Who Carries the Burden: Gendered perspectives on Double Energy Vulnerability

by

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Table of Contents

Abstract

This thesis explores how vulnerability to Double Energy Vulnerability (DEV)—the simultaneous experience of energy poverty (EP) and transport poverty (TP)—is shaped by gender. While EP and TP have largely been treated as separate issues in existing research, their intersection remains underexamined. Drawing on a mixed-methods analysis of quantitative survey data and qualitative interviews conducted in Bridgewater, Nova Scotia, this study investigates whether DEV is gendered, and if so, how its impacts are differentiated between women and men. Quantitative findings show that women report DEV at significantly higher rates than men, a disparity linked to socioeconomic disadvantage, caregiving responsibilities, and limited access to energy and mobility resources. Qualitative analysis reveals that women not only experience heightened physical and financial burdens but also assume emotional and cognitive labour in managing household energy and transport needs—burdens that often go unrecognized.

1. Introduction

As governments attempt to push toward decarbonization, the silent struggle of those living in double energy vulnerability (DEV) often goes unnoticed. DEV is a circumstance whereby people are heightened risk of energy poverty (EP) and transport poverty (TP) simultaneously (Simcock et al., 2021). Both, EP and TP are understood as severe forms of energy injustice and can be understood as the inability to attain a socially and materially necessitated level of domestic energy and transport services, respectively (Bouzarovski & Petrova, 2015; Simcock et al., 2021). Lacking both energy and transport services may prevent individuals from adequately heating their homes or reaching places of work or education, with potential consequences for their health, education, employment prospects, income, and overall life opportunities.

While both EP and TP have been extensively studied as separate issues, their intersection, remains underexplored. Existing research has rightly pointed out the limitations of addressing EP and TP in silos, as doing so obscures the overlapping, compounding hardships that arise when households struggle with both (Martiskainen et al., 2021; Robinson & Mattioli, 2020). Yet, despite increasing awareness of the need for integrated approaches, studies that examine DEV remain relatively scarce. Notably, the role of gender in DEV is unexamined. Although both EP and TP literatures have touched on gendered dimensions independently, there is an absence of research directly addressing how gender shapes the experience of DEV. This is despite growing evidence that women face compounded risks due to lower incomes, caregiving responsibilities, longer time spent in the home, and limited mobility (Petrova & Simcock, 2021). Structural and socio-cultural gender inequalities are well-documented contributors to energy-related hardship, yet they are rarely analyzed through the dual lens of EP and TP.

This study addresses a significant gap by exploring DEV as an integrated phenomenon while foregrounding gender as the central analytical category. In doing so, it contributes to both the theoretical development of DEV and the practical understanding needed for more equitable energy and transport policy.

This thesis aims to examine whether vulnerability to DEV is gendered, and if so, to identify the differentiated effects of this vulnerability. Along with this aim, I posit four research questions: Is DEV is gendered when using self-reported indicators? Are there socioeconomic characteristics associated with the experience of DEV? How does DEV affect the life outcomes of women? How does the lived experience of women and men differ with regards to DEV? In

order to answer these questions, I used a mixed method approach conducting a secondary analysis on survey data and transcribed semi-structured interviews. The data was collected in the Town of Bridgewater, Nova Scotia, where research has found that nearly 40% of households experience EP.

The following chapters include a literature review on energy justice, DEV, and gender and energy services, the methodology, a presentation of findings, and a discussion.

2. Literature Review

This literature review begins with a brief discussion of decarbonization and energy systems to establish the broader context of the thesis. It then turns to the body of scholarship on DEV, beginning with separate overviews of EP and TP, and then an overview on the current state of the literature. This overview will outline how DEV has been conceptualized, the metrics and indicators used, and the socio-spatial vulnerabilities emphasized in the literature. Finally, the review will explore how gender has been addressed within energy services research, with a focus on both energy and transport domains.

2.1 Decarbonization and Energy Justice

Energy is not merely a commodity but a fundamental precondition for participating in everyday life (Lowans et al., 2021; Simcock & Mullen, 2016). Energy systems are deeply embedded in the structures of our societies, shaping everything from infrastructure and economic systems to social organization and daily routines (Allen & Farber, 2019; Sovacool, 2012). Humankind is profoundly dependent on existing energy systems. Problematically, current patterns of consumption and reliance on fossil fuel-based energy are driving the accelerating climate crisis. To mitigate the impacts of climate change, experts urge the movement towards decarbonization. Decarbonization refers to the transition from fossil fuel-based energy systems to low-carbon alternatives. It is seen as a necessary condition to meet global climate targets (Golubchikov & O'Sullivan, 2020). This shift is essential for reducing greenhouse gas emissions and mitigating the environmental impacts of energy production and consumption (Golubchikov & O'Sullivan 2020). The decarbonization of key sectors, like transport, infrastructure, buildings and energy, will have direct consequences for millions of people (Abram et al., 2022).

There is widespread recognition that the benefits and costs of decarbonization will not fall equally on all people (Bennear, 2022; Simcock & Mullen, 2016). Abram et al. (2022) states that paradigms within climate policy have been accused of relying on reductionist logic and techno-political narratives that neglect consideration of the complexity and interesting nature of social inequalities (Abram et al., 2022). Thereby, decarbonization efforts risk replicating uneven socio-economic and political distributions of opportunity, representation and power. Scholars have illustrated these processes of exclusion, inequality, and marginalization within decarbonization strategies (Sovacool et al., 2019). For instance, transitions to a lower carbon system may lead to changes in energy prices, accessibility, and more (Mullen & Marsden, 2016; Stern, 2006). Increased energy costs can disproportionately impact low-income households which often already spend a higher percentage of their income on energy (O'Sullivan et al., 2020). Additionally, efforts to modify patterns and levels of energy consumption will also result in burdens that are unfairly distributed along geographic localities. For example, localities may be utilized for externally owned and controlled renewable energy projects, which can lead to displacement, marginalization or dispossession of the local population (Golubchikov & O'Sullivan, 2020).

Energy justice is a useful concept when examining the distribution of costs and burdens of a low-carbon transition. The concept is emerging from social science research and covers a broad range of topics, including the distributive impacts of energy production and exclusion of affected communities from energy system decisions (McCauley et al., 2013; Simcock & Mullen, 2016). According to Jenkins et al. (2016), the energy justice approach evaluates where injustices arise, determines which sections in society are ignored, and establishes processes for addressing these issues in order to lessen such injustices (Jenkins et al., 2016). An energy justice approach argues that it is critical to identify which communities are most susceptible to the adverse effects of the energy transition and which communities are in the best position to successfully respond. Energy justice creates the contextual base of my thesis. The following sections seek to identify pre-existing vulnerabilities to prevent for more disadvantage.

2.2 Double Energy Vulnerability

Double energy poverty (DEV) is a circumstance whereby people are at heightened risk of energy poverty (EP) and transport poverty (TP) simultaneously (Simcock et al., 2021). Both EP and TP

are understood as forms of energy injustice. Bouzarovski and Petrova (2015) define EP as "the inability to attain a socially and materially necessitated level of domestic energy services." Lowans et al. (2021) define TP as the "enforced lack of mobility services necessary for participation in society, resulting from inaccessibility, and or unaffordability, and or unavailability of transport" (Bouzarovski & Petrova, 2015; Lowans et al. 2021). Although households can experience EP and TP simultaneously with mutually reinforcing effects, most research treats them as separate issues, leaving DEV underexplored (Mattioli et al., 2017; Simcock et al., 2021).

2.2.1 Energy Poverty

Energy poverty is a situation where people are unable to access and/or afford the necessary energy services for maintaining good health, well-being, and engaging in unrestricted participation in society (Simcock et al., 2021). This can take many forms, for example being unable to keep a home at a comfortable temperature, operate a medical device, keep the lights on, or cook meals. Energy poverty commonly results from a convergence of low-income, poor quality housing, inefficient energy provision, and/or increased energy needs (Bouzarovski & Petrova, 2015). As a result, households struggle to afford energy bills and are forced to limit energy use or cut back on other essential expenses with important consequences on physical and mental health (Ballesteros-Arjona et al., 2022).

The concept of EP emerged in England with the first publications released in the late 1970's (Lowans et al., 2021). Its prominence in academic and political discourse was catalyzed by the publication of Brenda Boardman's seminal work, *Fuel Poverty: From Cold Homes to Affordable Warmth,* in 1991, which significantly elevated public awareness of energy poverty (Boardman, 1991; Liddell, 2012). Her book brought attention to fuel poverty; it is now a widely recognized societal challenge among academic and policy-making circles (Bouzarovski and Petrova, 2015). The recognition of energy poverty as a significant systemic issue is most firmly rooted in academic and policy discussions across Europe, especially in the UK and Ireland.

A lack of universal definition, and associated measures, has been cited as an issue within the study of energy poverty, with a variety of terms and definitions used in the literature, with terminology including "fuel poverty," "energy vulnerability," "energy precarity" and "energy insecurity" (Boardman, 1991; Hernández et al., 2018; Middlemiss & Gillard, 2015). The term energy poverty will be used in this thesis as it is more commonly used in the Canadian context

(Das et al., 2022; Riva et al., 2021). The lack of universal definitions and measures is a challenge, as the chosen approach significantly affects results, leading to over- or under-estimation of energy poverty and misdirected alleviation efforts (Fahmy et al., 2011; Mattioli, 2017a; Tirado-Herrero, 2017). Although a limitation, the use of multiple methods to measure energy poverty is understandable, since measuring energy poverty may require specific analytical methods as "it is a culturally sensitive and private condition, which is temporally and spatially dynamic" (Thomson et al., 2017).

Despite definitional challenges, most EP metrics generally fall into four categories: expenditure-based measures, which assess energy spending relative to an absolute or relative threshold; direct measures, which evaluate home energy use against established standards; self-reported measures, where households report on domestic energy conditions and hardship; and composite measures, which combine multiple indicators (Lowans et al., 2021; Thomson et al., 2018). Expenditure, direct, and composite measures are quantifiable and seen as relatively objective, and therefore widely used in academia and notably, policy (Tirado-Herrero, 2017). Self-reported measures are regarded as more subjective; proponents of self-reported indicators argue that they are based on household's actual perceptions and therefore can be adjusted for social, spatial, and temporal context (Tirado-Herrero, 2017). Self-reported energy hardship, for example, can be seen as closer to the lived experience and actual outcome of EP, although there are issues with misreporting and 'denial of reality' bias (Tirado-Herrero, 2017). Due to the advantages and limitations of both subjective and objective measures, many EP scholars argue for multiple indicator approaches, recommending for the deployment of a range of measures to capture the experiences and intensities of EP rather than one single official metric.

Energy poverty is a problem experienced by millions of people globally (Simcock et al. 2018). The groups identified by the literature as most vulnerable to energy poverty are low-income households, older adults, ethnic minorities, women, people living with disability, lone-parent households, and people living alone (Debanne, 2023; Lowans et al., 2021). Experiencing energy poverty can affect one's physical, mental, and social health and well-being outcomes (Howden-Chapman et al., 2021). Inadequate temperatures in dwellings can promote respiratory, cardiovascular, and musculoskeletal illnesses, and in extreme cases can cause death (Jessel et al., 2019). Mold formation is also a concern, as it is associated with increased rates of asthma and other respiratory issues (Marmot Review Team, 2011). The financial and emotional strain of

living in a situation of energy poverty can lead to high levels of anxiety (Liddell & Guiney, 2015). Lastly, social stigma and isolation have also been observed in the context of energy poverty (Harrison & Popke, 2011).

2.2.2 Transport poverty

Transport poverty is broad concept understood to encompass the sub-concepts of mobility poverty, accessibility poverty, transport affordability, and exposure to transport externalities (Lucas et al., 2016). This definition comes from Lucas et al.'s (2016) seminal work in which TP is posited as an umbrella concept that contains the problems of affordability, mobility, accessibility, and transport externalities which involve exposure to negative outcomes of transport systems, such as pollution or pedestrian casualties (Lucas et al. 2016). Prior to this definition, transport poverty had not been adequately articulated within academic or policy literature, perhaps due to the "nebulous nature of mobility as a 'merit good', as well as to the less obvious causal chain between a lack of transport and knock-on negative social consequences" (Lucas et al. 2016). The problem is multi-dimensional, relational, and dynamic (Lucas, 2012). TP can affect nearly all aspects of an individual's life, as it restricts access to essential destinations such as places of employment, healthcare, and leisure.

Unpacking Lucas et al.'s (2016) lexicon further, *mobility poverty* is related to a systemic lack of transport and mobility options, that generates difficulties in moving (Lucas et al., 2016). It is usually associated with lack of services or infrastructure and in the car dominant societies we live in today, often results forced car ownership. Forced car-ownership is defined as households who own car despite limited economic resources due to lack of other alternatives (Mattioli, 2017a). Similarly, car deprivation is defined as the lack of access to services, opportunities and social networks that can arise from not having access to a car (Mattioli & Colleoni, 2016). *Accessibility poverty* extends on notions of mobility poverty to consider the difficulty of reaching certain key activities at a reasonable, ease, and cost (Lucas et al., 2016). The most widely recognized definition of transport poverty centers on *transport affordability*, referring to the lack of financial resources needed to access and maintain adequate transportation. (Lucas et al., 2016). Once again, this definition is largely linked to costs of car ownership and usage. Lastly, exposure to *transport externalities* encapsulates the outcomes of disproportionate exposure to the negative effects of the transport system, which is divided into two environmental categories, the disproportionate exposure to traffic related externalities, such as air pollution or

car related causalities, and the negative impacts of transport infrastructure projects on the lives and livelihoods of local communities residing nearby (Lucas et al., 2016).

The corpus of transport poverty literature is smaller and more scattered than that of energy poverty (Lowans et al., 2021). Research started in the late 1990's and has considered a broad range of applications and contexts (Simcock et al. 2021). There are numerous other terms used to describe related issues, and much of the research on transport poverty has emerged from a coalescing of previously disparate fields of study. A diversity of perspectives and approaches has made it challenging to develop a singular, universally accepted definition or framework for understanding transport poverty (Lucas et al. 2016). Transport affordability, mobility poverty, accessibility poverty, and exposure to transport externalities have different descriptive methods seeking to capture them; for an overview see Lowans et al. (2021). Notably, Sustrans (2012) and Berry et al. (2016) have created composite metrics that aim to cover multiple aspects of transport poverty (Berry et al., 2016; Sustrans, 2012). Overall, efforts to measure transport poverty as a whole have seen limited success, whereas more progress has been made when examining its individual components.

Although the TP literature faces challenges with definitions and measurement, several studies have shed light on socio-spatial patterns of vulnerability. Lower-incomes individuals, older adults, households with children, people with disabilities, women, and ethnic minorities are more likely to be vulnerable to TP (Simcock et al., 2021; Lucas et al., 2016). The social consequences of TP are significant and compounds the challenges faced by marginalized groups. Those with lower incomes are often the least mobile, relying primarily on walking or cycling for transportation. Individuals with limited mobility or poor access to transport can become spatially trapped in areas with adverse living conditions, reinforcing cycles of poverty (Dorantes & Murauskaite-Bull, 2023; Lucas et al., 2016). More broadly, TP contributes to widespread social exclusion that extends beyond financial hardship, limiting access to essential opportunities such as employment, education, social networks, civic engagement, and participation in decision-making processes (Lucas, 2012).

