Energy Poverty, Housing and Vulnerability in Canada

A literature review

Abhilash Kantamneni

Efficiency Canada

Carleton University

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1125 Colonel By Drive

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abhilash.kantamneni@efficiencycanada.org

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About the author

Abhilash Kantamneni is an Efficiency Canada research manager specializing in energy poverty and low-income energy efficiency. He has a Master of Science in Physics, and Computer Science from Michigan Tech, and a Bachelor of Engineering in Electrical Engineering from Anna University. Before joining Efficiency Canada, he worked with communities across the U.S. and Canada to achieve local priorities, including improved housing, increased good jobs and reduced poverty.

About Efficiency Canada

Efficiency Canada is the national voice for an energy-efficient economy. Our mission is to create a sustainable environment and better life for all Canadians by making our country a global leader in energy efficiency policy, technology, and jobs. Efficiency Canada is housed at Carleton University's Sustainable Energy Research Centre, which is located on the traditional unceded territories of the Algonquin nation.

The views expressed, as well as any errors or omissions, are the sole responsibility of the authors.

About Create Climate Equity

Create Climate Equity is a not-for-profit that advocates for energy and climate policies and programs that are equitable, just, and effective for all. It achieves this through the delivery of energy efficiency programs and the incubation of innovative energy research and projects.

Summary

Energy poverty and housing vulnerability are critical issues affecting many Canadians. The lack of access to affordable, reliable, and modern energy services coupled with inadequate housing conditions can have severe consequences for individuals, families, and communities across the country. While there is significant international literature and emerging Canadian literature on energy poverty and its impacts, the links between energy poverty and housing vulnerability are not well understood.

The goal of this literature review and annotated bibliography is to bring research on energy poverty and housing vulnerability into closer dialogue by exploring the intersection between these issues, particularly in the Canadian context. Understanding how energy poverty and housing vulnerability interact can help diagnose the drivers, risks and outcomes of the co-occurring problems, coordinate policy responses, and direct resources toward alleviating their negative impacts for all Canadians.

To this end, Section 1 sheds light on energy poverty as a complex and multidimensional phenomenon that spans many disciplinary boundaries. We highlight papers that explore the historical evolution of the term 'energy poverty', and the socioeconomic, demographic, and geographic patterning of energy poverty. We highlight the recent turn in literature towards conceptualizing energy poverty in terms of vulnerability - as the potential for future harms arising out of experiences with energy poverty. This offers us a conceptual entry point into the literature on energy justice, which calls for a nuanced understanding of lived experiences and highlights the need for tailored and effective policy interventions.

Section 2 provides a brief overview of the emerging body of literature on energy poverty from the Canadian perspective, and how it is linking up to, and contributing to, global research on energy poverty and vulnerability.

Section 3 highlights literature on definitions, metrics and measures of energy poverty, including how energy poverty emerges as a conceptual category and policy priority distinct from general poverty. Then, we highlight papers exploring the complexities and trade-offs associated with different measures and metrics of energy poverty, with implications for targeted supports and policy interventions.

Section 4 traces the links between energy poverty and housing-related vulnerability. We explore how energy poverty is linked to housing standards and housing costs. We then outline how housing conditions and energy poverty are linked together as social determinants of adverse health outcomes and how coping mechanisms by households experiencing energy poverty increase the risk of health-related housing outcomes. We highlight studies evaluating how energy-efficient housing interventions can improve well-being while recognizing the methodological challenges associated with establishing robust causal links between them. We also point to the emerging literature on social patterning of vulnerability to energy-related housing outcomes and note the challenges associated with establishing causal links between defining 'households that need policy support the most' with energy poverty and health. We conclude this section by reflecting on the recent turn in housing literature towards defining housing vulnerability as a 'risk of undesirable harms and its conceptual linking with energy poverty literature's turn towards defining energy vulnerability as a 'risk of future harms'.

Section 5 covers literature that offers a critical analysis of energy poverty policy interventions such as social tariffs, subsidy programs and targeted energy efficiency interventions. We highlight challenges associated with evaluating the effectiveness of energy poverty policy, such as the complexity of underlying drivers of energy poverty and methodological challenges with defining 'vulnerable groups'. We then outline growing consensus in the literature on the need for a more precise understanding of vulnerability in the context of policy interventions and highlight calls for incorporating lived experiences, developing novel participatory mechanisms and incorporating principles of energy justice.

Section 6 brings these conceptual themes together to propose a novel framework for linking energy poverty and housing insecurity through the perspective of vulnerability. We use a few archetypes of lived experiences to illustrate how this vulnerability framework can bring greater clarity toward articulating policy goals and designing effective interventions that are appropriate for people who need them the most.

Finally, in Section 7 we conclude with a closing summary and outline the next steps for advancing this research.

Section 1: What is energy poverty?

The annotated bibliography in this section offers a multifaceted look at energy poverty. It emphasizes the complexity and multidimensionality of the issue spanning across and intertwining perspectives from health, dignity, justice, geography, policy, vulnerability, housing, energy transitions and climate change. Each paper collected in this section is a conceptual or scoping review of a boarder field within and with implications for energy poverty.

The origins of the concept of energy poverty, and historical evolutions of the term 'energy poverty' alongside a related but distinct term 'fuel poverty', and the landscape of literature on energy poverty including journals, authors, publications, concepts, and methodologies, are discussed in (Bouzarovski and Petrova 2015; Primc, Dominko, and Slabe-Erker 2021; Ulucak et al. 2021; Xiao et al. 2021; Halkos and Gkampoura 2021). These reviews emphasize that all forms of energy poverty are underpinned by the inability to attain a socially and materially necessitated level of domestic energy services. The original conceptualization of energy poverty as the situation described as not having enough energy to adequately heat and cool homes is increasingly understood to be a complex phenomenon with many overlapping determinants that interact to produce varied negative outcomes for different groups of people due to their use of energy at home.

Hence, several papers in this section point to the socioeconomic and geographic patterning of energy poverty (Bouzarovski 2018; Popescu et al. 2023) while other reviews explore the role of energy poverty in social change incorporating demographic factors such as disparities regarding gender, race, age, disabilities, income and housing tenure (Q. Wang et al. 2021; Shahzad et al. 2022; Pachauri and Rao 2013; Middlemiss 2022).

More recently, research on energy poverty has taken a turn towards conceptualizing energy poverty in the context of vulnerability. This theme is picked up in (Day, Walker, and Simcock 2016; Grossmann and Trubina 2021; Bouzarovski 2018; Middlemiss et al. 2019; Middlemiss and Gillard 2015; Bouzarovski and Petrova 2015). By bringing energy poverty into dialogue with literature on vulnerability, these reviews are exploring the concept of "energy vulnerability", defined as the *potential for future harm* due to a person or household's exposure to energy poverty, sensitivity to energy poverty and

capacity to adapt in response to energy poverty. Such a conceptualization opens up the opportunity to examine energy poverty from a "bottom-up" perspective of those with lived experience of energy poverty, which offers insights for better design and delivery of effective interventions.

Along these lines, several papers included here explore energy poverty through the lens of energy justice, zooming in on the experiences of disadvantaged groups and the uneven distribution of vulnerabilities, which call for a nuanced understanding and multifaceted approach to deal with energy poverty, recognizing the interdependencies and the need for inclusive and tailored strategies (K. Jenkins et al. 2016; Grossmann and Trubina 2021; G. Walker and Day 2012; Middlemiss and Gillard 2015; Middlemiss et al. 2018; Jessel, Sawyer, and Hernández 2019; G. Walker and Day 2012). Related to this are several papers that review the impacts of energy poverty on the health and well-being of occupants, and in particular the socioeconomic and demographic patterning of harms and impacts of energy poverty (Ballesteros-Arjona et al. 2022; Halkos and Gkampoura 2021; Liddell and Morris 2010; Middlemiss 2022; Pachauri and Rao 2013; Harriet Thomson et al. 2019).

Other papers in this section link energy poverty with broader literature on just transitions, climate change mitigation, social innovation, energy security, and economic development (González-Eguino 2015; Jessel, Sawyer, and Hernández 2019; Manjon, Merino, and Cairns 2022; Popescu et al. 2023; Stojilovska et al. 2022; Streimikiene and Kyriakopoulos 2023; Streimikiene et al. 2021).

Finally, the rest of the papers here are a meta-summary of research on energy poverty, identifying methodological challenges with research on energy poverty and outlining directions for future research such as underpinnings of energy poverty, rights to energy, and new methodological approaches (Dubois and Sinea 2023; Jiglau et al. 2023; Primc, Dominko, and Slabe-Erker 2021; Xiao et al. 2021).

Annotated references

Ballesteros-Arjona et al 2022. "What Are the Effects of Energy Poverty and Interventions to Ameliorate It on People's Health and Well-Being?: A Scoping Review with an Equity Lens." *Energy Research & Social Science* vol 87 (May 1, 2022): 102456. https://doi.org/10.1016/j.erss.2021.102456

This paper presents a comprehensive review of the relationship between health and energy poverty along the axis of inequalities such as gender, age, race, ethnicity, region and class. The review finds that energy poverty is linked to poor general, mental and respiratory health, worsening chronic conditions, higher mortality, higher use of health services and higher exposure to health risks. The review also finds that these negative impacts are worse for vulnerable groups. The authors suggest that future research must consider the effects of inadequate warm temperatures and social inequalities.

Bouzarovski 2018. "Understanding Energy Poverty, Vulnerability and Justice." In *Energy Poverty: (Dis)Assembling Europe's Infrastructural Divide*, edited by Stefan Bouzarovski, 9–39. Cham: Springer International Publishing, 2018. https://doi.org/10.1007/978-3-319-69299-9_2

This book chapter reviews literature and draws conceptual links, interactions and interdependencies between energy poverty, energy vulnerability, energy justice and energy transitions. The author argues that energy poverty is a deeply geographical and political phenomenon, like other inequalities. The paper identifies housing and locality-based vulnerability to energy poverty as an underexplored research topic. The author calls for an examination of spatial and geographical patterning of energy poverty, alongside a better understanding of power interests, relations and processes that produce energy-related inequalities.

Bouzarovski and Petrova 2015. "A Global Perspective on Domestic Energy Deprivation: Overcoming the Energy Poverty–Fuel Poverty Binary." *Energy Research & Social Science* vol 10 (November 2015): 31–40. https://doi.org/10.1016/j.erss.2015.06.007

This paper describes the origins and evolutions of two related but distinct terms, energy poverty (global North) and fuel poverty (global South), from an occasional area of interest to a robust research and policy agenda. This paper then conducts an extensive review of the literature on energy, poverty, human geography, environmental policy and social practices to develop conceptual links between energy poverty and fuel poverty. The paper emphasizes a) all forms of energy and fuel poverty are underpinned by the inability to attain a socially and materially necessitated level of domestic energy services, and b) the importance of "energy vulnerability" (probabilistic, temporal and risk-factors based) thinking to identifying and addressing energy/fuel poverty.

Day, Walker, and Simcock 2016. “Conceptualising Energy Use and Energy Poverty Using a Capabilities Framework.” *Energy Policy* vol 93 (June 2016): 255–64. https://doi.org/10.1016/j.enpol.2016.03.019

This paper makes a novel conceptual contribution by proposing energy poverty be defined using a “capabilities approach”, rather than on standards of material adequacy or thresholds of incomes and expenditures. Borrowing from capabilities theory, the authors conceptualize energy poverty as “an inability to realize essential capabilities as a direct or indirect result of insufficient access to affordable, reliable and safe energy services, and taking into account the availability of reasonable alternative means of realizing these capabilities”. In doing so, authors argue that such an approach is multi-dimensional and recognizes the central role of energy services without mentioning specifics such as health, dignity or material well-being. The authors also argue that this definition allows the exploration of alternative routes to realize capabilities that do not lock in assumptions about required energy services.

Dubois and Sinea 2023. “Methodological Challenges in Energy Poverty Research.” *International Journal of Market Research* vol 65, no. 2–3 (March 2023): 340–58. https://doi.org/10.1177/14707853231155393

This comprehensive review of recent research on energy poverty in the global North identifies methodological challenges to understanding and/or taking action on energy poverty, namely a) broadness of conceptual definitions of energy poverty, b) difficulties associated with identifying, measuring and then sustaining engagement with the energy poor, and c) dealing with the complex and overlapping nature of their vulnerabilities.

González-Eguino 2015. “Energy Poverty: An Overview.” *Renewable and Sustainable Energy Reviews* vol 47 (July 2015): 377–85. https://doi.org/10.1016/j.rser.2015.03.013

As one of the most widely cited papers in this field, this paper provides a comprehensive overview of global energy poverty - definitions, approaches to measurement and impacts of (in)action. The paper also situations energy poverty within the broader contexts of economic development, and argues that while energy poverty alleviation calls for specific policies and programs, they also need to be incorporated into wider policies such as economic development.

Grossmann and Trubina 2021. “How the Concept of Dignity Is Relevant to the Study of Energy Poverty and Energy Justice.” *Frontiers in Sustainable Cities* 3 (2021). https://www.frontiersin.org/article/10.3389/frsc.2021.644231

Energy poverty is usually expressed in terms of material deprivation, lack of capabilities or vulnerability to risks and harms. This paper makes a conceptual contribution by arguing that the concept of dignity serves as a pathway to examining energy poverty from a non-material, less tangible perspective. In doing so, authors review three aspects of dignity relevant for households experiencing energy poverty - a) stigmatization, humiliation and feelings of inferiority, b) shame, loss of self-respect and self-image and c) disconnections leading to dependency on systems, institutions, friends and family.

Halkos and Gkampoura 2021. “Coping with Energy Poverty: Measurements, Drivers, Impacts, and Solutions.” *Energies* 14, no. 10 (January 2021): 2807. https://doi.org/10.3390/en14102807

This paper presents a comprehensive review of energy poverty including a) a history of how definitions of energy poverty have evolved, b) the impacts of energy poverty on health, socioeconomic well-being, and the environment, c) approaches for measuring energy poverty, including quantitative energy expenditures, subjective assessments through surveys and outcome-based approaches. The paper also provides an overview of how energy poverty research and practice differ between regions of the world. Taken together, this paper can serve as a good entry point into the literature on energy poverty.

Jenkins et al2016. “Energy Justice: A Conceptual Review.” *Energy Research & Social Science* vol 11 (January 1, 2016): 174–82. https://doi.org/10.1016/j.erss.2015.10.004

This conceptual review of energy justice principles highlights how energy poverty and energy justice are entangled through a) how the social and spatial patterning of energy poverty concepts like the uneven distribution of vulnerabilities such as energy cost burdens and/or affordable energy services and b) the need for recognition of and inclusion of lived experiences of those vulnerable to energy poverty in designing interventions.

