

**Encouraging Customer Participation in Residential Electrification in New Zealand:  
A Systematic Literature Review**

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## Abstract

As New Zealand pursues net-zero carbon emissions by 2050, the electrification of residential energy use emerges as a critical yet underdeveloped component of the national energy transition. While commercial and industrial electrification have received substantial attention, residential uptake remains low, hindered by financial, behavioural, and regulatory barriers. This study conducts a systematic literature review (SLR) of 63 peer-reviewed empirical studies to identify the global factors (financial, social, policy, technological and geographical) influencing residential electrification and to develop a context-specific framework for supporting customer participation in New Zealand.

The review identifies five core dimensions shaping household electrification decisions: economic and financial feasibility, social and behavioural influences, policy and regulatory settings, technological readiness, and geographical context. Economic factors- particularly upfront costs and perceived long-term savings- emerge as the most influential, with social norms, trust, policy stability, and retrofit complexity acting as key enablers or constraints. Policy design is found to significantly influence both financial and behavioural outcomes, especially when stable and well-communicated. The review also highlights critical research gaps, including the limited representation of renters, lower-income households, and emerging technologies like hot water heat pumps and battery storage.

Drawing on these insights, the study proposes a New Zealand-specific framework that emphasises targeted financial support, especially for vulnerable households, long-term policy consistency, culturally inclusive communication strategies, support for technological retrofitting, and regionally tailored programme delivery. This framework reflects the interdependent nature of consumer electrification decisions and aims to inform integrated strategies across policy, industry, and marketing research.

The findings underscore that residential electrification is not solely a technological shift, but a complex socio-economic transition requiring systemic, context-aware interventions. By synthesising global evidence and tailoring it to local conditions, this study contributes to more equitable and effective electrification pathways in New Zealand.

**Attestation of Authorship**

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed:

Name: Janhavi Surve

Date: 25/07/2025

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To my husband, thank you for your encouragement, and to my two cats for the comfort and occasional comic relief during the long writing sessions.

Lastly, I would like to acknowledge my friends and peers for their support and motivation during this process.

**Ethics Approval**

This research was conducted in accordance with the ethical guidelines of Auckland University of Technology. As the study involved secondary analysis of published literature and did not engage human participants directly, formal ethics approval was not required.

## Chapter 1. Introduction

### 1.1 Background

The global climate crisis has reached a critical point, with nations worldwide facing the urgent need to reduce greenhouse gas emissions to mitigate the most severe impacts of climate change. In response, many countries have set ambitious targets, including New Zealand, which has legislated a commitment to achieve net-zero carbon emissions by 2050 (Ministry for the Environment, 2023). Energy use is a significant contributor to New Zealand's emissions, accounting for approximately 40% of the national total (EECA, 2015). To meet its targets, New Zealand must rapidly transition from carbon-intensive energy sources, such as fossil fuels, to cleaner alternatives.

Central to this transition is electrification, a process that involves shifting from fossil fuels, such as LPG and natural gas, to electricity as the primary energy source across residential, industrial, and commercial sectors. The urgency of electrifying New Zealand's energy sector is further intensified due to the accelerated depletion of the country's natural gas reserves, which is occurring at a much faster rate than initially projected (MBIE, 2025). This development poses a significant threat to the reliability and affordability of the nation's gas supply. As a result, the industrial and commercial sectors, which are the largest consumers of natural gas, have become the primary focus of electrification efforts and discussions (About the Industry, n.d.). However, residential electrification in New Zealand remains in the early stages (Sahng et al., 2023). Currently, nearly half of the households in New Zealand still use fossil fuels in their homes (EECA & TRA, 2024)

Several factors have contributed to the relative oversight of the residential sector in the broader electrification conversation. While households use a smaller proportion of gas, the significant upfront costs associated with replacing gas systems with electric alternatives, coupled with consumers' familiarity and preference for gas appliances, have made the transition appear daunting (Sahng et al., 2023). Additionally, the diverse needs of different household types complicate the electrification process, reinforcing the perception that residential electrification is a formidable challenge (Sahng et al., 2023). Addressing residential electrification is now critical to ensure that households, alongside the commercial and industrial sectors, are less vulnerable to fluctuations of gas supply and prices (Edmunds, 2025). This imperative is particularly pronounced in New Zealand's socio-economic context, where substantial income inequality and a high prevalence of renting mean that low-income households and tenants are likely to face disproportionate barriers to electrification.

Moreover, recent technological advances and shifting energy economics have made residential electrification increasingly attractive. Reports indicate that fully electrified homes could save New Zealand households between \$500 and \$1,200 annually on energy costs, depending on their current energy mix (Ellisoon et al., 2024). This transitional phase presents a critical opportunity to shape equitable and effective

pathways forward. This dissertation addresses the urgent need to understand and support electrification in the residential sector by synthesising global evidence through a systematic literature review. Specifically, it seeks to understand motivations and barriers that influence the customer willingness and decision to adopt electric technologies. By doing so, it develops a framework tailored to New Zealand's context that supports increased household participation in electrification.

Globally, prior research has identified a range of factors that influence customer participation in energy efficiency solutions, including residential electrification. Financial considerations are frequently highlighted, with many studies pointing to high upfront costs and uncertain payback periods as common barriers to adoption (Aydin et al., 2018; Lau et al., 2020; Shen et al., 2022; Zander, 2020). Financial incentives such as rebates and upfront discounts are widely used to support adoption, though their effectiveness is not universal (Dilek Uz & Mamkhezri, 2024; McCarthy & Liu, 2022; Sovacool et al., 2022). These variations warrant the need to better understand the financial factors influencing consumer decisions to invest in electrification technologies.

Alongside financial considerations, social and behavioural factors are also frequently discussed in the literature. Peer effects and social norms are commonly cited, with studies showing that households are more likely to adopt technologies like solar PV when they observe uptake within their community or social networks (Best & Nepal, 2022; Irwin, 2021). Environmental identity and personal values can also shape intentions to electrify, although their influence often depends on context (Gong et al., 2020). Behavioural tendencies such as time discounting or mistrust in information sources may delay decision-making (Hughes & Podolefsky, 2015; Sharma, 2021). These findings highlight that social and behavioural influences are many, and may vary across markets and their contexts, reinforcing the need to understand their role more systematically.