2.2.3 A communication gap between the two research silos

Although research into both energy and transport poverty is well-established, they have predominantly been analyzed as separate problems, often seen as having their own causes and consequences (Martiskainen et al., 2021; Robinson & Mattioli, 2020; Simcock et al., 2021). As

asserted by Martiskainen et al. (2021) this "siloed approach contributes to different scholars and policymakers focusing on each of these domains, with the connections and similarities between them often missed" (Martiskainen et al. 2021). Indeed, Robinson and Mattioli (2017) identify three reasons that energy and transport poverty should be looked at together: transport accounts for a large share of household energy consumption and associated climate emissions; carbon pricing could affect expenditure in both domains; households often make trade-offs between domestic and transport energy expenditures. Research finds that restrictive patterns in domestic energy consumption may be driven by the high costs associated with transport energy (Mattioli, 2017a). Addressing these issues separately overlooks the ways in which they reinforce one another. By treating them as distinct problems, policies and interventions may fail to address the compounded vulnerabilities that arise when both energy and transport poverty intersect, ultimately perpetuating social inequalities and failing to provide comprehensive solutions for affected communities (Martiskainen et al., 2021; Robinson & Mattioli, 2020).

2.2.4 Measuring double energy vulnerability

When examining the measurement of DEV, Lowans et al. (2021) provide a comprehensive review of the current state of EP and TP metrics, examining various measures used in each field and exploring possibilities for their integration. Their work offers a valuable overview of the most commonly applied metrics in EP and TP research and identifies potential pathways for unifying approaches. They argue that a combination metrics, as opposed to a single indicator, yields more accurate insights, particularly when combined with health data and a vulnerability-informed perspective. Moreover, they emphasize that assessing vulnerability qualitatively is often more feasible than developing a representative quantitative metric, which can be technically complex and difficult to standardize (Lowans et al., 2021). Mattioli et al. (2017) share a similar perspective, emphasizing the numerous challenges involved in developing a unified metric for EP and TP. They highlight that many studies mistakenly treat EP metrics as interchangeable with those for TP, without accounting for the significant differences in their underlying drivers and contextual conditions. A major barrier to integration lies in the misalignment of measurement frameworks—such as the use of household vs. individual units, distinctions between required and actual spending, and the application of unrelated thresholds (minimum household temperature for EP versus access to essential services for TP). See Mattoli

et al. (2017) for a more in-depth comparison and contrast between drivers, measures, and policy responses to EP and TP.

Despite these challenges some novel measures have been used to quantify rates of DEV. Okushima & Simcock (2024) used a cost-burden approach in Japan, highlighting its strength in enabling meaningful comparisons between groups without the need to establish a fixed threshold (Okushima & Simcock, 2024). Analysis examines the proportion of gross household income spent on domestic energy, private transport energy, and public transport energy, along with a proxy variable indicating the degree of rurality-urbanity. Notably, this method does not set a fixed percentage threshold to indicate EP and/or TP, instead, results are gathered from the examination of the relative differences between different socio-demographic groups and spatial settings, with higher relative burdens indicating greater vulnerability to DEV.

Other scholars have attempted to look at DEV through spatial and intersectional analysis (Robinson & Mattioli, 2022; Bouzarovski et al., 2024; Lowans et al., 2023). Unlike the Okushima and Simcock's (2024) cost-burden approach, these methods rely on defined metrics to establish thresholds. Robinson & Mattioli's (2022) approach uses traditional EP measures, like Boardman's >10% indicator and Hill's Low Income, High Costs metric, to measure rates of EP, while Mattioli et al. (2019)'s composite indicator of vulnerability to fuel price increases is used to measure TP. Specifically, the composite indicator of vulnerability to fuel price increases of looks at three vulnerability dimensions; the cost burden of motor fuel, economic resources, and accessibility to key services by modes alternative to the car (Mattioli et al., 2019). Local Moran's I cluster analysis was used to find spatial relationships between vulnerability to both EP and TP. Alternatively, Bouzarovski et al.'s (2024) study constructs multi-dimensional indexes relating to energy and transport related injustice, in order to study the socio and spatial vulnerability to DEV in the UK. The composite index of EP has three central components; central heating coverage, energy efficiency of homes, and social vulnerability (which is captured through household energy costs and income data). The TP index similarly incorporates measures of social vulnerability, alongside access to mobility services, assessed through population density, car ownership, and public transport provision. Both indices were constructed using neighbourhood-level data, standardized using z-scores, and weighted according to theoretical assumptions (Bouzarovski et al., 2025). Lowans et al. (2023) adopt the expenditure-based 2M metric of EP and jointly apply it to measure EP and TP (Lowans, Foley, Del Rio, et al., 2023). Their analysis

examines whether household or individual spending on energy and transport exceeds twice the sample median, as well as whether it falls below half the national median. To account for 'hidden energy poverty', the study also incorporated self-reported indicators such as arrears on bills, inability to keep warm, car ownership, and perceived adequacy of public transport. 'Hidden energy poverty' is not captured by expenditure-based measures, as it occurs when when households intentionally limit their energy use to decrease energy costs (Charlier & Legendre, 2021).

Overall, the quantitative measurement of DEV remains a significant challenge in the field. The selection of metrics can substantially influence findings, and the lack of standardization makes cross-study comparisons difficult, something of particular concern for policymakers and regulatory bodies (Robinson & Mattioli, 2022; Bouzarovski et al., 2024).

Scholars have also employed qualitative methods (e.g., conducting semi-structured interviews or focus groups) to capture lived experiences of DEV (Furszyfer Del Rio et al., 2024; Lowans, Foley, Del Rio, et al., 2023; Lowans, Foley, Furszyfer Del Rio, et al., 2023; Martiskainen et al., 2023; Sovacool & Furszyfer Del Rio, 2022; Upham et al., 2022, 2023). Among these, the work by Martiskainen et al. (2023) is particularly valuable. Drawing on cross-national, empirical data, the study examines how individuals experience the intersection of EP and TP in their daily lives. Through semi-structured interviews, the researchers identified four themes: being locked into infrastructure, facing high costs and low incomes, choosing between energy for the home and for transport, and missing out important personal dimensions of life (Martiskainen et al., 2023). Their analysis presents DEV as a relational, contingent, and ongoing phenomenon (Martiskainen et al., 2023). Beyond its empirical contributions, the study also highlights the importance of incorporating lived experience into policy design and emphasizes that constraints are spatially contingent and require a place-based approach. Furthermore, the need for a place-based approach is underscored by the diverse contexts and demographic groups examined in qualitative studies, including Irish Travellers in Northern Ireland, migrant workers in the United Arab Emirates, slum dwellers in Mexico City, and middle-income households in Iceland (Upham et al., 2022; Furszyfer Del Rio et al., 2024; Lowans et al., 2023; Furszyfer Del Rio & Sovacool, 2023; Sovacool & Furszyfer Del Rio, 2022).

2.2.5 Socio-demographic and spatial vulnerabilities to double energy vulnerability

Supporting Lowans et al. (2021) argument that assessing vulnerability is often more feasible that developing representative quantitative measures, several studies have focused on identifying the social and spatial patterns of DEV to better understand which populations are most at risk (Lowans et al., 2021; Robinson & Mattioli, 2021; Bouzarovski et al., 2024)

While poverty itself functions as a core mechanism, limiting access to both domestic and transport energy, certain groups face additional risks due to systemic and structural disadvantages. These include feedback loops of deprivation, reduced mobility, and limited agency, all of which deepen the experience of DEV and compound existing inequalities.

Simcock et al.'s (2021) systematic review stands out for its robust methodology and detailed analysis of the overlapping occurrences of energy poverty (EP) and transport poverty (TP) along socio-demographic and spatial lines. By pre-identifying groups known to be vulnerable to both EP and TP and then analyzing the frequency with which these vulnerabilities appear in the literature, the study offers a valuable framework for assessing compounded risk of experiencing DEV. Results were separated into 'socio-demographic vulnerabilities' and 'spatial vulnerabilities.' The identifications of socio-demographic vulnerabilities by Simcock et al. included: households on low-incomes, people who are unemployed, those with precarious employment, older people, households with children, people with disabilities, women, and people from ethnic minorities.

Issues of affordability are made worse by additional material and infrastructural disadvantages. Low-income households often pay more for energy services, because they may not have the means to engage with energy efficient improvements or to live in energy efficient housing (Walker et al., 2014). Similarly, individuals with little financial capital are less likely to own fuel-efficient cars (Mullen, 2021; Mullen & Marsden, 2016). Furthermore, low-incomes are associated with forced car-ownership and increased commuting travel (Mattioli, 2017b)
Older adults and people who are disabled are vulnerable to EP because they have higher energy needs as they spend more time at home (therefore requiring more energy) and often have physiological needs with indoor temperatures (Okushima & Simcock, 2023; Wright, 2004). Regarding TP, older individuals and people living with disability have often decreased mobility due to physical health. For older people, specifically, giving up their driver's license (or having it revoked) increases the reliance on public transportation, with is not always accessible (Ricciardi

et al., 2015). Households with children also require more energy consumption. At home, more rooms and appliances may need to be heated to maintain comfort for children (Legendre & Ricci, 2015; Walker et al., 2014). In transport, children can lead to increased journeys to school and extra-curricular activities (Mattioli, 2017; McLaren, 2016). This can mean parents are dependent on cars, impacting affordability. Historic processes such as income inequality, racial segregation and uneven infrastructural development along racial lines can explain why people from ethnic minorities might be more susceptible to experience DEV (Hernández & Siegel, 2019; Sole & Wagner, 2018). Additionally, immigrants can face barriers to transportation due to new languages and driving systems. Lastly, women are identified as vulnerable to both EP and TP; the mechanisms of these vulnerabilities are explained in the third section of this literature review.

The systematic review also identifies spatial vulnerabilities to DEV, conforming to four forms of spatial categorization - urban, suburban, rural, and towns – an approach consistent with vast majority of literature surveyed. Notably, the identifications of spatial vulnerabilities reveal that overlaps between EP and TP are less frequent when examined through a spatial lens. This complexity likely reflects the highly context-dependent nature of vulnerability patterns, which vary significantly across regional and national settings. This suggests that geographical, infrastructural, and environmental, and environmental interact in variable ways to shape DEV, reinforcing calls in the literature for a place-based approach.

It has been found that individuals living in urban settings, specifically those in the ‘inner city’, are more likely to suffer from energy poverty than transport poverty (Simcock et al. 2021, Okushima & Simcock 2024). This is partly due to high housing costs and the spatial distribution of poverty, as well as the influence of infrastructural factors. Housing tends to be older and not well maintained, leading to poor energy efficiency (Bouzarovski & Simcock, 2017). Transport poverty is not commonly cited as an issue due to proximity to services and more accessible public transportation (Mattioli et al. 2017).

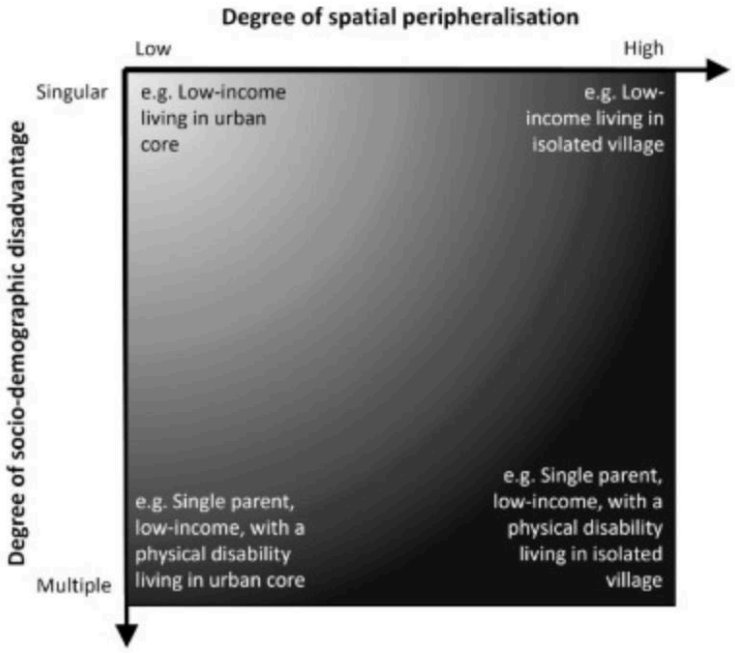
Conversely, suburban areas are seen as more vulnerable to transport poverty. Suburban areas often have fragmented transportation options, and their sprawling nature results in longer travel times to key services (McLaren, 2016; Xia et al., 2016). Further, suburban life is incompatible with active transport, inducing car dependency and associated transport costs (Dorantes & Murauskaite-Bull 2021). Suburban housing is rarely linked to energy poverty, as it is newer and typically home to middle- and upper-class residents (Robinson & Mattioli, 2020).

Rural areas, however, appear to exhibit the greatest overlap in vulnerability to both issues (Cupples et al., 2007; Okushima & Simcock, 2023; Robinson, 2019; Robinson & Mattioli, 2020; Simcock et al., 2021). Living in geographically isolated areas increases the need to travel long distances to access essential services. Rural areas have fewer nearby goods, services, and employment opportunities (Pyrialakou et al., 2016). These areas often lack public transport services due to low population density, which makes such systems financially unsustainable and less practical to implement. This is coupled with a reliance on expensive household energy, due to lack of access to nationalized heating networks, and car fuel expenditure (Martiskainen et al., 2021; Robinson, 2019).

The prevalence of vulnerability to DEV in rural areas should not be viewed as a neutral condition. Spatial inequalities are constructed through political-economic processes that privilege some areas and disadvantage others. Space, in this context, should be understood as produced, influenced by an uneven geographical development and distribution of resources (Simcock et al. 2021). 'Cores', which are places of wealth and power, and 'peripheries', places of dependency and disadvantage, are created in pursuit of profit maximization (Okushima & Simcock 2024). As defined by Golubchikov and O'Sullivan (2020) energy peripheries are "place-bound conditions of systematic vulnerabilities and disadvantages experience by some communities through the entire energy system due to their non-core position within the spatially asymmetrical distribution of political, material, economic, symbolic, and other resources and capabilities" (Golubchikov & O'Sullivan 2020). Sparsely populated peripheries have a lack of agency both in their energy use choices and also within greater decision-making processes (Martiskainen et al. 2023).

Overall, the literature indicates that the greatest level of DEV is among households that face a combination of multiple, intersectioning socio-demographic disadvantages alongside a high degree of spatial peripheralization (Furszyfer Del Rio & Sovacool, 2023; Okushima & Simcock, 2024; Simcock et al., 2021; Sovacool & Furszyfer Del Rio, 2022). A conceptual representation created by Simcock et al. (2021) is helpful in understanding the social and spatial relationship of vulnerabilities created by the experience of DEV, as illustrated in Figure 1. below.

Figure 1. Overlapping conditions of vulnerability to DEV. Source: Simcock et al. 2021.



2.3 Gender in energy and transport services scholarship

This section explores the literature on gender in the contexts of EP and TP, examining them separately due to the absence of integrated studies on gender and DEV. Energy services can be understood as the "ability to use energy and electricity at home for space and water heating, cooking, lighting, and the use of appliances", and transport services, although more difficult to define include the "capacity to use transport modes (e.g., car, bike, bus, and walking) whether privately owned, shared or public, in order to access essential services and opportunities (Martiskainen et al., 2023). To date, no studies directly investigated the role of gender in shaping the experience of DEV. While gender has often been acknowledged as one of many vulnerability factors, it has never been the central focus of studies on DEV, acting as a gap in the literature on DEV. As such, this review draws on existing research examining gender inequalities in household energy use and access to transportation, in order to identify relevant patterns and dynamics that can inform analysis. Rm mkl

2.3.1 Gender and Energy Poverty

Although gender has not traditionally been centered in EP research, a growing body of scholarship highlights its significant role in shaping both vulnerability to and the experience of

EP. This section draws on existing literature to examine how gendered economic inequality, household roles, and emotional labour intersect with energy poverty.

