the literature as decisive for whether equity commitments are institutionalised in market-based programmes (Kaswan, 2011; Raymond, 2019). In New York, a technocratic architecture persisted for years before state climate legislation mandated equity provisions and created a community-led body to define disadvantaged communities; in California, the early exclusion of EJ actors triggered sustained conflict that ultimately produced binding distributive rules and the development of CalEnviroScreen; in Washington, equity was incorporated directly into the enabling statute from the outset, including a tribal set-aside, but oversight largely remained advisory. While all three now deploy screening tools and spending floors, institutional legacies continue to shape implementation, producing convergence in form yet divergence in substance (Aldy & Stavins, 2012).

Targeting rules determine who gains from cap-and-trade revenues and how those gains are distributed, as the design of indicators, statutory equity earmarks, and legally defined criteria for what qualifies as a ‘benefit’ embed normative interpretations of equity directly into administrative practice (Boyce et al., 2023; Klinsky, 2015). Since each programme earmarks 35-45% of investments for disadvantaged or overburdened communities, the weighting of indicators is not merely technical: it determines which communities qualify for these statutory allocations and, in turn, shapes the portfolio of funded projects. New York’s screening tool elevates social indicators and forward-looking climate risk, while California and Washington’s exposure-heavy tools privilege cumulative environmental burdens, producing distinct geographic and demographic investment patterns. California's dual requirement that projects be both located in and demonstrably beneficial to such communities has sharpened accountability, underscoring how small definitional choices can have far-reaching distributional effects (Cuéllar, 2012). Nonetheless, most EJ advocates consider current statutory floors insufficient to remedy entrenched disparities, framing them as a starting point in a sequencing strategy towards higher equity allocations (Pahle et al., 2018). Across the cases, higher climate ambition coincided with stronger equity provision, which appears driven by both political necessity, as deeper decarbonisation requires broader coalitions, and by fiscal capacity, as larger auction revenues expand the scope for targeted redistribution and visible local benefits.

As targeting rules diverge, so too do spending patterns, with resulting allocations prompting questions about their alignment with stated equity goals. In New York, RGGI revenues have largely supported building retrofits and private transport incentives, reflecting the programme's focus on the power sector but directing most benefits to higher-income households able to meet co-financing requirements, thereby sidelining the co-benefits and place-based investments central to EJ frameworks (Caulfield et al., 2022; Parry et al., 2015). California began in 2025 to divert climate revenues to plug budget gaps, a practice widely criticised for eroding trust in carbon pricing and climate policy (Muth, 2024; Woerner et al., 2024). The state also directs roughly 40 percent of auction proceeds to a universal Climate Credit, which is salient yet weakly targeted and fails to address underlying energy cost burdens (Smith et al., 2024). Washington favours targeted affordability relief through the Families Clean Energy Credit, producing more immediate distributive effects, yet could amplify its equity impact by reallocating a greater share of funds towards structurally addressing energy insecurity rather than concentrating heavily on high-cost infrastructure such as ferry electrification. This applies to many of the investments financed in all three programmes. Fire prevention, forest management, or large infrastructural projects would arguably be better funded through general taxation, allowing carbon revenues to be focused on community-driven investments with direct and measurable climate and equity impacts, thereby strengthening confidence in the integrity of these programmes (Klenert et al., 2018).

The analysis reveals recurring tensions among the tenets of climate justice. Recognition without decision-making authority risks producing tokenism, as illustrated by the early resignation of California's EJAC when its role was relegated to the margins, and by the largely advisory remit of Washington's Environmental Justice Council. Procedural rigor, while essential for transparency, can undercut distributive aims when reporting demands exceed the capacity of community-based organisations, channelling funds towards larger, better-resourced actors; remedies include simplified application processes, upfront planning grants, and funded technical-assistance hubs (Colenbrander et al., 2017). Distributive and restorative objectives can also come into conflict, as long-horizon infrastructure investments such as high-speed rail advance intergenerational equity but yield little immediate relief to overburdened communities. The trade-off between flexibility and durability is equally salient: statutory earmarks for public transport or affordable housing can preserve commitments through political and fiscal cycles, yet flexible appropriations enable responsiveness to evolving needs (Camacho & Glicksman, 2016). Finally, recognition frameworks that under-weight structural drivers risk addressing symptoms rather than causes, limiting restorative potential to mitigation of current exposures rather than transformation of the underlying inequities (Lewis et al., 2021; Smith et al., 2022).

The limits of restorative justice are apparent across the three cases. Even at their peak, carbon pricing revenues are modest relative to the scale of historic harms such as tribal displacement, concentrated environmental hazards, entrenched health disparities, or racialized wealth gaps. These funds are not inconsequential, but they cannot, on their own, repair deep structural damage. Their potential is maximized when paired with complementary instruments: redistributive policies outside the carbon finance sphere, such as fairer wealth taxation; ownership and labour measures, including community land trusts and stronger worker power in clean-energy supply chains; and sovereignty-affirming tools for tribes and frontline communities, from co-management arrangements to long-term operational funding (Carattini et al., 2019; Gough, 2021; Ranco et al., 2011). Absent these, cap-and-trade dollars will primarily offset harm rather than restore equity.

Control over agenda-setting power shapes which distributive and restorative choices are even considered. In all three cases, these powers were forged through sustained interaction between advocacy networks, agency staff, and political allies – a dynamic consistent with the 'advocacy coalition framework', where long-term coordination shifts the boundaries of what is politically and administratively possible (Gabehart et al., 2022; Sabatier, 1988). California most clearly illustrates this, as persistent contestation between EJ coalitions and state agencies reframed the definition of legitimate 'climate investments' and secured binding statutory rules. New York reflects a more incremental version, with coalition influence layered onto a technocratic foundation via the CLCPA, while Washington's design, though informed by cross-jurisdictional policy learning, was still shaped by durable alliances from earlier carbon pricing battles. Procedural justice in this sense is not merely a question of process quality; it is constitutive of substantive outcomes (Skinner-Thompson, 2022). The most consequential levers for embedding such power are formal governance seats with binding authority and budget instruments (Dobbin & Lubell, 2021).

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Clearly communicating the impacts of investments also affects the political durability of cap-and-trade programmes. Washington's 2024 defeat of a repeal initiative marked the first time anywhere that voters have chosen to uphold an existing, economy-wide carbon pricing law at the ballot box, underscoring the global significance of pairing such policies with visible, place-based benefits that resonate more immediately than abstract climate goals.[76] The campaign's success rested in large part on making the prospective losses from repeal tangible to voters, activating both loss aversion – the tendency to guard against losing valued benefits – and the endowment effect – the heightened attachment that comes from having already experienced them (Kahneman & Tversky, 1979; Thaler, 1980). This outcome was secured by a broad, cross-sector coalition, whose mobilisation was strengthened by explicit equity commitments, without which many frontline actors would have resisted alignment with the programme's defence.

Several equity provisions have proven portable across jurisdictions, with the CalEnviroScreen methodology and the CLCPA innovations particularly influential. Both these screening tools and the principle of statutory equity earmarking served as a blueprint for the Biden administration's flagship EJ initiative, Justice40, which sought to direct at least 40% of the benefits from certain federal investments to disadvantaged communities (Cohen et al., 2023). The earmarking has also travelled internationally: the EU's recent reform of its Emissions Trading System, which will extend carbon pricing to residential heating and transport fuels, thereby affecting households more directly, earmarks roughly 25% of revenues for a Social Climate Fund to support disadvantaged households and microenterprises in the energy transition (Bartenstein, 2025).

These interpretations must be tempered by the study's limitations. First, Washington's programme is still in its early implementation phase, and one biennium of data cannot reveal long-term patterns. Second, the analysis relies on administrative reports, which vary in completeness and may lag actual expenditures. Third, the qualitative interviews, while essential for tracing mechanisms, carry risks of selection and recall bias despite purposive sampling and triangulation. Finally, the study focuses on the design and implementation of equity provisions rather than on establishing causal effects, which would require different data and identification strategies. These constraints underscore the need for longitudinal tracking of equity delivery, matched comparisons across programme designs, and integration of outcome metrics, such as co-pollutant reductions, health improvements, and affordability impacts, into the same evaluative frame as targeting and spending data.

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76 Switzerland's 2023 referendum also codified net-zero targets and related measures, but constituted a forward-looking mandate rather than a decision on whether to retain an existing carbon pricing regime (Montfort et al., 2023).

Taken together, the cases show that equity in cap-and-trade is not the result of a single design choice but of a bundle: targeting rules, benefit definitions, budget architecture, and institutional authority over decision-making. States are converging on the components of that bundle, but their assembly remains path dependent. Programmes that appear both durable and equitable share three traits: clear and enforceable benefit standards, structured community authority in design and allocation, and a benefit mix that is both targeted to need and broadly legible to the wider public.

9.7 Conclusion

This study examined how revenue recycling can align cap-and-trade with environmental justice principles. Across New York, California, and Washington, statutory equity floors, screening tools, and community oversight bodies have become common features, yet their operation reflects path-dependent political trajectories, governance legacies, and the strength and strategies of EJ advocacy. In each case, advocacy shaped not only whether equity provisions were adopted but also how they were defined and implemented, producing convergence in formal commitments but divergence in how equity is operationalised and experienced by affected communities.

Cap-and-trade revenues alone cannot deliver full restorative justice, but they can be designed to reduce current disparities and support longer-term transformation when combined with complementary measures. Formal equity provisions can be readily adapted from other jurisdictions, but their substantive impact depends on tailoring spending to local conditions. The priorities, delivery channels, and project types that build legitimacy in one state may fall flat in another; these must be identified through direct engagement with affected communities and grounded in local institutional realities. Trade-offs among justice tenets are inevitable: procedural rigor can impede distributive objectives, and long-term restorative investments may postpone immediate relief, yet these risks can be mitigated through simplified processes, targeted capacity support, and balanced investment portfolios. Protecting climate funds from budget backfilling and maintaining transparency in benefit delivery are central to sustaining trust. We also observe that higher ambition and larger revenue pools tend to bring stronger equity provisions, reflecting both the need to assemble broader coalitions for deeper decarbonisation and the fiscal space that bigger auctions create for targeted redistribution and visible, place-based benefits.

Political durability hinges not only on legal safeguards but also on delivering benefits that are both targeted to need and broadly visible to the wider public. Washington's experience defending its programme against repeal shows that visible, place-based benefits can secure support even under direct democratic challenge. The broader implication is that carbon markets achieve justice not by default but through deliberate institutional choices that embed equity in both the allocation of resources and the governance of those decisions. Designing for this dual purpose strengthens both the effectiveness and legitimacy of climate policy.

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10 Conclusion

This chapter brings together the thesis' central findings, situates them in the broader literature, and reflects on their implications. It begins from the core premise that a just energy transition cannot be achieved without addressing domestic energy deprivation. To advance this claim, the thesis first refined the problem definition (Part I), then analysed how targeted interventions function in practice (Part II), and finally examined the governance principles and institutional arrangements that condition their durability and legitimacy (Part III).

Bringing these strands together, the conclusion revisits the three research questions, traces their connections, and shows how the thesis responds to the gaps identified in the Introduction. In doing so, it demonstrates that reframing domestic energy deprivation as a multidimensional social risk clarifies the conditions under which interventions and governance arrangements can promote justice and bolster the legitimacy of the energy transition.

The chapter proceeds in three sections: 10.1 summarises the key findings, 10.2 sets out academic contributions, societal relevance, and policy recommendations, and 10.3 reflects on limitations and directions for future research.

10.1 Summary of main findings

10.1.1 Gaps in understanding domestic energy deprivation as a social risk

RQ1: How can domestic energy deprivation be more accurately identified and incorporated into policymaking as a multidimensional social risk shaped by factors beyond income alone?

Part I (*'Problem definition'*) demonstrates that domestic energy deprivation is indeed a multidimensional social risk, irreducible to income alone. Three findings stand out.

First, measurement choices determine who becomes visible to policymakers and who receives support. Headcount indicators compress a complex condition into a binary, masking both the depth of shortfalls and their spatial clustering. The gap-based metrics developed in Chapter 2 quantify how far households fall below socially necessary energy services and reveal the intensity of deprivation that headcount statistics obscure. Simulations of Dutch crisis allocations show that had intensity rather than incidence guided support, resources would have shifted markedly. The implication is clear: diagnostics must capture not only how many households are affected, but also the magnitude of their shortfalls and where these shortfalls are concentrated.

Second, energy poverty extends beyond income poverty. Drawing on income elasticity estimates, Chapter 3 demonstrates that demand patterns differ significantly across groups. For low-income households not in energy poverty, heating demand is almost unresponsive to additional income. By contrast, for households classified as living in energy poverty, income elasticity is significantly higher: when their income rises, they do increase spending on heating, though the effect remains modest. This shows that income poverty and energy deprivation only partly overlap: energy poverty statistics reflect unmet needs that income measures alone cannot capture. It also shows that even in this group, demand is largely rigid and non-discretionary: households already close to subsistence levels of heat, hot water, and light cannot meaningfully 'choose' to spend less when prices rise. This supports the introduction's claim that domestic energy is a necessity good and that price increases not only have regressive effects but also constitute a major social risk.

Third, this social risk is driven largely by structural housing conditions. Regression analyses identify dwelling energy efficiency as the strongest determinant of heating demand, with dwelling size and off-grid fuels also significant. While income shapes affordability, it does not by itself explain whether a household lives in a cold home. The theoretical implication is that energy deprivation should be seen as a compound social risk produced by the interaction of needs, housing, and energy systems, consistent with the thesis' sufficiency lens. What matters is whether households can attain socially necessary levels of energy services, not simply their position in the income distribution. The practical consequence is that diagnostics must link to structural levers, with energy efficiency as the main determinant, to guide both targeting and evaluation.

Taken together, these findings show why refining the problem definition is essential for effective interventions, and they lay the foundation for the analysis of policies and practices in Part II.

10.1.2 Design and delivery of targeted household energy support

To what extent do targeted policy interventions across governance levels respond to the needs and vulnerabilities of households at risk of domestic energy deprivation?

The second set of chapters in Part II ('*Policies and practice*') addresses this question by evaluating which instruments are effective, and for whom, across both local and national policy frameworks.

At the frontline, professionals in social housing providers (SHPs) increasingly recognise how their strategic choices shape tenants' experiences of domestic energy deprivation, while emphasising that they cannot address the problem alone (Chapter 4). SHPs hold unique levers, such as large-scale retrofitting programmes, rent unit allocation, and rent setting, but operate under constrained mandates, limited data, and misaligned incentives. Practitioners consistently judged prioritised retrofits for tenants in greatest need as the most effective and desirable strategy, outweighing options such as allocating other energy efficient dwellings to them or lowering their rents. In practice, however, without granular data and adequate mandates, any such prioritisation remains difficult to realise.

Municipal experimentation in the Netherlands (Chapter 5) shows that modest physical upgrades, such as draught proofing, radiator balancing, LED replacement, significantly improve residential comfort and reduce stress regarding energy bills, with the largest effects among households with the highest energy burdens. These

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measures are inexpensive per dwelling and still deliver immediate welfare gains. Behavioural interventions were less effective: single-visit energy coaching produced no measurable effects, while multi-visit coaching yielded modest improvements in comfort, sustainable behaviours, and perceived bill reductions, especially when combined with physical upgrades. The implication is that municipalities can secure quick, tangible welfare gains when programmes are tailored to local capacity and household circumstances.

At national level during the 2021-2023 price shock (Chapter 6), European governments relied first on broad price measures (tax cuts, caps) for speed and salience. These were often regressive and fiscally heavy. As the crisis evolved, layered policy package designs, consisting of measures like tiered price caps complemented with means-tested transfers, delivered greater equity and efficiency in contexts with sufficient administrative capacity and fiscal space. Such designs reduced energy poverty gaps more per euro spent while curbing undesirable incentives. The key lesson is that crisis responses need not choose between targeting and universalism but can combine both through 'targeting within universalism', establishing a universal baseline and layering targeted support where need is greatest.