Policy design and regulatory settings further shape household decisions. Feed-in tariffs, that is tariff earned for exporting energy to the grid, and tariff designs, influence both the financial appeal, and the broader policy confidence required to adopt new technologies (Sommerfeld et al., 2017; Spiller et al., 2023; Tsvetanov, 2019). The level of consumer awareness and trust in providers, policies, and technologies is also shown to affect willingness to act (Pless et al., 2020; Sharma, 2021). Additionally, technological and geographical factors can influence adoption decisions (Andreolli et al., 2021; Best & Nepal, 2022; Jayaraj et al., 2024; Spiller et al., 2023).

Existing literature thus identifies a diverse set of economic, social, behavioural, policy, geographical and technological factors that interact to shape consumer electrification decisions. However, these insights are highly context-dependent, and there is limited understanding of how they interact, and translate to New Zealand's unique socio-economic, cultural, and geographic landscape. Without addressing this gap, efforts to increase residential electrification risk being ineffective, inequitable, or poorly targeted.

## 1.2 Research Aim and Objectives

This research aims to synthesise global evidence on residential electrification adoption and develop a framework tailored to New Zealand's context that supports increased household participation in electrification.

The research is guided by three questions:

- What factors have been identified in existing literature as influencing residential energy customers' decisions to adopt electrification?
- What are the key differences in outcomes due to socio-economic, cultural, and geographical variables?
- How can these global insights be adapted to develop a framework for customer participation in electrification within New Zealand's socio-economic, cultural and geographic context.

This review provides a foundation for future customer-focused electrification strategies, enabling policymakers, energy providers, and researchers to identify and address the most important levers for accelerating adoption.

## 1.3. Significance of the Study

To my knowledge, no systematic literature review (SLR) has consolidated global knowledge on residential electrification adoption, and especially not within the marketing literature. Existing insights are often fragmented across disciplines—such as energy economics, behavioural science, technology adoption, and policy research. This SLR addresses that gap by integrating findings from diverse fields to present a coherent understanding of what drives or hinders household electrification.

This review contributes to theoretical development by proposing a conceptual framework that explains how and why customers engage—or disengage—with residential electrification. Rather than relying on single-factor or single-discipline explanations (Abdulkarim Alsulami et al., 2024; Andreolli et al., 2021; Best & Nepal, 2022; Gong et al., 2020; Jayaraj et al., 2024; Zander, 2020; Zander 2021), the study demonstrates that consumer adoption decisions emerge from the interplay of multiple influences. These are shaped by policy design, household characteristics, cultural norms, contextual constraints, and perceptions of value and risk. By highlighting this complexity, the framework lays the groundwork for more nuanced analysis and encourages marketing scholars to move beyond reductionist models toward more layered approaches.

In mapping both well-studied and underexplored factors, the review identifies theoretical, methodological, and practical gaps. This not only supports future marketing research agendas but also helps

reduce duplication in academic efforts. Importantly, it offers a cross-cutting synthesis that can inform theory-building without proposing a fixed or universal model.

From a marketing perspective, this review contributes to the literature by conceptualising residential electrification as a consumer value proposition, shaped by perceived value, perceived risk, and decision effort rather than objective payback alone. It further shows how policy design and market settings create or reduce adoption friction across segments, informing customer-centric proposition design and engagement pathways for electrification offerings.

For policymakers and industry, the study provides practical, evidence-based insights to design more effective and equitable electrification strategies. It helps identify priority actions to support underrepresented groups, build consumer trust, and address financial and infrastructural barriers.

Finally, by contextualising global insights within New Zealand's unique socio-economic, cultural, and geographic landscape, this research strengthens the cross-cultural relevance of the literature. In a fast-evolving energy landscape, the SLR offers a timely foundation to guide both policy development and empirical inquiry.

#### **1.4. Scope and Definitions**

The research focuses on residential electrification, defined as the transition of household energy use from fossil fuels to electricity for heating, cooking, hot water, and other essential services (Sahng et al., 2023). Electrification in this research explicitly includes the adoption of renewable household technologies such as rooftop solar panels and battery storage. These technologies are critical in meeting rising electricity demand, reducing reliance on the national grid, and addressing New Zealand's vulnerability to climate-driven supply constraints. Their inclusion reflects the need to integrate both short-term solutions and long-term energy resilience into residential electrification strategies. The study excludes vehicle electrification and commercial or industrial energy use, as these sectors face distinct drivers and barriers.

#### **1.5. Dissertation Structure**

The remaining sections of the dissertation are organised into the following chapters:

Chapter 2: Methodology – Details the systematic literature review approach, adhering to PRISMA guidelines (Moher et al., 2009). It outlines the search, selection, data collection and synthesis process and explains the thematic approach used to categorise key findings.

Chapter 3: Results – Presents the findings, organised into thematic categories identified as drivers or barriers to residential electrification.

Chapter 4: Discussion – Interprets the findings in relation to the research objectives, examining how the identified themes contribute to customer engagement in residential electrification. Potential relationships and hierarchies among these factors are discussed, leading to a conceptual framework for New Zealand.

Chapter 5: Conclusion – Summarises the key findings and discusses their implications for policy, industry, and future research. Limitations are addressed, with recommendations for practical application and further study.

## Chapter 2: Methodology

This chapter outlines the systematic literature review (SLR) methodology used to investigate the factors influencing residential electrification adoption. The review follows PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and replicability through each stage of the process (Moher et al., 2009).

This study applies a systematic literature review (SLR) with a theme-based approach guided by Braun and Clarke's principles of reflexive thematic analysis (RTA) (Byrne, 2021). This flexible, iterative approach facilitated a nuanced synthesis of findings across diverse disciplines, ensuring that patterns of meaning related to residential electrification adoption were captured while maintaining researcher reflexivity.

The chapter gives a comprehensive overview of the search strategy, study selection, data collection and data synthesis processes.