Empirical evidence suggests that gender plays a significant role in the experience of EP, yet some argue that proper integration of gender in EP analysis is absent (Listo, 2018; Petrova & Simcock, 2021; Robinson, 2019; Simcock & Petrova, 2017). This absence may be attributed to Robinson's (2019) observation that, within the context of the Global North, energy poverty is often perceived as a gender-neutral issue (Robinson, 2019). Many studies rely on gender-disaggregated data when presenting results but this does not equate to meaningful gender analysis (Clancy & Roehr, 2003). Notably, even influential reviews and reports—such as the widely cited Hills Report (2012), which introduced the Low-Income High Costs (LIHC) indicator—fail to consider gender as a key vulnerability factor (Petrova & Simcock, 2021). Instead, the focus tends to remain on general indicators like income or health, with little attention paid to the ways these intersect with gender or other axes of identity.

A further limitation is the lack of intersectional analysis. Gender inequality is not felt evenly, instead its configuration and intensity are dependent on interconnections with other axes of social difference and oppression. Petrova and Simcock (2021) offer a crucial critique, pointing to the widespread use of the household as the primary unit of measurement in EP research. This methodological choice treats the household as a single, homogenous entity, overlooking intra-household dynamics and individual experiences. As they argue, this framing "fails to account for domestic power dynamics and the individual energy-related roles of household members in shaping vulnerability and the everyday experience of energy poverty" (Petrova & Simcock, 2021). As a result, key inequalities remain hidden, reinforcing the need for a more intersectional and individual-focused approach in EP scholarship.

Although gender has not been a central focus in much of the energy poverty (EP) literature, there are clear reasons to consider it a significant vulnerability factor. Most notably, women are disproportionately represented among low-income populations—a pattern well-documented across multiple studies (Clancy & Roehr, 2003; Simcock et al., 2021; Robinson, 2017; Petrova & Simcock, 2021). This overrepresentation explains why women are more likely to face energy-related hardship. The literature identifies a range of structural and societal factors that contribute to women's economic vulnerability. A key issue is the persistent gender pay gap, which reflects broader systemic exclusion from economic opportunities (Clancy et al., 2017;

OECD, 2022). This is compounded by occupational segregation, where women are concentrated in lower-paying sectors, as a result of long-standing gender norms and expectations (ILO, 2020). Additionally, socially constructed gender roles led women to take on more unpaid caregiving responsibilities, which limits their ability to work full-time or advance in their careers (Pickard, 2015; Robinson, 2019; Sunikka-Blank, 2020). Policies can further reinforce this divide. For example, maternity leave policies that do not offer equivalent parental leave for fathers entrench caregiving as a primarily female responsibility (Petrova & Simcock, 2021). Lone-parent households, most of which are headed by women, are particularly vulnerable to poverty due to the difficulty of balancing childcare with full-time employment (Sunikka-Blank, 2020; Robinson, 2019). These structural disadvantages persist over the life course, leaving many older women with limited financial security.

A significant portion of the literature on gender and energy poverty (EP) highlights how socially constructed gender roles not only contribute to women's economic disadvantage but also shape the division of labour within the household, further influencing the experience of EP. Despite broader shifts in labour market participation, women continue to be expected to take on primary responsibility for domestic tasks and caregiving (Pickard, 2015). This gendered patterning has several implications for understanding vulnerability to EP. First, women are more likely to be exposed to energy poverty simply because they spend more time at home (Chard & Walker, 2016). Second, household practices, like cooking and cleaning, are closely tied to energy services. As Sunikka-Blank (2020) notes, this positioning makes "women the main stakeholders of energy policy in terms of load shifting or absorbing the shock of increasing energy prices, and it applies to reducing comfort standards as well as reliance on electrical appliances" (Sunikka-Blank, 2020). This inequality is particularly pronounced in heterosexual households, where men tend to engage more in discretionary tasks (e.g., repairs, outdoor work), while women handle routine, time-sensitive responsibilities such as cooking, cleaning, and childcare (Bianchi et al., 2012). Empirical studies show that even when women participate in the workforce, they continue to do a disproportionate share of unpaid domestic labor, a phenomenon known as the "second shift" (Hochschild & Machung, 2012; Statistics Canada 2022). The impact of the division of labour on household experiencing EP, is well examined by a study by Petrova and Simcock's (2021) study offers a clear illustration of how this division of labour plays out in households experiencing EP. The study found that it was almost always the female partner who undertook

‘everyday’ alterations to routines in order to reduce consumption, likely because of domestic duties associated with role in the household. Women in this study altered the process or timing everyday chores, such as vacuuming less, or handwashing instead of machine (Petrova & Simcock, 2021). Alternatively, men in the study were more heavily associated with energy retrofits, such as installing more efficient appliances or low-energy light bulbs (Petrova & Simcock, 2021). This study reveals women doing the majority of the work necessary to ration energy consumption and navigate energy poverty (Petrova & Simcock, 2021). It also made the argument that perceptions of ‘masculine’ and ‘feminine’ endeavors could leave women more vulnerable to EP, as they may not see themselves as fit to making physical energy improvements (Petrova & Simcock, 2021).

The literature also highlights that gendered susceptibility to negative physiological and mental health impacts associated with the experience of EP. Clancy et al. (2017) found that women are more sensitive to ambient temperatures which impacts, and Day and Hitchings (2009) found that they tend to feel colder than men. This may worsen the experience of EP. Although, Cupples et al.’s (2007) study suggests that different thermal perceptions may not actually be physiological but instead related to men’s attempt to align with masculine gender roles, and stereotypes of ‘toughness’ (Cupples et al., 2007). Similarly, Wright (2004) found that within older couples experiencing EP, “men were far more likely than women to say that they never felt cold” (Wright, 2004). This study also highlighted the ways perceptions of temperature led to tension in households (Wright, 2020).

In addition to its physiological effects, energy poverty (EP) has been shown to produce significant mental and emotional impacts. A growing body of research highlights the emotional strain involved in managing the daily negotiations and compromises required to cope with EP (Day & Hitchings, 2011). Anderson et al. (2012) postulates that EP can elicit feelings of disappoint with men, since the traditional masculine role of a provider is not being fulfilled (Anderson et al., 2012). Emotional burdens are particularly acute for those who spend more time in the home, and as previously discussed, this is often women. There is evidence that women experiencing EP, may also feel a sense of distress associated with unsuccessful alignment with gender roles, instead it being with insufficient provision of care (Petrova & Simcock, 2021). This can lead to self-sacrificial behaviours, where mothers will use heating more when dependents are in the household, and then reduce the temperature when others aren’t home as well (Harrington

et al., 2005; Middlemiss & Gillard, 2015). Additionally, constant monitoring and minimization of energy consumption, while trying to care for others is a mentally draining activity that worsens the mental health of women experiencing EP (Petrova & Simcock, 2021).

2.3.2 Gender inequalities in transportation

Compared to the literature on gender and energy poverty, there is a more developed body of work examining gendered vulnerability in transportation. Following the lexicon established by Lucas et al. (2016), I understand TP as a broad, inclusive framework that encompasses issues of mobility, accessibility, affordability, and exposure to transport-related externalities. In line with Lucas et al.'s (2016) observation that the transport poverty literature is fragmented, I did not find studies that focused exclusively on gender and transport poverty. As a result, I had to interpret and draw insights from studies using a variety of related terms. This review therefore draws from a broad range of sources that explore gendered experiences across intersecting themes. By synthesizing insights from research on gendered mobility, transport disadvantage, and everyday travel behavior, this section aims to uncover the ways in which gender roles and social structures shape differential experiences of transport poverty.

Scholars have been exploring the gendered dimensions of transport access for several decades (Law, 1999). Broadly, two key issues emerge: low-income levels and reduced mobility or accessibility, often due to limited access to a private vehicle. These constraints have been linked to outcomes such as trip-chaining and time poverty. Law (1999) articulates that "gendered norms of domestic responsibility, overlaid on temporal rhythms of childcare and domestic work, and on spatial patterns of segregated land-uses, and combined with inflexible service hours, and minimal public transport, generate time- space constraints that restrict the mobility of those responsible for this work (mainly wives and mothers)" (Law, 1999).

One key mechanism of TP that disproportionately affects women relates to car use. Historically, car-use rates have been higher among men; recent studies, however, suggest that this gender gap is narrowing, with licensing rates and car availability increasingly converging between men and women (Priya Uteng, 2021). Despite these changes, women still tend to have lower levels of access to private vehicles compared to men, which contributes to thier transport disadvantage (Scheiner, 2019). This disparity is particularly pronounced among older adults. Research by Siren (2002) finds that older women are more likely than men to give up their driver's licenses, and they often do so earlier and under less critical health circumstances. In

contrast, men tend to drive for as long as their physical condition permits (Ortoleva & Brenman, 2004; Siren & Hakamies-Blomqvist, 2005). These behavioural patterns can render older women more vulnerable to TP, especially in car-dependent environments, and have been linked to issues of subsistence and reduced access to essential services. This traditional limit on car-access and behavioural patterning may explain the evidence that finds that women use public or active transport more than men to perform their daily activities (Cresswell & Priya Uteng, 2008; Priya Uteng, 2021).

Lack of car access for women is particularly critical when considering the nature of the trips women make. Domestic labour/gender roles that place women as caregivers or homemakers require more varied and complex activity patterns as compared to those who are commuting to places of employment. Research has shown that women are more likely than men to combine multiple errands, such as grocery shopping, school drop-offs, or transporting children to extracurricular activities, into a single, multi-stop journey. In contrast, men are more likely to make single-purpose trips (Turner & Grieco, 2000; Wang, 2016). This pattern, commonly referred to as "trip-chaining," reflects a gendered approach to travel that is shaped by caregiving and domestic responsibilities (Ortoleva & Brenman, 2004; Priya Uteng, 2021). Studies have found that both the frequency and complexity of trip-chaining are significantly higher among women (Heinen & Chatterjee, 2015). Viewed from a broader perspective, the prevalence of trip-chaining highlights a disconnect between transport infrastructure and the daily mobility needs of women. Urban systems are often designed to accommodate direct commutes, such as those typically made by those traveling to and from work, rather than the more fragmented and complex travel patterns associated with domestic labour. As Turner and Grieco (2000) argue, women can be described as "time poor" due to "the disproportionate level of household tasks they are required to perform within present social structures as compared to men" (Turner & Grieco, 2000). Time poverty is further exacerbated by disparities in car ownership and access. Men are more likely to own and use private vehicles, whereas women are more reliant on public transportation (Ortoleva & Brenman, 2004). This reliance forces women to navigate less flexible transport systems while managing complex travel needs, resulting in increased time burdens and financial costs.

As in the literature on energy poverty, strong connections have been made between gender, transport disadvantage, and barriers to accessing the 'productive' labour market. Within

transport poverty (TP) research, these connections are often illuminated through analyses of gendered travel behaviour (Law, 1999). One of the most notable insights in this area involves the consistent finding that women tend to have shorter commutes compared to men. Turner and Niemeier (1997) found that women, particularly those who are married, demonstrate distinct work-trip patterns from their male counterparts (Turner & Niemeier, 1997). Similarly, Kwan (2000) confirmed these patterns, even when controlling for employment status and commuting distance (Kwan, 2000). Law (1999) argues that these differences are not merely coincidental but are instead deeply rooted in gendered social roles, particularly around unpaid labour and caregiving responsibilities (Law 1999). As women shoulder greater household responsibility than men, there is a tendency to choose shorter commutes, as domestic labour and caregiving following strict temporal rhythms that reduce employment opportunities (Law, 1999; Kwan 2000). This highlights the importance of examining not only infrastructural barriers to mobility, but also socio-spatial influences, like the unequal distribution of domestic labour, that shape and limit women's everyday transport choices.

Another important dimension of the literature on gender and transport is the impact of fear and safety concerns on women's mobility. Numerous empirical studies have highlighted the prevalence of sexual harassment experienced by women in transit environments (Ball & Wesson, 2017; Useche et al., 2024). Beyond actual incidents, the perceived threat of sexual violence significantly shapes women's travel behaviours. Early research by Valentine (1989) revealed a range of self-protective strategies adopted by women to mitigate perceived risk, often resulting in behavioural constraints on their mobility (Valentine, 1989). Kelly (2012) conceptualized this practice as 'safety work', which can be understood as consisting of the routine, but invisible, strategic decisions made by women and girls globally to avoid sexual harassment and other forms of sexual violence (Kelly, 2012; Vera-Gray & Kelly, 2020). Vera-Gray (2018) argues that "when these routine strategies are made visible, the impact of men's practices on women and girls comes to be understood not only in terms of their safety but also their freedom" (Vera-Gray, 2018). These precautionary measures limit mobility, altering modal preference and accessibility (Vera-Gray, 2018). Women's transportations become further limited as they also need to weigh safety when choosing transport options (Vera-Gray, 2018). This position is highlighted by Verma et al. (2017), who found that women's perceptions of safety while using public buses influences their modal preferences for buses (Verma et al., 2020). Critically, women may

decisions on which jobs they accept based on feelings of safety (Pryia Uteng, 2021). Thus, perceived threat and gender-based violence has repercussions that affect socio-economic growth for women.

3. Conceptual Frameworks and Context

3.1 Vulnerability framework

This thesis draws on the vulnerability framework as applied to the study of energy poverty. A vulnerability framework uses a bottom-up approach that considers the distribution inequalities within energy and transport poverty and facilitates the development of placed-based and context-specific research (Middlemiss & Gillard, 2015).

Despite the absence of a universally agreed-upon definition, vulnerability can be conceptualized as an assessment of susceptibility to potential harm (Hinkel, 2011). Thomson et al. make a clear distinction that this assessment is not a descriptor of a state at a given point in time but "as a fluid state, which a household may enter or exit after an externally- or internally-induced change" (Thomson et al., 2018) Double energy vulnerability fluctuates, and the energy vulnerability framework helps us anticipate its onset and cessation. Middlemiss and Gillard apply this understanding to energy poverty defining energy vulnerability as "the likelihood of a household being subject to fuel poverty, the sensitivity of that household to fuel poverty, and the capacity that household has to adapt to changes in fuel poverty" (Middlemiss & Gillard, 2015).

Building on this, Hihetah et al. (2024) argue that "given the lack of a universally accepted definition of energy poverty, a vulnerability perspective becomes essential in providing a comprehensive understanding of the factors leading to energy poverty at a household level, within the household, and across different regions" (Hihetah et al., 2024). Their insight reinforces the relevance of a vulnerability framework, not only as a response to definitional gaps, but as a tool for unpacking the multi-scalar and socially differentiated nature of energy deprivation.

Taken together, these contributions support the use of a vulnerability lens in this thesis to examine how intersecting structural conditions, particularly gendered inequalities, shape differentiated experiences of double energy vulnerability.

3.2 Feminist Geography Framework

Second, I will use an intersectional feminist geographies framework. This body of work is set upon the understanding that gender is a social structure that both labels and legitimizes specific behaviors, roles, and identities, thereby shaping and constraining social interactions. This labelling is dichotomous, placing behaviors and identities in either 'feminine' or 'masculine' categories (Risman, 2004). These binary shapes unequal social relations and dictates the range of actions individuals can undertake, the resources available to them, and their opportunities for personal growth.