Jessel, Sawyer, and Hernández 2019. “Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature.” *Frontiers in Public Health* vol 7 (2019). https://www.frontiersin.org/article/10.3389/fpubh.2019.00357

This paper presents a comprehensive review of energy poverty and related concepts such as energy affordability and energy insecurity in the context of poverty and a changing climate. The paper argues that contemporary literature on energy poverty a) does not sufficiently consider that vulnerable communities often experience energy poverty bundles with and exacerbated by other hardships, and b) does not examine energy poverty and associated challenges regarding health through the lens of climate change. The paper develops and uses an energy-health-justice framework to argue that energy poverty, social vulnerabilities and co-occurring hardships are linked, thereby presenting a unique opportunity to improve the well-being of vulnerable populations.

Jiglau et al 2023. “Looking Back to Look Forward: Reflections from Networked Research on Energy Poverty.” *IScience* 26, no. 3 (March 2023): 106083. https://doi.org/10.1016/j.isci.2023.106083

This paper provides a comprehensive review of existing research on energy poverty and sets an agenda for future research and policy on energy poverty. The paper identifies new research avenues for energy poverty, namely a) social underpinnings of energy poverty - trust, values, and power relations b) shift from consumers to ’right-to-energy, c) expanding the scope of energy poverty to other policy issues areas such as tenant-rights or taxation (see “Compendium”) and d) new methodological approaches to bridge data gaps.

Liddell and Morris 2010. “Fuel Poverty and Human Health: A Review of Recent Evidence.” *Energy Policy*, The Role of Trust in Managing Uncertainties in the Transition to a Sustainable Energy Economy, Special Section with Regular Papers, 38, no. 6 (June 2010): 2987–97. https://doi.org/10.1016/j.enpol.2010.01.037

One of the most cited papers in the field of energy poverty. This paper provides a comprehensive review of evidence linking energy poverty to adverse impacts on health, drawing primarily from large-scale studies mainly between 2000-2010. The review finds that energy poverty has significant impacts on the respiratory health of children, physical health and susceptibility to illness in infants as well as mental health effects on

adults and adolescents. The authors recommend that a wider range of quality-of-life measures be incorporated into future investigations into the effects of energy poverty interventions on physical, mental and population health.

Manjon, Merino, and Cairns 2022. "Business as Not Usual: A Systematic Literature Review of Social Entrepreneurship, Social Innovation, and Energy Poverty to Accelerate the Just Energy Transition." *Energy Research & Social Science* vol 90 (August 2022): 102624. https://doi.org/10.1016/j.erss.2022.102624

This review paper attempts to bring literature on social entrepreneurship and social innovation into dialogue with research on tackling energy poverty. Its main contributions are a) conceptualization of energy poverty concerning social entrepreneurship as a shared vision for justice and person-centred approaches, particularly in the context of vulnerable groups b) categorizing social innovation initiatives as either reducing energy consumption or empowering people towards collective action.

Middlemiss 2022. "Who Is Vulnerable to Energy Poverty in the Global North, and What Is Their Experience?" *WIREs Energy and Environment* vol 11, no. 6 (2022): e455. https://doi.org/10.1002/wene.455

This review paper summarizes empirical literature on energy poverty in the Global North to paint a picture of the lived experiences of those in energy poverty. The main findings are that a) commonly disadvantaged social categories (for instance disabled people, single parents, visible minorities, etc) are more likely to experience energy poverty. b) experience discomfort and health-related challenges at home due to low-indoor temperatures and inability to adequately warm homes c) energy poverty is linked to a range of health conditions such as excess winter and summer deaths, cardiovascular disease, respiratory conditions, anxiety and depression, and increased risk of flu, pneumonia asthma and accidents at home, and d) Energy-poor households also tend to engage in more risky behaviours, self-rating energy and other essentials, experiencing social disenfranchisement. The paper notes that major gaps for future research are a) better understanding intersectionality of various forms of disadvantage and how it links up with the impacts of energy poverty on health, social and financial life. b) bringing energy poverty into dialogue with just transitions literature.

Middlemiss et al. 2019. “Energy Poverty and Social Relations: A Capabilities Approach.” *Energy Research & Social Science* vol 55 (September 2019): 227–35. https://doi.org/10.1016/j.erss.2019.05.002

This paper uses the “capabilities framework” to make the conceptual contribution that social relations - such as connections with family, friends, agencies and distant others - influence how individuals and households cope with energy poverty. The authors argue that the connection between energy poverty and social relations is recursive, and shaped by structural, institutional and material factors. The authors suggest that policy interventions to address energy poverty must take into account the quality of social relations, as well as consider the (positive and negative) impact of policy interventions on social relations.

Middlemiss and Gillard 2015. “Fuel Poverty from the Bottom-up: Characterising Household Energy Vulnerability through the Lived Experience of the Fuel Poor.” *Energy Research & Social Science* vol 6 (March 2015): 146–54. https://doi.org/10.1016/j.erss.2015.02.001

This paper makes the conceptual contribution of bringing literature on vulnerability into dialogue with research on energy poverty to explore the concept of “energy vulnerability”. The paper characterizes energy vulnerability as the potential for future harm due to a person or household’s exposure to energy poverty, sensitivity to energy poverty and capacity to adapt in response to energy poverty. The paper then examines energy vulnerability from the perspective of those with lived experience of energy poverty. In doing so, it develops a “bottom-up” understanding of energy vulnerability and links it to six challenges, namely quality of dwelling fabric, tenancy relations, energy costs and supply, stability of household income, social relations and ill health. The paper suggests that these six challenges can be used as qualitative indicators of whether a household is falling further into energy poverty or is on a pathway out of energy poverty.

Pachauri and Rao 2013. “Gender Impacts and Determinants of Energy Poverty: Are We Asking the Right Questions?” *Current Opinion in Environmental Sustainability*, Energy Systems, vol 5, no. 2 (June 2013): 205–15. https://doi.org/10.1016/j.cosust.2013.04.006

This paper makes the conceptual contribution of drawing links between women's well-being and energy poverty. The paper focuses on identifying key gaps in current research and providing directions for future research.

Popescu et al 2023. "Past, Present, and Future of Critical Issues in Energy: Poverty, Transition and Security—A Systematic Review." *Energies* vol 16, no. 14 (January 2023): 5484. https://doi.org/10.3390/en16145484

This review paper attempts to bring literature on energy poverty, energy security and energy transition into dialogue to inform public policy in light of several global challenges such as international wars, increased urbanization, modernization of energy processes and services, and increased expectations of individual comfort.

Primc, Dominko, and Slabe-Erker 2021. "30 Years of Energy and Fuel Poverty Research: A Retrospective Analysis and Future Trends." *Journal of Cleaner Production* vol 301 (June 10, 2021): 127003. https://doi.org/10.1016/j.jclepro.2021.127003

Using a bibliometric and network analysis of research papers in the 3 decades since the first paper to mention "energy poverty" in 1991, this paper finds (using the Scopus database) that energy and fuel poverty are concepts that are still evolving in their definitions, boundaries and principles. The paper also identifies research hotspots, top journals, most cited researchers and articles, and important keywords relevant to energy poverty research. The paper also identifies 4 existing knowledge gaps and future areas of research : public-policy landscape, social aspects of energy transition, engineering and architectural advancement and novel methods to collect data on energy poverty.

Shahzad, et al. 2022. "Resolving Energy Poverty for Social Change: Research Directions and Agenda." *Technological Forecasting and Social Change* vol 181 (August 2022):. https://doi.org/10.1016/j.techfore.2022.121777.

This review paper provides an integrated review of the literature on energy poverty up to 2021, in the context of the role of energy poverty alleviation and social change. The authors identify several topical gaps in extant literature namely, a) energy vulnerabilities, b) developing bottom-up policies by incorporating local knowledge c) social mobilization d) developing frameworks that link energy poverty with broader policies

such as health, entrepreneurship etc and e) accounting for gender and other disparities. The authors also outline a future research agenda centred on socioeconomic conditions, women's well-being, robust inequality-based indices, ethnicity and race, social development and environmental factors.

Stojilovska et al. 2020 "Compendium: On Existing and Missing Links between Energy Poverty and Other Scholarly Debates." European Energy Poverty Agenda Co-Creation and Knowledge Innovation, 2020. https://repositorio.ul.pt/handle/10451/44180

This report is a review of how energy poverty is conceptually and practically linked with a wide array of fields of literature. Mainly, this review is a series of short reviews on energy poverty and a) factors behind household incomes, including economy, labour market, employment, welfare, and capitalistic modes of production, b) factors behind housing energy efficiency, including quality of buildings, housing market affordability, urban planning, homeownership, and transportation and mobility, and c) factors behind energy costs, including infrastructure, tax policy, corporate power and air pollution, and d) cross-cutting interdisciplinary and intersectional issues such as climate change, gender, justice, inequalities, human rights, minority rights and social inclusion/exclusion.

Streimikiene et al. 2021 "Energy Poverty and Low Carbon Just Energy Transition: Comparative Study in Lithuania and Greece." *Social Indicators Research* 158, no. 1 (November 2021): 319–71. https://doi.org/10.1007/s11205-021-02685-9

This paper brings literature on energy poverty and low-carbon energy transitions to developing a framework for tracking "just low-carbon transitions". The framework includes economic, environmental and social indicators. The paper then applies this framework to an empirical case study of two European countries to make policy recommendations for just climate-change mitigation policies at the household level.

Thomson et al. 2019. "Energy Poverty and Indoor Cooling: An Overlooked Issue in Europe." *Energy and Buildings* vol 196 (August 2019): 21–29. https://doi.org/10.1016/j.enbuild.2019.05.014

Most literature on energy poverty focuses narrowly on the inability of households to achieve adequate indoor heating. This paper makes a conceptual contribution to the

issue of summertime energy poverty and indoor cooling. The authors categorize the driving forces of household vulnerability to excessive indoor heat into three factors: a) the likelihood of a household being subjected to risks of exposure, b) the adaptive (in)capacity of individuals to respond to extreme indoor heat, and c) sensitivity to harmful consequences of extreme indoor-heat for their well-being.

Ulucak et al. 2021. "Bibliometric Literature Analysis of a Multi-Dimensional Sustainable Development Issue: Energy Poverty." *Sustainability* vol 13, no. 17 (January 2021): 9780. https://doi.org/10.3390/su13179780

This review paper uses the larger Web of Science index to conduct a bibliometric analysis of literature. The paper identifies leading authors, most cited papers, different strands of literature and how they are related and highlights potential research gaps - such as lack of micro-level local data on energy poverty.

Walker and Day 2012. "Fuel Poverty as Injustice: Integrating Distribution, Recognition and Procedure in the Struggle for Affordable Warmth." *Energy Policy*, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, vol 49 (October 2012): 69–75. https://doi.org/10.1016/j.enpol.2012.01.044

This paper makes the conceptual contribution that energy poverty can be understood as an expression of injustice involving the compromised ability to access adequate energy services to secure a healthy living environment. The authors argue that while the distributional injustice of energy poverty is commonly recognized and acknowledged, addressing energy poverty has to involve cultural and political recognition of marginalized social groups as well as their involvement and inclusion in decision-making processes.

Wang et al. 2021. "Racial Disparities in Energy Poverty in the United States." *Renewable and Sustainable Energy Reviews* vol 137 (March 2021): 110620. https://doi.org/10.1016/j.rser.2020.110620

This paper makes the methodological contribution of connecting energy poverty to long-term trends in racial disparities to formulate regional disparities in energy-related inequalities using the United States as a case study. The paper finds that energy poverty is more common than income poverty in the United States, and makes policy

recommendations for targeting low-income and racialized communities for energy poverty alleviation.

Xiao et al. 2021 “Mapping the Worldwide Trends on Energy Poverty Research: A Bibliometric Analysis (1999–2019).” *International Journal of Environmental Research and Public Health* vol 18 (January 2021): 1764. https://doi.org/10.3390/ijerph18041764.

This paper provides a comprehensive review of energy poverty publications from 1999-2019. The key contribution of this paper is identifying two key paths of evolution of energy poverty research over that same period, as represented by literature on a) discussing determinant and living conditions of households experiencing energy poverty and culminating in the application of principles of energy justice to alleviate energy poverty, and b) concerning the developing of coping mechanisms, indicators and measurement metrics, and targeted interventions to alleviate energy poverty. The paper also identifies the following areas for future research: a) energy poverty in developing countries b) impacts of energy poverty on vulnerable populations c) macro-level root causes of energy poverty, and d) impacts of emission reduction policies.

Section 2: What are Canadian perspectives on energy poverty?

This section collects key papers offering insights on energy poverty in Canada and/or published by researchers primarily working in or writing about energy poverty in the context of Canada.

Energy poverty, while a significant concern, is not officially or uniformly defined in Canada. In jurisdictions such as the UK[1] and France[2], energy poverty was defined by an act of legislature, while in others such as Ireland[3] and New Zealand[4] energy poverty was defined through public consultation by specific ministries. Canada can follow the flexible approach of the European Union, setting a broad conceptual definition of energy poverty[5] and allowing each member state to develop locally specific policy responses based on a set of suggested energy poverty indicators, which are briefly reviewed in Section 3. The question of how and by whom energy poverty can be defined and operationalized in Canada will be taken up in the consultation phase of this research project.

Meanwhile, Canadian research on energy poverty is connecting with themes identified in broader and global literature on energy poverty – such as vulnerability and energy justice implications of energy poverty (Das et al. 2022; Rezaei 2017); socioeconomic, geographic and demographic patterning of different measures of energy poverty (Das, Martiskainen, and Li 2022; Mylene Riva et al. 2021), impacts of energy poverty on health

[1] Energy poverty in Uk defined by Warm Homes and Energy Convervation Act 2000: https://www.legislation.gov.uk/ukpga/2000/31/contents

[2] Energy poverty in France fedined by Grenelle 2 Law in 2020 : https://ec.europa.eu/social/BlobServlet?docId=25972&langId=en

[3] Energy poverty in Ireland defined by Department of Environment, Climate and Communications in the 'Energy Poverty Action Plan: https://assets.gov.ie/242876/dc4744fb-d2cd-4ba1-b4e1-170cbd77816a.pdf

[4] Energy poverty in New Zealand defined by Ministry of Business, Innovation and Employment https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-hardship/defining-energy-hardship/

[5] Energy poverty in EU is defined as 'a household's lack of access to essential energy services that 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 social policy and other relevant policies, caused by a combination of factors, including but not limited to non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes' in 2023 Climate Fund Regulation https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733583/EPRS_BRI(2022)733583_EN.pdf

(Mylène Riva et al. 2023) and the need for targeted interventions with a focus on disadvantaged groups (Hoicka and Das 2021; Das et al. 2022; Tozer, MacRae, and Smit 2023).