### 2.1. Search Strategy

To ensure comprehensive coverage of the subject, a structured search strategy was employed in keeping with the PRISMA guidelines (Moher et al., 2009).

#### 2.1.1. Key Concepts Identification

The first step involved identifying the key concepts from the research questions, which focus on residential electrification, related energy technologies, and factors affecting consumers' adoption decisions. These key concepts formed the foundation for the search strategy.

#### 2.1.2. Inclusion and exclusion criteria

To ensure the relevance of the studies, inclusion and exclusion criteria were applied. These criteria helped narrow down the studies to those most pertinent to the topic.

Inclusion Criteria:

- Studies addressing residential or household-level electrification.
- Peer-reviewed journal articles written in English.
- Studies focusing on factors such as customer willingness, motivation, barriers, or drivers influencing electrification uptake.
- Articles published in the last 10 years to ensure the research reflects the most current developments, technological and policy contexts relevant to residential electrification.
- Only articles from journal A\* and A rankings (according to the ABDC list) were included to ensure robustness and quality of the findings.

Exclusion Criteria:

- Studies focused on vehicle or transport-related electrification.  
Research specific to commercial, industrial, or non-residential applications.

### 2.1.3. Preliminary Search and Refinement

A preliminary search was conducted to gain an understanding of the scope of available literature. This initial search provided insight into the relevancy of terms, revealing the need for further refinement. For instance, some relevant studies were not captured when using the term "electrification" alone, as alternative terms like "renewable energy" and "decarbonisation" were frequently used. Similarly, exclusion of the term "EV" still allowed for studies related to vehicles and transport in the search results. This insight prompted further refinement of search terms to ensure comprehensive coverage of the topic. The search string was iteratively adjusted based on preliminary results, and additional terms were introduced.

### 2.1.4 Final Search String Development

After the refinement stage, the final search string was developed, encompassing five key concepts:

Concept 1: Electrification

- Keywords: *electrification, decarbonisation, energy transition, renewable energy, gas transition*

Concept 2: Technologies Related to Electrification

- Keywords: *solar, battery, heating, cooling, cooking*

Concept 3: Residential Context

- Keywords: *residential, home, household*

Concept 4: Adoption

- Keywords: *adoption, switch, uptake, willingness, motivation, barrier*

Concept 5: Exclusion

- Studies related to transport electrification were excluded using: *NOT vehicle OR transport*

The final search string developed was as follows:

("Electrification" OR "decarbonisation" OR "energy transition" OR "renewable energy" OR "gas transition") AND ("solar" OR "battery" OR "heating" OR "cooling" OR "cooking") AND ("residential" OR "home" OR "household") AND ("adoption" OR "switch" OR "uptake" OR "willingness" OR "motivation" OR "barrier") NOT ("vehicle" OR "transport").

### 2.1.5. Database Selection

The search was conducted across four major academic databases: Scopus, EBSCO Business Source Direct, Greenfile and Emerald Insights to ensure coverage of research in the marketing and behavioural economics disciplines (Khan et al., 2022). The same search string was applied across the first three databases; however, it was modified for Emerald Insights as the initial search returned over 29,000 results. Upon further review, it was determined that the Emerald database lacks advanced search functionality (Library Guides: Systematic Review: Systematically Search Databases, 2025). Therefore, the search string for Emerald was refined and simplified through an iterative process to yield more relevant results. The final search string used for Emerald Insights was as follows:

(content-type:article) AND (("Energy Transition" OR Solar OR Electrification) AND (Residential) AND (Consumer) - (transport))

## 2.2 Study Selection

The study selection process was conducted using the HubMeta platform to manage and track articles. An initial dataset of 1,158 papers was retrieved from the database searches. Following the removal of duplicates, the dataset was reduced to 957 unique articles.

**1. Initial Screening:** The title and abstract of each paper were screened for relevance based on the research focus and inclusion criteria, narrowing the dataset to 91 articles. Two reviewers (myself and supervisor) independently screened the titles and abstracts to assess relevance based on predefined inclusion criteria. Any discrepancies were resolved through extensive discussion until consensus was reached. The most common reasons for studies to be excluded at this stage were:

- **Journal Ranking:** Articles from journal ratings below A (according to ABDC list) were excluded to ensure robustness and quality of the findings. While this was defined in the inclusion criteria, its application was missed in the first round of screening.
- **Sectoral Focus:** Articles focused on non-residential sectors, such as industrial, commercial, or transport-related electrification, were excluded. While the search string was intended to focus on residential energy customers, several studies falling outside this scope were still retrieved during the preliminary search.
- **Impact vs. Adoption:** Studies that examined the impacts of electrification, such as social, economic, or environmental outcomes were excluded as this review is concerned with the factors driving the decision to electrify a household rather than the effects post-electrification.
- **Energy Usage Behaviours:** Studies exploring energy usage behaviours, or the choice of specific electric appliances were excluded as they did not align with the focus on broader electrification adoption.

- **Geographical Context:** Articles focusing on extremely remote regions, where access to grid electricity is limited or unavailable, were excluded. In these regions, electrification is primarily about gaining access to electricity rather than transitioning from fossil fuels to electricity, which is the focus of this review.

**2. Full-Text Screening:** The remaining 91 articles were then subjected to full-text review to ensure they met the research criteria and were relevant to the research questions. Sixty-three studies were selected for inclusion in the final systematic review based on their alignment with the factors influencing residential electrification adoption. Similar to the initial screening, full-text articles were independently reviewed by two reviewers to determine final inclusion. Differences in assessment were discussed in detail and resolved collaboratively to ensure consistency and rigour in selection.

Figure 2.1 shown at the end of the chapter depicts the search strategy and study selection process.

### 2.3 Data Collection and Extraction

Following the selection of 63 relevant articles, key information was systematically extracted using a structured Excel matrix designed to ensure consistency and facilitate comparison across studies. The matrix captured a range of data points including the year of publication, geographic focus (country or region), type of electrification technologies examined (e.g., electric space heating, induction cooktops, solar PV, batteries), research methodology employed (e.g., qualitative interviews, surveys, case studies, econometric modelling), and the main findings related to drivers and barriers of residential electrification.