Yet the durability and legitimacy of these interventions ultimately depend on the broader principles and governance frameworks in which they are embedded, which is the focus of Part III.

10.1.3 Institutional and normative logics in shaping just energy transitions

In what ways do governance traditions and institutional logics shape the integration of justice and welfare provisions into energy and climate policy frameworks?

The chapters in Part III ('*Principles and governance*') examine how governance traditions and institutional logics influence the embedding of justice principles and welfare provisions within policy design, and how this, in turn, shapes household outcomes and strengthens, or undermines, the durability and legitimacy of the energy transition.

In the UK, the evolution of energy support since WWII has followed a residualist-compensatory welfare model increasingly reliant on means-tested relief and supplier obligations, interrupted only by brief, crisis-driven episodes of universalism (Chapter 7). Ambitions to prevent domestic energy deprivation through systematic energy efficiency improvements remain underfunded and are constrained by a Treasury focus on immediate budget costs, which sidelines longer-term social and economic co-benefits and creates structural short-termism. Reforms have mostly taken the form of incremental adjustments to eligibility thresholds or delivery mechanisms, with occasional remixing of instruments, but without evidence of a durable shift to a preventive, rights-based approach. The implication is that, in the absence of codified standards and multi-year mandates, preventive policies remain structurally vulnerable to fiscal cycles.

At the EU level, Chapter 8 showed that justice concerns have been progressively layered onto a liberalised energy and climate policy framework. Since the market reforms of the 1990s, policy has evolved through sequencing and layering: early adjustments were followed by stronger consumer protections and redistributive instruments such as the Social Climate Fund and Just Transition Fund under the Green Deal. In Hall's terms, these represent second-order changes involving new instruments and safeguards, rather than a third-order paradigmatic shift to a rights-based sufficiency model where affordable clean energy and mobility are entitlements. Hall's framework is useful here because the multi-level, consensus-driven EU system makes abrupt paradigm shifts unlikely, while the Advocacy Coalition Framework and punctuated equilibrium theory help explain which actors drive reforms and why bursts of change occur. Overall, justice has been more firmly embedded procedurally, but substantive guarantees remain partial and contingent.

Across U.S. state cap-and-trade programmes (Chapter 9), justice provisions depend on a specific institutional bundle: statutory equity floors, screening tools to identify disadvantaged communities, clear benefit definitions, community authority over allocations, and a benefit mix that is both targeted and widely visible. While states converge on this institutional architecture, they diverge in substance depending on statutory design, advocacy coalitions, local needs, and path-dependent institutional contexts. Where place-based benefits are visible and communities exercise governance authority, programmes are more likely to secure public support, as shown by the approval of Washington State's cap-and-trade scheme in a statewide referendum. Where equity provisions are thin, distributive shortcomings tend to erode procedural trust and leave legitimacy vulnerable. These dynamics confirm the thesis' central claim that justice must be institutionally designed, with distributive and procedural dimensions reinforcing one another.

10.1.4 Policy pathways towards a just energy transition

This final section returns to the thesis' main research question and synthesises the findings across Parts I–III in direct response:

How do different policy approaches across governance levels guide efforts to identify, address and integrate domestic energy deprivation within the broader just energy transition?

The findings demonstrate that the policy approaches taken to address domestic energy deprivation are consequential because they configure not just the resources distributed, but also because they determine which needs are recognised, how support is perceived, and whether impactful interventions and protections endure. Domestic energy deprivation is not a marginal issue that can be solved through income support alone. It is a structurally mediated condition that exposes the limits of narrow policy framings and highlights the need for rights-based and sufficiency-oriented logics across governance levels. Policies that treat only symptoms miss the underlying vulnerabilities tied to housing quality, energy systems, and differentiated needs. By contrast, rights-based and sufficiency-oriented approaches place energy services at the centre of justice concerns and provide more durable foundations for a just energy transition.

Across governance levels, policy approaches shape outcomes in three decisive ways, reflecting the three dimensions examined in this thesis. First, diagnostics determine visibility: measures that capture both the severity and spatial concentration of shortfalls redefine who is seen and how resources are allocated. Second, instrument mixes shape impact: combining compensation with structural improvements (for example, social energy tariffs layered onto retrofit programmes) produces different outcomes than either instrument alone. Third, rules and mandates underpin durability: once entitlements and mandates are codified, progress extends beyond short-term crisis relief.

In sum, a just energy transition advances when problem measurement, policy delivery and governance frameworks are aligned with principles of justice, and falters when any one of these elements is mis-specified. Sustaining legitimacy therefore requires policies that not only mitigate immediate burdens but also embed structural improvements and institutional guarantees, ensuring that fairness becomes an enduring feature rather than a temporary fix.

10.2 Contributions and policy recommendations

10.2.1 Academic contributions

Research on domestic energy deprivation has grown rapidly, yet the field remains fragmented and conceptually misaligned. This thesis addresses these deficits along three dimensions corresponding to the gaps identified in Section 1.2.2. First, it sharpens the problem definition by addressing the methods and measurement gap, developing distribution-sensitive, gap-based metrics that reveal the depth and spatial concentration of energy deprivation beyond simple headcounts. Second, it evaluates policies and practice to bridge the comparative and governance gap, using systematic cross-level analysis of instruments and institutional logics to explain when and why particular approaches succeed or fail across contexts. Third, it examines principles and governance to narrow the integration gap, linking welfare state theory, energy and climate policy and housing studies, and embedding practitioner perspectives through transdisciplinary collaboration.

Conceptually, this thesis reframes fuel poverty, energy poverty, energy insecurity and related phenomena – collectively referred to here as domestic energy deprivation – as a multidimensional and compound 'third wave' social risk of decarbonisation rather than a narrow affordability issue, embedding it firmly in the welfare agenda of the energy transition (Gough, 2021; Mandelli et al., 2024; Zimmermann, 2024). Recognising that conventional decarbonisation policies can entrench socio-economic disparities and lack a distributive baseline, this thesis advances a sufficiency-first framework that treats a minimum of domestic energy access, in line with the capabilities approach, as the basis for essential functionings such as warmth, health, and social inclusion, and thus as a benchmark for fairness and legitimacy (Day et al., 2016). Following Stojilovska et al. (2023), it positions domestic energy deprivation as a core policy metric at the intersection of climate and social policy and extends classic welfare state debates on universal versus targeted and preventive versus compensatory approaches into the energy and climate domain. The thesis deepens the conceptual understanding of constrained consumption by operationalising and testing Boardman's (1991) proposition that *"the income elasticity* [of energy demand] *is high if there is deprivation"*, confirming this claim in contemporary contexts and identifying structural (e.g. dwelling energy efficiency, heating system) and situational (e.g. household composition, occupancy patterns, health conditions, employment status) factors that shape demand independently of income (Rhiger Hansen & Gram-Hanssen, 2023). In addition, the thesis contributes to understanding Schlosberg's (2007) distributive, recognition and procedural justice tenets as analytical principles across the policy cycle, linking diagnosis, design, evaluation and institutionalisation, and shows how diagnostic choices shape instrument selection and ultimately distributive outcomes.

The thesis also advances this concept methodologically by translating its sufficiency-first framework into concrete measurement tools. Existing binary expenditure-based thresholds reduce this condition to a single cut-off, masking variation in severity, distribution, and causation. Building on critiques of the overused 10% threshold (Boardman, 2010) and the fragmented indicator landscape (Bouzarovski & Petrova, 2015; Thomson et al., 2017), the thesis develops and applies relational, gap-based metrics that position households relative to a socially defined sufficiency threshold, making visible both the depth of deprivation and the distribution of shortfalls across the population (Foster et al., 1984). This orientation resonates with a Rawlsian perspective: by allowing higher sensitivity to inequality – for example, by squaring shortfalls with the Foster-Greer-Thorbecke index – the 'inequality' metrics in Chapter 2 give even more weight to those furthest below the threshold, operationalising the difference principle's insistence that justice requires prioritising the least advantaged. Incorporating distribution-sensitive tools such as TIP curves (Jenkins & Lambert, 1997) enables a comparative, visual mapping of where deprivation is concentrated and which groups are most affected. This addresses a major blind spot in the literature: most policy evaluations still rely on crude headcounts rather than measuring intensity or inequality. For example, the ex post assessment of Spain's social tariff by Bagnoli and Bertoméu-Sánchez (2022) judged policy impact mainly by the number of households lifted above the poverty line. By contrast, a gap-based approach such as that developed in Chapters 2 and 6 exposes what such evaluations miss, revealing substantial welfare gains among the most severely deprived households who, though still classified as energy poor, experience meaningful improvements. By demonstrating how the definition and operationalisation of sufficiency thresholds directly influence both *ex ante* and *ex post* policy assessment, the thesis shows how gap-based metrics can deliver more accurate evaluations of targeted energy transition policies. In doing so, it helps to bridge the methods and measurement gap, moving beyond simple headcounts.

Beyond measurement, the thesis integrates comparative methods to understand how policies address domestic energy deprivation across time, space, and governance levels. In temporal terms, historical tracing reveals underlying policy logics and patterns of policy learning (Boin et al., 2017; Hall, 1993): in both the 1970s and the 2020s energy price shocks, governments initially deployd blunt, highly visible yet costly universal measures, shifting over time towards more targeted and layered approaches as fiscal pressures mounted and political salience declined. Spatially, it deepens theoretical understanding of geographic patterns of energy deprivation by mapping where deprivation is most severe and offering explanations why they arise. A multi-level perspective, linking frontline social housing providers, municipalities, states, national governments and supranational policy frameworks, follows calls for polycentric analysis of climate and energy governance (Sovacool, 2011). This perspective explains both convergence and divergence among actors, while also illuminating tensions across levels (e.g., social housing providers operating without adequate national mandates or national governments unevenly implementing EU directives). By comparing social housing providers' approaches across countries, the thesis also foregrounds the perspectives of essential yet often overlooked actors (Libertson, 2024), whose tenants experience some of the highest levels of domestic energy deprivation in Western Europe and whose strategic decisions strongly shape these outcomes (Longhurst & Hargreaves, 2019).

Together, these cross-level analyses address the comparative and governance gap identified in Section 1.2.2 by showing how domestic energy deprivation is shaped and mitigated across different institutional settings and governance levels. Building on this, the thesis extends the same comparative lens to policy instruments themselves, examining both established measures and newer interventions, such as energy coaching and shallow 'Fix Team' retrofits, that spread rapidly during the energy crisis despite limited evaluation (Barrella et al., 2023; Simcock & Bouzarovski, 2023). Responding to Mahoney et al.'s (2024) call for more explicit assessment of trade-offs in energy and climate governance, the thesis examines how various instruments differ and operate across contexts, evaluating how effectively they mitigate energy deprivation while balancing cost-efficiency, conservation incentives and political salience. Drawing on Zimmermann's (2024) account of welfare regimes as stabilisers of green transitions through social protection and compensation to address emerging social risks, this thesis extends the analysis by adding a forward-looking category – social investment – to capture structural, preventive measures. Policy instruments in this dimension, such as deep and shallow retrofits, behavioural advice, and accelerated renewable deployment for low-income groups, reduce reliance on repeated crisis spending. Table 10.1 applies this tripartite framing, comparing the effectiveness and trade-offs of instruments examined in the thesis.

TABLE 10.1 Policy instruments analysed in this thesis, classified by Zimmermann's (2024) welfare categories of social protection and social compensation with an added social investment category

Welfare category	Policy instrument	Effectiveness & trade-offs	Main chapter(s)
Social protection	**Disconnection bans**	Prevents loss of basic energy supply for vulnerable households; no effect on bills or structural issues	8
	Social tariffs	Immediate relief for low-income households; limited coverage and may exclude near-poor groups	6 + 7
	(Social) housing governance	Links rent and allocation to energy costs; may trap lowest-income households in inefficient dwellings	4
Social compensation	**Means-tested or categorical transfers**	Targeted relief for vulnerable groups; risks misallocation, reinforcing poverty traps, and diversion from energy expenses	6 + 7
	Universal VAT cuts	Rapid bill relief for all, avoiding 'exclusion errors'; costly and regressive, weakens saving incentives	6
	Price caps	Offers security to all, politically popular; costly, reduces conservation incentives, tiering better targets essentials	6 + 7
	Carbon pricing revenue recycling	Can offset regressive climate policy; effectiveness depends on targeting, lasting and visible investment benefits, and stable revenue streams	8 + 9
Social investment	**Deep retrofits**	Large, lasting savings and comfort gains; high costs, personnel shortages and slow timelines limit targeting of vulnerable households	4 + 7 + 8
	Deployment of local renewables	Cuts bills sustainably and reduces market dependence; high upfront cost and landlord–tenant split incentives limit uptake	4 + 6 + 8
	Shallow retrofits	Low-cost, delivers quick, visible comfort gains; insufficient to address major inefficiencies	5 + 6
	Behavioural interventions	Scalable, potential gatekeeping role; minimal gains from single visits, trust risk if only form of support	4 + 5

Beyond instrument-level trade-offs, the thesis contributes by showing how they stem from entrenched welfare and justice logics that structure governance at supranational, national, and subnational levels. To conceptualise these higher-order patterns, the thesis develops a fourfold ideal-typical framework of universalist-preventive, residualist-preventive, residualist-compensatory, and universalist-compensatory policy approaches. This framework categorises and illustrates interventions at the intersection of social and energy policy scholarship (Ferrera, 2017). The UK's approach to household energy support provides a cautionary example of the residualist-compensatory type, which undermines structural resilience. The thesis explains how this pattern has been shaped by political, institutional, and ideational dynamics: decades of privatised delivery, capped and means-tested schemes used to 'sell restraint' (Whiteside et al., 2021), and a Treasury-driven fiscal lens prioritising narrow cost-effectiveness. Together these dynamics entrench a model that systematically undervalues the broader benefits of prevention (Hemerijck & Matsaganis, 2024; Jennings et al., 2020). In a different register, the thesis tests Schlosberg's (2007) justice tenets against empirical evidence, showing how procedural and distributive justice reinforce each other when affected communities gain structured authority over investment decisions, but also how recognition-focused equity assessments can create administrative burdens that disadvantage smaller organisations and ultimately erode distributive outcomes.

Another contribution is the contextual understanding of policy change, examining how policy approaches emerge, evolve, and persist across political and institutional settings. Echoing calls for process-oriented analysis (Middlemiss et al., 2023), the thesis uses process tracing to uncover the causal mechanisms and political dynamics through which interventions emerge and evolve, explaining why particular forms of support crystallise in specific institutional settings. Rather than relying on a single framework, it interprets these findings through multiple theories, which together offer a more comprehensive understanding than any one approach could provide (Heikkila & Cairney, 2018). Where Hall's paradigm framework identifies deep shifts in ideas and instrument logics, the Advocacy Coalition Framework highlights the alliances that carry those ideas into programmes, Punctuated Equilibrium Theory captures the timing and magnitude of change, and Multiple Streams highlights how problems, policies and politics couple in these critical windows (Baumgartner & Jones, 2010; Hall, 1993; Kingdon, 1984; Sabatier, 1988). This plural lens is especially useful in explaining the gradual layering of social provisions onto the EU's energy and climate policy paradigms. Hall's framework illuminates processes of policy learning, while other perspectives reveal how energy was reframed as an essential service, coalitions secured redistributive measures, and successive crises normalised mandatory protections and price caps. By combining these perspectives, the thesis offers the most plausible explanatory mix for the policy changes observed, addressing recognised gaps in methodological transparency and explanatory depth in energy and climate policy research (Vanhala, 2017) and responding to recent calls for deeper historical tracing of justice considerations in this domain (de Looze et al., 2024).