Taken together, researchers in Canada writing about energy poverty in Canada call for a more nuanced understanding of energy poverty, stress the need for targeted effective solutions and call for multidisciplinary approaches for advancing research, policy and practice of energy poverty in Canada.

Annotated references

Das et al. 2022. "A Review and Analysis of Initiatives Addressing Energy Poverty and Vulnerability in Ontario, Canada." *Renewable and Sustainable Energy Reviews* vol.165 (September 2022): 112617. https://doi.org/10.1016/j.rser.2022.112617

This paper draws a conceptual distinction and overlaps between concepts of energy poverty and energy vulnerability. The authors draw from established academic literature to make two conceptual contributions : a) Energy poverty is not static, and risks of energy poverty can change over time and vary between and within households, b) Energy vulnerability is the risk of a household experiencing future harms as a result of susceptibility to experiencing energy poverty, the sensitivity of households to negative impacts of energy poverty and the (in)ability of the household to respond or adapt to changes due to energy poverty. The paper then reviews initiatives that assist energy-poor and energy-vulnerable households in Ontario, Canada, compares them against international policy and program responses to energy poverty and makes policy recommendations for effective solutions for addressing underlying causes of energy poverty.

Das, Martiskainen, and Li 2022 "Quantifying the Prevalence of Energy Poverty across Canada: Estimating Domestic Energy Burden Using an Expenditures Approach." *Canadian Geographer-Geographe Canadien*, (2022) 18–18. **https://doi.org/10.1111/cag.12750**

This paper studies the prevalence and determinants of energy poverty in Canada using 10% of income spent on home energy expenditures as the threshold for defining energy poverty. The main findings are a) Low income, geography, and dwelling conditions were the main predictors of energy poverty b) Certain households are at greater risk of

energy poverty, such as Households living in rural areas or homes built before 1980 or in living in houses that needed repairs or households receiving government transfers or single person households etc (this list is just a summary for the annotated bibliography, please refer to the paper for a full list of sociodemographic variables and relative risk) c) For households in energy poverty, at lower levels of household income, income increases are associated with increases in the budget share allocated to energy expenditures, whereas the share of income spent on energy is relatively constant for households not in energy poverty. This might suggest households in energy poverty are self-rationing energy use.

Hoicka and Das 2021 "Ambitious Deep Energy Retrofits of Buildings to Accelerate the 1.5°C Energy Transition in Canada." *The Canadian Geographer / Le Géographe Canadien* vol 65, no. 1 (2021): 116–27. https://doi.org/10.1111/cag.12637

This paper reviews energy use and building retrofits in Canada to argue - in part - that socially vulnerable populations such as households in energy poverty should be targeted for building energy retrofits to maximize positive social impact. The authors argue using a review of international research on energy poverty that a)certain demographics are more predisposed to energy poverty and b) energy poverty is linked to poor mental and physical well-being. The paper also calls for a greater understanding of energy poverty in Canada, particularly in the context of understanding the impacts of the changing policy landscape on vulnerable Canadian households.

Rezaei 2017 "Power to the People : Thinking (and Rethinking) Energy Poverty in British Columbia, Canada." University of British Columbia, 2017. https://open.library.ubc.ca/soa/cIRcle/collections/ubctheses/24/items/1.0351974

This thesis is likely Canada's first Ph.D. thesis on energy poverty. In this dissertation, the author positions energy poverty as an issue of energy justice and examines energy poverty through distributional, procedural, recognitional and restorative frames of energy justice. This thesis is also among the first attempts to define energy poverty in the Canadian context, and uses a 6% threshold of home energy expenditures to income as a threshold, based on calculations that suggest that the median Canadian household's spending on energy is 3% of income. Using this definition, the thesis then highlights socio-geographical patterns of energy poverty across Canada, explores ways

in which energy poverty is similar to and different from general poverty and makes policy recommendations for addressing energy poverty for modest-income households.

Riva et al. 2021 “Energy Poverty in Canada: Prevalence, Social and Spatial Distribution, and Implications for Research and Policy.” *Energy Research & Social Science* vol 81 (November 2021): 102237. https://doi.org/10.1016/j.erss.2021.102237

This paper conducts empirical research using a 2017 Survey of Household Spending to find that energy poverty is spatially and socially patterned across Canada - meaning energy poverty varies by geography and by factors related to household composition, dwelling characteristics, urban/rural location and province. The findings point to the need for cross-sectional and multidisciplinary research to inform energy retrofit policies to mitigate energy poverty.

Riva et al. 2023 “Energy Poverty: An Overlooked Determinant of Health and Climate Resilience in Canada.” *Canadian Journal of Public Health* vol 114, no. 3 (June 2023): 422–31. https://doi.org/10.17269/s41997-023-00741-0

This paper conducts empirical research using cross-sectional data from a 2018 Canadian Housing Survey to find that exposure to energy poverty is associated significantly increased likelihood of poor general and mental health. The likelihood of poor general and mental health was significantly higher for those dissatisfied with the energy efficiency of their dwelling and with their ability to maintain a comfortable temperature both in the winter and in the summer. These findings have implications for population health, climate resilience and energy retrofit policies.

Tozer, MacRae, and Smit 2023 “Achieving Deep-Energy Retrofits for Households in Energy Poverty - Buildings & Cities.” *Buildings & Cities*, 2023. https://journal-buildingscities.org/articles/10.5334/bc.304?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Buildings_%2526_Cities_TrendMD_0

This paper conducts a systematic literature review of energy retrofits literature to identify factors that influence energy retrofits among energy poor homeowners and landlords of energy poor households. Findings indicate that while a range of factors such as health, quality of life, availability of no-cost retrofits and regulatory requirements such as minimum energy standards for buildings might motivate retrofit

actions, there is a need for further research in retrofit policies specifically targeted toward households vulnerable to energy poverty.

Section 3: How is energy poverty identified, measured and tracked?

Accurate identification and measurement of energy poverty is a key aspect of efforts to improve energy-related well-being for all. The papers collected in this section offer key conceptual contributions concerning how energy poverty is defined, recognized, and characterized, review methodologies for measuring energy poverty, outline approaches to identifying hotspots and evaluate processes for tracking the impacts of policies to alleviate energy poverty. Table 1 provides a mini-review of common approaches to measuring energy poverty, their specific indicators, and the relative (de)merits of each approach.

Measurement approach	Example indicators	Advantages	Disadvantages
As a measure of income	Household incomes below a certain threshold	Easy to measure at household level to establish program support qualification; links in with poverty and social programs	Does not account for differing energy needs based on climate, health, culture, regional variations; does not account for other determinants such as energy costs or housing quality, energy efficiency, or vulerabilities
As a measure of energy expenditure – total household energy costs as an absolute or relative threshold of income or its proxies	Energy prices; energy expenditure; energy costs as a percentage of income (energy cost burden); energy costs as a percentage of disposable income after accounting for housing costs; energy cost burden is twice national median; energy cost burden is above a certain threshold (6%, 10% etc)	Quantifiable at different scales, allowing for standardization, benchmarking and comparisons across regions; directly tied to affordability	Difficult to collect at household level, prone to exclusion errors due to households self-rationing energy use; may not be sensitive to near-term fluctuations in energy prices or housing expenditures due to inflation; relative measures prone to inclusion errors – high income households with high energy expenditures may technically fall within energy cost burden threshold
As a measure of indoor housing conditions – self-reported (in)ability to attain necessities relative to recommended thresholds	Dwelling comfort in winters and summers; presence of leaking, mold and rot; ability to keep home adequately warm or cool; arrears on utility bills	Captures lived experiences and broader range of issues such as comfort and health	Requires surveys of population – a large undertaking; measure subject to individual perceptions and expectations
As a measure of general housing quality relative to standards	Energy performance rating of dwelling below a certain threshold; share of dwellings equipped with heating; share of dwellings equipped with cooling; overcrowded housing	Links housing issues with energy and climate policies	Does not address other determinants such as incomes or energy expenditures
As a measure of risks of negative outcomes and impacts to well-being and health	Excess winter or summer mortality; people at risk of social exclusion; households at risk of poverty	Focuses attention on those “who need supports the most”	Causally linking health outcomes to specific energy poverty measures may be empirically challenging. Health outcomes may lag intervention by several decades.

Table 1: Common approaches to measuring energy poverty, drawn largely but not exclusively from European Union member states

In (Bednar and Reames 2020; Moore 2012; Nussbaumer, Bazilian, and Modi 2012), the authors trace the evolution of definitions of energy poverty in their jurisdictions as a concept distinct from general poverty, emphasizing the need to connect definitions of energy poverty with recognizing root causes and establishing clear policy goals.

To this end, several papers (Castaño-Rosa et al. 2019; Faiella and Lavecchia 2021; Gouveia, Palma, and Simoes 2019; Herrero 2017; Pelz, Pachauri, and Groh 2018; EPAH 2022; Moore 2012; K. Wang et al. 2015; Harriet Thomson, Bouzarovski, and Snell 2017) review existing approaches for measuring energy poverty with an emphasis on data availability, recognition of various underlying determinants, achieving effective measurement across scales, addressing methodological limitations and highlighting limitations and trade-offs between various national indicators of energy poverty.

Several papers (EUNI 2022, Gouveia, Palma, and Simoes 2019; Primc, Slabe-Erker, and Majcen 2019; Romero, Linares, and López 2018; Pachauri and Spreng 2011; Sareen et al. 2020; Siksnelyte-Butkiene et al. 2021; Siksnelyte-Butkiene 2021) describe and/or propose methodologies and identify best practices for constructing multidimensional energy poverty metrics and indicators that can help identify hotspots of vulnerability, with implications for targeted supports and policy interventions.

Taken together, these papers point to an ongoing struggle to narrow down on a unified method for defining, understanding and measuring energy poverty, but also reflect an emerging consensus around the need for more nuathe nced, multi-indicator approaches that account for and critically examine systemic inequalities, methodological uncertainties, data politics and quality, sociospatial patterning of vulnerability, complexities of underlying determinants, and alignment with broader policy arenas.

Annotated references

Bednar and Reames 2020. “Recognition of and Response to Energy Poverty in the United States.” *Nature Energy* 5, no. 6 (June 2020): 432–39. https://doi.org/10.1038/s41560-020-0582-0

This review paper traces the history of measurement and metrics used by the U.S. federal government’s response to energy poverty. Drawing from the literature on food insecurity (in the U.S.) and international responses to measuring energy poverty (in the

UK and EU), this paper recommends a formal national recognition of energy poverty as being distinct from general poverty to catalyze rapid investments in energy efficiency and align federal program responses with associated health outcomes and performance measures. The paper ends with a call to action for a more inclusive definition of energy poverty that establishes the incidence and intensity of energy poverty experienced in the US, along with a call to explore drivers, determinants and impacts, as well as evaluating the effectiveness of policies and programs. This discussion is very relevant for the Canadian policymaker audience, as it reflects similar ground realities in Canada, where the lack of a formal definition of energy poverty means existing programs use income-based measures to quality households for policy responses, thereby lacking the conceptual engagement with the distinct category of drivers, determinants and impacts of energy poverty.

Castaño-Rosa et al. 2019 "Towards a Multiple-Indicator Approach to Energy Poverty in the European Union: A Review." *Energy and Buildings* vol 193 (June 2019): 36–48. https://doi.org/10.1016/j.enbuild.2019.03.039

This paper provides a comprehensive review of measures, metrics and concepts used to characterize energy poverty (or fuel poverty) in the EU from the perspective of factors that influence everyday activities of a household such as comfort, health and well-being. In doing so, the paper finds a weak spot in conventional approaches to measuring energy poverty (such as energy cost burdens) in that they do not reflect household vulnerability to the impacts of energy poverty. The authors then propose a multiple indicator approach for defining "vulnerable households at risk of energy poverty" based on vulnerability factors such as access, affordability, flexibility, energy efficiency, household needs and social practices across the domains of available infrastructure, energy efficiency, socioeconomic poverty and health/wellbeing. Bringing all this together, the authors propose that vulnerable households can be identified through a composite index that takes into account disparities due to income, quality of dwellings and broader systemic inequalities which combine together to cause future harm to physical and mental health.

EUNI 2022 "Energy Poverty National Indicators: Insights for a More Effective Measuring." EU Commission Report, October 2022 https://energy-poverty.ec.europa.eu/discover/publications/publications/energy-poverty-national-indicators-insights-more-effective-measuring_en

This European Commission report reviews and compares indicators used by EU jurisdictions to measure and identify energy poverty and to develop national strategies for mitigation. The paper categorizes indicators into primary - if they directly depict energy poverty and secondary - if they are meant to characterize circumstances that lead to a situation of vulnerability. Examples of primary indicators include quantitative measures like high energy cost burdens or arrears on utility bills, or qualitative measures like inability to maintain adequate indoor temperatures. Secondary indicators include metrics like dwellings in densely populated areas, housing needing major repairs etc. The paper then follows with a critical analysis of each indicator, highlighting with examples the strengths and limits of each indicator in the context of adequately capturing the elements of energy poverty to set policy.

Faiella and Lavecchia 2021 "Energy Poverty. How Can You Fight It, If You Can't Measure It?" *Energy and Buildings* vol 233 (February 2021): 110692. https://doi.org/10.1016/j.enbuild.2020.110692

Using Italy as a case study, this paper compares two national approaches to measuring energy poverty - one based on actual energy expenditures and one independent of household preferences, based on heating expenditure needed to achieve thermal comfort indoors. The main contributions of this paper are a review of the history of how the European approach to measuring energy poverty has evolved and a list of descriptive statistics of households more likely to experience energy poverty.