To identify patterns of meaning, each article was reviewed in full, and inductive coding was applied consistent with Braun and Clarke's reflexive thematic analysis (RTA) approach (Byrne, 2021). No pre-determined codes were imposed; instead, initial codes emerged organically from the 91 articles, capturing recurring concepts and influences on electrification adoption. The coding framework was iteratively refined to reflect sub-themes and contextual nuances as analysis progressed.

This approach enabled a consistent yet flexible categorisation of findings, allowing themes to be applied across diverse research designs and contexts. The structured coding process also facilitated cross-comparison of factors such as economic, social, behavioural, policy, technology and geographical variations. Ultimately, this process supported the development of a thematically organised synthesis, providing the foundation for identifying patterns, contradictions, and gaps in the existing literature on residential electrification.

### 2.4 Data Synthesis

**1. Descriptive Analysis:** Descriptive analysis was used to map the scope and characteristics of existing research on residential electrification. Studies were categorised by country or region, research methods,

population segments (e.g., homeowners, renters), types of electrification measures (e.g., space heating, cooking, solar PVs), and the contextual factors considered (e.g., socio-economic status, policy environment, cultural influences). This process helped reveal research patterns, as well as imbalances, such as an overrepresentation of studies from certain regions.

Descriptive analysis also highlighted methodological gaps (e.g., a lack of longitudinal studies), and limited theoretical perspectives. These findings were essential for identifying areas where the literature could fall short in addressing New Zealand's unique socio-economic, cultural, and geographic context, and where further research or localisation of global insights was needed to support customer participation in electrification.

**2. Thematic Analysis:** Following the descriptive review, thematic analysis was used to identify, organise, and synthesise key patterns and insights across the selected studies. The thematic analysis followed Braun and Clarke's RTA principles, focusing on generating meaning-based themes rather than rigid classifications (Byrne, 2021). Codes and themes were inductively derived, allowing insights to emerge naturally from the data in alignment with the research questions. This approach emphasised researcher reflexivity and iterative interpretation to ensure themes accurately reflected the complexity and diversity of the literature.

Thematic analysis captured patterns, contradictions, and interrelationships between economic, social and behavioural, policy, technological, and geographic factors. This process provided a structured yet flexible foundation for developing the conceptual framework tailored to New Zealand's residential electrification context.

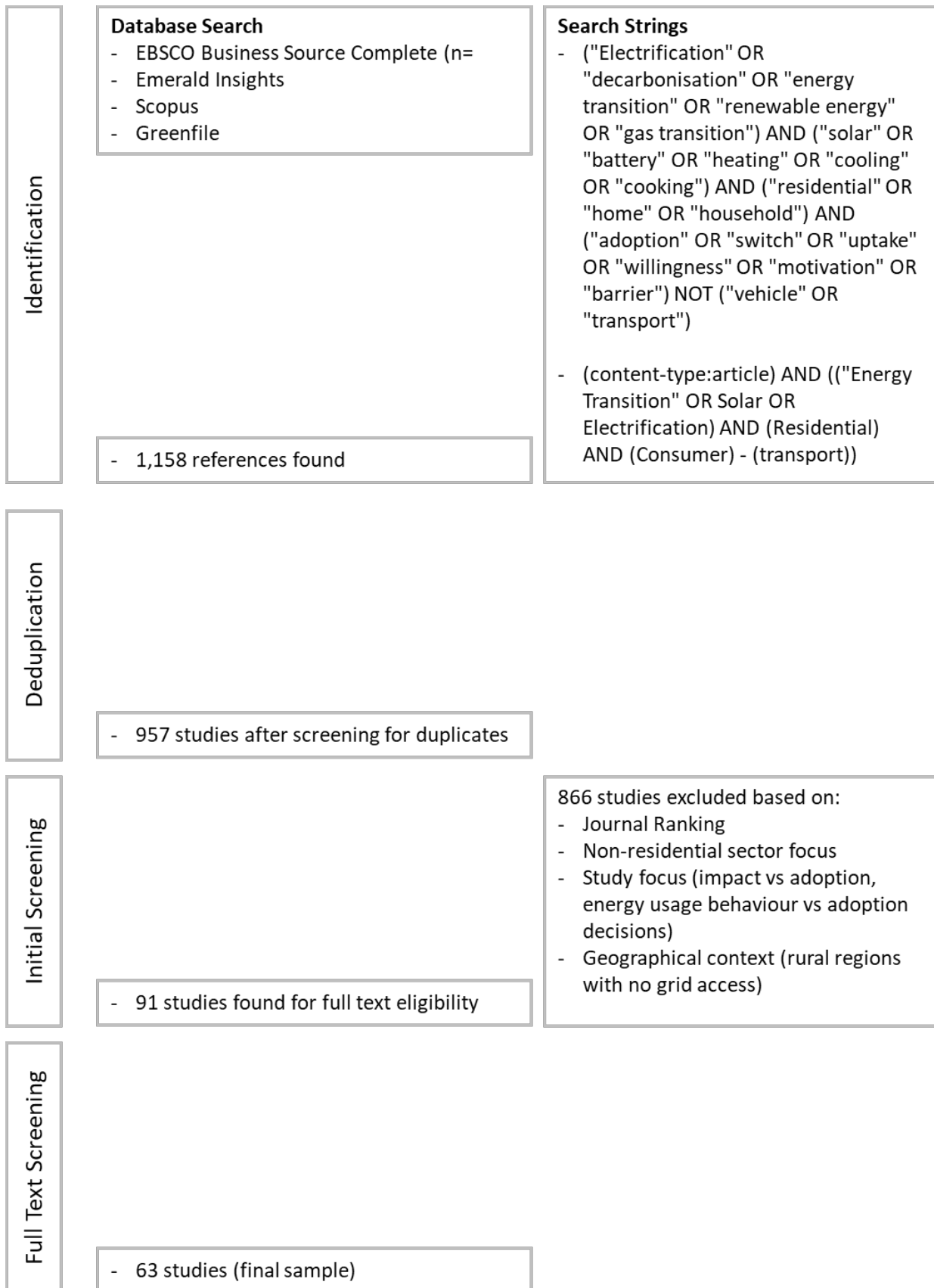


Figure 2.1 Search and Selection Strategy

## Chapter 3: Results

### 3.1 Descriptive Analysis

#### 3.1.1 Temporal Trends

An analysis of the publication dates reveals a clear growth in academic interest in residential electrification (see figure 3.1.1 below). Between 2010 and 2016, only a small number of studies were published, reflecting the relatively early stage of household-level energy transition research. Starting in 2017, publication volume began to increase steadily, with a notable surge from 2021 onward. In fact, more than 50% of the studies reviewed were published between 2021 and 2024.