Finally, building on the third gap concerning disciplinary silos, this thesis makes a distinctive interdisciplinary and transdisciplinary contribution by bringing together theories from social policy, energy policy and housing studies. It applies key concepts from welfare state theory, including the preventive versus compensatory logics and the universalism versus targeting debates, together with poverty-measurement techniques from welfare economics, to analyse energy and climate interventions and generate theoretical insights that would not emerge within disciplinary silos. Drawing on housing studies, it highlights the central role of the built environment and landlord-tenant dynamics in shaping energy deprivation, thereby linking social and technical determinants of vulnerability more directly (Burlinson et al., 2018; Longhurst & Hargreaves, 2019). This cross-pollination responds to calls for stronger interdisciplinary integration in the study of domestic energy deprivation (Bouzarovski et al., 2021; Varo et al., 2022) and contributes to the broader academic effort to embed diverse social science perspectives into climate policy assessment and governance, moving beyond narrowly technocratic approaches to mitigation and adaptation (Victor, 2015). Beyond interdisciplinarity, this thesis advances transdisciplinary research practices by engaging non-academic stakeholders in joint problem framing, knowledge co-production and iterative feedback loops. This reflects a deliberate shift from research *on* actors to research *with* actors, aligning with the growing body of work on transdisciplinary sustainability and energy research, which shows that co-production with practitioners improves both the quality and the legitimacy of scientific knowledge (Hansson & Polk, 2018; Lang et al., 2012).

10.2.2 Societal relevance

This thesis addresses pressing societal challenges by exploring how justice in the energy transition can be understood and applied in real-world policymaking. Even if not treated as an intrinsic policy objective in its own right, its practical implications cannot be ignored. The recent energy crisis showed that, under public pressure, governments will intervene at scale, yet without a strong evidence base interventions worth hundreds of billions of euros struggled to balance social protection with environmental and fiscal sustainability. Similar trade-offs arise in climate mitigation: policies focused narrowly on efficient decarbonisation risk faltering if their costs are perceived as unfairly distributed. The political economy perspective adopted here emphasises that such balances are inherently contested. Fiscal rules, welfare traditions, and political incentives determine which trade-offs are prioritised, whose needs are recognised, and how durable interventions become. By acknowledging these realities, rather than treating policies as if they operated in a vacuum, the thesis enhances its societal relevance and provides insights directly usable for policymakers. The following discussion of societal relevance mirrors the thesis structure: beginning with problem definition, turning to policies and practice, and concluding with principles and governance. This parallel structure highlights how each dimension generates not only academic contributions but also tangible implications for policy and practice.

The most immediate and tangible societal impact of this thesis lies in its contribution to problem definition: how poverty is measured and therefore addressed in Dutch policymaking. As argued in Chapter 2, and further elaborated in the Dutch journal *Economische Statistische Berichten* (Croon, 2023) and a TNO report (Mulder et al., 2024), poverty statistics should not focus solely on incidence (the number of people below the threshold) but also on intensity, meaning how far below the threshold people fall. Without this distinction, policies may appear effective while failing those in deepest need. This issue became particularly apparent in 2023, when the Rutte IV government committed to preventing a rise in poverty. The influential Netherlands Bureau for Economic Policy Analysis (CPB) evaluated various policy options and concluded that raising the rent allowance would reduce poverty more than increasing social assistance, as it would lift more households just over the poverty line. Yet this approach risked prioritising statistical gains over real improvements in well-being for the most deprived, an outcome many viewed as unjust. The argument for incorporating intensity gained traction: the TNO report was debated in Parliament, and the ESB article discussed in a national radio interview with then-Minister for Poverty Policy, Participation and Pensions, Carola Schouten. As a direct result, Statistics Netherlands (CBS) has since announced it will include intensity metrics in its annual energy poverty monitor, and the CPB has also committed to integrating intensity metrics into its modelling on poverty alleviation.

These institutional shifts show how research-led advocacy can reshape both the metrics and the allocation of public resources, strengthening the moral and material basis of social policy. Beyond the Dutch context, the approach has gained wider traction: a World Bank report cites our *Energy Policy* article (Robayo-Abril et al., 2024), and within the EU, the European Commission's research unit on Fair Transitions has now commissioned its science hub, the Joint Research Centre (JRC), to incorporate energy poverty gap metrics into the distributional assessment of forthcoming Social Climate Plans under the €87 billion Social Climate Fund, including the country factsheets used by Commission negotiation teams in discussions with Member States about the policy mix. Establishing this diagnostic baseline matters because it directs where funds flow and how success is judged, setting the stage for the next question in this thesis: which delivery models work, for whom, and under what conditions.

Building on this, the thesis investigates and compares how different forms of support are delivered in practice, taking seriously the institutional realities that shape what is possible in democratic welfare states. Much economic research – both neoclassical and heterodox – tends to overlook these constraints, the former due to its rigid theoretical assumptions, and the latter through limited engagement with the policymaking process. Some critics adopt an uncompromising approach, dismissing reformist efforts as too incremental or narrowly focused on poverty, overlooking implementation timelines, political realities and fiscal constraints. This thesis proceeds from the view that such critiques risk undervaluing the urgent task of improving policies likely to be adopted within current socioeconomic systems. Accordingly, it evaluates policies as they are implemented, identifying where and for whom they work, and how they can be improved under real-world conditions. It shows, for example, how local Fix Teams deliver near-term structural welfare gains; how social housing providers can programme long-term renovation plans to prioritise their most vulnerable tenants; how governments can provide targeted crisis relief that mitigates energy deprivation while preserving conservation incentives; and how cap-and-trade revenues can be redistributed to shield those most exposed to regressive impacts. Rather than dismissing such measures as incremental, the analysis underscores their immediate importance for households who cannot afford to wait for radical change, while also clarifying the trade-offs and limitations each approach entails.

Throughout, the thesis is explicit about the trade-offs involved – between efficiency and salience, universality and residualisation, short-term relief and long-term ambition – seeking to clarify rather than obscure the difficult decisions real-world justice demands. Building on Elsinga et al. (2020), who call for policy grounded in moral values rather than ideological reflexes, this thesis makes explicit a Rawlsian, prioritarian commitment to securing a sufficiency floor for those at risk of falling below it. It places the well-being of the most disadvantaged at the centre of its analysis, treating it as the key measure of just policy. The thesis not only clarifies which interventions work best under which conditions but also shows how policy mixes can be sequenced so that immediate relief and structural improvements reinforce, rather than undermine, each other.

At the level of principles and governance, the thesis explores how fairness can be embedded in institutional logics and policy frameworks so that interventions are not only effective in the short term but also legitimate and durable. This orientation has been strengthened by sustained, two-way engagement with policymakers, housing providers and cross-sector stakeholders through the RE-DWELL research network and voluntary practice as an energy coach, which together grounded the analysis in everyday governance realities. Beyond these collaborations, the research has begun to inform longer-term institutional debates. or instance, Chapter 4 was translated into a white paper for the European Federation for Living (EFL), a network of housing providers, showing professionals how they could begin to explore their role in a just energy transition using data they already collect and by placing domestic energy deprivation at the heart of their strategy building (Croon et al., 2023). Chapters 6 and 8, which focus on crisis governance and justice integration in climate policy, have been used in Brussels-based thinktanks and European Commission directorates to inform debates on energy crisis relief (Lausberg & Croon, 2023). Chapter 9 contributed to transatlantic exchanges on equitable use of carbon revenues organised by the International Energy Agency (IEA), illustrating how normative principles of sufficiency, fairness, and prioritarian distribution can be translated into policy design and governance debates.

Taken together, this thesis not only advances academic understanding but also demonstrates the potential for research-led evidence to shape real-world policy debates. Yet, as the thesis itself has shown, embedding justice and welfare provisions in governance frameworks is always a contested and fragile process. To what extent the shifts described here will become anchored and institutionalised remains to be seen; the durability of these advances depends on sustained political will, institutional mandates, and public support. Even so, the research has already begun to drive tangible change, shaping policy metrics and influencing debates on policy design and governance across multiple levels, thereby laying the groundwork for broader, longer-term reforms.

10.2.3 Policy recommendations

Before setting out the recommendations, it is important to reiterate one of the central arguments of this thesis: that a just energy transition can only advance by balancing principled commitments to fairness with the practical realities of institutions and politics. As Max Weber (1919) observed in a very different context – one in which coal-fired industry defined modernity – effective political action requires both staying true to one's principles (*Gesinnungsethik*) and judging what is feasible in practice (*Verantwortungsethik*), combined with maintaining a sense of proportion (*Augenmaß*).

In this spirit, the policy recommendations are grounded in the thesis' core normative stance that prioritises the most vulnerable households through a sufficiency-oriented, Rawlsian-prioritarian notion of justice, while remaining attentive to real-world feasibility in line with its critical-realist, problem-driven approach (Section 1.2.3). They are structured along the three dimensions that frame this thesis: first, how the problem is defined and diagnosed, with recommendations aimed at statistical offices and regulators who determine what counts as deprivation and how it is measured; second, how policies and practices are designed and delivered, with recommendations for municipalities, housing providers, and national administrations responsible for reaching households; and third, how principles of justice are embedded in governance frameworks, with recommendations directed at national governments and EU institutions. Table 10.2 summarises these recommendations across governance levels, while the following sections expand on each dimension in turn, with the latter two discussed together. Presenting delivery alongside governance clarifies the sequencing from immediate interventions to institutional anchoring and the trade-offs this entails.

TABLE 10.2 Overview of policy recommendations by dimension and governance level

Dimension	Local actors	National governments	EU institutions
Problem definition and targeting	• Combine registries with frontline knowledge to target Fix Teams and one-stop-shops • Use combined diagnostics to steer renovation strategies	• Integrate registries (income, EPC, health) across governance levels • Set and monitor targets to reduce, and ultimately, eliminate deprivation	• Require reporting on intensity as well as incidence • Tie fund disbursement to verifiable reductions in the intensity of energy deprivation
Policy design and delivery	• Link shallow retrofits to pipelines for deeper retrofits • Combine physical and behavioural interventions • Coordinate municipalities and housing providers to bridge retrofit delays	• Apply principle of 'targeting within universalism' • Layer crisis relief (universal baseline + targeted top-ups) • Provide universal retrofit support, tapering with income/ need	• Adapt procurement rules to recognise co-benefits and spillovers • Support innovative delivery models with pilot funding and technical assistance • Facilitate cross-country exchange of effective practices
Governance and institutionali-sation	• Ensure stable funding for proven models (e.g. Fix Teams) • Formalise cross-sector coordination between housing and welfare providers	• Anchor entitlements to minimum energy efficiency/ services • Protect preventive budgets from fiscal retrenchment	• Embed binding safeguards and earmarked funding in directives • Require meaningful stakeholder input in Social Climate Plans

Recommendations on problem definition and targeting

A first set of recommendations concerns the way problems are defined, as this fundamentally shapes who qualifies for support and how scarce resources are allocated. A key finding is that local actors such as municipalities and social housing providers are especially well placed to identify vulnerable households. They already hold much of the necessary information: social housing providers, for instance, often know which tenants receive benefits and have detailed records of energy performance labels. Even where this is not the case, higher-level administrative data such as income registers can serve as useful proxies. Therefore, local actors should be empowered by granting them access to relevant administrative data within the safeguards of existing privacy legislation and encouraged to make more strategic use of information they already hold to steer renovation strategies as well as short-term support priorities. Yet quantitative data alone are insufficient. Such mandates should be complemented by the on-the-ground knowledge that neighbourhood response officers, social workers, and frontline staff develop in daily contact with residents. Their familiarity with local conditions makes them uniquely positioned to indicate which building blocks require urgent attention and where Fix Teams or one-stop-shops should be established. The value of combining these different sources of knowledge is clear: it would produce diagnostics that are both accurate and socially grounded, ensuring that scarce resources are directed to where they matter most.

Equally important is how these diagnostics are applied. Deprivation metrics should be treated primarily as governance tools for steering funding allocations, rather than as criteria for complex, potentially stigmatising household benefits. This approach ensures alignment with principles of justice while maintaining administrative simplicity and public legitimacy.

At the national level, the findings of this thesis underline that governments have the levers to make diagnostic practices systematic and binding. During the energy price crisis, incidence measures were often used as the dominant indicator, but these captured only how many households were affected, not how severely. As a result, support was not always aligned with the households experiencing the deepest hardship. National authorities are better positioned than municipalities to integrate administrative datasets, combining income registers, energy consumption statistics, energy performance certificates, and health-related indicators. Based on these findings, a key policy recommendation is to mandate the use of gap-based indicators in national monitoring and in the formulas that allocate renovation funds or social transfers, while using integrated registries to establish automatic eligibility for households without requiring complex application procedures. Governments should also set explicit targets for reducing the energy poverty gap, not merely its incidence. This approach directs resources towards those in greatest hardship, ensures more efficient use of scarce funds, and allows progress to be measured in ways that are visible and credible both to citizens and to auditing agencies.

Within the EU, progress has been made in recognising domestic energy deprivation as a distinct policy concern, with new legislation and the establishment of observatories and advisory hubs. Yet substantive monitoring remains patchy and uneven across Member States, and current EU frameworks largely stop at requiring reporting. This thesis finds that without stronger anchoring, equity considerations risk remaining peripheral. Building on this finding, a recommendation is to embed gap-based indicators more firmly at EU level, for example by adopting them as benchmarks within the Social Climate Fund and by tying disbursement to verifiable reductions in the energy poverty gap rather than relying solely on output-based indicators such as the number of vulnerable households reached.[77] In parallel, the mandate of the Energy Poverty Advisory Hub should be expanded to provide technical support on diagnostics and targeting systems, helping Member States to align their practices. The relevance of these recommendations lies in creating

77 This would also address a main criticism raised by the European Court of Auditors (2025) on the first performance-based financing framework the EU launched before the Social Climate Fund, the Recovery and Resilience Facility (RRF), namely that performance should be measured using results-based indicators, such as emissions reductions or energy poverty reduction, rather than output-based indicators.

a common European standard that reinforces national and local action, ensures comparability and accountability across the Union, and signals to citizens that EU climate policy is socially balanced and directed at reducing real hardship rather than only ticking procedural boxes.

Recommendations on delivery and governance

A second set of recommendations focuses on effective policies and their institutionalisation. At the local level, this thesis finds that interventions such as energy coaching and Fix Teams, trialled by municipalities, can be effective in reducing hardship and improving residential comfort, even when limited to relatively shallow measures like draught proofing, radiator balancing, or LED replacement. They could also help foster trust between residents and public authorities. Evidence further shows that interventions are most impactful when they are targeted at the most vulnerable households and when engagement is sustained over time: single-visit schemes often yielded negligible effects, whereas longer visits by Fix Teams or repeated energy coaching sessions generated substantial improvements in comfort and reduced financial stress. Building on these findings, a recommendation is to institutionalise such services with stable funding, ensuring they become part of municipal infrastructure rather than ad hoc projects, and to mandate local actors to prioritise households flagged through diagnostic tools and frontline knowledge. Municipalities and social housing providers should work closely together so that Fix Teams can bridge the long waiting periods before deep retrofits are completed, while also providing the face-to-face coaching that helps residents sustain energy-saving practices and avoid rebound effects. The added value of these arrangements goes well beyond energy bill savings: they deliver visible comfort gains, strengthen trust and help relieve financial anxiety. More broadly, cross-sector coordination between housing and welfare providers should be formalised, recognising that energy deprivation cuts across institutional boundaries.