Gouveia, Palma, and Simoes (2019). "Energy Poverty Vulnerability Index: A Multidimensional Tool to Identify Hotspots for Local Action." *Energy Reports* vol 5 (November 2019): 187–201. https://doi.org/10.1016/j.egyr.2018.12.004

This paper develops a spatial scale composite index focusing on socioeconomic indicators as well as building characteristics and energy performance to map vulnerability to energy poverty and identify hotspots for local action. The index methodology advances current state-of-the-art approaches by combining (i) socio-economic indicators of population (e.g. presence of elderly and young people; unemployed; income and education level) with (ii) climate variables (heating degree days, external outdoor temperature, heating and cooling seasons duration), (iii) energy consumption levels (e.g. electricity, natural gas, biomass), (iv) calculated energy

demand for space heating and cooling (per square metre, per household), (v) climatization technologies details (efficiency, ownership) and (vi) construction characteristics of several building typologies (e.g. heightgroup, bearing structure, type of wall, windows, roofs). This paper is a good entry point into muddling through different kinds of indicators that can be used for developing a composite energy poverty index, as well as a literature-backed rationale to support the choice of each indicator.

Herrero 2017 "Energy Poverty Indicators: A Critical Review of Methods." *Indoor and Built Environment* 26, no. 7 (August 2017): 1018–31. https://doi.org/10.1177/1420326X17718054

This paper presents a critical review of national practices for measuring energy poverty and a discussion on the risks of uncritically using nationally reported energy poverty statistics. The main contributions of this paper are identifying the key conceptual and methodological challenges associated with defining and measuring energy poverty, namely a) need to account for diversity of energy services b) distinguishing between actual and "required" energy expenditures to maintain adequate quality of life c) setting thresholds for energy cost burdens and incomes for qualification d) equivalizing incomes and energy expenditures across households and regions e) accounting for subjective responses to surveys f) accounting for housing and transportation costs (or not) g) issues surrounding spatial, temporal and socio-demographic representativeness of data h) weighing variables in composite indices and i) identifying measures to capture the "depth" of energy poverty.

Moore 2012. "Definitions of Fuel Poverty: Implications for Policy." *Energy Policy*, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, 49 (October 2012): 19–26. https://doi.org/10.1016/j.enpol.2012.01.057

This paper provides a historical review of how the definition and subsequent identification/measurement of energy poverty has evolved in the context of the UK's policy approaches to addressing energy poverty. While the paper was published in 2012, many of the arguments in the paper are relevant to contemporary debates in Canada regarding establishing a nationally relevant measure of energy poverty from a policy development and program implementation perspective. The main conceptual contributions of this paper are a:) The importance of distinguishing between policy

goals of alleviating energy poverty vulnerability (households most at risk from future harms) vs energy poverty severity (households least able to afford energy costs) b) recognizing that definitions of energy poverty are imperfect and every definition is likely to bias the inclusion of one vulnerable groups over others. c) The ultimate goals of energy poverty alleviation policy will and should inform how energy poverty is defined, without this connection the underlying root causes of energy poverty may not be addressed.

Nussbaumer, Bazilian, and Modi 2012. "Measuring Energy Poverty: Focusing on What Matters." *Renewable and Sustainable Energy Reviews* 16, no. 1 (January 2012): 231–43. https://doi.org/10.1016/j.rser.2011.07.150

As one of the most cited publications in this field, this paper is among the first to propose measuring energy poverty based on deprivation of access to modern energy services - a shift from conventional approaches that focused on access to energy in the Global South. The main contribution of this paper is methodological- developing a composite aggregated metric using a measure of the incidence of energy poverty (number of people who are energy poor) and quantification of its intensity (how energy poor they are).

Pachauri and Spreng 2011. "Measuring and Monitoring Energy Poverty." *Energy Policy*, Clean Cooking Fuels and Technologies in Developing Economies, 39, no. 12 (December 2011): 7497–7504. https://doi.org/10.1016/j.enpol.2011.07.008

This paper reviews alternative measures of household energy poverty intending to inform policy development and program implementation. While much of the focus of the paper is on metrics for the Global South, the main conceptual contribution of this paper is the categorization of indicators in terms of spatial scale - from macro indicators such as the percentage of the population living under poverty thresholds to community level indicators, such as labour force participation etc and household level indicators such as the size of households and the number of children.

Pelz, Pachauri, and Groh 2018 "A Critical Review of Modern Approaches for Multidimensional Energy Poverty Measurement." *WIREs Energy and Environment* 7, no. 6 (2018): e304. https://doi.org/10.1002/wene.304

Measuring energy poverty and energy access remains challenging, both because of a lack of consensus on definitions and sparse data on its underlying causes in different contexts. Written mostly in the context of the Global South, this paper reviews recent efforts (before 2018) at deploying multidimensional measures of energy poverty such as single indicators, composite indices as well as dashboards of indices. Key lessons from this review include : a) there is no consensus on standard methodology or theoretical framework underpinning the selection of demographic, sociological or dwelling-related variables that can be linked to energy poverty, thereby highlighting the limitations of multidimensional energy poverty indices in identifying causal relationships between variables b) metrics must seek balance between availability, accuracy and relevance, these tradeoffs are manifest in applicability for policy planning and implementation c) future research into metrics must meaningfully include a conceptual approach of energy vulnerability.

Primc, Slabe-Erker, and Majcen 2019 “Constructing Energy Poverty Profiles for an Effective Energy Policy.” *Energy Policy* vol 128 (May 2019): 727–34. https://doi.org/10.1016/j.enpol.2019.01.059

This paper claims that most empirical studies on determinants and causal factors of energy poverty investigate the effects of selected variables in isolation, which may neglect the possible importance of how these variables interact and interrelate. The paper also finds that socio-demographic characteristics and housing characteristics on their own are never sufficient to adequately causally explain energy poverty. The paper advocates for taking an “energy profiles” approach as a conceptual model for articulating the diverse and sometimes contradictory factors that influence energy poverty.

Romero, Linares, and López 2018 “The Policy Implications of Energy Poverty Indicators.” *Energy Policy* vol 115 (April 2018): 98–108. https://doi.org/10.1016/j.enpol.2017.12.054

This paper reviews commonly used income-based energy poverty indicators from the perspective of implications for policy design. This paper argues that a) energy cost burden threshold-based indicators such as the 10% indicator are prone to generating a lot of false positives, and are a better measure for energy inequality than energy poverty, b) Low-Income-Hight-Cost indicators account for false positives by specifying a

threshold for both income as well as expenditure but are more complex to calculate and not helpful for isolating causes and c) Minimum Income Standard, by which definition a household is regarded as energy poor if income left over after spending on housing costs and energy costs are below a certain minimum income standard required to participate meaningfully in society (in Canada, this would be LIM or LICO or MBM threshold). The paper recommends using the Minimum Income Standard as a more accurate and consistent measure of a household's ability to afford energy costs as it accounts for other budgetary standards such as childcare etc.

Sareen et al. 202 "European Energy Poverty Metrics: Scales, Prospects and Limits." *Global Transitions* vol 2 (January 2020): 26–36. https://doi.org/10.1016/j.glt.2020.01.003

This paper presents a critical review of the methodologies for developing energy poverty metrics. The authors argue that any basket of indicators risks silencing significant but hard-to-measure aspects, or unwarrantedly privileging others. They argue for a balanced approach that can represent contextualized energy use issues such as energy access, quality, energy cost burdens, the built environment and thermal comfort while also retaining simplicity and comparability for policy traction. The main conceptual contribution of this paper is drawing attention to "data politics and problematic tensions" inherent within any process for developing energy poverty metrics. The authors argue that institutionalizing new energy poverty metrics and indicators is a deeply political project, a range of affected actors have competing stakes and priorities. The paper concludes with the observation that 'the mobilization of metrics to address energy poverty must be informed by an understanding of the quality and politics of data woven into the metrics, and thus situated within concrete contexts and key policy flows.'

Siksnelyte-Butkiene 2021. "A Systematic Literature Review of Indices for Energy Poverty Assessment: A Household Perspective." *Sustainability* vol 13, no. 19 (January 2021): 10900. https://doi.org/10.3390/su131910900

Conventional approaches to measuring energy poverty took the simplified approach of calculating single economic indicators such as "energy cost burden thresholds" (currently used by the Canadian federal government in research reports) or minimum income standards (used by all existing low-income energy efficiency programs in

Canada). In recent years, more comprehensive and multidimensional indicators have been developed. This paper reviews these old and newer indices of energy poverty (proposed between 1994 and 2020) from the perspective of households and their lived experiences. The main conceptual contributions of this paper are; a) it distinguishes between indices that measure energy access, energy poverty and poverty vulnerability, and provides detailed reviews of indices for each category, and b) it develops a framework for categorizing indices for sustainable energy poverty assessments, namely economic, social and environmental indicators.

Siksnelyte-Butkiene et al. 2021 "Energy Poverty Indicators: A Systematic Literature Review and Comprehensive Analysis of Integrity." *Sustainable Cities and Society* vol 67 (April 2021): 102756. https://doi.org/10.1016/j.scs.2021.102756

This paper provides a systemic review and an assessment of 71 composite indicators for evaluating energy poverty to make recommendations for the "practical use" of energy poverty indicators. The main contributions of this review paper are a) the choice of representative index is crucial for providing policy advice, b) the duality of concepts embedded within energy poverty need to be separated into "energy access poverty" and "energy expenditure poverty", and c) recommendations for separating Structural Energy Poverty Vulnerability index from Energy Poverty and Energy Vulnerability Index. The paper also traces the historical evolution of composite energy poverty indicators and outlines the main advantages/disadvantages of each of them.

Thomson, Bouzarovski, and Snell 2017 "Rethinking the Measurement of Energy Poverty in Europe: A Critical Analysis of Indicators and Data." *Indoor and Built Environment* vol 26, no. 7 (August 2017): 879–901. https://doi.org/10.1177/1420326X17699260

This paper presents a critical review of statistical options for measuring energy poverty deployed in EU jurisdiction through the lens of "vulnerability thinking". In doing so, the authors outline a range of vulnerability factors and connect each vulnerability factor with measurable drivers of energy poverty vulnerability with measurable impacts on households experiencing energy poverty. The authors also make recommendations for an expanded "basket of measures" approach to capture experiences of energy poverty, by combining different measurement approaches; expenditure-based (absolute or relative energy costs), consensual (self-reported assessment of indoor housing conditions) and direct measurement (level of energy services achieved compared to a

set standard). The paper concludes by recommending that a new dedicated statistical survey of energy poverty is needed to increase recognition and identification of the problem, and opportunities to integrate energy poverty alleviation strategies with other areas of policy and research such as climate change responses and public health.

Wang et al. 2015 “Energy Poverty in China: An Index Based Comprehensive Evaluation.” *Renewable and Sustainable Energy Reviews* vol 47 (July 2015): 308–23. https://doi.org/10.1016/j.rser.2015.03.041

While this paper presents a case study of the development of a composite energy poverty index in the context of evaluating regional energy poverty in China, it is a good entry point into broader literature on commonly used energy poverty measurements. The main conceptual contributions of this paper are a) categorizing commonly used energy poverty measurements into energy service availability, energy service quality and satisfaction, and b) evaluating energy poverty measurements based on data availability and index applicability.

Section 4: How is energy poverty linked with housing-related vulnerabilities?

Papers collected in this section suggest three possible themes through which housing issues can be linked to energy poverty.

Firstly, housing standards and energy poverty are linked through (un)affordability of housing costs and cost burdens (Burlinson, Giulietti, and Battisti 2018; Legendre and Ricci 2015; Karpinska and Śmiech 2020). Housing costs are implicated in the definition and subsequent measurement of energy poverty – shaping spatial geography of who is regarded as energy poor based on whether housing costs are included or excluded measures of relative energy cost burdens (Robinson, Bouzarovski, and Lindley 2018). Households that experience housing unaffordability spend a disproportionate portion of their income on housing costs and have lower disposable income for spending on energy costs.

Households in low-quality housing are more likely to experience energy poverty (Chen and Feng 2022). Poor housing conditions such as inefficient housing directly contribute to higher energy bills. Energy bills can also form a significant component of overall housing costs and are often the component of housing costs that are the first component to be self-rationed by households facing material difficulties (Karpinska and Śmiech 2020). The right to adequate access to energy can be regarded as a part of the human right to adequate housing and habitability (Scott 2016).

Secondly, reviews point to energy-related housing conditions (such as leaky homes) as a social determinant of health (Canada 2018; Raphael et al. 2020) for factors such as excess winter and/or summer mortality (El Ansari and El-Silimy 2008; Ormandy and Ezratty 2012) and increased risk of poor health in individuals with pre-existing conditions (Baudu, Charlier, and Legendre 2020; Charlier and Legendre 2022; El Ansari and El-Silimy 2008). Energy poverty also creates emotional distress, frustration, fear and isolation due to poor housing conditions and a lack of trust among renters that these conditions will be mitigated by their housing provider (Longhurst and Hargreaves 2019).

(Kahouli 2020)finds that energy-related housing conditions take time to manifest as poor health, therefore requiring longitudinal study over a long observation period to draw causal links.

In the other direction, energy poverty behaviours increase the risk of poor health-related housing outcomes. Several papers find that coping mechanisms and occupant behaviour in responding to energy poverty through self-rationing of energy use result in worsening prevalence of conditions such as mould and cold homes, which can lead to poor health outcomes (Chen and Feng 2022; El Ansari and El-Silimy 2008; Sharpe et al. 2015). For instance, energy-poor households living in uninsulated rental homes tend to underheat their indoor environments in winter due to concerns about energy costs, which contributes to excess winter mortality, particularly for seniors (Brunner, Spitzer, and Christanell 2012).

While a huge amount of research on housing and health has been published, very few studies have investigated if improved housing conditions have a causal link to improved occupant health. Some papers in this collection fill this gap (Hilary Thomson et al. 2013; Shortt and Rugkåsa 2007; Kahouli 2020; Ige et al. 2019; Howden-Chapman et al. 2012; Czerwinska 2021; C. Wang, Wang, and Norbäck 2022), finding that improvements in housing conditions and provision of affordable warmth may lead to reduced absences from school or work, increase usable space at home, allowing greater levels of privacy and improving social relationships at home. However, (Ige et al. 2019) urge caution by concluding that methodological challenges with most case studies make it difficult to draw direct causal links between housing upgrades and improved well-being. This challenge is also echoed by (Charlier and Legendre 2022; Healy and Clinch 2002), who note that causal links between energy poverty and negative outcomes related to housing beyond adverse health effects, such as impacts on occupancy, thermal comfort, remain underexplored.

In terms of policy recommendations, some papers (such as Czerwinska 2021 and Kahouli 2020) call for energy retrofits as curative measures for alleviating energy poverty through improving standards of existing housing, while others such as (Charlier, Legendre, and Risch 2019) call for building new high-efficiency social housing a preventative measure for addressing energy poverty. Some papers (Zhu et al. 2021) find that energy-related housing upgrades are linked to broader social goals like better health outcomes and reduced healthcare spending. However, a few other authors

caution that in practice there are contradictions between refurbishments that prioritize energy savings and measures to improve housing conditions (D. Jenkins, Middlemiss, and Pharoah 2011; Vilches, Barrios Padura, and Molina Huelva 2017).