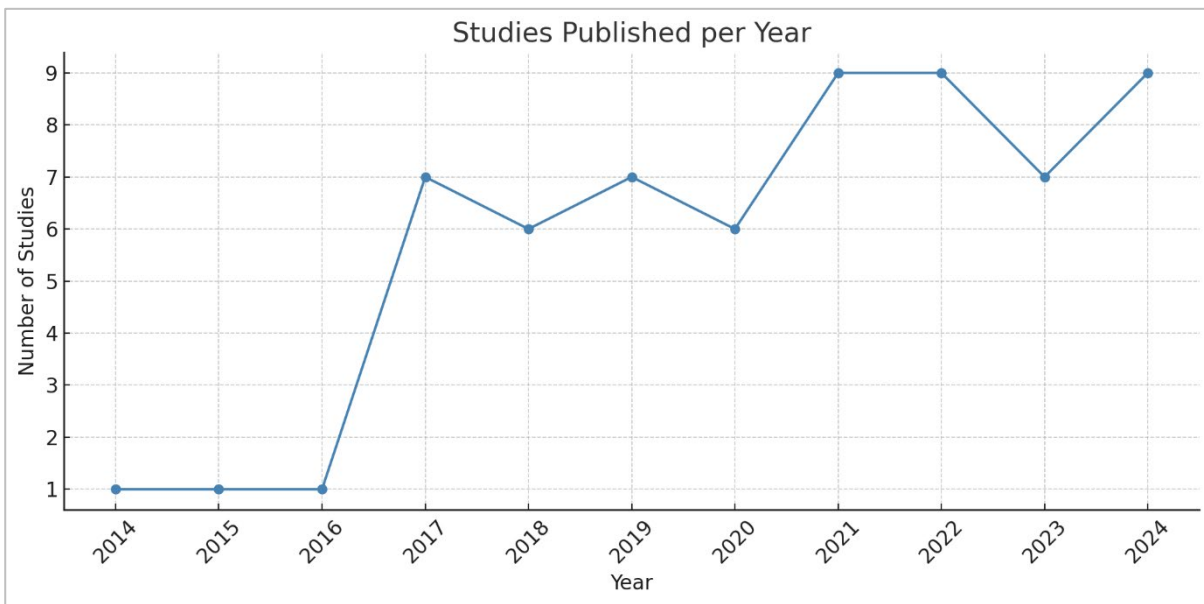


Figure 3.1.1: Temporal trends

#### 3.1.2 Geographic Scope

Analysis reveals a strong regional concentration in the literature (See table 3.1.2 below). A majority of studies are clustered in high-income countries, particularly Australia, the United States, and Germany. These countries typically have established solar markets mature regulatory frameworks, and accessible household-level energy data, which likely explains the research focus. For example, Australia alone accounts for over 14% of reviewed studies, many of which examine rooftop solar uptake (Hammerle et al., 2023; Sommerfeld et al., 2017; Zander et al., 2019; Zander, 2020) and retail pricing effects (Chesser et al., 2018; Zander et al., 2019)

The presence of studies in lower-income and rural contexts—such as Nepal and Africa is growing but remains modest. A possible explanation for this imbalance is the exclusion of studies that focus on extremely remote off-grid regions.

Country/Region	Percentage of Studies	Number of Studies
United States	27%	17
Australia	14%	9
China	10%	6
Germany	10%	6
UK	5%	4
Rest of EU (Belgium, Greece, Finland, Austria, Italy, Malta, Lithuania)	14%	9
Middle East (Iran, Lebanon, Saudi Arabia)	6%	6
Africa (Uganda, Nigeria, Namibia, Ghana)	6%	4
Rest of Asia (Singapore, Malaysia, Nepal)	6%	4
New Zealand	2%	1

Table 3.1.2. Geographic Scope

### 3.1.3 Technology Focus

The majority of papers (75%) explore solar PV (see figure 3.1.3 below), either alone or in combination with other technologies (De Groote & Verboven, 2019; Dilek Uz & Mamkhezri, 2024; Sommerfeld et al., 2017). This suggests a strong bias toward solar PV adoption, likely reflecting its relative maturity and widespread availability. Fewer studies examine integrated systems such as PV + batteries (Andreolli et al., 2021; Jayaraj et al., 2024) or other system level electric technologies such as electric cooktops, water heaters and heat pumps (Gong et al., 2020; Lindgren, 2024; Shen et al., 2022)