Because gender is socially constructed it is subject to change and variability. It is constantly remade and renegotiated, and it is constituted in varied ways over space and time (McDowell, 1999). It is important to highlight that because gender inequality is inextricably tied to other axes of oppression it is not experienced the same. Interconnections with class, race, ethnicity, ableness, sexuality, and age create the need for an intersectional understanding (Crenshaw, 1991). The incorporation of geography can connect the significance of place and space within intersectional dynamics. As explained by Caitlan Robinson, "geographical variations in gender relations [...] are integral to the construction and reproduction of geography either through their contribution towards uneven development or regional and local variations" (Robinson, 2019).

Intersectional feminist geography serves as a valuable tool for comprehending how double energy vulnerability is differentially experienced within homes. Social constructions of femininities and masculinities are (re)produced within the domestic sphere. Blunt and Dowling (2006) have developed a 'critical geographies of home' understanding to examine the home as "material and imaginative multi-scalar nexus of power and identity" (Petrova & Simcock, 2021). Households must not be understood as a single unit that is affected by double energy vulnerability. Instead, by exploring feminist perspectives in geography, particularly those concerning the concept of home, we can observe that instances of energy poverty manifest at the individual level.

3.3 Context

The province of Nova Scotia, where this study is located, experiences different energy and transport services provision compared to other provinces (Debanné et al., 2025). A number of structural factors contribute to the high prevalence of EP and TP, in both the province and the town of Bridgewater.

Firstly, the prevalence of EP in Nova Scotia is among the highest in the country. After accounting for housing costs Riva et al., 2021 found that around 33% households are in energy poverty, based on the 2M indicator (Riva et al., 2021). This high prevalence is likely tied to the province lack of access to low-cost natural energy resources. Unlike provinces, such as Quebec or Alberta, where hydroelectric power or hydrocarbon resources reduce energy costs, Nova Scotia lacks access to low-cost natural resources. As a result, the province relies heavily on imported energy, leading to significant price disparities across Canada. For example, in 2022, the average residential electricity price in Halifax was 17.3 cents per kilowatt hour (¢/kWh), compared to just 7.6 ¢/kWh in Montreal (Urban, 2021). Compounding this issue, roughly 32% of households in Nova Scotia rely on oil for heating—a method identified by Campbell (2023) as the most expensive in the country.

Second, the province has some of the highest poverty rates in Canada. Saulnier and Plante (2021) note that poverty is disproportionately concentrated in Atlantic provinces, with Nova Scotia ranking the highest. The decline of traditional economic sectors such as fisheries, coal, and forestry has contributed to limited job opportunities and persistently low wages (Beaton, 2004; Gibson et al., 2015).

Housing conditions further exacerbate energy-related hardship. According to the 2021 Census, 9% of households in Nova Scotia live in dwellings in need of major repairs, higher than the national average of 6%. Much of the province's housing stock dates back to the 1970s and 1980s, increasing both maintenance needs and energy inefficiency (Beaton, 2004). The current housing crisis has also intensified affordability concerns across the province (Arsenault, 2021).

Finally, geographic and infrastructural characteristics contribute to transport vulnerability. Approximately 41% of Nova Scotians live in rural areas (more than double the national average of 18%), resulting in longer travel distances and limited access to public transportation. Within this context, Bridgewater, a town of 8,800 located roughly 100 km southwest of Halifax, is the largest urban centre on Nova Scotia's South Shore.

Altogether, these factors illustrate how spatial patterns of vulnerability to DEV are deeply context dependent. Infrastructure, geography, and regional resource access significantly shape the lived experience of energy and transport poverty in Nova Scotia.

4. Data & Methods

The following sections first describes the BridgES study, in which my thesis is embedded. This is followed by the methods used to conduct secondary analyses of i) quantitative data collected from a community-wide survey, and ii) qualitative data from 39 semi-structured interviews to better understand the gendered experience of double energy vulnerability. I employ mixed-methods analysis to better capture the multi-dimensional experiences and outcomes of DEV. The use of mixed methods within approach has been found to be successful in EP research as the combination numerical and descriptive data of yields rich insights (Hihetah et al., 2024). Examining the lived experience of DEV responds to calls for more research that captures the complex realities of vulnerability. As Rotmann et al. (2020) emphasize vulnerability is "not limited to specific groups like low-income households. It is also a function of other life circumstances (e.g. being older, disabled, having young children) and a function of, e.g., a complex intersection of life circumstances, social circumstances, availability of infrastructure, market (de-) regulation and the political climate (Rotmann et al., 2020).

4.1 Quantitative analysis

4.1.1. Data

The data used in this study comes from the BridgES (Bridgewater Energy Security) study, which was developed in collaboration with the Town of Bridgewater The BridgES dataset was designed to provide a baseline measure of energy poverty rates in the community prior to the implementation of the Energize Bridgewater program, as well as to document the health and well-being impacts of the program over time. This research uses data collected at baseline, i.e., before the full implement of Energize Bridgewater. The quantitative data was collected through a community-wide survey questionnaire in the spring of 2022 by five student researchers. A report summarizing the results of this survey are available online (Riva et al., 2022).

Participant Recruitment

The recruitment of participants to the survey employed multiple methods and was realized with the collaboration of Energize Bridgewater employees, community organizations, and local businesses. Information about the survey was communicated through municipal websites, social media, groceries stores, libraries, community centers, local business, and community events such as church services. Additionally, the research team engaged with residents about the survey by going door-to-door and by participating in community events (Riva et al., 2022).

To take part in the survey, individuals needed to meet certain criteria: they had to be 19 years or older, living within the Town of Bridgewater (defined by postal code), and either renting or owning their current residence. Only one adult per household was eligible to participate.

A total of 516 individuals completed the survey, representing for approximately 13% of Bridgewater households. Overall, the demographic composition of the sample of respondents to the survey was representative of the town of Bridgewater, with the exception that fewer men participated compared to women (Riva et al., 2024).

Survey questionnaire

The questionnaire used in the data collection included six sections exploring housing composition and dwelling conditions; energy use, energy costs, and energy hardships; satisfaction with dwelling; health and well-being; mobility; and demographic and socioeconomic characteristics (Riva et al., 2022). It could be completed online, over the phone, or in person. Questions were mostly adapted from existing Canadian and international population surveys.

4.1.2. Variables and measures

Gender

I used a binary classification of gender (men and women) due to the limited number of participants reporting diverse gender identities.

Double Energy Vulnerability

To measure domestic energy vulnerability in Bridgewater, I used a self-reported indicator that was a combination of two questions on the questionnaire. Participants reported a) if they had difficulty affording their transportation needs in the previous year (broadly defined to include personal vehicles and/or public transportation) and b) if they had difficulty affording to keep

their dwelling warm. A dichotomous variable was created to classify respondents who reported difficulty affording both their transportation needs and to keep their dwelling warm.

Socioeconomic characteristics

I used socioeconomic data to identify characteristics associated with the experience of DEV. I selected the following socioeconomic characteristics: marital status, education, age, household composition, activity limitations, and occupation status. I selected these characteristics as they have been found to be associated with energy poverty in the literature. This data was used to contrast the socioeconomic characteristics of women facing DEV, and in the process of identifying confounding variables.

Health and well-being

Health and well-being were assessed by looking at two variables: self-rated stress in daily life and social support. I created a binary variable to contrast participants reporting their life to be quite a bit or extremely stressful vs. a bit, not very, or not at all stressful. The social support variable was based in the 3-item Oslo Social Support Scale (Kocalevent et al., 2018). Participants reported the number of people they could rely on for major personal problems, the interest and concern others showed in their activities, and the ease of getting help from neighbors. Responses were summed into scores ranging from 3 to 14. A binary variable was then created to distinguish participants with lower social support (scores of 3–8) from those with higher social support.

4.1.3 Data analysis

Data management and analysis was conducted in Stata/BE 18.0. Throughout the results, I statistical significance level is set at $p<0.05$.

I first described the composition of the sample by running proportion tests, differentiated by gender. This gave initial insight into significant differences in key socio-economic characteristics between men and women. These descriptive statistics provide context for later analyses and acts a reference to ensures that gendered patterns of DEV were accurately captured.

To answer my first objective, i.e., establish if the experience of DEV is gendered, I ran a cross-tabulation between the two variables. This initial tabulation informed me that the sample size of men experiencing DEV was too small to run further analysis, so after this I only focused on women participants.

I continued with my second objective, identifying socioeconomic characteristics associated with the experience of DEV, by first running cross-tabulations by gender with a range of socioeconomic variables to assess which relationships were significant. Next, I conducted bivariate logistic regression analyses to estimate the odds of experiencing DEV based on various predictor variables. Logistic regression was chosen because it is well-suited for binary dependent variables, allowing me to model the probability of an event occurring versus not occurring. The results are presented as odds ratios, which indicate the strength and direction of the relationship between each independent variable and the likelihood of the outcome. An odds ratio greater than 1 indicates how much more likely it is to observe DEV in a certain demographic group compared to a reference group. Conversely, an odds ratio lower than 1 indicates a lower likelihood of observing DEV among those within a certain demographic. The confidence interval (CI) informs on the precision of the estimated odds ratio. I used the predictor variables (i.e.., income category, marital status, education, age, household composition, activity limit, occupation status) that had showed significant association with DEV during tabulations or could be confounders. Odds ratios, confidence intervals, and p-values are reported.

Lastly, to address the final objective, I used logistic regression to explore the relationship between DEV, health and well-being. To gain insight on the individual experience I used the binary variable 'stress in daily life' to see the likelihood of individuals experiencing DEV reporting high levels of stress as opposed to those not experiencing DEV. I then tested the binary variable 'social support' to determine whether individuals experiencing DEV were more likely to report low social support compared to those not experiencing DEV.

4.2 Qualitative analysis

4.2.1 Data

The second dataset, collected by the BridgES research team as a follow-up to the 2022 survey, was designed to capture aspects of energy poverty beyond the questionnaire's scope. Thirty-nine semi-structured interviews were conducted with people experiencing energy poverty in Bridgewater and the surrounding areas. A report summarizing the main findings are available here (Riva et al., 2022). Analysing this this dataset enhances my understanding of DEV, its demographic patterns, and its impact the lived experience, and complements the quantitative results.

Interview Recruitment

The interviews were conducted by one member of the McGill research team in September 2023. Participants were recruited through purposive and snowball sampling, through various methods: follow-ups with respondents from the 2022 survey, referrals from a local housing support association and a community organization, and connections made through other participants. Overall, 32 interviews with 39 individuals were conducted. Most interviews were conducted individually, while four involved two or three participants.

Interview Process

The interview guide was developed collaboratively with the staff from Bridgewater and the housing support organization, the South Shores Open Doors Association (SSODA). During the interviews, participants were asked questions about their housing conditions (including experiences of homelessness, if applicable), energy consumption and costs, ability to maintain comfortable temperatures in the home, experiences with extreme weather, transportation requirements, health and well-being, and access to support services. The interviews were transcribed.

4.2.2 Data analysis

I employed thematic analysis (using NVivo 14 software), a method that identifies common topics, making links across interviews. My work builds on, and extends, thematic coding already completed by the BridgES team. The team coded each transcript and worked together to find themes. Coding can be understood as labelling specific sections of interviews. The team systematically coded each transcript and collaboratively identified five major themes within the broader context of energy poverty and housing challenges: physical needs, financial strain, seeking support, health and well-being impacts, and coping strategies. While this work provided a valuable foundation, I conducted my own analysis tailored specifically to address the objectives of my research.

To answer the third and fourth objectives, i.e., explore the life outcomes of women and identify how the experience of women and men differ, I began by reading all the transcribed interviews. During the reading process, I began coding sections that appeared relevant in relation to the themes identified in my literature review. This process allowed me to gather a list of relevant codes. As new codes emerged, I added them to the list, and revised in previously coded

sections, so each interview was coded using the same list of codes. In the end, I had a total of eight 'parent codes' (DEV, EP, TP, parenthood, division of labour, constraints on agency, response to hardship, leisure) and 40 more specific 'child codes.' See Table 5 in the appendix for a complete overview parent and child codes, as well as definitions and representative quotes. After reading and coding all 39 transcripts, I identified themes that emerged from the analysis. Guided by my fourth objective, and my classification of parent and child codes, I found three main themes: (1) care responsibilities and constrained choice (2), coping through divided domestic labour, and (3) hidden burden of gendered roles.

All participant names have been changed to preserve confidentiality.

5. Results

This section presents the quantitative findings of the study, using survey data to examine which groups within the sample are associated with vulnerability to double energy vulnerability (DEV) and how this relates to health outcomes.

5.1 Quantitative results

5.1.1 Description of survey participants

Overall, 516 individuals in Bridgewater completed the community-survey, 316 women (62.5%) and 190 men (37.6%). The sample differs from the population of the Town of Bridgewater as there is an overrepresentation of women and an underrepresentation of men. The lower participation of men is a common issue in population surveys and complicated my research process. As mentioned previously, only 14 men self-reported being in a state of DEV, forcing me to focus my quantitative analysis on only women. Notably, both the sample and Bridgewater are predominantly White/Caucasian, limiting options to look at the role of ethnicity and the experience of DEV.

Table 1. below summarizes socio-demographic features of the sample, differentiating between men and women, as well as providing a numeric count of the sample. A similar table is presented in the summary report written by the McGill research for the Town of Bridgewater, as well as more information about the similarities between the sample and the actual population according to census data (Riva et al., 2022). It also describes the proportion of men and women in categories related to EP and TP.

Table 1. Proportion (%) of participants by socio-demographic, energy use and transportation characteristics, stratified by gender

	Men (%)	Women (%)	All (n=)
Socio-demographic characteristics (%)			
Gender	37.6	62.5	516
Age			
19-34 years	15.8	15.8	80
34-64 years	46.3	53.5	257
≥65 years	37.6	30.7	169
Cultural identity/ethnicity			
White/Caucasian	95.3	95.6	483
African Nova Scotian, Asian, Latinx or Indigenous	4.7	4.4	23
Marital status			
Married/Common law	67.4	46.5	275
Single	16.3	26.9	116
Separated	4.7	5.1	25
Divorced	6.3	11.1	47
Widowed	5.3	10.4	43
Household composition			
Couples w/out children	40.5	24.7	155
Couples with children	19.5	23.7	112
Lone-parent household	10	11.7	56
Person living alone	24.2	31.3	145
Other	5.8	8.5	38
Highest level of education attained			
Less than high school	7.4	8.9	42
High school	31.6	24.4	137
Trade certification	10.5	7	42
College/post-secondary	21.6	33.2	146
University	29	26.6	139
Occupation status			
Work full time	45.3	39.6	211
Work part time	11.1	7.6	45
Domestic labour	1.1	12.7	42
Retired	30	25.6	138
Longterm illness/ Disabled	5.8	6.3	31
Other	6.8	8.2	39
Income			

<$20,000	5.9	11.3	46
$20,000-39,999	19.7	28.6	126
$40,000-59,999	16.5	23.2	103
$60,000-99,999	37.2	20.6	134
$≥$100,000	20.7	16.4	90
Activity limitations because of health problem	34.53	65.47	233
Housing tenure and energy use			
Tenure			
Owner	67.9	63.3	329
Renter	32.1	36.7	177
Dwelling type			
Single-detached house	56.3	50.3	266
Semi-detached house	5.3	5.1	26
Mobile home	10.5	13.9	64
Apartment	25.2	26.3	131
Other	2.6	4.4	19
≥10% of income spent on energy after housing cost	20	31	117
≥ 2M (double the national median share of income spent energy on after housing cost)	47.3	58.3	236
Transportation mode and accessibility			
Transportation mode			
Car, as a driver	83.2	71.5	384
Car, as a passenger	4.7	14.2	54
Transit	2.1	4.1	17
Active transport	6.8	7.3	36
Other	3.2	2.9	15
Has a driver's license	91.6	84.8	422
Owns a car	82.6	80.7	412
Avoided trips to lower transport costs	53.2	67.7	315
Double energy vulnerability			
Difficulty affording energy and transportation	6.8	15.5	62

Descriptive statistics provide the first look into gender differences among men and women. In terms of household composition, women are more likely to live alone (31.3% vs. 24.2%) or in lone-parent households (11.7% vs. 10.0%), while men are more likely to be married or in common-law relationships (67.4% vs. 46.5%). Educational attainment differs slightly, with a higher proportion of women having completed college or post-secondary education (33.2% vs. 21.6%). Women also report lower income levels, with 40% earning below $40,000 compared to

26% of men. In terms of transportation, a higher percentage of men report driving a car (83.2% vs. 71.5%), whereas women are more likely to travel as passengers or use public transit. Finally, 15.51% of women report experiencing DEV, more than twice the proportion of men (6.84%). An accompanying Pearson chi-squared test found that this result was significant at 0.04.