National experience during the energy price crisis shows that relief schemes struggled to balance fiscal cost, adequate support for vulnerable households, conservation incentives, and political legitimacy. The evidence here supports the principle of ‘targeting within universalism’: universal baselines, such as tiered tariffs, preserve broad public support, while layered supplements for households in greatest need ensure fairness and efficiency. Yet evidence from the UK also shows the limits of relying too heavily on short-term, compensatory relief. Preventive investments in energy efficiency deliver deeper and more durable welfare gains, but remain chronically underfunded, fragmented, and vulnerable to fiscal retrenchment. A similar recommendation follows: energy efficiency should be universal in access but financed through tiered support. Governments should ensure that social housing landlords have sufficient funding to rapidly retrofit the homes of vulnerable tenants, while private landlords must be required to meet phased minimum energy performance standards, accompanied by adequate rental security for their tenants. Low-income homeowners should be protected by interest-free loans, repayable only upon sale of the property, while subsidies should gradually decline for wealthier households. This structure ensures universal access to retrofits while directing the greatest support to those most in need.

On the EU agenda, the Draghi (2024) and Letta (2024) reports have placed competitiveness at the core of policy strategy, presenting market integration and interconnection as the backbone of a dynamic, resilient, and clean energy system. These measures are expected to lower prices through efficiency gains, protect Europe's industrial base against relocation, and, together with carbon pricing, standards, and targeted subsidies, drive cost-efficient decarbonisation. Yet every market, and especially those for essential goods such as energy, risks excluding some households from adequate access. Sustaining the political and social legitimacy of energy and climate policies thus requires robust social protection, compensation, and investment measures of the kind proposed in this thesis, ensuring that basic energy needs are guaranteed as a right. The findings of this thesis suggest that equity cannot remain a procedural add-on: it must be embedded directly in the directives that deliver the transition. A central recommendation is therefore to move beyond reporting obligations alone and to earmark a defined share of efficiency investments for vulnerable households within the Energy Efficiency Directive, the Renewable Energy Directive, and the Energy Performance of Buildings Directive. To ensure that local innovations such as Fix Teams can become durable parts of welfare infrastructure, EU procurement rules must also be adapted to recognise the broader co-benefits and spillovers of grassroots initiatives, rather than crowding them out through narrow cost criteria, as highlighted in a co-authored study outside this thesis (Bokhorst et al., 2025). Such anchoring would shield national efforts from fiscal retrenchment or shifting political priorities and create a durable European framework that links competitiveness with social fairness.

Lessons from the United States underline this point. As illustrated in Chapter 9, Washington State became the first jurisdiction globally in 2024 to preserve a cap-and-trade scheme in a direct referendum, with a campaign that highlighted the tangible benefits communities would lose if the law were repealed, from transit upgrades to direct bill support for low-income households. More broadly, U.S. states increasingly use equity screening tools to channel investments towards disadvantaged groups. The lesson for Europe is that energy and climate policies gain legitimacy and durability when they visibly improve people's lives, especially for those most at risk. Yet legitimacy is not automatic: it depends on benefits being both delivered and communicated effectively. Anchoring equity in policy design, and ensuring its visibility in public debate, is therefore essential if the energy transition is to command lasting support.

10.3 Reflections, and future pathways

10.3.1 Epistemological and methodological reflections

A central set of limitations and delimitations concerns availability, validity, and representativeness of datasets, particularly across quantitative or mixed-method analyses (Chapters 2, 3, 5, 6, and 9). These reflections aim to enhance transparency by distinguishing between constraints imposed by data and scope boundaries that were consciously set through methodological design. Several of the core data sources – such as the 2020 CBS administrative microdata (Chapters 2 and 5), the 2019 English Housing Survey (Chapter 3), and the 2020 Eurostat Household Budget Survey underpinning distributional simulations (Chapter 6) – were collected prior to the COVID-19 pandemic and the 2021-2022 energy crisis. While these datasets provide robust structural insights into household characteristics and energy-related vulnerabilities, their temporal limitations restrict the ability to capture more recent behavioural adaptations, crisis impacts, and evolving policy responses. This temporal disconnect affects both the external validity of the findings, limiting the extent to which they can be generalised to current conditions, and the accuracy of counterfactual modelling.

The evaluation presented in Chapter 5 illustrates these challenges in a concrete way. The quasi-experimental design, limited to three Dutch municipalities, relies on voluntary participation and a modest sample, factors that weaken internal validity through possible selection bias and limited statistical power, whereas the locality-specific context constrains representativeness and, by extension, scalability. A short follow-up window and an observational rather than randomised design further temper causal claims, even though observable confounders and subgroup interactions are controlled. Similar constraints apply to Chapter 3, where the English Housing Survey provides rich cross-sectional data on household and dwelling conditions but relies on self-reported values, uses modelled rather than observed energy consumption, and offers no causal identification strategy. Across Chapters 2, 3, and 5, limitations in available data on energy performance meant that EPC ratings were either missing, outdated, or unreliable, which necessitated the use of proxy indicators such as building type, tenure, or construction year. In Chapter 6, the simulation of national relief policies rests on stylised eligibility rules and static income distributions from harmonised household budget data, while Chapter 9 faces comparable constraints in classifying ‘equity’ investments under cap-and-trade programmes. Although triangulation, robustness testing, and interpretive caution mitigate these issues, they reflect the broader structural challenge of conducting policy-relevant energy research in a data environment still characterised by fragmentation, delay, and uneven reporting.

The qualitative research components, notably in Chapters 4 and 7 to 9, bring distinct limitations related to sampling, interpretation, and reliability. Chapter 4 employed focus group discussions with social housing providers in England, France, and the Netherlands to explore institutional responses. This method yielded rich practice-based insights and was deliberately chosen over surveys to enable interaction and peer validation among professionals. With only six focus groups drawn from organisations managing substantial housing portfolios, however, the sample cannot claim representativeness, and the insights are embedded in specific national and organisational contexts, limiting generalisability beyond Western European settings. Although thematic coding was systematically applied and grounded in established literature, it remains interpretative in nature. Comparable issues apply to Chapters 7 to 9, which drew on legislative texts, policy documents, secondary sources, and semi-structured interviews to trace evolving justice framings, institutional logics, and implementation strategies. These approaches necessarily privilege formal processes and recorded intent, often at the expense of informal dynamics, implementation failures, or marginalised perspectives. In Chapter 8, for example, the legislative sample was confined to selected European Green Deal acts, excluding other relevant EU instruments, and interpretative choices shaped how policy paradigms were classified. In Chapter 9, interview access was constrained by time limitations and the competing agendas of key stakeholders; as a result, only ten interviews were conducted directly by the author, supplemented by over forty additional transcripts from colleagues at Columbia. This provided broader insight but also introduced variation in interview timing, questioning, and context, which affects comparability. While these constraints represent empirical limitations, the decision to privilege formal institutional perspectives constitutes an explicit delimitation. Despite these constraints, the qualitative and documentary methods deployed here enriched and challenged the quantitative analyses, and they provided theoretically informed perspectives grounded in institutional practice.

The wider epistemological orientation of the thesis also shapes its boundaries. This constitutes a further layer of delimitations. Adopting a critical realist stance, as outlined in Section 1.2.3, means that the research aims to explain context-dependent mechanisms rather than to produce universally generalisable laws. This epistemological transparency clarifies what kind of knowledge the thesis seeks to generate and under what conditions its insights hold. This choice privileges an understanding of what works for whom, and in which contexts, at the expense of predictive power. The conclusions therefore speak to mechanisms embedded in specific welfare and governance regimes and should be applied with caution in different contexts.

An additional limitation arises from the way sufficiency was operationalised. Rather than adjudicating household-specific thresholds of what counts as 'enough' energy, which would require detailed assessments of health, age, and circumstance, the analyses relied primarily on macro-level proxies. This choice enhances policy relevance and scalability but inevitably simplifies diverse household needs, which may lead to misclassification. By contrast, the household survey in Chapter 5 moved closer to subjective sufficiency by capturing self-reported comfort and adequacy while linking these responses to administrative data, which suggests that hybrid designs combining reliable microdata with survey data collection are a promising way forward.

Finally, the thesis is framed by a clear normative commitment, grounded in a sufficiency-first, Rawlsian perspective (Section 1.2.3), which prioritises lifting households above minimum thresholds of energy services. This lens provides moral clarity and a consistent evaluative baseline, but it also conditions the conclusions: a utilitarian or strict egalitarian approach would interpret trade-offs differently, and recognition-based accounts might foreground diverse lived experiences more strongly than this research was able to do. While the thesis sought to engage with distributive, procedural, and recognition dimensions of justice, the empirical emphasis fell most heavily on distributive outcomes and formal procedural aspects, with recognition addressed indirectly through practitioner perspectives. This imbalance reflects deliberate design choices that complement existing scholarship on lived experience rather than duplicating it, but it also highlights a limitation in terms of capturing the full spectrum of justice claims.[78]

Taken together, these epistemological and methodological reflections demonstrate that the contribution of this thesis is not diminished by its limits but clarified through them. The explicit articulation of stance and method underscores the transparency of its approach and the rationale behind its delimitations, showing how the research navigated inevitable trade-offs between breadth and depth, policy relevance and granularity, and structural insight and lived experience. Such transparency strengthens the validity and credibility of the findings by making the scope and boundaries of the claims explicit. Future research could expand the comparative scope to additional welfare regimes and developing contexts, integrate participatory and ethnographic methods to capture recognition claims more fully, stress-test conclusions under alternative normative baselines, and update analyses

78 Insights from lived experience also informed this research through volunteering with households facing domestic energy deprivation (see Acknowledgments). While these encounters reinforced the salience of the issue, the thesis deliberately concentrates on policy and governance responses rather than reproducing the already substantial literature on everyday coping (e.g. Hernández & Laird, 2025; Longhurst & Hargreaves, 2019; Middlemiss & Gillard, 2015).

with longitudinal datasets. By acknowledging the boundaries of its claims, the thesis remains consistent with the epistemological commitments laid out in the Introduction and sets a clear agenda for advancing research on domestic energy deprivation.

10.3.2 Avenues for future research

Looking ahead, what the field emphatically does *not* need is yet another energy poverty indicator. If anything, the proliferation of new indicators has begun to outpace their practical utility. This thesis instead aims to improve existing indicators by capturing the severity of deprivation rather than relying on binary thresholds. An urgent task now is to interrogate the tension between metric-driven targeting and the lived realities of domestic energy deprivation (Middlemiss et al., 2019). Future research should prioritise the validation and comparative assessment of existing indicators. Which (combined) metrics best predict real hardship? Which align most closely with outcomes such as residential comfort, payment arrears, or even excess winter mortality? These are not merely technical questions but moral ones, with real consequences for whom the state sees and supports.

A complementary agenda concerns the upper bound of sufficiency. While this thesis concentrates on lifting households above deprivation thresholds, future work should examine how to curb ‘energy extravagance’ (Okushima, 2024), consumption far beyond basic capabilities that strains ecological limits (Gough, 2020). This implies conceptual and empirical tasks: defining defensible ceilings, testing social acceptability, and evaluating governance tools (e.g., inclining-block tariffs with protected medical baselines, targeted charges on luxury uses, demand-side obligations for high-consumption properties) that moderate excess demand without penalising need arising from age, disability or health.

Empirical evaluation, too, demands a methodological step-change. The heterogeneity of local and institutional responses exposed in this thesis points to a pressing need for more robust causal inference. Randomised controlled trials (RCTs) – currently underused in this field – offer a powerful means of testing the effectiveness of targeted interventions (Duflo et al., 2007). What merits testing now are not only established retrofit subsidies or information campaigns, but the newer, more experimental delivery models proliferating across Europe. These include the Fix Teams studied in this thesis, but also the one-stop-shops that promise to integrate financial advice, technical assessments, and contractor coordination under a single roof. All are heavily promoted in policy discourse, yet few have been subjected to rigorous counterfactual evaluation (Brown et al., 2019). RCTs, particularly when designed in collaboration with implementing agencies and community actors, and supplemented by administrative household data, could assess not only energy savings or cost-effectiveness, but also secondary impacts: uptake by marginalised groups, household stress reduction, or changes in trust and engagement. As this thesis has argued, such trials must go beyond asking *what* works, but *for whom*, and *under what conditions*. For example, how performance varies when delivery is led by municipalities versus social housing providers, or when accompanied by targeted outreach, with subgroup effects extending beyond income alone.

Beyond questions of causal effectiveness lies a further normative frontier. The justice framework advanced in this thesis, grounded in John Rawls's concern for the least advantaged and the priority of basic needs, offers a principled basis for developing just transition policies. Yet legitimacy in the energy transition may depend on more than distributive calibration alone. As Michael Sandel (2003) argues in *Liberalism and the Limits of Justice*, political principles cannot be fully detached from the shared moral practices and communal contexts in which citizens understand themselves and their obligations. Recent evidence indicates that measures with minimal material effect, such as banning private jets or requiring ministers to travel by train, can significantly increase support for otherwise unpopular climate policies by reshaping perceptions of fairness and credibility (Tallent et al., 2026). In the context of this thesis, similar dynamics may arise when tightly targeted energy poverty relief is complemented by highly visible measures, such as levies on luxury energy uses or modest universal climate dividends, that signal shared effort beyond their immediate distributive effect. The empirical findings in Chapters 6 and 9 likewise suggest that salience, visibility, and expressions of collective benefit can shape public acceptance even when policy packages include progressive targeting. Future research should therefore explore how policy design can reconcile high redistributive impact with broader social and symbolic resonance, thereby contributing to durable democratic legitimacy for climate action.

Another frontier lies in the legal and institutional foundations of energy justice. Many existing support schemes remain embedded in residual, discretionary welfare models vulnerable to political rollback. Revisiting the idea of energy as a social right, not merely as a rhetorical commitment but as a legal entitlement enforceable through the courts, could radically shift the normative and institutional terrain. Marlies Hesselman and colleagues (2021, 2022, 2023) have laid important groundwork in tracing the emergence of the 'right to energy' in international discourse, and argue that the growing use of rights-based language at EU level opens a space for more ambitious legal recognition of energy access. Future work should explore how a right to energy could be meaningfully specified within national legal frameworks, drawing lessons from adjacent domains such as housing or health. As Jiglau et al. (2023) suggest, this shift would not require a wholesale reinvention of welfare states, but rather their steady recalibration: extending existing social contracts to include domestic energy as a foundational good, governed not solely by market logic but by public obligation. This becomes even more urgent in the face of ‘third wave’ social risks, as decarbonisation renders fossil fuels prohibitively expensive while many low-income households remain locked in energy inefficient dwellings (Mandelli et al., 2024). Without institutional protections anchored in legal rights, the risk is not only distributive injustice but also erosion of political support for the transition itself.

A further promising avenue lies in comparative policy research, across geographies and jurisdictions. Too often, studies remain confined to isolated case studies, missing the opportunity to interrogate how different political economies interpret and institutionalise vulnerability, fairness, and social investment. As demonstrated in the analysis of U.S. cap-and-trade programmes in Chapter 8 of this thesis, the way public bodies choose to spend carbon revenues is not merely a technical matter but a window into competing social contracts. With the EU’s Social Climate Fund now entering its operational phase, 27 Member States are poised to define, and, crucially, operationalise, their national visions of vulnerability and just transition. This presents an unparalleled opportunity for comparative research on how climate mitigation is socially embedded across different welfare regimes and political contexts. Such work could illuminate not just which approaches prove most equitable or durable, but how institutional design and political contestation shape the social outcomes of decarbonisation (Green, 2023; Lockwood, 2022)

Finally, future research should broaden its comparative scope to encompass a wider range of national contexts and welfare regimes. This thesis has primarily focused on justice and domestic energy deprivation in advanced European and North American settings, yet the principles it develops are relevant to other political economies where energy transitions pose acute distributional challenges. As governments worldwide confront the dual imperatives of decarbonisation and affordability, there is a pressing need to investigate how distributive and procedural justice can be embedded in different institutional and cultural settings. Particular attention should be paid to subsidy reform in contexts where fossil fuels are still subsidised across the board, blunting incentives for renewable deployment and locking in carbon-intensive energy systems. Identifying politically acceptable policy packages to reform these subsidies – without triggering social unrest – may be one of the most critical research frontiers for climate and energy policy alike, as also increasingly highlighted by the IMF (Montes de Oca Leon et al., 2024) and World Bank (Bambe et al., 2024).