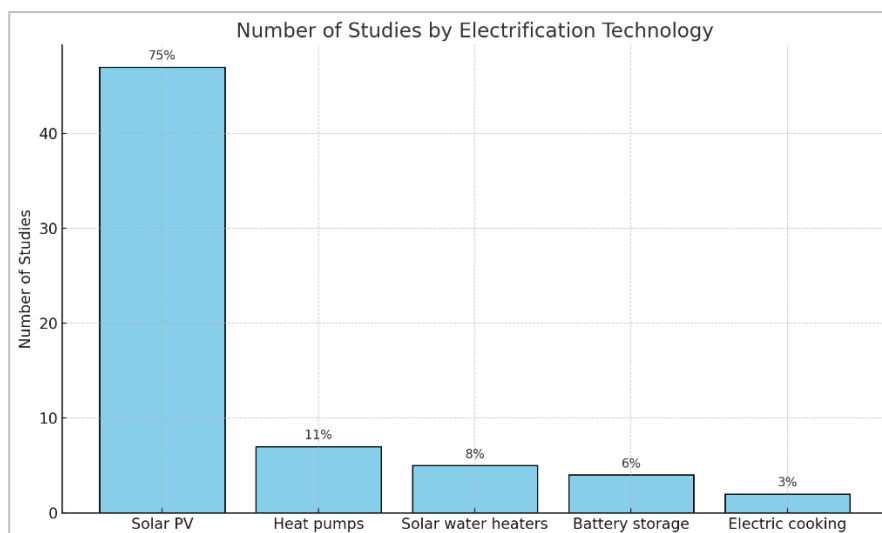


Figure 3.1.3 Technology Focus

Most notably absent are studies on relatively newer hot water systems and technologies, such as hot water heat pumps and outdoor electric water heaters. This represents a severely under investigated area of

research and a significant opportunity for further research, especially considering that hot water usage is estimated to account for 30% of the household energy consumption (EECA, 2025).

### 3.1.4 Research Methods

Across the 63 studies, quantitative approaches dominate, comprising roughly 60% of the total. These include econometric models, stated preference surveys, and regression-based analyses to identify drivers of adoption and policy impact. Their strength lies in providing statistically generalisable insights, especially in markets with robust datasets.

Qualitative studies—though fewer—offer important contextual depth, particularly in understanding trust, identity, and culturally specific norms that influence adoption. Methods include in-depth interviews, focus groups, and case study analyses, often applied in developing or rural settings where behavioural drivers are less understood.

Mixed-methods designs offer a promising bridge between the rigour of quantitative research and the richness of qualitative inquiry, though only a handful of studies in the sample employed this approach. This suggests an opportunity to expand such methods in future work to enhance explanatory power and policy relevance.

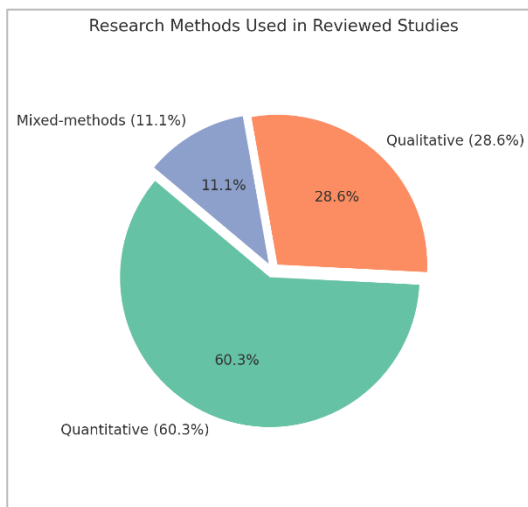


Figure 3.1.4: Research Methods

### 3.1.5 Study Populations

The reviewed literature primarily focuses on owner-occupier households. This group is often targeted by incentive schemes as they have greater autonomy over technology decisions.

In contrast, renters (Zander, 2020) and multi-unit dwellings (Briguglio & Formosa, 2017) are significantly underrepresented, despite being a large and growing segment in many markets, including New

Zealand (Renting vs Owning in NZ | Stats NZ, 2019). This is likely due to the well-documented split-incentive problem (Hammerle et al., 2023) where landlords lack motivation to invest in upgrades that benefit tenants. Some studies note (Hammerle et al., 2023; Zander, 2020) this barrier but stop short of examining renter-specific adoption pathways in detail.

- Owner-occupiers – 47 studies (75%)
- Renters – 8 studies (12.7%)
- Low-income or rural households – 15 studies (23.8%)

These figures show that while income-related barriers are increasingly addressed, tenure-based inequality (e.g. the split-incentive problem in rentals) is relatively underexplored.

The descriptive analysis has provided an overview of the scope, geographic and methodological patterns, and focal technologies of the studies included in this review. It also highlighted key gaps in the current body of research, including limited coverage of renter households, and emerging technologies such as hot water heat pumps and battery storage. To move beyond these patterns and better understand the factors that influence household-level electrification decisions, the next section presents a thematic analysis of the literature. This analysis synthesises common drivers and barriers across studies and directly addresses the first two research questions:

1. What factors have been identified in existing literature as influencing residential energy customers' decisions to adopt electrification?
2. What are the key differences in outcomes due to socio-economic, cultural, and geographical variables?

## **3.2 Thematic Analysis**

### **3.2.1 Economic and Financial Factors**

#### *3.2.1.1 Upfront Costs and Payback Period*

Upfront costs remain one of the most consistently cited and empirically validated barriers to residential electrification (Andreolli et al., 2021; Gong et al., 2020; Kyere et al., 2024). The significant initial investment required for solar PV, heat pumps, and battery storage often discourages households from transitioning, especially when weighed against long and uncertain payback periods.

Numerous studies show that households' willingness to adopt electrification technologies is inversely related to the perceived and actual upfront cost. In Malaysia, for example, price was identified as the most dominant factor in consumers' decision-making, even more than environmental awareness or knowledge of solar PV (Lau et al., 2020). Research from Australia has shown that high installation costs are

a major deterrent for both solar and battery adoption, particularly among renters and low-to-middle income groups (Jayaraj et al., 2024; Zander, 2020; Zander, 2021).

Moreover, high upfront costs also extend the payback period, diminishing the financial appeal of electrification. Research across markets highlights that many households will only consider adoption when the payback period falls below a certain psychological threshold, typically between 5 to 10 years (Aydin et al., 2018; Bauner & Crago, 2015). Technologies with longer payback horizons, even when highly efficient, are frequently passed over in favour of cheaper, more familiar alternatives.

### *3.2.1.2. Cost of energy*

Studies show that higher electricity prices increase the perceived economic benefit of solar PV, battery and energy efficiency investments, particularly in markets where households can offset high retail tariffs by generating their own electricity (Andreolli et al., 2021; Chesser et al., 2018; Sahari, 2019; Wim Van Opstal & Smeets, 2023; Zander, 2020). In these contexts, electrification becomes a defensive strategy against escalating utility bills. In regions where electricity is relatively cheap, households often lack the economic motivation to switch to renewable or electrified alternatives.