5.1.2 Associations between Socioeconomic characteristics and DEV

Bivariate logistic regression and proportion tests were used to identify socio-economic characteristics associated with women's experience of DEV. See Table 2 below.

Table 2. Bivariate logistic regression associations between socioeconomic characteristics and DEV among women.

Variables	Women experiencing DEV
Odds ratios and confidence intervals (OR (95% CI)	
Age (categorical)	
19-34	1.41 (0.65, 3.00)
34-64	(ref.)
≥65	0.29 (0.12, 0.73)***
Income	
<20,000-39,999	6.72 (2.5, 18.04)**
40,000-59,999	5.79 (2.00, 16.74)**
≥ 60,000	(ref.)
Occupation	
Full time	(ref.)
Retired	0.37 (0.14, 0.97)**
All other	1.10 (0.57, 2.14)
Household composition	
Couple without kids	(ref.)
Couple with kids	3.52 (1.30, 9.49)**
Lone-parent household	3.31 (1.05, 10.38)**
Other (person living alone or roommates)	2 (0.76, 5.28)
Marital status	
Married/Common law	(ref.)
Single	2.53 (1.21, 5.30)**
Separated/Divorced	3.01 (1.32, 6.87)***
Widowed	0.57 (0.12, 2.61)
$*p < 0.05$. $**p < 0.01$. $***p < 0.001$.	

Age appears to be a significant factor, with women aged 65 and older having lower odds of experiencing DEV, compared to those aged 34 to 64 years. Income is also strongly associated with DEV; women reporting a household income lower than $40,000 per year have significantly higher odds of experiencing DEV. Specifically, women reporting household income below $40,000 are 6.72 times more likely to experience DEV and those with a household income between $40,000–$59,999 have 5.79 times higher odds, compared to those in household i=with incomes ≥ $60,000. Occupation status also plays a role, with retired women having lower odds of experiencing DEV. Regarding household composition, mothers are more likely to experience DEV, as opposed to women in households without children. Similarly, marital status influences DEV risk, with the odds of experiencing DEV being 2.53 times more likely among simple women, and 3.01 times more likely among separated/divorced women, compared to women who are married or in common law relationships.

While women with lower incomes and certain household structures (e.g., lone-parent households) show significantly higher odds of experiencing DEV, the wide confidence intervals for these estimates suggest caution in the interpretation of results, which is likely due to smaller subgroup sample sizes.

5.1.3 Exploring the life outcomes of women facing DEV

Women experiencing DEV show significantly higher odds of reporting negative health and well-being outcomes, as reported in Table 3. below.

Table 3. Associations between women experiencing DEV and health and well-being indicators from adjusted logistic regression models

Variables	Higher stress in daily life	Lower social support
	OR (95% CI)	
Experiencing DEV		
No	(ref.)	(ref.)
Yes	4.67 (1.95, 11.17)***	4.10 (1.78, 9.43)**
Income		
>=100,000	(ref.)	(ref.)
<20,000-39,999	2.87 (0.96, 8.55)**	3.65 (1.13, 11.76)***
$40,000-59,999	2.14 (0.72, 6.36)	2.44 (0.75, 7.90)
$60,000-99,999	3.14 (1.12, 8.79)**	2.42 (0.77, 7.63)
Marital status		
Married/common law	(ref.)	(ref.)
Single	2.02 (0.86, 4.72)	1.68 (0.71, 3.97)
Divorced/Separated/Widowed	3.49 (1.38, 8.84)***	2.78 (1.10, 7.04)***
Has children		
No	(ref.)	(ref.)
Yes	1.49 (1.38, 3.12)	1.31 (0.61, 2.86)
Age (continuous)	0.97 (0.94, 1.00)***	0.98 (1.00, 1.01)
$*p < 0.05$. $**p < 0.01$. $***p < 0.001$.		

Women experiencing DEV are 4.67 times more likely to report higher stress in daily life, compared to women not experiencing DEV, after adjusting for confounding variables. Similarly, women experiencing DEV are 4.10 times more likely to report lower social support. These results suggest a strong association between DEV and adverse life outcomes, though wide confidence intervals indicate some variability in estimates.

5.2 Qualitative results

This section presents the qualitative findings of the study, drawing on semi-structured interviews to explore how individuals experience and respond to double energy vulnerability (DEV). The analysis is organized thematically to highlight the gendered dimensions of DEV.

5.2.1 Description of interviewees

Of the 39 individuals interviewed 29 were women, and 10 were men. 10 participants were homeowners, 20 were renters, and 9 participants were precariously housed (Table 4). Of the nine precariously housed participants, five were not living in a dwelling at the time of the interview, three were living transitionally with families, and one had just received an eviction notice. Among the various household compositions, 15 participants lived in households with children (under 18 years), 12 lived alone, and the remaining participants lived with partners or adult family members. More information on the sample of participants can be found in (Debanne et al., 2024).

Table 4. Descriptive summary of sociodemographic characteristics of sample

	Number of participants (n)	Proportion (%)
Gender		
Woman	29	74.4
Man	10	25.6
Age category		
19 to 34 years	10	25.6
35 to 64 years	18	46.2
≥65 years	9	23.1
Not given	2	5.1
Annual household income (CAD)		
No income or < $20,000	20	51.3
$20,000 to $39,999	11	28.2
$40,000 or more	8	20.6
Highest attained level of education		
Less than high school	12	30.8
High school diploma or equivalent	12	30.8
Post-secondary education	13	33.3
Not given	2	5.1
Household Composition		
Couple without kids	10	25.6
Couple with kids	4	10.3
Lone-parent household	2	5.1
Multi-generational household	11	28.2
Person living alone	12	30.8
Income Source		
Government	30	76.9

Employment	9	23.1

5.2.2 Themes

My results are presented first with a short section presenting the background evidence of the participants experience of DEV. I then explore the three narrative themes I identified: (1) care responsibilities and constrained choice (2), Coping through divided domestic labour, and (3) hidden burden of gendered roles

Care responsibilities and constrained choice

Care responsibilities and constrained choice relates to caregiving duties, commonly carried by women, which restrict agency in negotiating situations of DEV. Care responsibilities refer to the unpaid tasks involved in looking after others, such as caring for children, elderly family members, or people with disabilities. Limited agency can be understood as a reduced capacity of individuals or groups to act independently, make their own choices, and exert influence over their lives and surroundings.

Within the sample, women's care responsibilities were shown to constrain their ability to decide where and how to live. Limited financial resources already contribute to increased vulnerability to DEV, and the need to secure housing that is suitable for children further complicates decision making. Caregivers often faced trade-offs between children between securing housing adequate for children and maintaining affordability in rent and energy services. Megan, who has one 5-year-old son, previously shared a one-bedroom apartment with her roommate Jakob and his 15-year-old son. In that arrangement, Jakob and his son slept on a pull-out couch in the living room, while Megan and her son shared the bedroom. These crowded conditions did not work for them and recently, Megan and Jakob moved into a new house. Although the rent is high and the house is not energy efficient, which has resulted in significant energy debt, Megan now has "*more room and [her] son has his own room*." In this case, Megan and Jakob 'accept' energy poverty in order to provide enough space for their children.

Conversely, other parents may choose to live in overcrowded conditions to avoid unaffordable housing and energy costs. Affordability concerns can lead families to live in conditions that do not meet the spatial needs of young children. As Hazel explained, space can

feel "*tight, especially for boys as they get busy and active*." She and her partner had recently moved into her parents' house with their two sons, unable to afford a home of their own. Overcrowding was a common experience across the sample. Children often require additional space, such as larger common areas or more bedrooms, yet affordability constraints left families navigating difficult trade-offs between adequate space and the cost of rent and energy services.

Similarly, the presence of children can put suitable housing conditions at risk, particularly when caregivers lack control over their living environment. Marin also mentioned future concerns with neighbors as she was worried that when her daughter reached toddler stage, there would be disputes about noise and banging that she would have no control over due to her vulnerable status as a renter and stay-at-home mom. Her role as her daughter's primary caregiver, coupled with her limited housing security, may lead to future exposure to situations of DEV.

Caregivers' ability to decide where and how to live was also influenced by structural housing conditions, through discrimination in the housing market and government programs. Multiple women in the study identified bias against children in rental applications as a significant barrier to accessing affordable housing. Both Mindy and Lauren shared experiences of encountering landlords who refused to rent to families. Lauren is a young single mother who, after a series of adverse life events is separated from her children and living out of a van. The extract below reveals Lauren's experiences with discrimination in her efforts of trying to find a way to live with her kids again:

> Lauren: It's kind of nuts. Yeah. And then, of course, as soon as you mentioned that you have children or you're a student or any other type of real life, anything nobody wants to rent to you.
>
> I: So you've experienced discrimination?
>
> Lauren: Absolutely.
>
> I: Has it been said to you? Is it kind of you can't prove it, but it's like an undertone of?
>
> Lauren: Can't prove it, but it's an undertone for sure. It was the same thing in Ontario, like I've been not rented places in the past because I have children or because I'm a smoker and even though I smoke outside anyways.

Additionally, Lauren faces barriers to accessing government housing. Her experiences with past abusive relationships have left her with a strong desire for privacy, but as she explained:

> It seems like the government wants to push everybody into shared accommodations. Which doesn't work in the real world for a bunch of reasons, especially when you have kids and especially when you have kids who have the history of my family like. I will not live in a shared accommodation with my children.

This inability to access government housing is shared by Megan, who noted a desire for more affordable low-income housing, as she has "*been on a low-income housing list since [her] son was eight months old. He's now five.*" Children can make accessing social housing more difficult.

Housing choices were also shaped by the need to remain close to children's services and routines, reflecting a negotiation between their well-being and energy use. This was largely related to issues caused by accessibility poverty, which led families to prioritise transport spending over energy. Cindy, a stay-at-home mother of four, explained that even though her home had what "*feels like a lot of mold*" in "*the basement and main living area*" she has struggled to move out. Cindy believes that there is a definite connection between her own and her children's health issues (asthma and allergies) and the housing conditions and states: "*If I had the option where I could buy right now, if there were things to buy in Bridgewater area, we definitely would be moved out in our own home*." Problematically, Cindy is constrained by "*the market, and the location that we need due to the school district that our kids are in*." Due to medical reasons her children go to a special school, which leads Cindy to drive the car much more than she wants to. Cindy finds public transport inaccessible, and moving away from her children's schools could worsen the transport burden she already faces. Meeting her children's needs creates accessibility and affordability challenges that further limit Cindy's ability to mitigate energy poverty. This is a clear example of DEV. Similarly, Colleen who also lives in a situation of EP, echoed concerns about housing, transport, and her kid's schooling:

> "He takes the bus. I was just going to say we are scared because don't know where we're going to move, so if we have to drive him to school every day, that's already an expense weighing on my head, like, because I don't want to have to switch them schools again. It's his last year of elementary he's in Grade 6. But, that's going to be a big expense."

She worries upsetting his social life but also must consider the potential transport costs if they need to drive him to school every day. Parents must balance multiple needs at once, looking out for their children's physical and social needs, while also dealing with vulnerability to EP and TP.

In sum, the presence of children plays a critical role in shaping women's housing choices, transportation burdens, and overall vulnerability to DEV. Care responsibilities intersect with structural barriers, such as housing discrimination and rigid government housing policies, to further limit women's agency in securing stable, comfortable homes. Women in this study were often forced to choose between competing priorities: safety, affordability, proximity to services, and energy efficiency, with caregiving concerns frequently taking precedence.

Coping through divided domestic labour

Coping through divided domestic roles refers to the various actions individuals take to reduce their energy burden. This section explores how these strategies, associated responsibilities, and their outcomes differ by gender.

Within the sample, individual, undertook behavioural strategies to reduce energy bill, largely through two pathways, through daily alterations to energy use and through retrofits. It is important to highlight that changes were made by individuals rather than households, as engagement with these strategies appeared to differ by gender. This differentiation is likely shaped by socially constructed notions of feminine and masculine roles within the domestic sphere.

Women discussed alterations to daily tasks in length. Carrie, an older woman, shoulders significant responsibilities as a grandmother in her multi-generational home. She makes efforts to decrease her family's monthly energy bills but feels like there are no more adjustments she can make: *"Try to do less laundry, not use the dryer as much and stuff. That's basically all I could do, because the only other thing that I use electricity of course, is the TV. And fridge and stove, and freezer. That's it."* Other women reported similar everyday alterations but on top of changing behaviour constantly monitor their use by checking their energy bill very closely. Ashley is a young single mom who estimates how the energy be is going to be every month, then reads the bill in detail to ensure it is accurate and not over their budget: *"I make sure everything's correct. Right down to the dollar. And sometimes the benefit comes in from them is lower than*

what I even estimated." When the bill feels too high, she calls the energy provider to understand why:

> "If we get a bill that's high I'll call and say, OK, what, what do you think is going the most in our home right now that can cut back on? Most of the time they'll say, OK, it's your humidifier that going and most of the times, I'm like, OK, well, that's something I can't really credit in because of our mold and dampness in our basement. It's not like something I can really unplug in the rooms. But we always cut back like on like when we go away on vacation like we go to my mother in laws in Cape Britain. We unplug all our TVs, anything that we know that doesn't have to be plugged in we unplug."

Like Carrie, she has made all the adjustments she can without compromising the health of her family. Colleen, another young mother, also closely reads her bill to see if it is accurate. Her behavioural changes involve cooking:

> "If I bake something and use the oven for a meal, I would go back and see what my usage is versus a day that we weren't home and, like, see how accurate that is. I'm really on top of that. And like we have a really good three layer convection oven. So I tend to try and cook like three meals in a row that we just have to quick reheat just cause it's all done at once."

Within households, women are more likely to undertake care responsibilities and housework, largely as a result of enduring gender norms and expectations (Statistics Canada, 2022; Robinson, 2019). Therefore, women are more likely to be engaged with everyday practices that can be adjusted, potentially placing greater responsibility on them to implement these changes (Wang, 2016).

Interviewees and their households not only engaged in everyday alterations but also in larger projects, retrofitting their home to be more energy efficient. When looking at energy retrofits, responsibility appears to be shifted to the men in women's lives, boyfriends, fathers, etc. Participants Lindsey and Carrie both stated that they hadn't made many changes to their homes, besides the alterations made by their father, and husband, respectively.