As this thesis has argued, addressing these questions requires moving beyond neoclassical assumptions and prescriptions, and instead adopting a political economy perspective that is attentive to institutional constraints, questions of social legitimacy, and the real trade-offs governments must navigate in practice. Together, the analyses in this thesis show that a just energy transition hinges on three interlocking dimensions: how domestic energy deprivation is defined and measured; how interventions are designed and delivered; and how principles of justice are embedded in governance frameworks. Advancing a just energy transition depends on integrating these dimensions rather than addressing them in isolation. Linking diagnosis to delivery and embedding both in stable policy and governance arrangements provides the foundation for durable and legitimate progress. The future research agenda outlined above offers a practical pathway for testing, refining and institutionalising these alignments so that fairness becomes a defining and enduring feature of the transition ahead, rather than an afterthought.

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Appendices

Appendix 1 [Chapter 2]

Average fixed energy cost and tariffs in 2019 (Statistics Netherlands, 2022) and after fictional doubling in price

Energy source	Sort of cost	Name of cost	2019	Price shock
Natural gas	*Fixed cost (in Euros)*	*Transport tariff*	177.61	
		Standard supply tariff	66.53	
	Proportional cost	*Variable supply tariff*	0.3505	1.1956
	(Euros/kWh incl. VAT)	*RE duty*	0.06340	
		Energy taxation	0.35469	
Electricity	*Fixed cost (in Euros)*	*Transport tariff*	238.32	
		Standard supply tariff	66.46	
		Annual tax deduction	311.62	
	Proportional cost	*Variable supply tariff*	0.0803	0.3169
	(Euros/m^3 incl. VAT)	*RE duty*	0.02287	
		Energy taxation	0.11934	

Appendix 2 [Chapter 2]

Different construction periods, typologies, and size categories that together form 440 housing classes (Van Middelkoop & Kremer, 2020)

Typology
Apartment
Corner house
Semi-detached house
Townhouse (row house)
Detached house

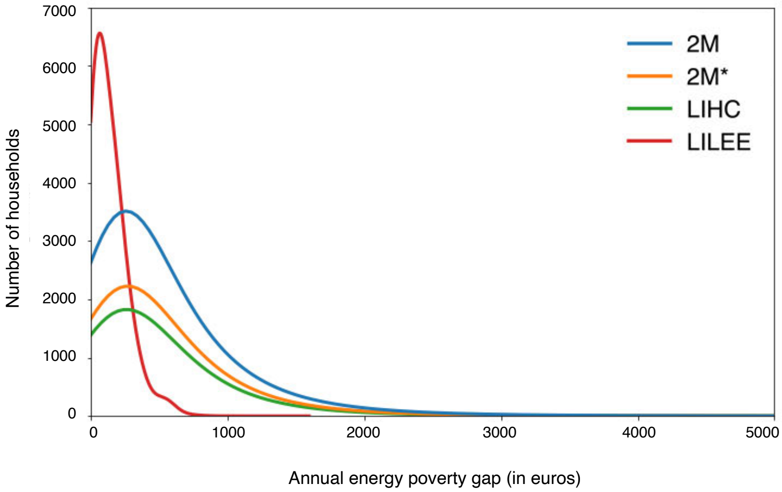
Construction period
< 1930
1930 – 1945
1946 – 1964
1965 – 1974
1975 – 1991
1992 – 1995
1996 – 1999
2000 – 2005
2006 – 2010
2011 – 2015
≥ 2015

Floor area (m^2)
< 15
15 – 50
50 – 75
75 – 100
100 – 150
150 – 250
250 – 500
> 500

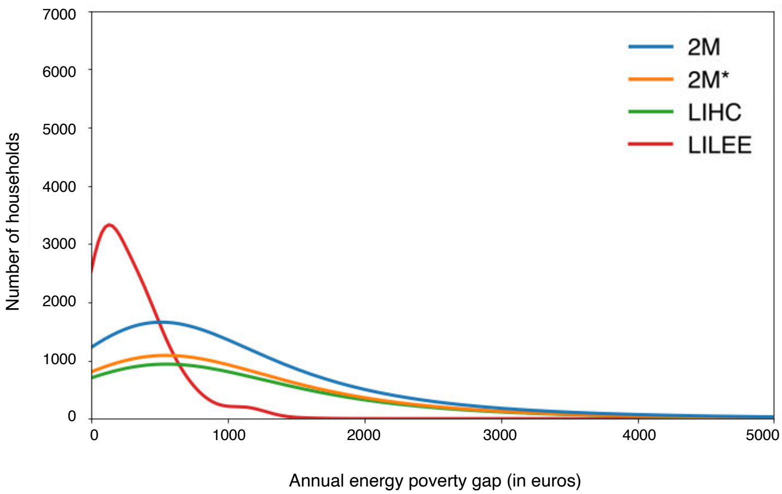
Appendix 3 [Chapter 2]

Two frequency graphs showing the distributions of energy poverty gaps according to the four indicators used in this study, with graph a. depicting distributions before the theoretical price shock, and b. after the price shock

a. Distributions before price shock

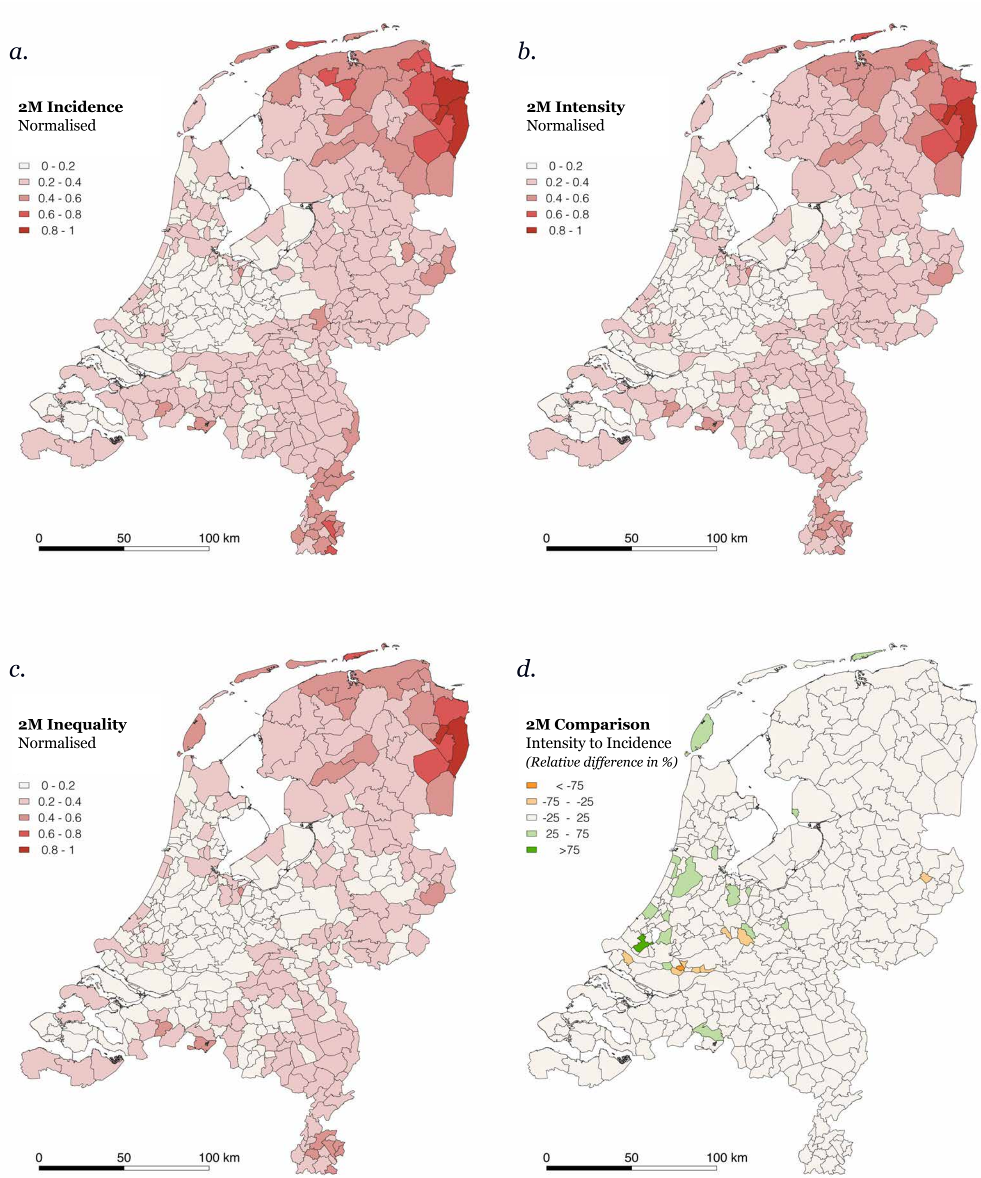


b. Distributions after price shock



Appendix 4 [Chapter 2]

Four maps depicting energy poverty per Dutch municipality according to the 2M indicator, with normalised scores for a.) incidence, b.) intensity, c.) inequality, and d.) relative intensity set against incidence to illustrate how national resource



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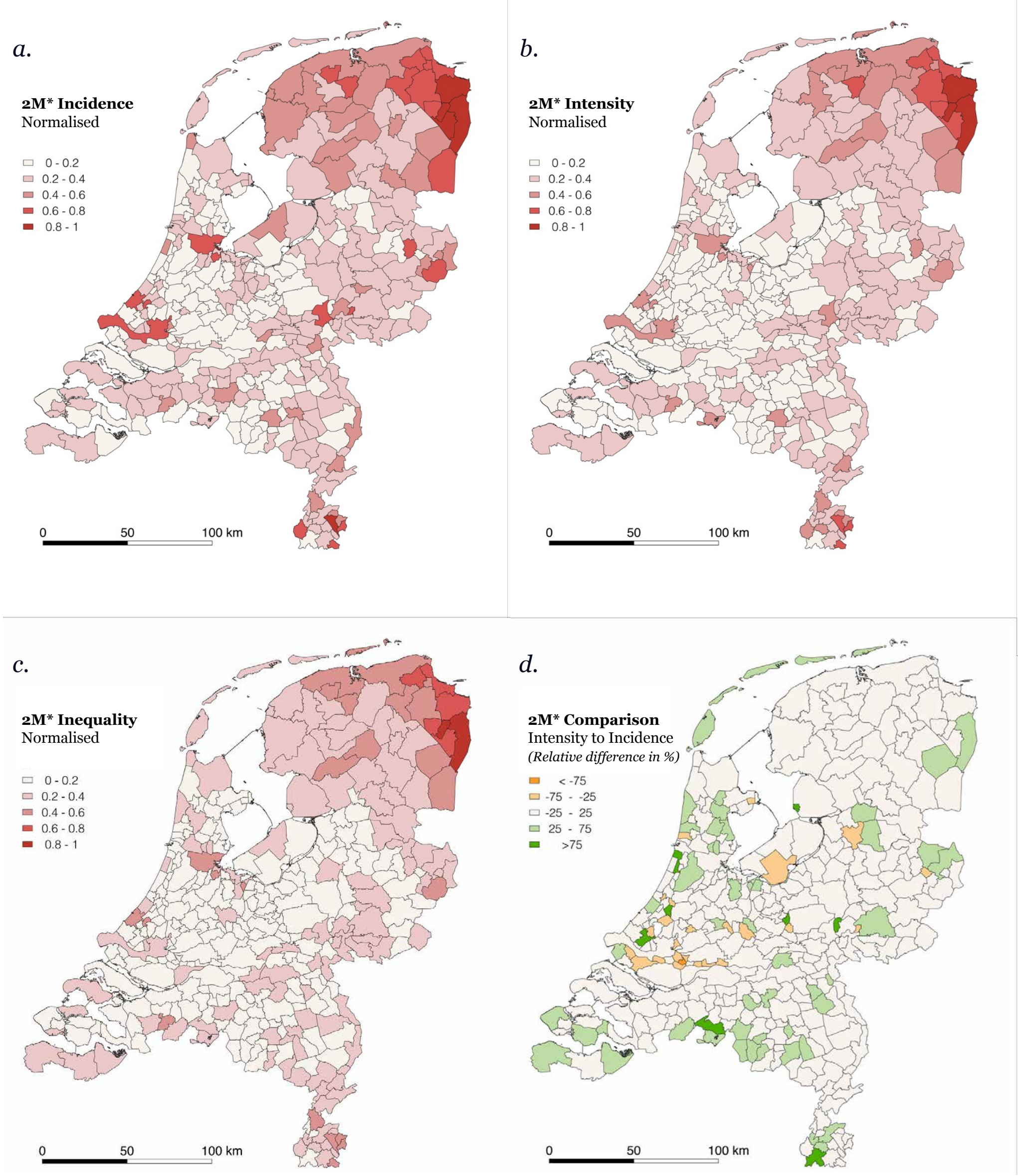
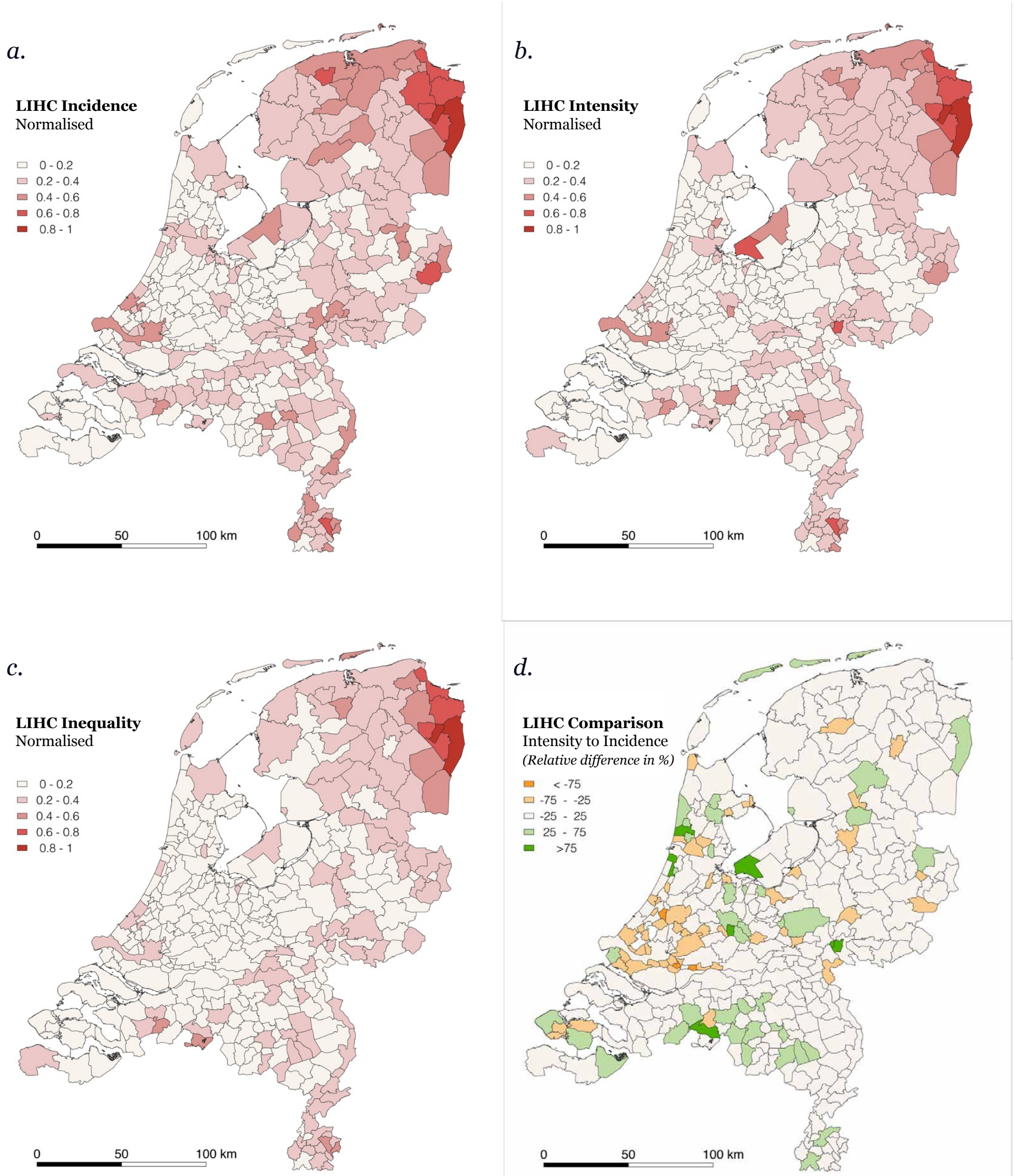
Appendix 5 [Chapter 2]