Finally, emerging research is tracing how the vulnerability to and impacts of energy poverty and poor housing outcomes are socially, demographically, and geographically patterned (Healy and Clinch 2002; Grey et al. 2017; Mylène Riva et al. 2023; Sánchez-Guevara, Fernández, and Aja 2015). Several papers describe the challenge of identifying and prioritizing households that need interventions the most because the simple classification of "vulnerable households" as a category tends to over-simplify the lived experiences and the causal links between energy poverty, housing vulnerabilities and health outcomes (Wright 2004; Mould and Baker 2017; Ormandy and Ezratty 2012).

This theme is also reflected in the literature on housing vulnerability. While Canada's National Housing Strategy identifies 12 groups as "vulnerable people for priority policy action" (CMHC 2018), authors such as (Zhu et al. 2021) note that "people who experience housing vulnerability are more than statistical and demographic categories they are grouped into. Such a categorization shines a spotlight on which is an insufficient and often inappropriate way to conceive of vulnerability." Instead, recent scoping reviews by (Spring and Rosol 2022; Zhu et al. 2021) that examine housing vulnerability from the Canadian perspective conceptualize vulnerability as the *risk of undesirable* harms experienced by individuals, households or communities due to *external risk factors* and conditioned their (in)ability to adapt or mitigate or respond adequately. Framed this way, 'housing vulnerability' links up conceptually with the concept of 'energy vulnerability' as outlined in Section 1.

In response to these trends, there is an emerging consensus for future research in this area to better explicate social patterns of vulnerability to energy-related impacts of housing and targeting interventions to increase individual and community's resilience, ability to respond and minimize the risk factors for negative outcomes due to energy poverty and related housing issues (Mould and Baker 2017; Longhurst and Hargreaves 2019; D. Jenkins, Middlemiss, and Pharoah 2011).

Annotated references

Baudu, Charlier, and Legendre 2020. “Fuel Poverty and Health: A Panel Data Analysis.” *FAERE Working Paper*, (April 2020) https://faere.fr/pub/WorkingPapers/Baudu_Charlier_Legendre_FAERE_WP2020.04.pdf

This paper connects housing and energy poverty through links to health-related outcomes. The main finding is that fuel poverty increases the risk of bad health by a factor of 7 for people with pre-existing poor health conditions, and by a factor of ~2 for those in good health. This paper is a good entry point into literature linking energy efficiency, energy poverty and health.

Brunner, Spitzer, and Christanell 2012 “Experiencing Fuel Poverty. Coping Strategies of Low-Income Households in Vienna/Austria.” *Energy Policy*, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, vol 49 (October 2012): 53–59. https://doi.org/10.1016/j.enpol.2011.11.076

This paper reviews coping strategies employed by the energy poor in dealing with poor living and housing conditions with energy use. Results are similar to previous findings in the literature that coping strategies occur across all age groups and even in households that may not at times be energy-poor. Energy-inefficient homes are the cause of heavy energy poverty burdens, but coping mechanisms largely reflect the “modesty” of energy-poor households with self-rationing energy use and lowering their standards of living.

Burlinson, Giulietti, and Battisti 2018 “The Elephant in the Energy Room: Establishing the Nexus between Housing Poverty and Fuel Poverty.” *Energy Economics* vol 72 (May 2018): 135–44. https://doi.org/10.1016/j.eneco.2018.03.036

This paper connects housing vulnerability with energy poverty by making a conceptual distinction between three different types of households with high energy cost burdens: a) households that are in poverty due to low incomes, b)households pushed into poverty due to housing costs and c) pushed into poverty due to energy costs alone. In isolating energy costs from overall housing costs, this alternative conceptual framing of energy poverty seeks to put forward an empirical strategy to help identify households most in need of specific supports. The paper argues that such an approach would help policymakers design income, housing and energy-related schemes to target specific subtypes under the overall dimension of energy poverty.

CPHA 2018. “Key Health Inequalities in Canada: A National Portrait – Executive Summary.” Research, (May 2018). https://www.canada.ca/en/public-health/services/publications/science-research-data/key-health-inequalities-canada-national-portrait-executive-summary.html

This paper evaluates housing standards as a key social determinant of health and health-related inequalities in the Canadian context. The paper finds that inequalities in rates of below standards were significant across a range of socio-economic and sociodemographic stratifiers including Indigenous identity, visible minority status, immigrant status, urban residence, income, education and employment status.

Charlier and Legendre 2022 “Fuel Poverty and Health: A Shared Agenda for Policy.” *Revue d’économie politique* vol 132, no. 2 (2022): 245–72. https://doi.org/10.3917/redp.322.0245

This paper notes that very few studies target causal links between fuel poverty and poor health. Using statistical methods on panel data, this paper concludes that fuel poverty has a significant impact on health, stressing the importance of energy efficiency retrofits in improving occupant well-being and reducing public health expenditures.

Charlier, Legendre, and Risch 2019 “Fuel Poverty in Residential Housing: Providing Financial Support versus Combatting Substandard Housing.” *Applied Economics* vol 51, no. 49 (October 2019): 5369–87. https://doi.org/10.1080/00036846.2019.1613501

This paper uses energy poverty in France as a case study to argue that existing public policies like social energy subsidies are palliative - only offer temporary relief, policies to encourage energy efficiency in homes are curative - substantially reduce energy inefficiency, which is a big cause for energy poverty. Instead, this paper argues that building social housing can be a preventative and efficient public policy to tackle fuel poverty, as this paper shows that social housing can reduce energy poverty by a significant amount through statistical analysis.

Chen and Feng 2022 “Linking Housing Conditions and Energy Poverty: From a Perspective of Household Energy Self-Restriction.” *International Journal of Environmental Research*

and Public Health vol 19, no. 14 (July 2022): 8254. https://doi.org/10.3390/ijerph19148254

This paper attempts to explicitly link housing and energy poverty based on an empirical case study of data from China. The paper finds that a) households are more likely to be exposed to energy poverty if live in poor quality or rental housing b) location and energy installations are the main characteristics that distinguish energy poor from non-energy poor c) link between housing conditions and energy poverty is reinforced by patterns and behaviours of energy use of households and d) measures undertaken by households to self-ration energy use can be counterproductive and worsen energy poverty in the long run. This paper is a good entry point into literature reviews explicitly linking housing conditions with energy poverty.

Czerwinska 2021 "Fuel Poverty : Retrofitting as a Policy Solution." Ph.D., Ulster University, 2021. https://pure.ulster.ac.uk/en/studentTheses/3be603d2-486c-40e9-9239-7846fda6c2fc

This thesis connects housing and energy poverty through retrofits as a policy solution. The paper contends that due to often misaligned socially-led policies, energy efficiency responses remain underdeveloped and there is a lack of evidence on the effectiveness of retrofitting solutions and their impacts on fuel poverty. To address this gap, this thesis undertakes an empirical study of fuel poverty and retrofitting strategy in Northern Ireland to find that "bespoke" and energy retrofits, combined with behavioural adaptations post-retrofit, are successful in lifting households out of energy poverty.

El Ansari and El-Silimy 2008. "Are Fuel Poverty Reduction Schemes Associated with Decreased Excess Winter Mortality in Elders? A Case Study from London, UK." *Chronic Illness* vol 4, no. 4 (December 2008): 289–94. https://doi.org/10.1177/1742395308090620

This paper argues that housing is a determinant of health and energy-inefficient homes contribute to health issues like excess winter mortality. While health-related outcomes have been the focus of energy poverty policy interventions, this paper warns that relationships between excess winter mortality and impacts of energy poverty policy interventions are difficult to interpret, as many factors such as biological, genetic, gender etc. are entangled.

Grey, et al. 2017 “Cold Homes, Fuel Poverty and Energy Efficiency Improvements: A Longitudinal Focus Group Approach.” *Indoor and Built Environment* vol 26, no. 7 (August 1, 2017): 902–13. https://doi.org/10.1177/1420326X17703450

This paper links cold homes, with energy poverty and energy efficiency policies for affordable warmth. Literature has identified cold homes and fuel poverty as factors in health and social inequalities that could be alleviated through energy efficiency interventions. While most papers focus on quantitative methods for analyzing the impacts of affordable warmth policy interventions, this paper uses a longitudinal study of lived experience with energy poverty before and after a policy intervention. Results show that improving the energy efficiency of energy-poor homes has an immediate impact on the social, material, economic and mental well-being of households, while some participants reported the intervention as a stressful experience.

Healy and Clinch 2022 “Fuel Poverty, Thermal Comfort and Occupancy: Results of a National Household-Survey in Ireland.” *Applied Energy* vol 73, no. 3 (November 2002): 329–43. https://doi.org/10.1016/S0306-2619(02)00115-0

There has been very little empirical work examining the relationship between fuel poverty and thermal comfort and the extent of indoor ‘cold strain’ (chronic stress due to prolonged exposure to cold temperatures) resulting from inadequately heated housing. Furthermore, the effects of fuel poverty on household occupancy continue to be underexplored. This paper employs a new national household survey of Ireland, a country with a level of fuel poverty similar to Britain, to examine these key issues. The paper finds that the health impacts of housing conditions are socially patterned, two-thirds of fuel-poor householders demonstrate cold strain, and over half of elderly households endure inadequate ambient household temperatures during winter.

Howden-Chapman et al. 2012 “Tackling Cold Housing and Fuel Poverty in New Zealand: A Review of Policies, Research, and Health Impacts.” *Energy Policy*, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, vol 49 (October 2012): 134–42. https://doi.org/10.1016/j.enpol.2011.09.044

This paper uses community trials in NZ as a case study to examine links between cold homes and health. The study finds that a) insulating existing homes led to improved

self-rated health reduced wheezing, reduced days off school/work and reduced visits to family doctors. b) installing effective heating led to improved self-reported health outcomes, such as decreased reports of poor child health, reduced reports of respiratory symptoms etc. These benefits point to the case for investment in energy efficiency in energy-poor homes from a health perspective.

Ige et al. 2019 "The Relationship between Buildings and Health: A Systematic Review." *Journal of Public Health* vol 41, no. 2 (June 2019): e121–32. https://doi.org/10.1093/pubmed/fdy138

This paper attempts to provide a systematic review of evidence underpinning the built environment of buildings with directly measurable effects on physical and mental health. The review finds that housing refurbishments such as the provision of adequate heating, and improvements to ventilation and water supply were consistently associated with improved respiratory outcomes, quality of life and mental health. However, the study also concludes that methodological issues make it difficult to draw direct causal links between features of housing and well-being.

Jenkins, Middlemiss, and Pharoah 2011 "A Study of Fuel Poverty and Low-Carbon Synergies in Social Housing." Monograph, 2011. https://www.hw.ac.uk/uk/schools/doc/egis/FuelPovertyReport220711.pdf

Using social housing in the UK as a case study, this paper argues that there are synergies and contradictions between low-carbon building retrofits and energy poverty reduction strategies. The results suggest that categorizing such a large number of dwellings and families into "energy-poor" monolith risks ignoring the range of responses to fuel poverty by different tenants. While energy-saving refurbishments, with their high capital costs, might be proposed as alternatives to fuel subsidies and payments, this will affect different families, in different dwellings, in different ways, and future research must account for social and cultural practices that underpin energy use at home.

Kahouli 2020 "An Economic Approach to the Study of the Relationship between Housing Hazards and Health: The Case of Residential Fuel Poverty in France." *Energy Economics* vol 85 (January 2020): 104592. https://doi.org/10.1016/j.eneco.2019.104592

This paper reviews a large-scale nationally representative dataset from France to uncover a causal relationship between fuel poverty and self-assessed health. The study finds that the causal relationship is strong and deferred - energy poverty takes time to manifest as poor health. The author recommends public policy priority of investing in improving housing standards to reduce fuel poverty and thereby improve health outcomes and reduce public expenditures on healthcare.

Karpinska and Śmiech 2020. "Invisible Energy Poverty? Analysing Housing Costs in Central and Eastern Europe." *Energy Research & Social Science* vol 70 (December 2020): 101670. https://doi.org/10.1016/j.erss.2020.101670

This paper estimates total housing costs (shelter costs) while accounting for the fact that households might be self-rationing energy costs. This paper considers energy costs to be the main component of housing costs which could be cut down by households experiencing material and financial difficulties.

Legendre and Ricci 2015 "Measuring Fuel Poverty in France: Which Households Are the Most Fuel Vulnerable?" *Energy Economics* vol 49 (May 2015): 620–28. https://doi.org/10.1016/j.eneco.2015.01.022

Using the case study of energy poverty in France, this paper links energy poverty and housing by proposing a definition of energy-poor households that zooms into energy costs as the triggering condition for pushing a household into poverty. In this paper, energy-poor households are defined as households that are pushed into poverty uniquely because of domestic energy use expenses. Therefore, households that are priori non-poor (not below 60% of the median adjusted income) when considering income net of housing costs, but turn poor when considering income net of housing costs and home energy costs - are regarded as energy poor. In doing so, this paper separates energy costs from overall shelter costs and regards energy-vulnerable households are those for which home energy expenditure is the triggering poverty factor.

Liddell and Morris 2010 "Fuel Poverty and Human Health: A Review of Recent Evidence." *Energy Policy*, The Role of Trust in Managing Uncertainties in the Transition to a

Sustainable Energy Economy, Special Section with Regular Papers, vol 38, no. 6 (June 2010): 2987–97. https://doi.org/10.1016/j.enpol.2010.01.037

One of the more frequently cited papers in this field, this paper reviews the health impacts of tackling energy poverty based on large-scale studies completed between the years 2000-2010. At the time of publication, this paper found that the anticipated physical health impacts of tackling fuel poverty in adults have been modest. this could be due to methodological limitations or that clinical impacts may take longer to manifest. The review does find significant positive impacts on the physical health of infants and children, as well as significant positive benefits to mental health among all age groups.

Longhurst and Hargreaves 2019 "Emotions and Fuel Poverty: The Lived Experience of Social Housing Tenants in the United Kingdom." *Energy Research & Social Science* vol 56 (October 2019): 101207. https://doi.org/10.1016/j.erss.2019.05.017

This paper links housing and experiences with energy poverty through the conceptual framework of emotional engagement with energy vulnerability. For instance, poor housing is recognized as a cause of unhappiness with persistent dampness and mound (all consequences of energy poverty) being a constant source of distress and frustration. Energy vulnerability is also marked by a lack of trust in housing providers, with landlord-tenant relations characterized by fear, stress and isolation.