Andrew is an older man who lives with his partner, Denise, in his long-time home. A grant from Energy Efficient Nova Scotia has helped the couple to install new energy efficient windows and doors and have the walls in the basement sprayed-foamed to prevent ground water leakage. The conditions of grant required a licensed contractor to install the retrofits, but throughout the

explanation Andrew repeatedly asserts that he would have been capable of doing the construction: *"My brother's a contractor, so I had to get, I could have done them myself, but I had to have a contractor to do it. So my brother done it, he's a contractor."* Andrew's convictions speak to the connection between technical competence in home improvement and traditional masculinity. He again asserts his 'masculine role' when discussing another home renovation project: "*I put a steel roof. I put a, her and I put a steel roof on the house six years, seven years ago*?" Here he first took responsibility for the undertaking, but corrects himself at the end, admitting that it was a collaborative effort between him and Denise. His comments reflect gendered perspectives about technical competence and home improvement as a masculine domain.

The gendered pattern of behavioral changes, with women handling daily alterations, and men taking on retrofits, does not hold unilaterally across the sample. Dolly, an older woman described the active role she played in improving the energy efficiency of the home she shared with her husband. She states, **"***We're trying to be more conscious in our choices. I've just bought all energy-efficient appliances. We renovated the kitchen since we've moved in, which was a complete gut. And, you know, I bought all new appliances that have a decent energy efficiency rating."* Her language suggests a mix of collective decision-making and individual agency. She further emphasizes her personal role in key choices, saying, *"I actually put in a gas stove in this house. It's something I had wanted for a while, but I wasn't prepared to put out the money for it until we felt fairly confident we were going to stay put. So we did do that, which is (A) economical but (B) gives us the heat source if we need it."* Like Andrew above, Dolly's shift between singular and plural pronouns is telling, potentially revealing information on who made the decisions regarding retrofits. The fluid movement between 'we' and 'I' underscores the negotiation of decision-making within the household, where certain choices reflect shared responsibility, while others highlight individual priorities. This suggests the possibility that although male household members may be the ones to implement the retrofits, the underlying intention may stem from women.

Behavioural strategies to improve affordability also influenced transportation practices. Deliberate efforts to reduce transport use were primarily linked to reduction of leisure activities, in order to save money. Other changes in transport methods were not driven by a direct intention to reduce transport but emerged from broader strategies to lower overall household expenses.

This reflects the ambiguous nature of transit as a 'merit good,' as it is a practice that is deeply interrelated with many aspects of daily life (Lucas et al., 2016). Limitations in mobility, accessibility, or affordability can trigger cascading effects. Below I highlight the increased time burden associated with transportation, care responsibilities, and affordability efforts.

As noted above, transport behaviour was often motivated by attempts to reduce overall household expenses. A common strategy was the practice of 'trip-chaining' which was used as a way to reduce spending on groceries and transport. Hazel, like many other participants, reported planning shopping around coupons and deals, leading to multiple stops:

> "We get some of the Bulk Barn because Bulk Barn has coupons associated with it. So it's just basically picking and choosing which grocery stores for which items. But we try not to drive to the grocery stores because we try and walk to Sobeys and the superstore and we normally don't go to No Frills and those sorts of things because they're on the other side of the bridge. They're just that much farther away, but yeah, it's a lot of looking, a lot more looking at the flyers and trying to plan your meals, associated with the flyers."

For those in the Town of Bridgewater without a car, the practice of trip-chaining, and transport in general, is restricted by transit provision. Overall, interviewees, particularly stay-at-home mothers, expressed dissatisfaction with the public transit services. The bus was reported to be inaccessible, slow, and unable to reach the right destinations. Cindy, spoke to both the inaccessibility and unaffordability of the transit system:

> "When you got 4 kids, it's not really affordable. Plus it doesn't fulfill all our needs the public transport. Like, if I get my kids to the bus stop four times in the morning and back and stuff. It doesn't go right up to your location that I need to go. So it I would have to go to stop and have to walk quite a distance on a main road, unfortunately."

Her perspective highlights the disconnect between transit provision and the realities of caregiving, particularly in terms of affordability and accessibility. This issues with affordability and accessibility can make it hard to carry out cost-saving behavioural strategies, such as trip-chaining. Difficulties with complex, multi-stop trips was reflected in the experiences of Jolee and Ann, a mother and daughter who live together with Jolee's partner and their baby for affordability reasons. While they described similar money-saving practices, they emphasized the challenges of transport affordability and accessibility, with Jolee stating *"When I used to get the*

flyers, we used to do that. We used to go to two different grocery stores but we don't do that now because it costs more to do that because you gotta get there." She went on to highlight the time and cost trade-off of reaching these deals:

> "Even, even if you did take the bus, it's just not always worth it, cause it's your whole day. You know, it's an hour... the way if you ever think about it, if you can get it, even if you have to pay a dollar extra just saves you that $2.00 bus ride or whatever it's going to cost you to take the car."

Ann added that they would still aim to get deals but really prioritize trips where they can "multi-task"; *"Like if there's a deal on at Walmart, I'll get it while I'm up there getting her diapers cause it's the only place I can buy her brand of diapers. So if there's sales on..."* Jolee and Ann's experience illustrates how transport disadvantage can cause behavioural adaptations intended to save money to become all-consuming, particularly in terms of daily routines and time demands.

Overall, this section illuminates how behavioral adaptations to situations of DEV impact daily routines, and how these impacts can differ by gender.

Hidden burden of gendered expectations

"Burden of gender roles" refers to how socially constructed expectations contribute to the emotional and psychological consequences of experiencing DEV. Gender norms can intensify stress, shame, and long-term challenges to mental wellbeing. While gender roles shape DEV outcomes differently for men and women, they both result in increased difficulty in alleviating vulnerability.

Men in the sample tended to meet DEV with stoicism, often minimizing hardship, reflecting gendered expectations of toughness and self-reliance. This is illustrated by the disconnect between men's self-reported living conditions, and their attitudes toward those circumstances. This was the case for Ronald, an older man living on disability and pension, in a mobile home. Ronald was clearly experiencing DEV. His health conditions leave him reliant on a scooter for mobility, but the scooter sometimes breaks, preventing his ability to get around. He relies on public transit or cabs for longer distances but struggles with affordability, which makes it difficult to visit his family who live outside of town. Additionally, his home conditions are insufficient leaving him too hot in the summer and too cold in the winter. When discussing how

he felt when his house was too cold, he said: *"Oh what's the point really? I don't, I don't just don't feel right myself, but. But I'm hoping anyway as time goes it will…"* In the summer, when his home is too hot it affects his COPD, which then triggers anxiety:

> "And you know, like once [the heat] starts happening, my anxiety kicks up… I remember one day, last year, or the year before my anxiety got worked up and of course again, got some old emotions out. You know, I had to go to the hospital because I felt grabbing a baseball bat and the first person to come up and have a good game baseball with that person. Using that person for a ball."

Ronald suffers greatly from DEV associated outcomes but when asked how the experiences impact his mental and physical health he responded, *"at times, but not as much now as it did"* and that they are "*just stressful, a little bit."*

Gordon, who lives in a bachelor pad that leaks and doesn't maintain a comfortable temperature, had a similar response to his living situation. He isn't bothered by the extreme cold, claiming that a multiple day power outage in the winter didn't bother him because of *"the environment [he] was born and raised in"* with him saying that while growing up:

> "I would usually get cold enough upstairs that the chamber pails would freeze, so I was sort of, I was sort of prepared for it or hardened to it. When I when I say hardened to it, let's say I was conditioned is a better word, I was conditioned to it."

He makes few adjustments to cope with the uncomfortable thermal conditions in his apartment, and when asked if heat caused him exhaustion or stress he responded: *"No, because everyone else is experiencing it, that doesn't use some type of air conditioning. Other people experience it too."* By downplaying his own discomfort, he frames suffering as something to be endured rather than addressed, reinforcing the idea that seeking relief is a luxury rather than a necessity. His statement suggests a collective struggle, but rather than using this as a justification to seek solutions, he uses it to dismiss his own suffering.

Stoic and dismissive responses to hardship can have harmful consequences. The underlying beliefs that encourage these responses can also act as barriers to seeking support, increasing the risk of social isolation and limiting access to informal support systems that might offer practical solutions. Gordon believes that he may have people in his life that would support him if he needed them to, but he asserts that *"I don't like to, I don't like to use that card unless I absolutely have to. It has to be in pretty, pretty dire straits situation before I consider tapping*

into that. And that hasn't happened yet." When further prodded about his comfort with seeking help, he revealed that his pride would get in the way and that he has never been that desperate. The mindset that prevents Gordon from reaching out may also contribute to social withdrawal, as admitting vulnerability could be seen as a sign of weakness. This tendency toward isolation was reflected in both Gordon and Ronald's accounts, as they shared that they are relatively isolated and rarely have visitors. Gordon's feelings towards his isolation are seen below:

> Gordon: Nobody comes in other than my Home Support workers, and well you here now.
>
> I: OK. OK. Yeah, I'm glad to be here.
>
> Gordon: Other than that, nope. I do, I get company, but people got their own lives and also have to do their things they got to do.
>
> I: Yeah, yeah. Do you wish you had more people around?
>
> Gordon: Yeah, yeah. Somebody to talk to.

This tendency may be shaped by broader social norms that conflate self-reliance and emotional restraint with masculinity.

The emotional consequences of experiencing DEV for women were often marked by high levels of stress, which negatively affected their overall life satisfaction. Within the sample, the stress appeared to affect women more frequently due to their involvement in social labour, both emotional and cognitive, and a broader sense of responsibility for the care of others.

Emotional labour involves managing feelings, caring, and worrying about the wellbeing of household individuals (Dean et al., 2022). For instance, this can be calming the children if they get upset, making sure everybody feels relaxed in the household, worrying if an older member doesn't feel comfortable and much more. Emotional labour takes on another dimension when households are in situations of DEV.

Hazel had only recently moved into her parents' house, along with her partner and their two sons. They moved in because they could not afford a home on their own. When asked about how her living situation impacted the members of her family Hazel responds that:

> "It's probably more stress on me. Yeah, I don't think it's affected them that like. I don't think it's made it stressful on anyone? It's harder at times cause you're dealing with multiple, you know, personalities all at once. So sometimes people like things and sometimes they don't."

This comment speaks to the emotional mediation required when six people are newly living in a home together. Similarly, Colleen lives with her husband who has MS, and their 11-year-old son, in nearly unlivable conditions. Unable to move out due to lack of financial resources, and constrained by his disease, her husband's health has worsened from the conditions. The cold triggers his pain and it causes him to lash out. Colleen then becomes a "referee." She describes the situation below:

> "So like, it's definitely a lot of tension there and my spouse just with his pain, like, it's not his fault, like his brains been mapped out, and like his brain's fault, but any stress or anything just makes like not physically aggressive but like so angry and like he's vocalizes aggression and like, it just sets my son off and my son takes that. So it's just. Like I'm just always in tears and trying to like be a referee."

Both Hazel and Colleen were forced to take on a larger share of emotional labour because of situations of deprivation. Constantly managing others' emotions can lead to stress and burnout, especially when combined with financial or structural constraints.

An interrelated concept, cognitive labour, encompasses the mental effort required to anticipate needs, identify options, make decisions, and monitor progress, often in the context of household management or childcare (Morini, 2007). It is usually associated with anticipating household needs, planning activities and playdates, delegating household tasks, and meal planning. It has found that been that this burden largely falls on women (Daminger, 2019). This result is also evidenced in this analysis, with men participants reporting that they let their wives handle budgeting and "*call the shots."* Carrie lives with her husband, their daughter and her partner, and their two grandchildren, in one mobile home with only two bedrooms. When discussing who in the household thinks about managing energy use to reduce bills Carrie reveals that she shoulders the burden of worrying about the issue. She explains that *"my husband had five heart attacks, so I tried not to let him even get too stressed about the power bill. It's just me."*

The nuance of DEV adds a layer of complexity. Many women interviewees report planning strategies to stay on top of energy bills and have emergency systems in place. A retired woman, Edie discussed her lengthy planning efforts, and the multiple savings accounts she keeps that her and her husband so that they *"aren't hit with any nasty surprises."* Colleen was also concerned about shocks and attempted to plan accordingly, claiming she spent much of her days

thinking about: "*a backup to a backup to a backup*" just in case the worst-case scenario comes true. Cognitive labour isn't just found in relation to emergency situations but also related to daily household tasks. Anticipating of needs is important as well. Because of the overly cold temperatures in her family's home Colleen also had to "*plan ahead, get up an hour early, preheat the house [with portable space heaters] so [her] son can have breakfast and a bath*."

Among participants, the burden of emotional and cognitive labour weighs heavily on women. For many, planning around DEV and anticipating worst-case scenarios stopped being solely a strategy and turns into a constant source of anxiety. Elderly woman Florence has chronic health issues and relies on an oxygen machine; her daughter Tula moved in with her to be her caregiver. When discussing energy usage, Tula speaks to the pervasive nature of cognitive labour and the chronic stress associated, stating:

> "I'm kind of trying to not think about it. But it's, it's hard not to. You know, because sometimes I can be sat her and be talking and next thing you know, I'm zoned out about 50 miles away, just siting and thinking, what if I can do this? What if I can do that?"

Similarly, Cindy (P_34) who experiences "*deep depression and anxiety*" because of the housing conditions, EP, and her children's health, perfectly sums this experience of the burden of the cognitive and emotional labour, stating: "*I guess I'm worried and everything so I'm the main person of the household. Mom, I guess you would say. I don't get much sleep*.," This work is daily and invisible, and increased load brought on by the situation of DEV make life harder.

Finally, it becomes clear that many women experience heightened stress due to the overwhelming sense of responsibility they carry for the wellbeing of their household members. Furthermore, it is found that women in the sample actively hide this burden from their families to protect them. The exert below reveals how energy, the responsibilities of care-giving, and chronic stress are intertwined and have impacts on Carrie's mental and physical health:

> I: Do you find the stresses had an impact on you in your health or?
>
> Carrie: I'm not healthy at all anyway. Yeah, I get my headaches. I actually started going three or four days vomiting just from stress and stuff so.
>
> I: And is the energy bill, what are your like? Is the energy bill one of your main sources of stress or?
>
> Carrie: Yeah

I: And what else is causes of stress in your life these days?

Carrie: Day-to-day living. My grandson, worrying about him. Worrying about my husband, my daughter. Everything, I'm the worrier.

I: Yeah. Are you the... Do you think you're like the not the like the head, not the head of the household, but the person that kind of cares for everyone at the home?

Carrie: Yeah.

Women in the sample, whether single mothers, mothers with husbands, daughters caring for aging parents, or grandmothers supporting extended families, often felt a stronger responsibility for caregiving, and as a result, experienced more stress when situations like DEV made it hard to keep their families comfortable. Carrie again, supports this saying: *"I have custody of my oldest grandson right now and I don't need anything to threaten that, and that's what gets stressful with the power."* The anxiety associated with living and dealing with conditions of EP and TP are exacerbated when you feel that you are putting other people, namely your children, at risk. When asked if her living situation led to an impact on her mental or physical health, Kayla responded

"Definitely, yeah. Living just in the condition of the building and like gradually realizing how bad it was, was stressful not only because, like, we're in it, but like, I'm constantly thinking, like, how is this affecting the kids? Are they breathing in mold? Is there mold behind the walls or in the ceiling or like, what? And like, after we moved out and everything was moldy. It was like oh my god! The kids were in that!"