Movements in the cost of fossil fuels can also accelerate or decrease the adoption of electric technologies. For instance, consumers in regions with increasing current expected lifecycle costs of fossil fuels show a higher likelihood of switching to electric alternatives, compared to regions where fossil fuel prices have declined (Michelsen & Madlener, 2016)

### *3.2.1.3 Financial Incentives*

Financial incentives such as subsidies, tax rebates and zero-interest loans play a critical enabling role in overcoming the upfront cost barrier of electrification technologies. Across global case studies, their impact is consistently strong, although not uniformly so across demographics or market contexts. For instance, a \$300-\$450 rebate program in North Carolina increased heat pump adoption by 13% annually (Shen et al., 2022). Similarly in California, solar adoption dropped by 67% after rebates were cut illustrating that incentives are not just a boost but often a precondition for adoption (Tsvetanov, 2019). In Nepal, where savings culture is strong, subsidies significantly reduced the time needed for households to accumulate funds, accelerating adoption (Best & Nepal, 2022). A further study from rural China confirmed that perceived fiscal support was a stronger predictor of clean heating adoption than environmental concern or awareness (Gong et al., 2020).

The optimal design of financial incentives varies across income groups. High-income households, who can afford upfront payments, often benefit from tax credits and rebate-based schemes. Low-income households, however, are less responsive to delayed or application-intensive incentives and benefit more from upfront discounts, on-bill financing, or zero-interest loans (Dilek Uz & Mamkhezri, 2024). Studies also

show that despite financial incentives, low-income households are less likely to install solar PV and other energy efficient technology, either due to lack of awareness of the incentives, perceived complexity or affordability concerns (Aydin et al., 2018; Sovacool et al., 2022). This discrepancy implies that financial policies should be carefully tailored and communicated to different socioeconomic segments rather than adopting a one-size-fits-all approach.

#### *3.2.1.4 Alternative Financing Models*

To address the significant barrier posed by upfront costs, a range of alternative financing models have emerged to make residential electrification technologies more accessible. These include leasing arrangements, power purchase agreements (PPAs), on-bill financing, zero-interest loans, and third-party ownership models (Antonopoulos et al., 2024; Best & Nepal, 2022; Singhal et al., 2022)

Studies consistently find that financing innovations are especially effective for middle-income households, who often cannot afford large upfront payments but are able to manage recurring expenses when there is a clear cost-benefit payoff (Hammerle et al., 2023). These households respond positively to models like PPAs, where consumers pay only for the electricity generated by the system, and ownership remains with a third party (Crago & Rong, 2022). For low-income households, microfinance, community energy schemes, and utility-sponsored on-bill financing have shown potential to bridge affordability gaps. For example, in Nepal, subsidy-supported microloans enabled rural households to adopt solar PV by allowing them to repay over time in alignment with seasonal income patterns (Best & Nepal, 2022). In parts of the U.S., on-bill financing programs that integrate monthly repayments into utility bills have proven effective in reducing financial friction for electrification upgrades (Antonopoulos et al., 2024).

However, these financing models are not without challenges. Some leasing and PPA agreements have been criticised for being opaque, locking consumers into long-term contracts with escalating costs, and offering limited consumer protection (Singhal et al., 2022). This has raised concerns about equity, transparency, and long-term value, particularly in deregulated markets where oversight is weak.

### **3.2.2 Social and Behavioural Factors**

#### *3.2.2.1 Peer Effects and Social Norms*

Social influence plays a significant role in shaping residential electrification decisions. Research consistently shows that peer effects, community influence, and social norms drive solar PV adoption, with households more likely to invest in renewable technologies if their neighbours have already done so, or if encouraged by their peers or family (Abdulkarim Alsulami et al., 2024; Best & Nepal, 2022; Gillingham & Bollinger, 2021; Lau et al., 2020). For instance, one study on spatial spillovers found that solar PV adoption increased by 17% when a neighbour had installed a system (Irwin, 2021). These effects are strongest in the early adoption

phase, when technologies are unfamiliar, and risk perceptions are high. Early adopters' experiences, positive or negative, can shape community expectations and either reinforce or suppress further adoption (Singhal et al., 2022). Adoption decisions can further be influenced by a desire to align with community values and gain social approval (Elmustapha et al., 2018).

The extent of peer effects can vary depending on socio-cultural contexts. In community-driven settings such as rural China, Namibia and Nepal, social learning, peer influence and a strong sense of community play a significantly stronger role in PV adoption (Best & Nepal, 2022; Chen et al., 2021; Lindgren, 2024).

### *3.2.2.2 Environmental and Social Identity*

While economic considerations often dominate decision-making, a growing body of literature highlights the role of environmental and social identity in driving adoption (Dong & Sigrin, 2019). Households with strong environmental self-concepts are more likely to install solar PV, heat pumps, or electric cooking appliances, even when financial incentives are limited (Gong et al., 2020; Michelsen & Madlener, 2016). These individuals often view electrification as an expression of their values and a form of moral or civic responsibility. This has been observed at a regional level as well, with environmentally inclined individuals in Austria and Italy showing a higher likelihood to invest in solar PV regardless of financial incentives (Braitto et al., 2017).

However, environmental concern alone is often insufficient to drive large-scale adoption, particularly when financial or infrastructural barriers exist. One study indicates that social identity plays a stronger role than individual environmental beliefs, suggesting that collective action and visibility of renewable energy use may be more influential than personal sustainability values (Zobeidi et al., 2022).