Mould and Baker 2017 "Documenting Fuel Poverty from the Householders' Perspective." *Energy Research & Social Science*, Narratives and Storytelling in Energy and Climate Change Research, vol 31 (September 2017): 21–31. https://doi.org/10.1016/j.erss.2017.06.004

This study uses based on fifteen illustrative case studies from Scotland to develop qualitatively unique profiles of vulnerability to energy poverty. In doing so, the paper reviews a significant body of literature connecting housing quality conceptually with energy poverty and vulnerability to physical/mental health. The many distinct case studies highlight the diversity of the situations of energy poverty as well as related impacts on poor mental health and well-being. The paper concludes with a call to develop a risk-based assessment vulnerability of households to energy poverty and its impacts.

Ormandy and Ezratty 2012 “Health and Thermal Comfort: From WHO Guidance to Housing Strategies.” *Energy Policy*, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, vol 49 (October 2012): 116–21. https://doi.org/10.1016/j.enpol.2011.09.003

This paper connects housing and energy poverty through WHO guidance on indoor air temperatures for thermal comfort (18-24*C). The paper calls to attention the need to maintain thermal comfort also in the summer through ACs or passive cooling solutions. The paper also highlights threats to health from energy poverty that are not just thermal discomfort. For instance, an inadequate supply of energy means inadequate food storage, cooking, maintenance of personal and household hygiene, artificial lighting etc. which could result in poor health outcomes such as food poisoning, infections, respiratory illnesses etc.

Raphael et al. 2020 “Social Determinants of Health: The Canadian Facts, 2nd Edition,” (October 2020) https://thecanadianfacts.org/The_Canadian_Facts-2nd_ed.pdf

This paper reviews housing as a determinant for public health in Canada. The paper argues that housing influences health through material environments. For instance, overcrowding allows for the transmission of respiratory and other illnesses. High shelter costs (which include energy costs) reduce resources available to provide other social determinants of health. Living in poor housing causes stress and unhealthy means of coping such as substance abuse. Poor housing quality such as the presence of mould, poor heating, draft, and inadequate ventilation are determinants of adverse health outcomes - such as respiratory illness. Housing vulnerability is a mental health concern for the majority of Canadians and is more pronounced for renters.

Robinson, Bouzarovski, and Lindley 2020 “‘Getting the Measure of Fuel Poverty’: The Geography of Fuel Poverty Indicators in England.” *Energy Research & Social Science*, Spatial Adventures in Energy Studies; vol 36 (February 2018): 79–93. https://doi.org/10.1016/j.erss.2017.09.035

Housing costs are implicated in the definition and subsequent measurement of energy poverty. When the UK changed the definition of energy poor from a 10% of income indicator to a LowIncomeHighCost (LIHC) indicator that uses a measure of income

after accounting for after-housing costs (better reflecting the financial flexibility of a house), it changed the spatial geography of who is regarded as energy poor. By excluding housing costs from the measurement of income, the percentage of fuel-poor households using the Low-Income, High-Costs indicator is likely to be higher in areas with a higher house price-to-earnings ratio, making energy poverty a largely urban phenomenon.

Sánchez-Guevara, Fernández, and Aja 2015. "Income, Energy Expenditure and Housing in Madrid: Retrofitting Policy Implications." *Building Research & Information* vol 43, no. 6 (November 2015): 737–49. https://doi.org/10.1080/09613218.2014.984573

This paper uses Madrid as a case study to describe a methodology for characterizing the housing stock of energy-poor households, to identify "households most in need". This methodology produces six household groups a) low-income households in energy poverty 2) modest-income households NOT in energy poverty 3) modest-income households in energy poverty 4) middle-income households who are vulnerable to poverty due to high energy cost burdens 5) middle-income households with no energy cost burdens 6) non-vulnerable households.

Scott 2016 "An Exploration of Human Rights Implications of Energy Poverty in Rural Ontario" *Canada Environmental Law Association* 2016. https://cela.ca/wp-content/uploads/2019/07/In-the-Dark.pdf

This thesis connects energy poverty and housing standards by framing energy access as a human rights issue, along the dimensions of a) a right to accessing energy as a part of the right to adequate housing, habitability, access to essential services and economic access and b) energy underpins other basic rights necessary for daily life such as access to drinking water and sanitation.

Sharpe et al. 2015 "Fuel Poverty Increases Risk of Mould Contamination, Regardless of Adult Risk Perception & Ventilation in Social Housing Properties." *Environment International* vol 79 (June 2015): 115–29. https://doi.org/10.1016/j.envint.2015.03.009

This paper conducts an empirical survey and presents results from approx. 4000 participating social housing properties to find that fuel poverty behaviours increased the risk of mould contamination, in line with literature on the subject. The contribution of

this paper is that the increased risk of mould is likely regardless of the built environment of housing or risk perception.

Shortt and Rugkåsa 2007 . "'The Walls Were so Damp and Cold' Fuel Poverty and Ill Health in Northern Ireland: Results from a Housing Intervention." *Health & Place*, Part Special Issue: Environmental Justice, Population Health, Critical Theory and GIS, vol 13, no. 1 (March 2007): 99–110. https://doi.org/10.1016/j.healthplace.2005.10.004

This article is one of the earliest empirical investigations linking housing conditions, energy poverty and energy efficiency interventions. While the study demonstrated that energy efficiency interventions can lead to improvements in health outcomes some households remain in fuel poverty after having full central heating installed, reflecting the significant contribution of low-income and general poverty to the production of fuel poverty. The article concludes by suggesting that interventions in this area require commitment from multiple sectors of society, including health professionals and local communities.

Spring and Rosol 2022 "'Pay the Rent or Feed the Kids': A Scoping Review of the 'Housing-Food Insecurity Nexus' in Canada," *SocArXiv Papers* (June 2022). https://doi.org/10.31235/osf.io/wd87b.

This paper explores the concepts of housing insecurity and food insecurity in the Canadian context and provides a framework for conceptualizing the nexus between these two topics, highlighting the sociodemographic patterning of co-vulnerabilities. This paper is a good entry point into understanding housing insecurity in the Canadian context.

Thomson et al. 2013 "Housing Improvements for Health and Associated Socio-economic Outcomes." *Cochrane Database of Systematic Reviews*, no. 2 (2013). https://doi.org/10.1002/14651858.CD008657.pub2

A huge amount of research on housing and health has been published but very few studies have investigated if improved housing conditions impact on residents' health. This paper fills that gap by reviewing a wide selection of studies from around the world published in the last 3 decades to investigate links between improving housing and

health. Among other findings, the review notes that Improvements in warmth and affordable warmth may be an important reason for improved health. Improved health may also lead to reduced absences from school or work. Improvements in energy efficiency and provision of affordable warmth may allow householders to heat more rooms in the house and increase the amount of usable space in the home. Greater usable living space may lead to more use of the home, allow increased levels of privacy, and help with relationships within the home. An overview of the best available research evidence suggests that housing which promotes good health needs to be an appropriate size to meet household needs and be affordable to maintain a comfortable indoor temperature.

Vilches, Barrios Padura, and Huelva 2017 "Retrofitting of Homes for People in Fuel Poverty: Approach Based on Household Thermal Comfort." *Energy Policy* vol 100 (January 2017): 283–91. https://doi.org/10.1016/j.enpol.2016.10.016

This paper argues that energy retrofits do not reduce energy consumption in a fuel poverty context due to "pre-bound" and "rebound" effects as households may be self-rationing energy use pre-retrofit. Therefore, energy retrofit does not produce monthly monetary savings for households experiencing energy poverty. This paper develops a methodology - based on thermal comfort, monthly budgets and initial costs - to choose the most appropriate retrofit measure in the context of energy poverty. The study recommends that public policy be designed with a household's monthly budget for energy expenditure in mind, and prioritize maximizing thermal comfort based on a household's monthly budget available for energy spending.

Wang, Wang, and Norbäck 2022 "A Systematic Review of Associations between Energy Use, Fuel Poverty, Energy Efficiency Improvements and Health." *International Journal of Environmental Research and Public Health* vol 19, no. 12 (January 2022): 7393. https://doi.org/10.3390/ijerph19127393

Paper reviews links between energy poverty, energy retrofits and health. More efficient heating and increased thermal insulation can improve health in homes experiencing fuel poverty. However, energy-saving measures in airtight buildings and thermal insulation without the installation of mechanical ventilation can impair health. Energy efficiency retrofits can increase indoor radon which can cause lung cancer. Installation of a mechanical ventilation system can solve many of the negative effects linked to airtight

buildings and energy efficiency retrofits. However, higher ventilation flow can increase indoor exposure to outdoor air pollutants in areas with high levels of outdoor air pollution.

Wright 2004. "Old and Cold: Older People and Policies Failing to Address Fuel Poverty." *Social Policy & Administration* 38, no. 5 (2004): 488–503. https://doi.org/10.1111/j.1467-9515.2004.00403.x

This paper connects housing with energy poverty through health impacts on seniors due to cold homes. As one of the first papers on the effects of energy-related housing conditions on health, this paper finds that public policies for energy efficiency and housing quality are disconnected from and do not extend to households (such as seniors, living rurally, in older homes) that need warmer homes the most.

Zhu et al. 2021 "Toward a Better Understanding of Housing Vulnerability." Simon Fraser University. https://summit.sfu.ca/item/31641.

This paper provides a scoping review of vulnerability associated with housing in the Canadian context and conceptualizes 'housing vulnerability' as the potential for future harm due to external risk factors and conditioned by a household's inability to respond. This paper is a good entry point into housing insecurity and vulnerability research.

Section 5: Discussion: What policies have been proposed for addressing energy poverty and how successful are they?

Most papers collected here offer critical analysis of the impacts of social and energy policies - including social tariffs, subsidies for heating, and targeted energy efficiency interventions – on energy poverty either through systematic reviews of literature or through empirical case studies.

However, several papers in this collection point to the methodological and conceptual challenges associated with measuring the effectiveness of policy interventions on the grounds that definitions of energy poverty and 'vulnerable groups' are political and contested (Kerr, Gillard, and Middlemiss 2019; Kyprianou et al. 2019; R. Walker et al. 2013) and that energy poverty is a complex phenomenon with diverse underlying factors and drivers whose interactions are poorly understood, rendering evaluation of causal links between policy interventions and outcomes hard to evaluate after the event (G. Walker and Day 2012; Middlemiss et al. 2023).

In response to these challenges, some papers in this collection propose a multidimensional policy approach or a policy mix approach to examining how energy poverty interventions interact with and influence broader policies on climate action, urban renewal, social policy, public health and just transitions (Bessa and Gouveia 2022; Stojilovska et al. 2022; Middlemiss et al. 2023; Avanzini et al. 2022; Streimikiene and Kyriakopoulos 2023; Middlemiss et al. 2018). In doing so, these papers argue that energy poverty is not always a primary concern of public policies such as public health or energy retrofits, thereby marginalizing vulnerable groups and their experiences with energy poverty from public policy. Therefore, integrating energy poverty into broader policies is critical in designing interventions which are fair, effective, and aligned with people's daily lives.

Thus, a growing consensus in literature calls for decisive policy action on alleviating the disproportionate impacts of energy poverty on vulnerable communities, underscoring the need for precise methods for identifying 'vulnerable communities'; understanding and incorporating lived experiences; novel participatory mechanisms; governance

innovations; and for incorporating energy justice principles into housing retrofit policies (Bouzarovski, Thomson, and Cornelis 2021; R. Walker et al. 2013; Middlemiss et al. 2018; Kyprianou et al. 2019).

Taken together, these papers showcase some case studies of policy interventions but also highlight the challenge of evaluating the effectiveness of policy interventions in the complex, contested, and emergent policy arena of energy poverty. However, these papers also point to a growing consensus for the need for decisive action to mitigate impacts on vulnerable communities by integrating energy poverty into wider social, economic, energy and climate policy agendas.

Annotated references

Avanzini et al. 2022 "Energy Retrofit as an Answer to Public Health Costs of Fuel Poverty in Lisbon Social Housing." *Energy Policy* vol 160 (January 2022): 112658. https://doi.org/10.1016/j.enpol.2021.112658

This paper argues that public health or fuel poverty are not always the primary concerns of energy efficiency retrofitting policies. These dimensions are often neglected when determining the economic feasibility of building retrofits, resulting in the exclusion of vulnerable groups (less affluent and energy poor) from policies and programs, leading to further degradation of the already inefficient housing stock of rental and low-income homes. This paper shows the potential for enhancing comfort through passive retrofitting can tackle energy poverty, mostly with positive effects on individuals' health and social life, while also reducing energy consumption and CO2 emissions. The main contribution of this paper is a conceptual framework that local authorities can use to allocate public funding for building retrofits that prioritize reducing energy use and improving thermal comfort and health.

Bessa and Gouveia 2022 "A Framework for Policy Mix Analysis: Assessing Energy Poverty Policies." *Journal of Environmental Economics and Policy* (December 2022): 1–17. https://doi.org/10.1080/21606544.2022.2153744

This paper contends that typical analysis of policies - including energy poverty policies - focuses on understanding singular fragments of energy poverty or evaluating the effects of a single policy. However, in practice, energy poverty is a complex phenomenon with many drivers and policies in the real world often having to interact

with different policies to produce outcomes. Therefore, this paper reviews energy poverty policies from the perspective of a policy mix. The authors propose a 5-step process for policy mix analysis; defining objectives, selecting instruments, analysis of single instruments, instrument interaction analysis and evaluation. The paper is a good entry point into policy mix and policy analysis literature. The main conceptual contribution of this paper is to encourage policy mix thinking for the analysis and prescription of policy solutions for energy poverty.

Bouzarovski, Thomson and Cornelis 2021 "Confronting Energy Poverty in Europe: A Research and Policy Agenda." *Energies* vol 14, no. 4 (January 2021): 858. https://doi.org/10.3390/en14040858

This paper reviews policy efforts to address energy poverty across a variety of decision-making scales in the EU and constituent member states. The paper looks at policies from the perspective of analyzing distributional and procedural justice provisions in national climate and energy plans to understand the power, ability and resolve of relevant institutions to tackle energy injustice. The authors find that the EU and member states have made progress with decision-making frameworks, however, the statutory set-up of energy poverty mitigation programs means that structural injustices that lead to energy poverty generally remain outside the remit of most policy efforts. The authors note some key issues that need to be addressed : a) translating generic commitments into decisive policy action b) encouraging participation from stakeholders outside the energy sector - social policy, housing, health, business, planning, regional development etc c) innovative participatory mechanisms to engage vulnerable (hard to reach) households in design and implementation of relevant programs. Based on these gaps, the authors also outline a future research and policy-making agenda.