Women in the sample not only deal with a greater responsibility of care, and emotional and social labour but they work to keep them from their family members as not to share the same experience of stress. Many women in the sample described the act of hiding their emotions from family and children. Kayla, mother to young twins, describes not letting her emotions be revealed to her kids saying "*Like after the kids go to bed like, Oh my God, that's kind of when I deal with my stuff. Kind of just turn it off until they go to sleep.*" Megan, mother of a five-year-old, echoes similar a notion, saying "*I don't need my kid going to school saying ohh, mommy's stressed out because she doesn't know how she's paying rent. No, my kid will never, My kid will never know that we're struggling. He always has what he needs."* Situations of DEV add to mothers and caregivers daily, already heavy burden. To prevent the physical and mental impacts of DEV from affecting other members of the household women try to shoulder this burden alone, which can worsen outcomes. This worry for the wellbeing of others leads participants to sacrifice

their own wellbeing further impacting their health. Many women in the sample describe putting their kids needs above all else making statements like "*well, my kids always come first, obviously. Like they get whatever they need for school. And for food. you know. I would say, as a mom, I would sacrifice my plate first for my kids before I would eat*" and "*like just [cutting out] leisure activities for ourselves, like I'll do anything for my kid, so I'll go without. So, like, if he wants to do something and I wanted to do something the next day. I'll cut what I wanted to do so that I could take him to do what he wanted to do.*"

The experiences of DEV are deeply shaped by gendered expectations, leading to distinct but equally harmful consequences for men and women. These gendered responses to DEV not only reinforce existing vulnerabilities but also limit individuals' ability to seek relief and support.

6. Discussion

The goal of this thesis was to assess if vulnerability to DEV is gendered and if so, what are the differentiated effects. Using data from a study conducted in the town of Bridgewater in Nova Scotia, results show that DEV affects individuals differently based on gender, with men and women experiencing and responding to these vulnerabilities in distinct ways. This chapter discusses the results of the analyses and identifies paths for future development while considering the limitations of the study.

6.1 Synthesis of results

Results show that in Bridgewater 15.51% of women report experiencing DEV compared to 6.84% of men. This disparity was statistically significant. The reasons that women are more vulnerable to DEV are explored below.

6.1.1 Social and structural influences

Women reporting experiencing DEV more than men is likely due to reduced access to financial capital. Lower incomes are consistently identified in research as the strongest predictor of vulnerability to DEV, as households with limited financial resources are less able to afford both energy and transport costs. Women are overrepresented in low-income groups, with research finding this due to systematic discrimination and structural gendered inequalities that

exist in the labour market (Robinson, 2019; Rubery, 2015; Simcock et al., 2021; Sunikka-Black, 2020). These structural constraints include, but are not limited to, the burden of unpaid care work, which prevents full-time participation in productive market, the gender pay gap, and interruptions in careers (ILO, 2018; Rubery, 2015). As a result, women's lower incomes leave them with fewer options for reducing or managing their exposure to energy and transport poverty.

This trend in disadvantage is seen among the sample of respondents, where women are disproportionately concentrated in lower income brackets and underrepresented in the higher ones, a relationship that is statistically significant. Supporting the association between low incomes and DEV, regression analysis showed that women a strong association between lower income and DEV, with women in households with an annual income below $40,000 being almost seven times more likely to experience DEV than those in households in the higher income group. Furthermore, these income disparities not only constrain women's access to energy and transport resources but can also foster women's financial dependence on their partners, typically men earners, which creates heightened vulnerability when women are single, separated, or divorced (Robinson, 2019). This was reflected in the regression analysis which showed that single, separated or divorced women were two to three times more likely to report experiencing DEV compared to women in a relationship (married or common-law).

Another key factor contributing to female participants' heightened vulnerability to DEV is the unequal burden of unpaid care work. A significant body of research finds that, globally, women are disproportionately responsible for tasks which fall under the definition of 'unpaid care work.' The concept of unpaid care work encapsulates tasks such as caring for children, the elderly, and the sick, as well as performing daily housework (ILO 2018). Although essential for household well-being, these activities largely unremunerated (Statistics Canada, 2022). In Canada, 32% of women provide unpaid care to children and 23% provide care to adults with long-term conditions or disabilities, compared to 26% and 19% of men, respectively (Statistics Canada, 2022). Among single-earner families, 16% have a stay-at-home mother and 2% have a stay-at-home father (Statistics Canada, 2016). Additionally, 78% of one-parent families with children aged 17 years or younger are headed by women (Statistics Canada, 2022). This unequal care burden is linked to economic exclusion, time poverty, and reduced flexibility, all of which restrict women's ability to access resources or take steps to alleviate DEV (Robinson, 2019).

Within the sample, the burden of unpaid care work was shown to affect women who were the primary caregivers to their children. The presence of children brought on additional expenditures in energy and transport services, particularly through the need for larger homes and more frequent car journeys. These requirements, coupled with budget constraints also narrowed housing options, making it harder to find affordable and suitable accommodation. Such constraints on housing stock are particularly harmful, as they increase the risk of DEV for individuals who already face limited ability to access, improve, or move out of energy-inefficient homes (Chen & Feng, 2022). This reflects findings from energy poverty and transport poverty research, respectively, both of which identify households with children as a vulnerable group (Simcock et al., 2021).

Additionally, mothers also reported issues with structural barriers, particularly in relation to government housing policies and rent discrimination. Research on female homelessness in Canada reinforces these findings, highlighting that single mothers face not only disproportionate childcare responsibilities but also significant structural barriers to accessing safe, affordable, and adequate housing (Schwan et al., 2020). In the sample, these barriers appeared as long waitlists for subsidized housing and discrimination against families in the rental market, both widely recognized challenges for women and their children (Vecchio, 2019).

These dynamics were also evident in the study's quantitative results: female lone-parent households were 3.31 times more likely to report experiencing DEV than women in couples without children. Interestingly, women in couples with children also faced elevated risk, reporting DEV at rates 3.52 times higher than childless couples (see Table 2.). These findings suggest that caregiving roles can directly limit women's capacity to navigate energy and transport trade-offs. These roles can be seen as limiting women's agency, an underlying driver of DEV identified in Martiskainenen et al (2023), who argued that the intersecting institutional, infrastructural, contextual, and spatial constraints that produce situations of DEV also reinforce limited agency, constraining individuals' ability to mitigate its impacts (Martiskainen et al., 2023). This dynamic illustrates the cyclical nature of DEV, where structural constraints not only produce vulnerability but also limit the means to escape it.

Notably, one aspect of this analysis that diverged from existing literature concerns the vulnerability of older women. They are frequently identified as a high-risk group in both energy and transport poverty research, primarily due to the barriers mentioned above, which can

accumulate over time, as well as their longer life expectancy compared to men. However, this pattern was not reflected in the findings of this study. The results showed that women aged 65 and older, as well as retired women, were less likely to experience DEV.

6.1.2 Health outcomes and social consequences of living with double energy vulnerability

Results also provided information on the health outcomes, and the lived experience, of those experiencing DEV. It was found that the experience of DEV increased women's daily labour burden. Women's daily burden is influenced by the concept of unpaid care work, as mentioned above. Unpaid care work is sustained by gender norms that frame caregiving as a natural responsibility of women. Gender norms are culturally produced beliefs about what behaviours, roles, and responsibilities are 'feminine' and 'masculine' (Risman, 2004). These norms portray women as nurturing, self-sacrificing, and naturally suited to domestic roles, thereby normalizing the unequal distribution of care and household labour. The connection between unpaid care work has been made in both EP and TP research (Sunikka-Blank, 2020, Petrova & Simcock, 2021; Robinson, 2021). Petrova and Simcock (2021) offer valuable insights into how gender roles shape the experience of energy poverty. They found that the absence of adequate energy services in the home can reinforce gendered vulnerabilities, as the strategies households adopt to cope often reflect traditional divisions of labour (Petrova & Simcock, 2021). They found that energy-saving adaptations often follow gendered lines: women typically take on everyday adjustments to domestic routines, while physical efficiency improvements are more often seen as 'masculine' labour. This result has also been replicated by Tjorring (2016). These gendered practices, reproduced under conditions of energy poverty, intensify women's emotional and physical labour burdens.

My analysis revealed similar gendered patterns in behavioural adaptations to reduce household costs. Women in the sample described adjusting daily domestic routines, such as limiting appliance use, or leaving things unplugged, to cut energy expenses. In contrast, men tended to focus on technical retrofits to improve energy efficiency. Furthermore, the fluid use of singular and plural pronouns in interviews suggested that, while men household members often carried out energy retrofits, the motivation and decision to implement them frequently came from women members. This suggests that even when men perform the physical tasks, the cognitive burden of initiating and managing energy-saving efforts often remains with women. Gendered differences also emerged in transport-related strategies. Several women reported trip-chaining as

a way to minimize transportation costs, including visiting multiple grocery stores to find the lowest prices.

However, trip-chaining often reflected constraint rather than choice. Many women lacked access to a personal vehicle, making complex, multi-stop trips difficult and time-consuming. This aligns with research on transport disadvantage, which highlights how infrastructure frequently fails to accommodate women's daily mobility patterns (Ortoleva & Brenman, 2004). Descriptive statistics from my analysis further support this: while 83.2% of men reported driving as their primary mode of transport, only 71.5% of women did. In contrast, 14.2% of women reported being car passengers (vs. 4.7% of men), and 4.1% relied on public transit (vs. 2.1% of men). These statistics also speak to high car-dependence in Bridgewater, in the context of limited public transportation option. Women without cars, often juggling caregiving duties and household shopping, were left navigating limited, infrequent, and often unaffordable public transit options. This exacerbated both time poverty and financial strain, particularly for low-income women already making strategic decisions to lower household costs.

Behavioural adaptations to energy and transport use were found to increase the labour and time burden for women in the sample. Daily adjustments to reduce energy consumption, such as limiting appliance use or shifting routines, often required more time and added tasks to women's already full schedules. Similarly, strategies like trip-chaining, shopping at multiple grocery stores to find the best prices or relying on public transit were more time-consuming than other alternatives for those unconstrained by budgetary concerns. These findings suggest that the lived experience of DEV for women is closely tied to an increased burden of unpaid labour and time poverty.

Lastly, findings revealed that the experience of DEV lead to a heavier mental and emotional burden, mainly for women. Multivariate regression used to assess the mental health outcomes of living in a state of DEV, found women experiencing DEV are almost five times more likely to report high stress in daily life, and four times more likely lower social support.

Qualitative analysis supports this finding and reveal that these negative health outcomes are at least in part due to the increased social labour associated with the experience of DEV. As explained by Daminger (2019) social labour can be understood as a facet of unpaid care work in that it is similarly unrecognized, uncompensated, and disproportionately carried out by women (Daminger, 2019). While unpaid care work often refers to physical tasks like cooking, shopping,

and caregiving, social labour encompasses the emotional and mental coordination that underpins these routines, such as planning meals, scheduling playdates, or anticipating others' needs (Hogenboom, 2021). Both forms of labour are sustained by gender norms that assign women primary responsibility for maintaining household well-being, and both contribute to the broader burden of invisible work that limits women's time, autonomy, and participation in paid employment.

Women interviewees described how DEV intensified the social labour they performed within their family structure. In terms of emotional labour, women explained that conditions associated with DEV, such as overcrowded spaces and uncomfortable temperatures, often heightened tensions among family members. In response, they frequently took on the role of mediator, working to diffuse conflict, effectively acting as "referees." Cognitive labour was also discussed in detail. Women spoke about the ongoing anticipation of hardship and the need to constantly plan for contingencies. This included developing backup plans in case essential devices, like life-support machines or the power was turned off. Cognitive labour was also oriented towards changing daily routines to maintain more comfortable experiences for other household members. For instance, one participant shared how she plans ahead, gets up an hour to preheat the house with portable space heaters, so her son can have a more enjoyable breakfast and bath in the morning. This kind of planning extended beyond practical logistics and became a pervasive source of stress. Several caregivers described this mental load as constant and overwhelming, with some reporting physical symptoms linked to stress. This included insomnia and, in one severe case nausea. These findings are echoed in other research. Petrova and Simcock (2021) note that women may more frequently encounter the emotional impacts of energy poverty due to the ongoing demand to reflect on, monitor, and reduce household energy use. This burden was further intensified by competing domestic responsibilities and societal expectations around being a 'good' mother, wife, or daughter (Petrova & Simcock, 2021).

Within the sample much of the distress was rooted in concern for other household members. Women consistently expressed anxiety about exposing vulnerable loved ones, such as elderly parents or young children, to unsafe or uncomfortable conditions. These findings underscore the extent to which women feel a deep sense of responsibility for the well-being and care of those in their household. The mental burden created by DEV was further intensified by women's self-sacrificial efforts, particularly their attempts to shield others from this stress. Many

participants described making personal sacrifices, such as skipping meals so their children could eat more, giving up all leisure activities, or only heating the rooms where their children slept. Yet, beyond these physical sacrifices, women also took on the emotional labour of concealing their own anxiety and distress. Some women hid the financial strain from other adults in the household. One participant, for example, explained that she kept information about the power bill from her husband, who has had multiple heart attacks, because she didn't want to add to his stress. Others focused on shielding their children from worry, expressing a strong desire to preserve their children's sense of stability. In doing so, women not only bore the weight of managing hardship but also shouldered the responsibility of buffering their families from its effects. This insight may partly explain why the regression results revealed women experiencing DEV are 4.10 times more likely to report lower social support.

Men in the sample also experienced an increased mental burden, often responding to DEV through what could be described as stoic coping strategies. When experiencing situations of DEV, some men choose to put on a tough face and suffer in silence. expressed discomfort with the idea of asking for help, saying they hadn't done so and wouldn't, citing pride as a major reason. This reaction is shaped by social norms around masculinity, which emphasize independence, resilience, and the ability to 'handle' problems alone. Rather than seeking solutions that might alleviate the effects of DEV men often adopt a mindset of enduring hardship. This aligns with findings from Cupples et al. (2007) who suggest responses to EP may be related to men's attempts to live up to stereotypes of masculine 'toughness', not wanting to appear a 'wuss' by turning up the home heating above a minimum level (Cupples et al., 2007).

Overall, the increased mental and physical burden for women can be understood as the cumulative effect of three intersecting factors: (1) their disproportionate responsibility for unpaid care work and the constraints it imposes on agency; (2) the unequal division of domestic labour; and (3) the social and emotional labour required to sustain household stability in conditions of scarcity. Taken together, these dimensions of invisible labour reveal that DEV is not only a condition of material deprivation, but also one of gender.

6.2 Strengths and Limitations

A significant limitation to the study was the underrepresentation of men participants in both the quantitative and qualitative datasets. Of the 62 participants reporting DEV, only 10 identified as men and reported experiencing DEV. Similarly, only 10 out of 39 participants in the qualitative interviews were men. This imbalance meant that the analysis was heavily weighted toward women's experiences. This gender disparity is not uncommon in social science research, where survey participation tends to be skewed toward women (Smith, 2008). However, this pattern may also reflect broader social dynamics, such as toxic masculinity and cultural stigmas around vulnerability, which can discourage men from disclosing experiences of hardship or energy vulnerability. As a result, important dimensions of the male lived experience in the context of DEV may have gone unreported or unexplored.

While women were overrepresented in the overall survey, the sample size of women experiencing DEV was nevertheless small to support robust statistical analysis. This restricted the ability to explore key variables and relationships in greater depth. Another important limitation was the lack of diversity in terms of race, ethnicity, and sexual orientation. This is the demographic reality of Bridgewater, which was reflected in the composition of the sample. The low participation of people of color and LGBTQ+ individuals precluded any meaningful intersectional analysis. This is unfortunate given that existing literature has highlighted the compounded vulnerabilities these groups may face in energy poverty and transition contexts. Their exclusion from the sample reinforces the existing gap in research.

One of the main challenges in this study was working with secondary data that wasn't originally collected with my specific research questions in mind. Because of that, there were a lot of limitations in what I could explore. Key topics like gender roles, TP, and household decision-making weren't directly addressed in the original surveys or interviews, which made it harder to get detailed insights into those areas. I often found myself wishing there were more targeted questions that could provide measurable data, rather than having to rely mostly on self-reported experiences.