Four maps depicting energy poverty per Dutch municipality according to the 2M* indicator, with normalised scores for a.) incidence, b.) intensity, c.) inequality, and d.) relative intensity set against incidence to illustrate how national resource



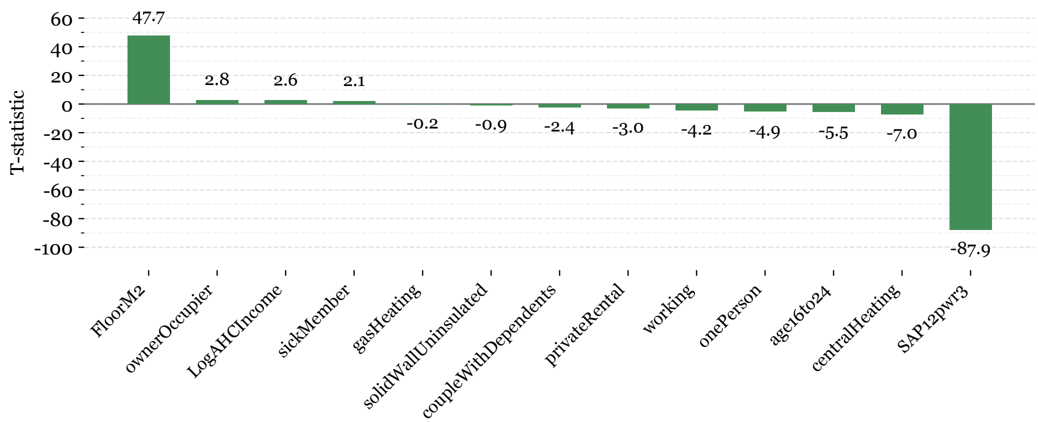
Appendix 6 [Chapter 2]

Four maps depicting energy poverty per Dutch municipality according to the 2M indicator, with normalised scores for a.) incidence, b.) intensity, c.) inequality, and d.) relative intensity set against incidence to illustrate how national resource



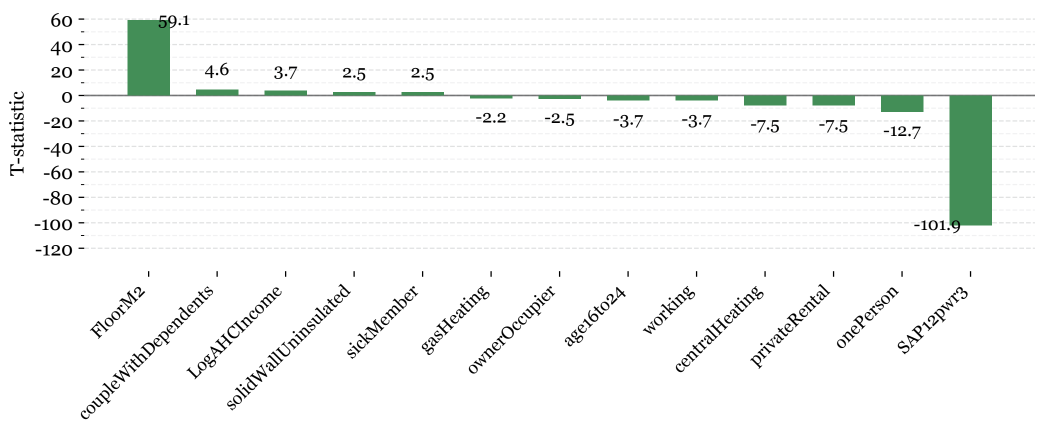
Appendix 7 [Chapter 3]

T-statistics low-income households (< 17,105) using variables transformed for normal distributions



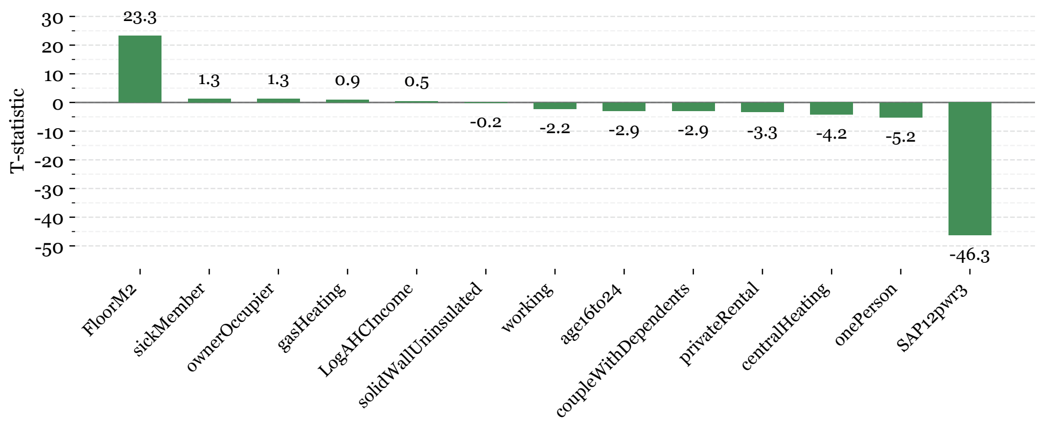
Appendix 8 [Chapter 3]

T-statistics high income (>= 17,105) using variables transformed for normal distributions



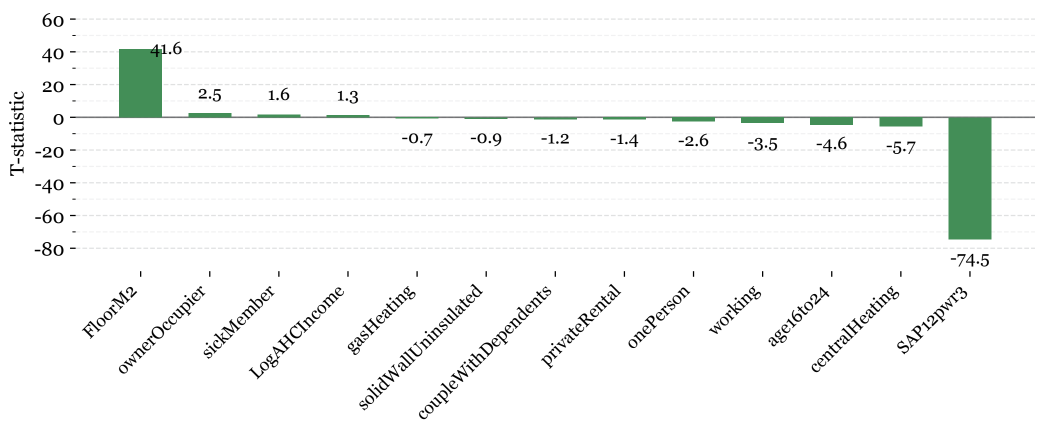
Appendix 9 [Chapter 3]

T-statistics very low income (< 9,000) using variables transformed for normal distributions



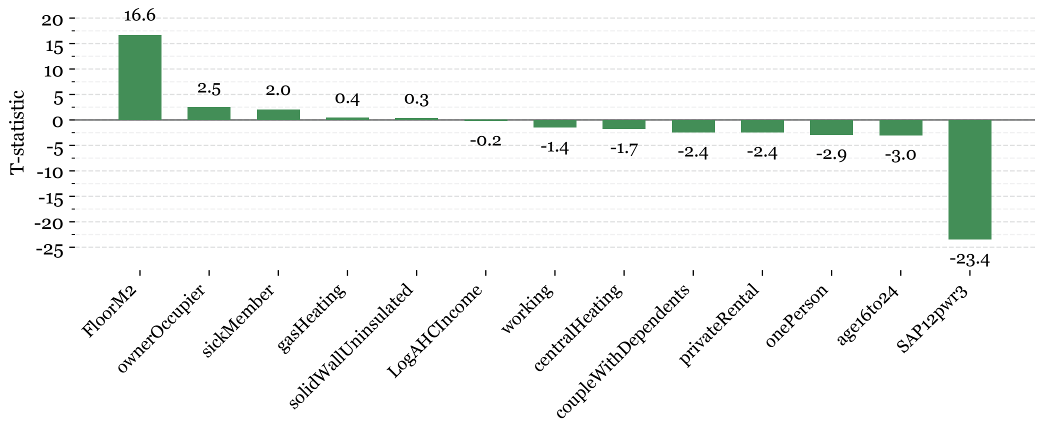
Appendix 10 [Chapter 3]

T-statistics mid low income (9,000 <= 17,105) using variables transformed for normal distributions



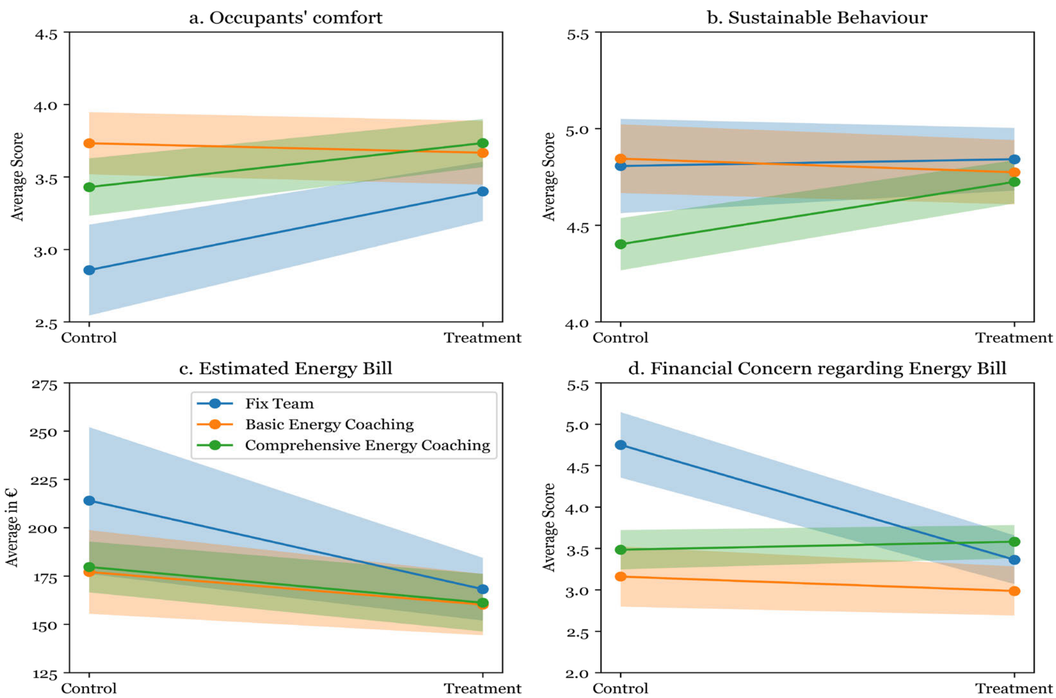
Appendix 11 [Chapter 3]

T-statistics, income < 9000, households not in energy poverty by LILEE indicator, using variables transformed for normal distributions



Appendix 12 [Chapter 5]

Comparison of unadjusted average outcomes between control group and treatment group per intervention



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Appendix 13 [Chapter 5]

Questionnaire

		Never	Rarely	Sometimes	Often	Frequently	Always
Occupants' comfort	Do you experience cold in your home?	☐	☐	☐	☐	☐	☐
	Do you experience draughts in your home?	☐	☐	☐	☐	☐	☐
	Do you experience dampness and/or mould in your home?	☐	☐	☐	☐	☐	☐
	Did you experience heat in your home last summer?	☐	☐	☐	☐	☐	☐
Sustainable behaviour	Do you turn off the lights in rooms where no one is present?	☐	☐	☐	☐	☐	☐
	Do you shower for less than 5 minutes?	☐	☐	☐	☐	☐	☐
	Do you put on a warm sweater or grab a blanket when you feel cold at home?	☐	☐	☐	☐	☐	☐
	At what temperature do you set the thermostat during the day?	Open answer (in °C)*					
Financial concern	Are you worried about paying your energy bill?	☐	☐	☐	☐	☐	☐
Estimated energy bill	How much do you pay monthly for your energy bill?	Open answer (in €)					

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Appendix 14 [Chapter 5]

Beta coefficients and standard errors for six GLM and ordered probit models evaluating the impact of three local interventions on four dependent variables with sequential control for outcome temperature (1 and 2), household characteristics (3 and 4), and dwelling features (5 and 6)

Basic Energy Coaching	(1) GLM	(2) Probit	(3) GLM	(4) Probit	(5) GLM	(6) Probit
Occupants' comfort		-0.007 (0.091)		-0.006 (0.096)		0.023 (0.099)
Sustainable behaviour		-0.029 (0.099)		-0.041 (0.105)		0.077 (0.111)
Financial concerns related to energy bill		-0.072 (0.098)		-0.099 (0.104)		-0.074 (0.109)
Estimated energy bill	-0.167 (0.102)		-0.204 (0.106)		-0.128 (0.111)	
Comprehensive Energy Coaching	**(1) GLM**	**(2) Probit**	**(3) GLM**	**(4) Probit**	**(5) GLM**	**(6) Probit**
Occupants' comfort		0.109 (0.070)		0.134 * (0.076)		0.144 * (0.076)
Sustainable behaviour		0.221 *** (0.071)		0.142 * (0.076)		0.144 * (0.077)
Financial concerns related to energy bill		0.035 (0.072)		0.014 (0.078)		0.007 (0.079)
Estimated energy bill	-0.159 * (0.093)		-0.140 (0.094)		-0.168 * (0.095)	
Fix Team	**(1) GLM**	**(2) Probit**	**(3) GLM**	**(4) Probit**	**(5) GLM**	**(6) Probit**
Occupants' comfort		0.229 * (0.121)		0.239 * (0.127)		0.338 ** (0.133)
Sustainable behaviour		-0.041 (0.130)		-0.134 (0.139)		-0.127 (0.143)
Financial concerns related to energy bill		-0.393 *** (0.136)		-0.397 *** (0.146)		-0.425 *** (0.153)
Estimated energy bill	-0.133 (0.128)		-0.068 (0.128)		-0.059 (0.132)	
Local Interventions (aggregated)	**(1) GLM**	**(2) Probit**	**(3) GLM**	**(4) Probit**	**(5) GLM**	**(6) Probit**
Occupants' comfort		0.084 * (0.049)		0.102 ** (0.051)		0.107 ** (0.052)
Sustainable behaviour		0.091 * (0.051)		0.051 (0.053)		0.053 (0.054)
Financial concerns related to energy bill		-0.085 (0.052)		-0.093 * (0.054)		-0.096 * (0.055)
Estimated energy bill	-0.164 *** (0.059)		-0.166 *** (0.058)		-0.144 ** (0.060)	