Kerr, Gillard, and Middlemiss 2019 "Politics, Problematisation, and Policy: A Comparative Analysis of Energy Poverty in England, Ireland and France." *Energy and Buildings* 194 (July 2019): 191–200. https://doi.org/10.1016/j.enbuild.2019.04.002

This paper reviews national approaches to energy poverty in England, Ireland and France to show how different policy solutions are affected by how energy poverty in each nation is defined and measured. The paper finds that the development of energy poverty as a political issue and how it is problematized is shaped by forces such as deregulation, the financial crisis of 2008, the emergence of climate change mitigation

policies and sustainability agendas. In response, energy poverty as a policy problem has shifted from being thought of as an issue of thermal comfort and household budgets to a household's inability to access a wider range of energy services. The paper finds that energy poverty definitions are primarily a means of assessing the scale of the issue rather than a means of directing and determining solutions. The paper also finds a disconnect between political rhetoric that favoured efficiency over affordability solutions and funding that favoured affordability over efficiency, suggesting that the process of aligning policies, politics and problems of energy poverty is not always pragmatic.

Kyprianou et al. 2019 "Energy Poverty Policies and Measures in 5 EU Countries: A Comparative Study." *Energy and Buildings* vol 196 (August 2019): 46–60. https://doi.org/10.1016/j.enbuild.2019.05.003

This paper contends that a majority of literature on energy poverty policies originates from just three countries; the UK, France, and Ireland. To address this gap, this paper reviews policies in 5 EU countries (Cyprus, Spain, Portugal, Bulgaria and Lithuania) that directly or indirectly address energy poverty. The main contribution of this paper is a conceptual categorization of energy poverty measures at the national scale into consumer protection, financial interventions, energy savings installations, and information provision. The paper also highlights two important roles for advancing energy poverty at the national level - defining energy poverty and defining energy poverty vulnerable consumer groups.

Middlemiss et al. 2018 "Plugging the Gap Between Energy Policy and the Lived Experience of Energy Poverty: Five Principles for a Multidisciplinary Approach." In *Advancing Energy Policy*, edited by Chris Foulds and Rosie Robison, 15–29. Cham: Springer International Publishing, 2018. http://link.springer.com/10.1007/978-3-319-99097-2_2

Using the UK, Spain and the Netherlands as case studies, this book chapter reviews existing policies for energy poverty from the perspective of lived experiences with energy poverty. The authors argue that understanding the lived experience of energy poverty along dimensions of housing, education, social policy, health etc. is critical in designing energy policies which are fair, effective and aligned with people's daily lives. The authors propose 5 principles for policy design informed by lived experiences; a) consider opportunities for joined-up and integrated policy (eg: partnership with the

health sector to reduce costs to the health care system due to energy poverty b) build momentum through state/non-state networks and partnerships c) anticipate intersecting challenges and unintended consequences d) measure wider positive impacts of tackling energy poverty, such as on housing, health, mobility, social isolation, climate change etc. and e) local action without waiting for national policy to be developed.

Middlemiss et al. 2023 "How Do Interventions for Energy Poverty and Health Work?" *Energy Policy* vol 180 (September 2023): 113684. https://doi.org/10.1016/j.enpol.2023.113684

This paper reviews existing evidence on interventions for energy poverty and health with a focus on how interventions work to produce health outcomes. The paper finds that the practicalities of implementation are shaped by causal assumptions between policy design and actual health outcomes. The paper contends that there are gaps between how policies and programs are designed and how participants respond to said policies and programs. The paper ends with the recommendation that energy poverty policies and programs should account for how people will respond to technological change, fund support for households that are adapting to new technology, offer an inclusive design process and be flexible in delivery. This paper is a good entry point into understanding causal assumptions in the literature about how policy interventions on energy poverty impact health, social and governance factors that shape policy implementation, behavioural factors that shape responses to interventions and mechanisms explaining why people do not engage in energy poverty interventions.

Schleich 2019 "Energy Efficient Technology Adoption in Low-Income Households in the European Union – What Is the Evidence?" *Energy Policy* vol 125 (February 2019): 196–206. https://doi.org/10.1016/j.enpol.2018.10.061

This paper reviews energy efficiency adoption by household incomes in eight EU countries and finds that adoption rates of energy-efficient technologies vary strongly by income quartiles. These findings suggest that financial support policies for comprehensive retrofit measures should target "poor homeowners".

Stojilovska, et al. 2022 “Energy Poverty and Emerging Debates: Beyond the Traditional Triangle of Energy Poverty Drivers.” *Energy Policy* vol 169 (October 2022): 113181. https://doi.org/10.1016/j.enpol.2022.113181

This paper reviews if, how and why energy poverty is linked to other related policy areas, using six diverse European countries as a case study. The paper finds that emerging debates link energy poverty to energy efficiency, good governance, new energy services and challenges with energy transition. The policy space is co-shaped by national path dependencies of existing social, economic, and energy market policies as well as experiences with dealing with energy poverty. Energy efficiency has the most explicit links to energy poverty due to the dominant techno-economic approach to addressing energy poverty, with less explicit references to social aspects of energy poverty. The authors concede that a multidimensional policy approach to dealing with energy poverty can have additional benefits across other policy areas, such as health, employment, air quality, climate data, technologies, and the just transition.

Streimikiene et al. 2020 “Climate Change Mitigation Policies Targeting Households and Addressing Energy Poverty in European Union.” *Energies* vol 13, no. 13 (January 2020): 3389. https://doi.org/10.3390/en13133389

This paper reviews the issues associated with climate change mitigation and energy poverty alleviation in EU households to provide an integrated framework for addressing energy poverty, just carbon-free energy transition and climate change mitigation at the household level. The paper finds that more targeted policies are necessary to link the reduction of energy poverty and realizing climate change mitigation potential in households.

Thomson and Bouzarovski 2019. “Addressing Energy Poverty in the European Union: State of Play and Action.” European Commission Energy Poverty Observatory, (April 2019). https://energy-poverty.ec.europa.eu/system/files/2022-04/paneureport2018_updated2019.pdf

This report is a comprehensive overview of energy poverty - concept, prevalence, measurement, definition, metrics, and measures to address energy poverty. From the executive summary: “This report starts by introducing the concept of energy poverty, before outlining what Energy Poverty Observatory is, its Tasks and Work Packages,

governance structures, activities to date, and forthcoming future activities. Then, we report on the prevalence of energy poverty in the EU using data from the EU Statistics on Income and Living Conditions, and Household Budget Surveys, with a description of the methodology used by the Energy Poverty Observatory. It is argued that energy poverty should be measured using multiple indicators in tandem, as it is a complex multi-dimensional issue that manifests in different ways across households and Member States. The third part of this report looks at measures to tackle energy poverty, both in terms of EU legislative requirements and national policy definitions of energy poverty and vulnerable consumers, as well as practical schemes to assist households. We find variations in the approaches taken by Member States, with a combination of social and energy policies, including social tariffs, subsidies for heating, and targeted energy efficiency interventions. This suggests significant learning opportunities exist for countries to transfer aspects of different policy frameworks to complement their existing work, or, indeed as part of new action to tackle energy poverty."

Varo et al. 2022 "Addressing Energy Poverty through Technological and Governance Innovation." *Energy, Sustainability and Society* vol 12, no. 1 (December 2022): 1–19. https://doi.org/10.1186/s13705-022-00377-x

This paper reviews 20 different energy poverty mitigation policies deployed in 10 different European countries with an ex-ante perspective (evaluate the concept and the design of the measures, rather than their impact) on the extent to which they are innovative on technological and governance dimensions. The conceptual foundation of this paper is that the introduction of new technological innovations must be examined within the complexity of governance contexts. The authors argue that combining technology with governance innovation has a better chance of generating more articulate, scalable and successful energy poverty mitigation policies.

Walker et al. 2013 "Evaluating Fuel Poverty Policy in Northern Ireland Using a Geographic Approach." *Energy Policy* vol 63 (December 2013): 765–74. https://doi.org/10.1016/j.enpol.2013.08.047

This paper includes a review of problems targeting energy poverty policies in a real-world setting, pointing to inherent difficulties in identifying "energy poor" and "households most in need". The needs and characteristics of the fuel poor are varied and multi-dimensional leading to inaccuracies in the targeting of many fuel poverty

policies. The problems are a) exclusion errors: energy-poor households are not covered by policies and b) inclusion errors: non-energy-poor households are wrongly awarded support. Limitations of existing policies are a) mismatch between social indicators of ‘vulnerable people’ (seniors, disabled etc) and energy poor, b) quality and energy efficiency of housing are not considered, which means programs do not benefit least efficient homes which leads to inclusion errors, and c) self-referral may lead to exclusion errors.

Section 6: Discussion: A vulnerability approach to linking energy poverty and housing

Conceptual framework

Energy poverty is a complex multifaceted phenomenon commonly understood to describe the situation where a household is unable to access adequate energy to maintain well-being at home. Energy poverty is typically considered to be caused by an interplay between unaffordability (low incomes and/or high energy costs) and poor housing conditions (such as inefficient, leaky homes).

While these determinants are common, each household's experiences with energy poverty are unique. Energy poverty is largely experienced behind closed doors and conditioned by social practices. These factors make energy poverty uniquely challenging to define, measure and track the patterning of its intensity and prevalence.

Against this backdrop, there is an increasing call for a more nuanced understanding of underlying factors that determine energy poverty and how they interact and overlap to have different impacts on different groups of people (as noted in Section 3). As noted in Section 4, there is a growing need for targeted and decisive action to mitigate impacts on vulnerable communities by integrating energy poverty into wider social, economic, energy, climate, housing and social justice policy agendas so that interventions are fair, effective and aligned with people's daily lives. Finally, section 5 notes the need for establishing clear policy goals and pathways for incorporating energy poverty and energy justice considerations while deploying housing-related interventions such as energy retrofits and refurbishments.

Therefore, an emerging consensus in the literature is calling for conceptualizing energy poverty as an uneven distribution of vulnerabilities, i.e the potential of future harm due to a person or household's exposure and sensitivity to energy poverty, combined with their (in)capacity to adapt or to respond meaningfully to energy poverty. This underscores the need for precise methods for identifying households vulnerable to energy poverty, for understanding and incorporating their experiences into designing solutions.

We respond to these calls by proposing a framework that conceptualizes **energy poverty as the vulnerability to future housing-related harms, amplified by energy-related risk factors and conditioned by a household's (in)ability to adequately respond**.

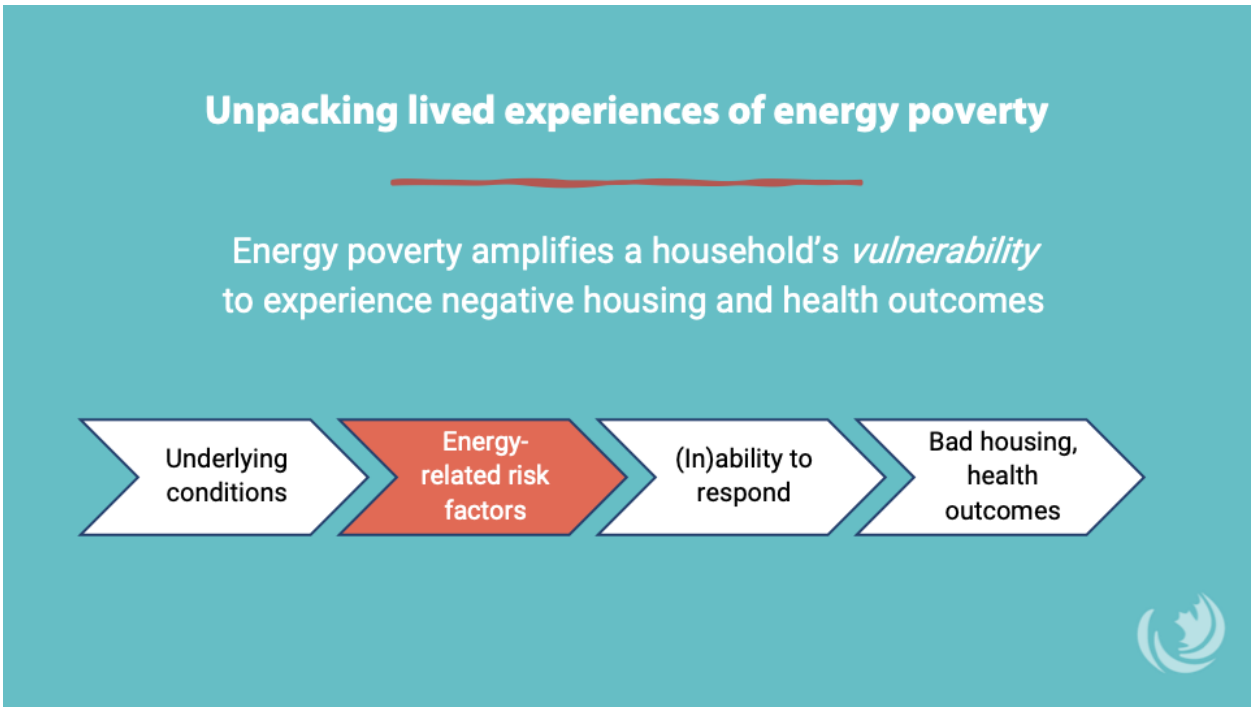

Figure 1: Conceptual framework of energy poverty as risk factors that amplify vulnerability to future housing-related harms

The underlying conditions are grouped into themes commonly regarded as determinants of energy poverty, and households may be experiencing any combination of these underlying factors in overlapping and intersectional ways. Examples of underlying conditions include:

- Affordability –low-incomes, single-earner household, precarious employment, fixed incomes, unstable incomes, cash-flow problems, high household debt, low-disposable incomes etc.
- Poor housing conditions – old leaky homes, inefficient heating, poor building envelope, housing needing repairs, lack of access to passive or active cooling, precarious housing, high shelter costs, inadequate housing, unsuitable housing, overcrowding, poor ventilation, dampness and mold issues, structural damages, etc.