Regarding the survey dataset, it would have been very insightful to record more information about transportation practices, in addition to questions regarding affordability. As highlighted above, TP is not solely related to affordability but encapsulates issues of mobility and accessibility. Included questions that got at this would allow for the potential creation of a

composite indicator, which would have been particularly interesting considering the car-dominated landscape of the town. Secondly the use of the household as a metric in measuring EP has been found to distort the picture of inter-household vulnerability, particularly for women (Petrova & Simcock, 2021; Robinson 2019). Although, this introduces a lot of complication, future research should strive to explore the different experience of DEV within a same household.

Within the interview process it would have been helpful to hear from a more diverse group of men. There were only 10 men interviewed and within this group there were no men with custody of young children. This may have led to missed insights about the nature of gender and caregiving. Second, it would be very useful to interview multiple members of households separately to gain a better understanding on inter-household dynamics; two first-person accounts has the potential to increase the likelihood that respondents present their honest perspective of household experience (Daminger, 2019).

Ensuring analytical rigor during the qualitative analysis phase was also challenging. Without a coding partner or a second reviewer, there was a heightened risk of researcher bias. Despite best efforts to maintain transparency and consistency, the absence of a collaborative coding process raises questions about selective interpretation.

The strengths of this project comes from the quality and depth of the pre-existing datasets. Within the scope of an honour's thesis, I wouldn't have been able to collect data this detailed or comprehensive on my own.

The datasets also allowed me to combine quantitative findings with qualitative insights, a mixed methods approach that's recognized as especially valuable in energy poverty research. It helps fill gaps left by difficult-to-measure concepts and self-reporting bias, and it grounds the statistical patterns in real, lived experience.

6.3 Policy implications

This study reveals that the intersection of EP and TP creates a distinct and underexamined phenomenon of DEV. Furthermore, it demonstrates that the experience of DEV is gendered and shaped by traditional gender roles, differential access to resources, and social expectations around caregiving and household responsibilities. It is experienced differently between men and women.

Policies that target households as a whole may disproportionately benefit certain members while placing greater burdens on others. This dynamic is observed in the work of Wang (2016) and Schultz (1993), who argue that environmental policies are often taken on by women in the household, increasing their domestic workload and reinforcing the feminization of environmental responsibility (Schultz, 1993; Wang, 2016). It is therefore essential that the design of decarbonization policies is attentive to intra-household dynamics to avoid uneven impacts and prevent gendering of environmental care.

Vulnerabilities should be understood as embedded within both domestic and public geometries of power (Listo, 2018). That is, energy and transport vulnerability are not simply technical or economic issues but are shaped by unequal power relations that operate at multiple scales, within households, communities, and broader governance systems. Without recognizing processes of peripheralization, policy responses risk addressing only surface-level symptoms while leaving structural drivers intact. Failing to engage with these deeper dimensions means that policies may not only be ineffective but may inadvertently reinforce the very inequalities they intend to address.

As decarbonization policies accelerate, it is vital to ensure that such efforts do not exacerbate existing social inequities. Energy transitions must be approached not only as technical or economic processes but also as deeply social ones. Incorporating gender-responsive and intersectional frameworks into policy design can help mitigate the unintended consequences of environmental measures, especially for vulnerable and marginalized populations. This approach aligns with broader energy justice principles, emphasizing the fair distribution of both the benefits and burdens of energy systems.

6.4 Avenues for future research

Research directions include the application of intersectionality frameworks to explore how overlapping social identities (e.g., gender, race, age, ability) shape experiences of DEV, with particular attention to under-researched groups.

There is also the need to conduct regionally and contextually specific studies that account for local governance structures and policy targeting, in order to assess how these factors influence both the prevalence and lived experience of DEV.

In addition, investigating intra-household dynamics through multi-participant or family-based interviews would offer a deeper understanding how roles, responsibilities, and burdens are distributed within households. This could reveal gendered or generational patterns that single-respondent interviews may miss.

Finally, examining the impact of DEV on children, including effects on well-being, education, and daily routines, as a critical yet understudied dimension of vulnerability.

7. Conclusion

This thesis reveals that DEV is not merely the sum of energy and transport poverty, but a complex, intersecting phenomenon shaped by social roles, spatial inequalities, and systemic exclusions. The experience of DEV is deeply gendered, structured by norms that assign women the bulk of caregiving responsibilities, limit their financial independence, and constrain their mobility. It is also spatially embedded, with regional factors like rurality and infrastructure gaps. These findings challenge the assumption of households as unified entities and underscore the need for policies that recognize intra-household dynamics, localized vulnerabilities, and the differentiated burdens of decarbonization. Tackling DEV calls for intersectional, gender-sensitive, and place-based approaches, ones that treat energy and mobility as interconnected rights, not separate silos, and that account for who bears the cost of transitions and who gets left behind.

Table 5. Thematic codebook

Parent codes	Child codes	Definitions	Example
DEV	Trade-offs/negotiations	The act of choosing what bills to allocate money to or skipping out on activities to afford bills	(P_08): I got some other bills to pay too as well, and I'm trying to... Uh, trying to work my money around so that way I can get, pay whatever bills I need to. I try to buy groceries, then my meds. And then I try to have something, some money leftover in case I do get a cab somewhere, right?
	Time poverty	chronic feeling of having too many things to do and not enough time to do them (Giurge et al., 2020)	(P_34): I wouldn't say... it's accessible. It's kind of accessible cause I'd walk if I needed to. I: Yeah, yeah. (P_34): But when you got 4 kids, it's not really affordable. And it doesn't fulfill all our needs the public transport. Like, if I get those to my kids bus stop four time in the morning and back and stuff. It doesn't go right up to your location that I need to go. So it I would have to go to stop and have to walk quite a distance on a main road, unfortunately
	Social Isolation	lack of social connections or interactions	Nobody comes in other than my Home Support workers and BON and, and well you here now. I: OK. OK. Yeah, I'm glad to be here. (P_08): Other than that, nope. I do, I get company but people got their own lives and also have to do their things they got to do. I: Yeah, yeah. And do you find it... Do you wish you had more people around? (P_08): Yeah, yeah. Somebody to talk to.
Energy Poverty	Cost of energy	Anything related to paying for domestic energy services	(P_04): Yeah. Yeah, cause on the power bill, it will tell you what you used over a year. And you can see how much you spent previous. So I listen to when Nova Scotia Power is going to hike the rates, then they get take more of my income to try to pay to pay the power bills during the winter months of December, January, February.
	Thermal discomfort	Feeling uncomfortable in extreme heat and cold in the home	(P_06): You know, I just don't know. When I'm cold so... I'm not happy. I'm just miserable. I like to be warm. So, I do.
	◦ Cold	Thermal discomfort specific to the winter	(P_17): it's because it's not livable in the winter. Like, like I said, it goes below –10 [celcius] in half of our house. So, like with the temperature's getting cold at night, that air is coming right in our house. Also, the work we've done to it so, I just

			feel completely hopeless now because like with winter coming.
	◦ Heat	Thermal discomfort specific to the summer	P_06): Oh, maybe a dozen. Maybe, but not all day. Like, in the morning when you get up, it's fine. But then as the day goes on, and if the humidity is so bad, then we'll put it on. And if it's really bad, like we leave... put it on at night too, like at nighttime, so that you can sleep.
Transport Poverty	Accessibility Poverty	"The difficulty of reaching certain key activities – such as employment, education, healthcare services, shops and so on – at reasonable time, ease and cost" (Lucas et al. 2016)	I: Yeah. Yeah. OK. And do you use public transportation at all? (P_39): Sometimes, the bus, yes, but it's convenient, but it's inconvenient because if you get off and you have to run in somewhere with two kids for 10-15 minutes and you have to wait for an hour for the bus to come back around, right, so it's good, but it's also inconvenient as well.
	Mobility poverty	A systemic lack of (usually motorized) transport that generates difficulties in moving, often (but not always) connected to a lack of services or infrastructures (Lucas et al., 2016)	I: And then is that your preferred mode of transportation is driving? (P_10): There's no transit out where we live.
	Transport affordability	"The lack of individual/household resources to afford transportation options, typically with reference to the car (in developed countries) and/or public transport" (Lucas et al. 2016)	(P_03): When you get so much money a month, with the price of gas, now we don't run the car that much
	Car dominance	Norm that prioritizes driving as the default mode of transportation	I: Do you ever use public transportation in Bridgewater? (P_12): No (P_13): No. I: And is there a reason for that? (P_13): we don't need it. (P_12): No, we don't. We don't need it. I: Yeah. Yeah. OK. And would you ever consider using it for any reason? Like, if you needed to, would you? (P_12): If we didn't have vehicles we would, I would.

Parenthood	Self-sacrificing behaviours	Parents making sacrifices to improve the lives of their children	(P_10): But it's mostly like just leisure activities for ourselves, like I'll do anything for my kid, but I'll go without. So, like, if he wants to do something and I wanted to do something the next day. I'll cut what I wanted to do so that I could take him to do what he wanted to do.
	Children's Needs vs Conditions	Incompatible housing and transport options for families with children	(P_23): But in the wintertime, when everybody's more home. It's tighter. And especially for boys as they get busy and active.
	Child-centered concern	Stress/anxiety caused by concern for children's wellbeing	(P_15): Definitely, yeah. Living just in the condition of the building and like gradually realizing how bad it was, was stressful not only because, like, we're in it, but like, I'm constantly thinking, like, how is this affecting the kids? Are they breathing in mold? Is there mold behind the walls or in the ceiling or like, what? And like, after we moved out and everything was moldy. It was like oh my god! The kids were in that!
	Child-Driven Decisions	The presence of children impacting choices and limiting certain avenues for parents	(P_34): A little bit of everything. A little bit of pricing, it's a little bit of what? The market, and the location that we need due to the school district that our kids are in.
Division of labour	Caregiving	providing support and assistance to family or friends	(P_28): I just move here to be with her, so I have to, because she can't by herself anymore and then I look after her. I normally reside down on [street name] but I'm pretty well familiar with this home and, yeah it's a home.
	Mental Load	often invisible and continuous burden of managing responsibilities and emotions within a household	(P_34): I guess I'm worried and everything so I'm the main person of the household. Mom I guess you would say. I don't get much sleep.
	◦ Emotional labour	Feelings of caring and being responsible for family members but also the emotional impact of this work (Dean, L., Churchill, B., & Ruppanner, L. (2021).	(P_17): So like, it's definitely a lot of tension there and my spouse just with his pain, like, it's not his fault, like his brains been mapped out, and like his brain's fault, but any stress or anything just makes like not physically aggressive but like so angry and like he's vocalizes aggression and like, it just sets my son off and my son takes that. So it's just. Like I'm just always in tears and trying to like be a referee.

	◦ Cognitive labour	The work of anticipating household needs, identifying options for meeting those needs, deciding among the options, and monitoring the outcomes. (Allison Daminger, 2024)	(P_25): Yeah, yeah, you have to plan it. You have to plan everything.
	Trip chaining	combined trips that create complex trip patterns, making transit time consuming, inconvenient or impossible (Ortoleva &Brenman, 2004)	I: OK. So just the traveling with the gas isn't worth it? (P_24): Even, even if you did take the bus, it's just not always worth it, cause it's your whole day. You know, it's an hour... the way if you ever think about it, if you can get it, even if you have to pay a dollar extra just saves you that $2.00 bus ride or whatever it's going to cost you to take the car. I Yeah, two hours or yeah. (P_25): Like if there's a deal on at Walmart, I'll get it while I'm up there getting her diapers cause it's the only place I can buy her brand of diapers. So if there's sales on... I: You trying to be strategic about it? (P_24): Yeah. Multitask. You're not really going there for groceries. But if, you know, if something is seen, that's whoa, we can get that. (P_24)
	Energy-efficient practices	Changes made to domestic energy-use to increase energy efficiency	
	◦ Retrofits	physical upgrades to a home that improve energy efficiency, often requiring a physical under-taking	(P_10): My dad helped us put all new weather stripping and stuff around the doors cause they were drafty, but otherwise we haven't had to do much.
	◦ Every day alterations	‘everyday’ alterations to household routines or behaviours in an attempt to reduce energy consumption	(P_17): Carefully and I keep an eye, like with the smart meter, I keep an eye on daily usage. If I bake something and use the oven for a meal, I would go back and see what my usage is versus a day that we weren't home and, like, see how accurate that is. I'm really on top of that. And like we have a really good three layer convection oven. So I tend to try and cook like three meals in a row that we just have to quick reheat just cause it's all done at once. So I'm really on top of

Constraints on agency	Personal safety concerns	Fears or risks related to physical or emotional security	I: And you were with your kids during that time? (P_19): Yeah. Someone tried to break into my place while I lived there, which might have had something to do with my ex, or maybe not. I'm not sure. I don't know. But like I wasn't involved in the drug scene or any of that, to invite that type of risk to my own space. You known what I mean? So living there was really stressful and depressing.
	Adverse life events	Difficult or traumatic experiences that created vulnerability	(P_24): No, it was for December 26. It was gonna run out. We, we left in October because of the... I You chose to leave? (P_24): Domestic violence situation.
	Peripheralization	place-bound conditions of systematic vulnerabilities	(P_21): And when you live down here, you need to drive to get everywhere. He doesn't have a vehicle, so my mom has a vehicle, my stepdad has a vehicle. My stepdad works every day. And my mom is a CCA private work. So she works nights at a place almost in Hubbard. So, today we were fortunate enough that my stepdad carpools with somebody else.
	Physical disabilities	Physical conditions that impact daily life	(P_17): I haven't been able to work for the last few years because my spouse was diagnosed suddenly with that MS in 2018. And that kind of started us on this horrible journey.
	Poverty	Lack of financial resources	I: Have you considered moving? (P_20): No, no can't afford it. That's why my daughter and her boyfriend and children are living with us. Because they can't afford it.
Response to hardship	Stress	The emotional response to difficult situations	I: And what else is causes of stress in your life these days? (P_20): Day-to-day living. My grandson, worrying abour him. Worrying about my husband, my daughter. Everything, I'm the worrier.
	Reaching out	Seeking help, support, or connection from others	I: Do you have people in your life that are supportive and can help you if you it? (P_15): For sure. My mom is a huge one.
	Denial	Minimization of hardship and downplaying struggles	I: A year, okay. And how were the housing conditions that you were in? (P_22): I thought they were great. It doesn't take much to keep me happy.

	Stoicism	Displaying strength to hide vulnerability.	I: And would you ever feel comfortable reaching out to them if you needed it, or would you prefer not to? (P_04): You know, my pride would probably get in the way. I've never been that desperate.
	Loneliness	Feelings of isolation or lack of social connection	(P_17): No, like your friends... that all kind of dwindled when Jesse got sick. So we're just, it's just us, his dad has cancer and he's in the hospital right now. So his parents are like, they're not really involved anyway, and my parents are in [Place name] but they're not financially able to help us. No one in my family like, I actually had a really tight family growing up, but we're the only people out of me and like 30 other cousins that didn't just get out of high school, marry and buy a house so like nobody gets it like I just feel so alone.
Leisure	Barriers	Obstacles preventing participation in leisurely activities	(P_12): And we don't travel anywhere. A lot of, a lot of people travel, I, we can't travel. We couldn't afford to go traveling. You know.
	Travel	Exploring for places for relaxation and/or enjoyment	(P_14): And, but mostly, and we'll, we get in the car and then we go somewhere like the beach and go for a walk or something.

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