** α < 0.1, ** α < 0.05, *** α < 0.01. Standard errors given in parentheses*

Appendix 15 [Chapter 6]

Incidence and average depth of energy poverty by country before the crisis (2019), under crisis conditions without support (2022), and after fiscal support (2022), reporting the share of households classified as energy poor (defined in Section 6.4, includes transport overspending as well) and the average energy poverty gap among households classified as energy poor, where incidence changes little because thresholds are relative to national medians while the gap reflects hardship intensity

Country	2019 price level (pre-crisis)		2022 price level (pre-support)		2022 price level (post-support)	
	EP share (%)	Avg. EP gap	EP share (%)	Avg. EP gap	EP share (%)	Avg. EP gap
BE	13	858	13	1,379	8	787
BG	18	194	18	252	13	185
DE	12	635	12	881	6	563
DK	22	1,465	22	2,232	20	1,921
EE	25	521	25	938	15	783
EL	16	490	16	760	6	269
ES	17	659	17	896	11	537
FI	21	817	21	1,126	21	1,046
FR	19	1,027	19	1,287	13	1,182
HR	19	368	19	425	8	294
HU	12	311	12	399	12	389
IE	23	1,306	23	1,969	16	1,286
LT	22	466	22	715	10	481
LU	16	1,022	16	1,612	11	1,195
LV	21	370	21	511	9	489
NL	13	693	13	1,335	7	958
PL	19	560	19	810	13	685
SK	15	508	15	603	7	410

Appendix 16 [Chapter 6]

Adjustment factors for households' income and energy expenditure by country (2020-2022), based on EU-SILC for income and HICP for energy expenditure (Eurostat, 2023c)

	Energy expenditure		Factor per income decile									
	Domestic	Transport	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
BE	1.94	1.31	1.11	1.10	1.08	1.07	1.07	1.06	1.07	1.07	1.02	1.02
BG	1.24	1.33	1.03	1.13	1.15	1.16	1.18	1.23	1.20	1.25	1.05	1.05
DE	1.34	1.31	1.19	1.08	1.03	1.01	0.99	0.96	0.94	0.93	0.92	0.92
DK	1.5	1.29	1.06	1.03	1.05	1.07	1.09	1.08	1.08	1.08	1.07	1.07
EE	1.83	1.36	1.09	1.10	1.10	1.11	1.10	1.11	1.13	1.14	1.09	1.09
EL	1.52	1.25	1.06	1.01	0.99	0.95	0.92	0.94	0.93	0.96	0.80	0.80
ES	1.37	1.22	1.01	1.01	1.02	1.02	1.05	1.06	1.06	1.06	1.06	1.06
FI	1.29	1.3	1.06	1.05	1.06	1.06	1.05	1.04	1.05	1.06	1.05	1.05
FR	1.26	1.23	1.11	1.06	1.06	1.06	1.06	1.06	1.06	1.05	0.98	0.98
HR	1.16	1.27	1.12	1.14	1.19	1.16	1.13	1.07	1.07	1.10	0.89	0.89
HU	1.26	1.22	1.75	1.44	1.35	1.29	1.26	1.22	1.19	1.17	1.06	1.06
IE	1.48	1.35	1.05	1.13	1.11	1.05	1.07	1.09	1.13	1.09	1.06	1.06
LT	1.8	1.35	1.08	1.14	1.18	1.21	1.21	1.23	1.20	1.21	1.08	1.08
LU	1.21	1.39	1.11	1.15	1.16	1.17	1.18	1.15	1.12	1.10	1.12	1.12
LV	1.56	1.38	1.13	1.11	1.13	1.12	1.11	1.09	1.09	1.09	1.10	1.10
NL	2.52	1.25	1.13	1.09	1.09	1.09	1.08	1.09	1.10	1.09	1.04	1.04
PL	1.46	1.45	1.17	1.13	1.14	1.13	1.10	1.08	1.08	1.08	0.99	0.99
SK	1.17	1.26	0.79	0.89	0.95	0.95	0.94	0.94	0.96	0.98	0.96	0.96

Appendix 17 [Chapter 6]

Environmental sustainability scores by policy type

Policy type	Score	Rationale
Universal fossil fuel subsidies	0	Encouraging polluting energy use
Targeted fossil fuel subsidies	1	Encouraging polluting energy use, but minimising unnecessary incentives
Universal electricity subsidies	2	Supporting energy use with varying pollution levels
Targeted electricity subsidies	3	Supporting energy use with varying pollution levels, but minimising unnecessary support
Universal lump-sum transfers	4	Facilitating consumption that may (indirectly) increase pollution
Targeted lump-sum transfers	5	Facilitating consumption that may (indirectly) increase pollution while minimising unnecessary consumption
Universal green subsidies	6	Reducing long-term energy demand
Targeted green subsidies	7	Reducing long-term energy demand, while addressing accessibility barriers

Appendix 18 [Chapter 7]

Codebook and operational indicators for eligibility and policy function

Scale position	Code	Label	Operational indicator in documents
1. Eligibility coverage codes*			
Strongly residualist	E1	Direct means-testing	Explicit income thresholds
	E2	Benefit passporting	Eligibility via receipt of specified benefits
	E3	Vulnerability category	Conditional on formal categorisation as 'fuel poor', 'vulnerable', or 'at risk', as defined in policy documents
Moderately residualist	E4	Discretionary gatekeeping	Case-by-case allocation by Local Authorities/suppliers
	E5	Compliance requirements	E.g. audits, proofs, landlord consent, co-funding, installer restrictions
Intermediate/ hybrid	E6	Dwelling-based proxy targeting	EPC bands or housing condition thresholds
	E7	Tenure targeting	Owner-occupiers, private renters, or social housing tenants only
	E8	Geographic targeting	Area-based programmes (postcode, Local Authority, etc.)
Moderately universalist	E9	Demographic entitlement	Age without means testing (e.g. pensioners)
Strongly universalist	E10	Universal household eligibility	Applies to all domestic customers or residents without screening
2. Policy function codes**			
Strongly compensatory	F1	Weather-triggered compensation	Payments activated by temperature thresholds or extreme weather conditions
	F2	Crisis price cap	Temporary caps on unit rates or standing charges to shield households from price shocks
	F3	Social tariff	Regulated discounts on energy bills for eligible groups
Moderately compensatory	F4	Flat-rate bill rebate	Fixed bill credits applied to accounts
	F5	Lump-sum transfer	One-off or periodic cash payments not directly linked to energy use
Moderately preventive	F6	Information and advice	Energy advice, audits, or one-stop-shops
	F7	Heating system upgrades***	Boiler replacement, heat pumps, heating controls
	F8	On-site renewables***	Solar PV, solar thermal, or household-scale renewable generation
	F9	Fabric insulation measures***	Insulation, glazing, and draught-proofing measures
Strongly preventive	F10	Whole-house/deep retrofit	Integrated multi-measure retrofits targeting long-term demand reduction

** Classification also took account of cross-cutting design features, such as automatic enrolment versus application-based access, which affect effective access and were used to refine relative placement along the eligibility scale.*
*** Regulatory approaches (e.g. minimum energy performance standards) are widely regarded as best practice for achieving durable demand reduction but operate through compliance rather than household support.*
**** These measures vary in scope and impact depending on technology choice, dwelling characteristics, and depth of intervention. Placement along the scale reflects specific policy design assessment.*

Appendix 19 [Chapter 7]

Substantiation of UK domestic energy policy landscape by policy function, eligibility, and budget allocation

Policy (à reform)	Compensatory/preventive	Residualist/universalist	Budget
Boiler Upgrade Scheme (BUS)	Narrow preventive focus (low-carbon heating only)	Broadly universal (open to homeowners/private tenants with consent)	£150M/yr (2022-2025); £295M allocated for 2025-2026
Cold Weather Payment (CWP)	Highly compensatory; triggered only in periods of vulnerability (extreme cold)	Strongly residualist; limited to eligible benefits recipients in cold areas	Avg. ~£40M/yr (fluctuating: £27.5K in 2013-14, £118.7M in 2017-18)
Energy Bills Support Scheme (EBSS)	Highly compensatory; direct flat-rate payment in response to crisis	Strongly universalist; applied automatically to all domestic electricity customers	£11.7B (2022–2023)
Energy Company Obligation (ECO3) à ECO4 and Great British Insulation Scheme (GBIS)	ECO3 moderately preventive; ECO4 more preventive (holistic); GBIS less preventive (insula-tion-focused)	ECO3 residual (low-income/ vulnerable); ECO4 narrower targeting; GBIS broader eligibility	ECO3 £450M/yr (2018-2022); ECO4 £1B/yr (2022-2026); GBIS £333M/yr (2023-2026)
Energy Price Guarantee (EPG)	Highly compensatory; short-term cap on unit prices to limit household exposure to price surges	Highly compensatory; short-term cap on unit prices to limit household exposure to price surges	£11.7B/yr (in total £23.4B from 2022- March 2024)
Green Homes Grant (GHG)	Strong preventive intent (primary insulation/low-carbon measures; secondary available)	Broadly universal (homeowners/ private landlords), higher subsidies for benefit recipients	Intended £1.5B (~9 months); £314M actually spent
Home Upgrades Grant (HUG)	Broad, comprehensive and integrated range of energy efficiency upgrades	Strongly residualist; targeted to low-income, off-grid, EPC D-G dwellings	£350M/yr (£700M total for 2023-2025)
Local Authority Delivery (LAD) à Warm Homes: Local Grant (WH:LG)	Limited prevention pre-2025 (minor upgrades); expanded deeper measures thereafter	Strongly residual until 2025 (low-income, inefficient homes); since then broader local criteria	LAD £287M/yr (2022-2023); WH:LG £206M/yr (total £412M for 2026-2028)
Social Housing Decarbonisation Fund (SHDF) à Warm Homes: Social Housing Fund (WH:SHF)	SHDF preventive ('fabric-first' insulation/heating measures); WH:SHF expanding scope (renewable generation, heating)	Targeted universalism; all inefficient social housing (EPC D-G)	SHDF £380M/yr (£3.8B total over 10 years from 2021); WH:SHF £433M/yr (£1.3B total for 2024-2027)
Warm Front (WF)	Preventive focus primarily on heating and basic insulation upgrades	Increasingly residual (low-income, vulnerable households targeted)	Varied annually; peak £345M in 2010-2011
Warm Home Discount (WHD)	Moderately compensatory (rebate-based); increasing in compensation 2022-2025 due to high-cost threshold	Residual but expanding: ~2.3M households pre-2022; ~3M (2022-2025); ~6M from 2025	~£350M/yr pre-2022, £475M/yr (2022-2025), £1B/yr from 2025
Winter Fuel Payment (WFP	Limited compensation; general lump-sum transfers rather than bill support	Highly universal until 2024 (all pensioners); residual from 2024 (~1.3M low-income pensioners)	~£2B/yr until 2024, ~£500M/ yr thereafter

Appendix 20 [Chapter 9]

Targeting criteria and indicator composition per state

Category	Indicators	Category weight
A. New York State (Disadvantaged Communities Criteria)		
Potential climate change risks	- Extreme heat projections [d] - Flooding in coastal and tidally influenced areas [d] - Flooding in other waterbodies [d] - Low vegetative cover [d] - Agricultural land [d] - Driving time to hospitals or urgent-care centres [d] - Limited evacuation routes [d]	2 (each indicator ≈3.6% of total)
Land use and facilities associated with historical discrimination or disinvestment	- Proximity to remediation sites [g] - Proximity to regulated management plan sites [g] - Proximity to major oil storage facilities [g] - Proximity to power generation facilities [g] - Proximity to active municipal waste combustors [g] - Proximity to scrap metal processors [g] - Industrial/manufacturing/mining land use [g]	1 (each indicator ≈1.8% of total)
Potential pollution exposures	- Vehicle traffic density (diesel truck) [f] - Particulate matter ($PM_{2.5}$) [f] - Benzene concentration [f] - Wastewater discharge [f]	1 (each indicator ≈3.1% of total)
Income	- Percent <80% area median income [a] - Percent <100% of federal poverty line [a] - Percent without bachelor’s degree [a] - Unemployment rate [a] - Percent single-parent households [a]	1 (each indicator ≈2.5% of total)
Race and Ethnicity	- Percent Latino/a or Hispanic [b] - Percent Black or African American [b] - Percent Native American or Indigenous [b] - Limited English proficiency [b] - Historical redlining score [b]	1 (each indicator ≈2.5% of total)
Health Outcomes & Sensitivities	- Asthma emergency department visits [e] - COPD emergency department visits [e] - Cardiovascular disease (MI) hospitalization [e] - Premature deaths [e] - Low birth weight [e] - Percent without health insurance [e] - Percent with disabilities [e] - Percent adults age 65+ [e]	1 (each indicator ≈1.6% of total)
Housing Mobility & Communications	- Percent renter-occupied homes [c] - Housing cost burden (rental costs) [c] - Energy poverty / cost burden [c] - Manufactured homes [c] - Homes built before 1960 [c] - Percent without internet [c]	1 (each indicator ≈2.1% of total)

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Category	Indicators	Category weight
B. California (CalEnviroScreen 4.0)		
Pollution burden (exposure)	- Ozone concentrations in air [f] - PM2.5 concentrations in air [f] - Diesel particulate matter emissions [f] - Drinking water contaminants [f] - Children's lead risk from housing [f] - Use of certain high-hazard, high-volatility pesticides [f] - Toxic releases from facilities [f] - Traffic impacts [f]	2 (each indicator ≈4.2% of total)
Pollution burden (environmental effects)	- Cleanup sites [g] - Groundwater threats [g] - Hazardous waste facilities and generators [g] - Impaired water bodies [g] - Solid waste sites and facilities [g]	1 (each indicator ≈3.3% of total)
Population characteristics (sensitive populations)	- Asthma [e] - Cardiovascular disease [e] - Low birth weight infants [e]	1.5 (each indicator ≈8.3% of total)
Population characteristics (socioeconomic factors)	- Educational attainment [a] - Housing-burdened low-income households [c] - Linguistic isolation [b] - Poverty [a] - Unemployment [a]	1.5 (each indicator =5% of total)
C. Washington State (Environmental Health Disparities Map)		
Environmental exposures	- Diesel emissions (PM2.5-diesel) [f] - Ozone concentration [f] - PM2.5 concentration [f] - Proximity to heavy traffic roadways [f] - Toxic releases from facilities (RSEI model) [f]	1 (each indicator =5% of total)
Environmental effects	- Lead risk from housing [g] - Proximity to hazardous waste treatment, storage, and disposal facilities (TSDFs) [g] - Proximity to National Priorities List (Superfund) sites [g] - Proximity to Risk Management Plan (RMP) facilities [g] - Wastewater discharge [f]	1 (each indicator =5% of total)
Sensitive populations	- Death from cardiovascular disease [e] - Low birth weight [e]	1 (each indicator =12.5% of total)
Socioeconomic factors	- Limited English [b] - No high school diploma [a] - Poverty [a] - Race – people of colour [b] - Transportation expense [c] - Unaffordable housing [c] - Unemployed [a]	1 (each indicator ≈3.6% of total)

[a] = Socioeconomic Factors (education, income, employment), [b] = Ethnicity & Historical Redlining, [c] = Housing, Energy & Mobility, [d] = Climate Change Risks, [e] = Health Outcomes & Vulnerability, [f] = Pollutant Exposure, [g] = Historical Environmental Burden

Appendix 21 [Chapter 9]

Harmonised spending data for state-level cap-and-trade revenues by category and time period

Spending data were compiled from official programme-level documents published by state agencies responsible for cap-and-trade revenue allocation: NYSERDA (2025), California Climate Investments (2025a, 2025b), and the Washington State Department of Ecology (2024). Where categorisation was unclear, additional project-level documentation and implementation reports were consulted to ensure consistent interpretation. All figures reflect author-applied category groupings based on these primary and supporting sources.