- Systemic marginalization – exclusion from policies (eg: renters or those who live in multi-unit buildings are not included in most Canadian energy-efficiency initiatives), challenges navigating complex systems of support (eg: newcomers who may face barriers learning about no-cost energy efficiency upgrades that are marketed in English or French), exclusion errors (eg: households that self-ration energy use may not show up in common measures of energy poverty such as high energy cost burdens), etc.

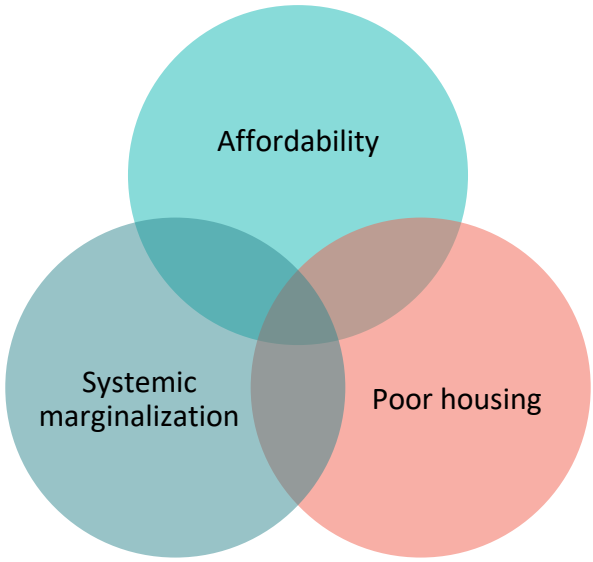

Figure 2: An intersectional look at underlying factors of energy poverty

Examples of energy-related risk factors could include, but are not limited to – high energy bills (chronic or a single large energy bill), disproportionate energy cost relative to income, high energy cost burdens, utility arrears, utility disconnections, disqualification from participation in energy efficiency programs for administrative reasons, using unregulated fuels for heating that require up-front payment, such as propane or heating oil, heating/cooling system malfunction requiring emergency replacement, and so on.

Examples of the inability of a household to respond adequately could include but are not limited to – lack of access to cooling during extreme heat events, unable to prioritize energy efficiency upgrades due to other competing priorities, living in housing situations that preclude the ability to undertake comprehensive energy upgrades, such as renting or living in multi-unit buildings, unable to make time for housing upgrades due to caregiving responsibilities, unable to access qualified installers to upgrade to

more efficient heating systems or improve building envelope due to rural and remote locations, and so on.

Examples of housing-related harms could include but are not limited to; housing insecurity, housing vulnerability, unaffordable housing, unsuitable housing, eviction, foreclosure, poor cardiovascular health, respiratory illness, poor mental health, social isolation, risk of mortality due to extreme weather events, loss of dignity, emotional distress, unhealthy means of coping, and so on.

Creating user profiles or archetypes of energy poverty

By explicating multiple specific examples under each category of underlying conditions, risk factors, and inabilities to respond adequately and impact future harms, we can construct archetypes or 'user profiles' that better reflect the heterogeneity of lived experiences with energy poverty. Table 2 illustrates this methodology with a few examples. Each row should be read as a causal link between underlying social vulnerabilities that are amplified by energy-related risk factors and leading to future housing-related harms.

Our forthcoming report, Energy Poverty User Profiles, expands on this framework and methodology to unpack the lived experiences of different vulnerable groups to energy poverty in Canada.

Underlying conditions		Energy-related risk factors	Inability to respond adequately	Housing-related negative outcomes
Affordability	Precarious employment in the gig economy	A single large energy bill	Missing a utility bill payment due to cash-flow issues or variability in month-month income.	Missing a utility bill as a renter can be grounds for eviction in many Canadian provinces
	Low disposable income after non-discretion costs (eg: childcare)	Chronic high energy bills	Cannot afford to upfront costs to finance energy efficiency upgrades	Unaffordable housing, as energy bills are a large component of total costs of housing
	Low-incomes	Chronic high energy bills	Families may turn down the thermostat and underheat homes in winter to save energy costs, which could cause moisture, dampness, and mould in walls.	Inadequate housing and respiratory illnesses
	Low-incomes	Chronic high energy bills	Households may turn down the thermostat in the house and crowd around a space heater in one room to reduce energy costs	Unsuitable housing and overcrowding
	Low-incomes and high household debt	Arrears on energy bills	Going further into debt to catch up with mounting utility arrears could lead to missing rent or mortgage payments.	Eviction or foreclosure
Unfavourable housing conditions	Poor insulation and building envelope	Inefficient heating systems	Households might live in a condo or rent an apartment, so cannot unilaterally upgrade the heating system or building envelope.	Unaffordable housing due to high energy bills
	Leaky drafty homes		Lack of qualified installers and skilled technicians to upgrade to more efficient and low-carbon heating system	Unaffordable housing due to high energy bills
	Poor ventilation		Lack of proper ventilation cause moisture, dampness, and mould in walls. (cite)	Inadequate housing
	Housing needs major repairs or mould remediation	Disqualification from energy efficiency programs	Unable to reduce energy use at home in productive ways, resorting to self-rationing	Unaffordable housing and/or poor health due to energy self-rationing

Underlying conditions		Energy-related risk factors or events	Inability to respond adequately	Housing-related negative outcomes
Systemic marginalization	Seniors living alone	Lack of access to passive heating or cooling	Unable to stay cool by installing AC or accessing cooling rooms during extreme heat events	Mortality during extreme weather events
	Single person households	Energy efficiency programs requiring multiple house visits	Unable to make time to schedule availability for pre-retrofit audit, retrofits and post-audit verification	High energy bills leading to unaffordable and uncomfortable homes
	Single parent households	Inadequate heating, cooling and/or ventilation	Less willing to grant entry to third party contractors to install corrective measures	High energy and housing costs, uncomfortable homes, poor childhood health as single parent families typically spend a greater amount of time indoors
	Newcomers to Canada	Old and inefficient heating systems	Energy efficiency not on list of priorities	High energy bills leading to unaffordable and uncomfortable homes
	Households that do not speak English or French at home	High energy bills	May not receive information about available low-income programs, lack of trust in government programs	High energy bills leading to unaffordable and uncomfortable homes
	Rural homeowners on fixed income	Use propane/oil for heat that require upfront payment	May not be able to afford upfront payment	Excess winter deaths

Table 2: Illustrative archetypes of lived experiences with energy poverty, as causal links between underlying conditions, risk factors, capacity to respond and future harms.

A few cautionary notes on Table 2: firstly, the factors enumerated and the causal mechanisms traced are merely illustrative, and are not meant to be exhaustive. Secondly, these factors are not mutually exclusive but may overlap and co-produce each other. For instance, inadequate heating and ventilation can both be an energy-related risk factor, but also a consequence of poor built environment and housing conditions.

Policy impact diagram

Our conceptual framework unpacks the policy domain of energy poverty, widening the policy arena for multiple targeted policy interventions. We can illustrate the significance of our conceptual framework for effective policy design with the following impact diagram:

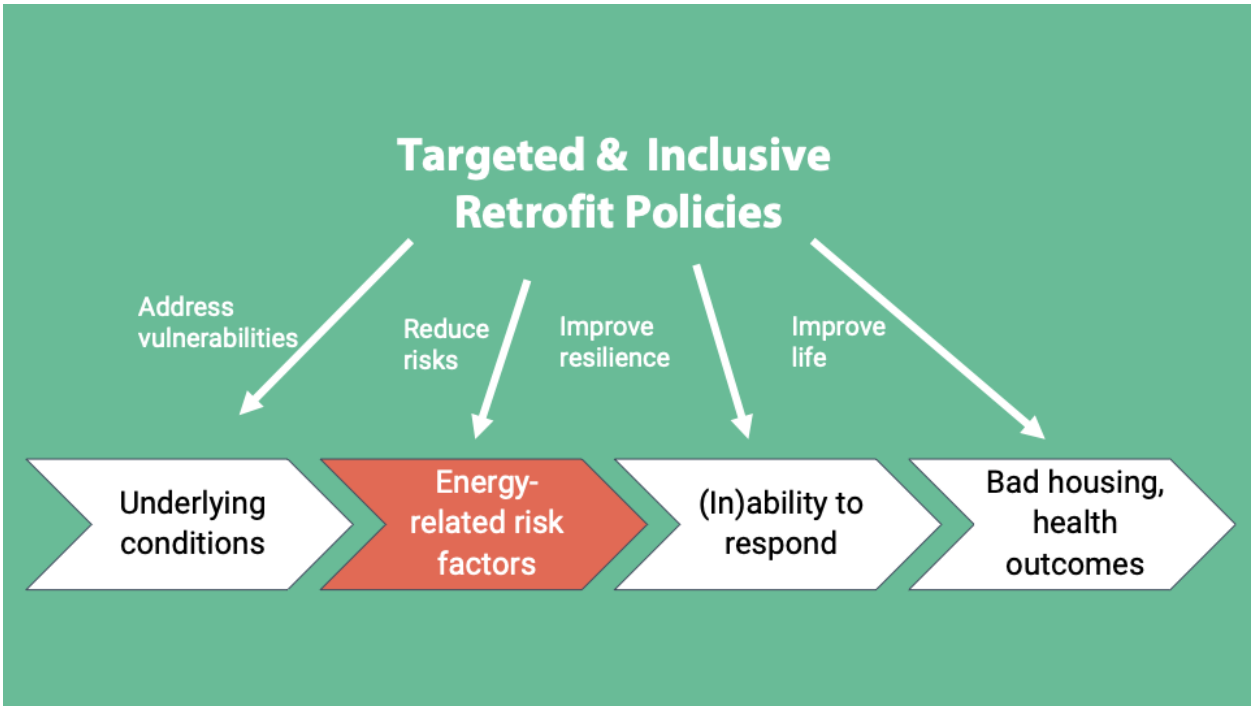

Figure 3: An impact diagram illustrating how our conceptual framework opens up energy poverty to a diversity of policy interventions.

Policies for addressing energy poverty can be preventative, seeking to directly address underlying root causes and conditions before they are exacerbated by external risk factors. For instance, policies with a focus on improving material and economic conditions might target job creation, raising standards of income, and improving employment in areas that have been identified as hotspots for unaffordability. Policies with a focus on improving housing conditions might zoom in on building performance standards, retrofit and new-building codes, increasing the supply of new housing, constructing new purpose-built affordable rentals, renovating existing affordable housing stock, urban planning and renewal, and so on. Policies with a focus on eliminating systemic marginalization may also take a social justice approach - ensuring everyone has equal opportunity to participate in and benefit from policy interventions

regardless of their specific circumstances. Preventative policies have a strong conceptual link to the principles of distributive justice, which calls for fairness in the distribution of benefits and burdens of impacts and outcomes.

Energy poverty policies can also be curative, focusing on reducing the incidence and likelihood of risks before they flare up underlying vulnerabilities. Such policies could include targeted interventions such as better utility rate design, emergency energy assistance programs, bill credits, no-cost energy upgrades, low-cost financing programs, rebate programs and so on. Energy poverty policies can also be adaptative, seeking to improve household resilience and ability to respond to risk factors. Such policies could include informational and awareness campaigns on energy use at home, provision of emergency shelters during extreme weather events, community aid programs to assist people with navigating complex systems of support, financial literacy programs to help households manage budgets, investments such as childcare support to free up household bandwidth and resources that can be dedicated to investing in the durability of their homes, and so on. Curative and adaptative policies have a strong conceptual link to principles of procedural and recognition justice, which emphasize the need for designing interventions that acknowledge and account for the various needs, rights and experiences of those most impacted by them. Rather than take a one-size-fits-all approach, policy interventions must tailor their support to be fair, effective, and aligned with people's daily lives. To be successful, energy poverty policies must encourage participation from stakeholders outside the energy sector, such as social policy, health, business, planning, community development and so on.

Finally, energy poverty policies can also be restorative, focusing on remedying and undoing past and ongoing harms to health and housing as a result of energy poverty. This links up with the concept of restorative justice, which is often advanced as a way of ensuring distributive, recognition and procedural justice are applied in practice so that those most impacted by energy poverty are prioritized every step of the way. However, as health and housing outcomes are typically not considered to be within the remit of energy poverty policies, there is a need for integrating the energy poverty agenda into cross-cutting interdisciplinary and intersectional issues such as climate change, just energy transitions, gender, justice, human rights, minority rights and social inclusion/exclusion. Transformative national policy pathways such as Canada's National Adaptation Strategy, Green Buildings Strategy, National Housing Strategy, and Net-Zero Emissions by 2050 must prioritize energy-poor households by dedicating

resources towards improving underlying conditions, reducing risk factors, improving resilience, and undoing harms caused by energy poverty.

Future research should validate this conceptual framework empirically and outline more archetypes of lived experiences with energy poverty. Supplementing these qualitative archetypes with quantitative data at different geographic scales would help identify hotspots of vulnerability and aid in the targeting of effective interventions.

Section 7: Next steps

Following in the methodological footsteps of (Zhu et al. 2021), we aim to convene a panel of Canadian academic and practitioner experts on energy poverty and solicit feedback on the questions listed below.

Responses and feedback to these questions can be sent to the author at abhilash.kantamneni@efficiencycanada.org.

Questions for subject matter experts:

1. What is missing from our conceptualization of energy poverty, housing and vulnerability as described above?
2. Have we adequately captured determinants, risk factors, inabilities to act and negative outcomes associated with vulnerability to energy poverty and housing insecurity?
3. What institution(s) can/should be responsible for defining, measuring, and monitoring progress on tackling energy poverty in Canada?
4. How can vulnerability to housing insecurity and energy poverty be better measured at the individual, household, and community levels? Are any local sources of data that can add value to a national dataset on these factors?
5. What are the negative outcomes associated with vulnerability to energy poverty and housing insecurity based on your group's lived experiences?
6. What is currently missing from existing programs that address energy poverty or housing insecurity?
7. How does this vulnerability perspective and dataset add value to your ongoing work/efforts to alleviate energy poverty and housing insecurity?

These partner consultations will help validate, ground and (if necessary) refine our vulnerability-based framework in a policy-relevant context. Our forthcoming report, Energy Poverty User Profiles, will deploy this framework to unpack the lived experiences of different vulnerable groups to energy poverty in Canada.

Insights from these reports and feedback from expert consultations will drive our strategy for identifying relevant data and variables for mapping energy poverty at different scales in Canada using the latest (Census 2021) data. This mapped data will

made available on Efficiency Canada’s website.

The data, consultations and research reports will together constitute the final deliverables of this project: a short report making recommendations on programs and policies reducing energy poverty through targeted interventions to support households that need it the most.