Category	Appropriation	% of Total
A. New York State (Regional Greenhouse Gas Initiative), Fiscal Year 2024-2025		
Building Energy Retrofits	$146,855,847	33.6%
Private Transport (EV)	$89,900,000	20.6%
Clean Energy	$79,970,544	18.3%
Research & Skills	$66,805,847	15.3%
Administration	$32,491,689	7.4%
Nature & Climate Resilience	$19,550,000	4.5%
Infrastructure	$1,500,000	0.3%
Public Transport	$0	0.0%
Energy Bill Assistance	$0	0.0%
Affordable Housing	$0	0.0%
B. New York State (Regional Greenhouse Gas Initiative), Cumulative 2019-2024		
Clean Energy	$703,976,247	32.9%
Building Energy Retrofits	$620,181,024	29.0%
Research & Skills	$291,763,541	13.6%
Administration	$233,552,171	10.9%
Private Transport (EV)	$172,530,948	8.1%
Nature & Climate Resilience	$100,362,241	4.7%
Infrastructure	$16,103,150	0.8%
Public Transport	$1,909,656	0.1%
Energy Bill Assistance	$0	0.0%
Affordable Housing	$0	0.0%

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Category	Appropriation	% of Total
C. California (Greenhouse Gas Reduction Fund & California Carbon Credit), Fiscal Year 2024-2025		
Energy Bill Assistance*	$2,370,000,000	39.3%
Nature & Climate Resilience	$1,296,000,000	21.5%
Public Transport	$1,233,000,000	20.5%
Infrastructure	$557,600,000	9.3%
Affordable Housing	$326,000,000	5.4%
Administration	$89,459,190	1.5%
Clean Energy	$75,000,000	1.2%
Private Transport (EV)	$53,000,000	0.9%
Research & Skills	$23,000,000	0.4%
Building Energy Retrofits	$0	0.0%
D. California (Greenhouse Gas Reduction Fund & California Carbon Credit), Cumulative 2015-2024		
Public Transport	$11,952,000,000	28.7%
Energy Bill Assistance*	$11,170,000,000	26.8%
Affordable Housing	$5,449,500,000	13.1%
Nature & Climate Resilience	$5,404,600,009	13.0%
Private Transport (EV)	$4,346,000,000	10.4%
Infrastructure	$1,175,500,000	2.8%
Clean Energy	$842,250,000	2.0%
Administration	$773,200,000	1.9%
Research & Skills	$283,900,000	0.7%
Building Energy Retrofits	$250,750,009	0.6%
E. Washington State (Climate Commitment Act Funds)		
Public Transport	$585,211,000	23.7%
Nature & Climate Resilience	$553,917,218	22.4%
Infrastructure	$429,625,513	17.4%
Clean Energy	$265,457,167	10.7%
Energy Bill Assistance	$185,000,000	7.5%
Building Energy Retrofits	$167,441,000	6.8%
Private Transport (EV)	$133,198,513	5.4%

** This refers to the California Climate Credit, which is distinct from the other items as it is not a state appropriation but a utility bill credit administered by the California Public Utilities Commission and financed through cap-and-trade revenue.*

Curriculum Vitae

Tijn Melle Croon

Tijn Croon is a public policy scholar who recently joined the European Commission as a Programme Manager, overseeing the Social Climate Fund and the social dimension of the European Semester, with primary responsibility for the Netherlands. In this capacity, he works to translate insights from his doctoral research into the design, delivery, and monitoring of EU policy.

From an early age, Tijn developed a curiosity about how economic systems shape social inequality. After studying political economy at the University of Amsterdam, he completed a master's in geography at King's College London, graduating with first-class honours and receiving the Best Geography Thesis Award for his research mapping household vulnerability to climate change across urban areas. Curious about how major institutions reconcile financial incentives with social and environmental objectives, he completed internships and traineeships at the Bank of England, Siemens, and ING, before joining Rotterdam-based advisory firm Springco Urban Analytics.

In 2021, his interest in what defines a 'just transition' led him back to academia. He joined Delft University of Technology as a Marie Skłodowska-Curie PhD fellow within the RE-DWELL Innovative Training Network, drawn by a position focused on the tensions between affordability and sustainability in the built environment. His doctoral work was further shaped by visiting appointments at TNO, where he developed Dutch energy poverty statistics; the University of Cambridge, where he analysed the income elasticity of energy spending and the targeting of household energy support; and Columbia University, where, as a Fulbright Scholar, he studied how U.S. states embed equity provisions into the revenue recycling of carbon pricing schemes.

Beyond academia, Tijn has been actively engaged in progressive politics and policy advocacy. He has organised training sessions for political parties and activists in Eastern Europe with the Foundation Max van der Stoel, co-authored the Labour Party's 2022 Amsterdam manifesto, and serves as a Fellow at the Foundation for European Progressive Studies (FEPS). These experiences reflect his conviction that social progress depends not merely on ideals, but on the practical capacity to translate them into collective action.

Employment

2025-present **European Commission,** Brussels, Belgium
Programme Manager Social Climate Fund and European Semester

2024-present **Foundation for European Progressive Studies,** Brussels, Belgium
9th Cycle Young Academic Network Fellow

2021-present **Delft University of Technology,** Delft, Netherlands
Doctoral Candidate and Teacher's Assistant

2024-2025 **Columbia University,** New York, NY
Visiting Fulbright Scholar at Center on Global Energy Policy (SIPA)

2021-2024 **TNO,** Amsterdam, Netherlands
Visiting Researcher at TNO Energy Transition Studies

2023 **Cambridge University,** Cambridge, United Kingdom
Visiting Researcher at Downing College, Cambridge

2020-2021 **Springco Urban Analytics,** Rotterdam, Netherlands
Consultant Urban Analytics

Education

May 2026 **Delft University of Technology**, Ph.D. in Public Policy, *Defence May*
Award: Marie Skłodowska-Curie Scholarship, Fulbright Scholarship

2020 **King's College London**, M.Sc. in Geography, *First class distinction*
Honours: Distinction (79%)
Award: Best Geography Thesis Award

2018 **University of Amsterdam**, M.Sc. in Political Economy,
Honours: Merit (GPA 7.83)

2017 **University of Amsterdam**, B.Sc. in Political Science
Award: Zeytun Academic Exchange

Teaching

2025 **European Environmental Policy**
Georgetown University, Washington DC, United States

2023 **Urban (Re)Development Game**
AMS Institute, Amsterdam, Netherlands

2023 **KSE Urban Planning Summer School**
Kyiv School of Economics, Online

2022-2023 **Academic Skills (AC1)**
Faculty of Architecture and the Built Environment, TU Delft, Delft, Netherlands

2022-2023 **Energy Affordability, Minor 'Poverty Interventions'**
Amsterdam University of Applied Sciences, Amsterdam, Netherlands

Selected Publications

Peer-Reviewed Journal Articles (Published)

Croon, T. M., Nia, E. M., He, S., Qian, Q. K., Elsinga, M. G., Hoekstra, J. S. C. M., Van Ooij, C., & Van der Wal, A. J. (2025). Energy coaching and 'fix team' retrofitting to mitigate energy poverty: An ex-post analysis of treatment and interaction effects. *Energy Research & Social Science, 119*, 103807.

Bokhorst, D., Bokhorst, M., & Croon, T. (2025). Cities as social investment frontrunners: the case of Amsterdam as innovator and welfare stopgap. *Journal of Social Policy*, 1-17.

Galvin, R., Sunikka-Blank, M., & Croon, T. (2024). Juggling the basics: How much does an income increase affect energy spending of low-income households in England?. *Energy Research & Social Science, 118*, 103766.

Croon, T. M., Hoekstra, J. S. C. M., & Dubois, U. (2024). Energy poverty alleviation by social housing providers: A qualitative investigation of targeted interventions in France, England, and the Netherlands. *Energy Policy, 192*, 114247.

Croon, T. M., Hoekstra, J. S. C. M., Elsinga, M. G., Dalla Longa, F., & Mulder, P. (2023). Beyond headcount statistics: Exploring the utility of energy poverty gap indices in policy design. *Energy Policy, 177*, 113579.

Peer-Reviewed Journal Articles (Forthcoming)

Croon, T. M., & Sokołowski, J. (under review). Fiscal Responses to the European Energy Crisis Comparing Trade-Offs in the Targeting of Household Relief Measures. *Journal of European Social Policy*.

Croon, T. M., Elsinga, M. G., Hoekstra, J. S. C. M., Sunikka-Blank, M., & Galvin, R. (under review). For the Few, Not the Many: Tracing the Residualist and Compensatory Nature of British Energy Support. *Environmental Policy and Governance*.

Croon, T. M., & Hernández, D. (under review). (Re)distributing Carbon Pricing Revenues: Embedding Equity Provisions in U.S. State-Level Cap-and-Trade Programs. *Climate Policy*.

Croon, T. M. (under review). The Climate-Social Nexus in the European Green Deal: Layered Reforms of Paradigm Shift?. *Journal of European Public Policy*.

Book Chapters

Bokhorst, D., Bokhorst, M., & Croon, T. M. (forthcoming). Amsterdam as Social Investment Frontrunner: Innovator and Welfare Stopgap. In A. Hemerijck & G. Scalise (Eds.), *Subnational Social Investment Strategies across Europe*. Oxford University Press.

Op-Eds & Interviews

Croon, T. M., Chahim, M., Bots, K., & Busscher, F. (2024). Waarom Nederland baat heeft bij een Europese groene industriedeal. *Economische Statistische Berichten, 109*(4837S), 40-45.

Croon, T. M. (2024, November 19). Gratis Lunch is wél sleutel tot hervormingen. *Het Financieele Dagblad*. Retrieved from [URL].

Croon, T. M. (2024, November 14). No such thing as a free lunch: Indonesia's plans may prove critics wrong. *The Jakarta Post*. Retrieved from [URL].

Leijsen, R. (2024, September 22). Interview Tijn Croon: Europees industriebeleid moet ook de verliezers compenseren. *Economische Statistische Berichten*. Retrieved from [URL].

Croon, T. M. (2024, September 17). Interview Tijn Croon: Ieder-voor-zich-industriebeleid EU 'inefficiënt en oneerlijk'. *BNR Nieuwsradio*. Retrieved from [URL].

Croon, T. M. (2023). Voor effectieve armoedebestrijding moet het CPB anders ramen. *Economische Statistische Berichten, 108*(4825), 417-419.

Croon, T. M. (2022, January 18). Hoe kunnen we de hoge energieprijzen beter compenseren?. *NPO Radio 1*. Retrieved from [URL].

Croon, T. M., & Brouns, S. (2022, January 16). Compensatie voor de hoge energieprijzen kan een stuk gerichter. *De Volkskrant*. Retrieved from [URL].

Reports and Commentaries

Mulder, P., Dalla Longa, F., & Croon, T. M. (2024). De energiearmoedekloof in Nederland Een microdata-analyse van het niveau en de ongelijkheid van energiearmoede. *TNO R11693*.

Batenburg, A., Schuurman Hes, T., Croon, T. M., Wijlhuizen, E., & Van Tilburg, X. (2023). Energiearmoede in Noord-Holland. *TNO P11481*.

Croon, T. M., Hoekstra, J. S. C. M., & Dubois, U. (2023). Addressing Energy Poverty in Social Housing Estates. *European Federation for Living*.

Croon, T. M. (2023). Energiearmoede: een ruimtelijk verdelingsvraagstuk. *AGORA Magazine 38*(3), 14-16. https://doi.org/10.21825/agora.90020.

Pittini, A., Turnbull, D., & Croon, T. M.. (2023). The State of Housing in Europe 2023. *Housing Europe*.

Lausberg, P., & Croon, T. (2023). Europe must fight energy poverty more effectively. *European Policy Center*.

Peer Reviews

2024-present **International Journal of Housing Policy**
2023-present **Housing Studies**
2022-present **Energy Research & Social Science**

Selected Public Presentations

Croon, Tijn (February 2025). Invited Speaker. (*Equitable Energy Transition)* at the Energy Opportunity Lab of the Center on Global Energy Policy at Columbia University, On-Campus Event in New York, NY, US.

Croon, Tijn (November 2024). Invited Speaker. (*Cap-and-Trade Revenue Recycling)* at Kleinman Center for Energy Policy at University of Pennsylvania, On-Campus Event in Philadelphia, PA, US.

Croon, Tijn (October 2024). Panel Discussant. (*Commodity Price Volatility and Sustainable Development Goals)* at the United Nations Department of Economic and Social Affairs, In-Person Event in New York, NY, US.

Croon, Tijn et al. (August 2024). Co-Organiser and Speaker. (*Local Energy Poverty Interventions)* at the ENHR Conference's Working Group on Energy Efficiency, On-Campus Event in Delft, Netherlands.

Croon, Tijn (July 2024). Delegate and Speaker. (*Green Industrial Policy)* at the FEPS Academic Seminar, In-Person Event in Vienna, Austria.

Croon, Tijn (July 2024). Paper Presenter. (*Subnational Social Investment in Energy Transition)* at the Council for European Studies 30th International Conference of Europeanists, In-Person Event in Lyon, France.

Croon, Tijn (June 2024). Panel Discussant. (*Advancing an Energy Minimum Right)* at the FEPS and Friedrich-Ebert-Stiftung, In-Person Event in Brussels, Belgium.

Croon, Tijn (May 2024). Invited Speaker. (*Just Energy Transition)* at the Strategy Department of De Nederlandsche Bank (Dutch Central Bank), In-Person Event in Amsterdam, Netherlands.

Croon, Tijn (March 2024). Invited Speaker. (*Structural Energy Market Reform)* at the Instituut voor Publieke Economie, Virtual Event.

Croon, Tijn (December 2023). Paper Presenter. (*Cap-and-Trade Revenue Recycling)* at the Cambridge Centre for Environment, Energy and Natural Resource Governance Research Symposium, In-Person Event in Cambridge, United Kingdom.

Volunteer Activities

- International House NYC, *Event coordinator*
- Kamala Harris for President 2024, *Campaign volunteer*
- Foundation Max van der Stoel, *Trainer*
- Stichting Woon, *Energy Coach*
- Labour Party Amsterdam, *Co-author, 2022 Election Manifesto*

TOC

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Justice, Welfare, and the Energy Transition

Comparative Policy Pathways Towards Addressing Domestic Energy Deprivation

Tijn Croon

The energy transition is often framed as a technological and economic challenge, but its durability ultimately depends on something more fragile: social legitimacy. As energy prices rise and decarbonisation policies reshape everyday life, domestic energy deprivation – the inability of households to attain adequate energy services in the home – has emerged as a new social risk at the intersection of social, housing, and energy policy. When households cannot afford to heat their homes or must choose between energy and other basic needs, climate policy ceases to appear as a collective project and instead becomes a source of grievance. This thesis argues that preventing such deprivation is therefore not a peripheral social concern but a central condition for sustaining public support for the energy transition. Drawing on a sufficiency-oriented perspective on justice, it explores what a minimum social standard of domestic energy services entails and how it can be safeguarded as societies decarbonise. Yet contemporary welfare states remain poorly equipped to address this risk. These institutions were built to manage industrial-era risks tied to labour markets and demographic change, not the distributional consequences of transforming energy systems and housing infrastructures. Against this backdrop, this thesis examines how domestic energy deprivation can be identified, what structural drivers give rise to it, and which policy responses can effectively alleviate it. Through a combination of quantitative and qualitative analysis, it investigates different interventions and the institutional settings in which they emerge, thereby exploring how social protection can be future-proofed to underpin a just energy transition.

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