### *3.2.2.3 Consumer Trust and Awareness*

Consumer trust in electrification technologies, government policies, media and service providers significantly impact adoption rates. Studies indicate that a lack of trust in government incentives and utility companies creates hesitation among consumers, particularly when there is lack of transparent and accessible information on the benefits. For instance, many cited a lack of clear cost-benefit analysis as a reason for hesitating to adopt solar water heaters. (Sharma, 2021). Even with financial incentives, concerns about maintenance costs and the longevity of government support can become a barrier to adoption (Chen et al., 2021; Dilek Uz & Mamkhezri, 2024; Eslami & Krishnan, 2023; Su et al., 2018)

Another consistent barrier to electrification adoption is the lack of consumer awareness, which often overlaps with perceived complexity, misinformation, and mistrust in the sources of available information. For instance, many households overestimated maintenance costs and underestimated long-term financial

benefits, contributing to uncertainty and decision paralysis (Pless et al., 2020). These misconceptions were particularly prevalent among consumers with limited prior exposure to renewable technologies or those in lower-income or rural segments. Similarly, limited access to credible information was linked to delayed adoption, with a lack of outreach and education being cited as a barrier for disengaged or passive consumers (Kyere et al., 2024). Further studies have also shown that uncertainty about savings and scepticism about reliability reduced confidence in new electric technologies, especially where prior consumer experiences were unknown or ambiguous (Kyere et al., 2024; Sharma, 2021).

On the other hand, improved trust in information sources can mitigate these barriers. For instance, one study found that consumers were more willing to consider adoption when content was shared by verified experts, government-affiliated pages, or trusted peer networks, reinforcing the importance of messenger credibility (Zobeidi et al., 2022).

#### *3.2.2.4 Behavioural Economics and Decision-Making Biases*

Consumer decision-making regarding residential electrification is influenced by a range of behavioural biases, which can either accelerate or delay adoption. One consistent finding across the literature is that households often discount future benefits, which makes long-term incentives less effective at motivating adoption (De Groote & Verboven, 2019).

Some studies find that consumers tend to rush adoption ahead of scheduled reductions in financial incentives, leading to spikes in installations followed by declines once subsidies are withdrawn (Hughes & Podolefsky, 2015; Klein & Deissenroth, 2017). This behaviour reflects a reliance on relative gains and losses from the current policy context, rather than a strict cost-benefit analysis. The opposite behaviour is also observed; some consumers delay adoption in the hope that incentives will improve over time, especially when facing high upfront costs or policy uncertainty (Andreolli et al., 2021; De Groote & Verboven, 2019; Michelsen & Madlener, 2016). Socioeconomic factors also play a role. For example, wealthier households tend to prefer long-term incentives, such as tax credits or feed-in tariffs, as they are better positioned to absorb the upfront investment and navigate policy frameworks (Zander et al., 2019). These contrasting behaviours underscore the importance of designing stable, well-communicated policy incentives that reduce uncertainty and avoid distorting adoption patterns.

### **3.2.3. Policy and Regulatory Factors**

#### *3.2.3.1 Policy Stability*

The long-term success of residential electrification programs depends heavily on consistent and predictable policy frameworks. Studies consistently find that markets with stable, well-communicated policies experience higher consumer confidence and steady adoption rates, while abrupt policy shifts create

investment hesitation and market volatility (Bennett et al., 2020). Households are more likely to invest in solar PV and other electrification technology when they can anticipate long-term policy support, such as sustained rebates, tax incentives, and favourable feed-in tariffs (FiTs).

Several studies caution that policy volatility discourages adoption, not only by increasing financial risk but also by eroding trust in government programs (Tan et al., 2023; Wolske et al., 2018; Zander, 2021). In regions where subsidies or feed-in tariffs have been abruptly reduced or removed, adoption has declined sharply, even in cases where the long-term economics remained favourable. For example, research in multiple jurisdictions showed that frequent policy reversals created consumer confusion and reinforced perceptions that incentives are unreliable, leading to reduced willingness to invest (Tsvetanov, 2019).

### *3.2.3.2 Tariff Structures*

The design of electricity tariffs and net metering policies plays a crucial role in shaping the financial attractiveness of residential electrification. Studies reveal that time-of-use tariffs, demand charges, and net metering policies can either encourage or discourage solar adoption depending on their design (Cho et al., 2023; Spiller et al., 2023; Zander, 2021)

Net metering policies that compensate households for excess electricity exported to the grid at retail rates have been instrumental in driving solar PV adoption. For instance, studies have shown that feed-in tariffs is a key motivator for investment in solar, and consumers in regions with higher FiTs were more satisfied with their solar investment compared to those with low FiTs (Gautier & Jacqmin, 2019; Sommerfeld et al., 2017). Similarly, research has highlighted that reducing net metering compensation rates can significantly slow down residential adoption (Chesser et al., 2018). This change diminishes the financial benefits of solar PV, particularly for households that rely on exporting excess energy rather than self-consumption. Time-of-use pricing models, where electricity rates fluctuate based on grid demand, can incentivize self-consumption and battery storage adoption. Research indicates that consumers are more likely to invest in energy storage solutions when peak electricity prices are high, allowing them to shift consumption to lower-cost periods (Andreolli et al., 2021).

On the other hand, high daily fixed charges and set fees that are unaffected by consumption levels can dilute the financial appeal of reducing grid electricity reliance. Research finds that high fixed charges undermine the incentive for households to invest in solar PV, as they limit the cost savings that come from lower consumption (Gautier & Jacqmin, 2019; Zander, 2020)

### *3.2.3.3 Rental and Shared Housing Regulations*

One of the most significant regulatory challenges in residential electrification is the split-incentive problem, where landlords bear the cost of upgrades, but tenants receive the benefits—creates disincentives to invest in

electrification (Hammerle et al., 2023). This barrier is particularly pronounced in regions with high rental occupancy rates, where a large portion of the population lacks the ability to directly invest in energy efficiency upgrades (Karytsas, 2018).

Solutions explored include landlord tax incentives, minimum energy performance standards for rental properties, and shared solar arrangements. Community solar projects, where renters and landlords can subscribe to a local solar array, show promise in democratising access and overcoming structural ownership barrier. Despite these solutions, adoption among rental properties remains significantly lower than in owner-occupied homes, indicating that further policy refinements are needed.

#### **4. Technological Factors**

##### *3.2.4.1 Grid Stability and Energy Storage*

The increasing penetration of residential solar PV presents grid management challenges, particularly concerning voltage stability, peak load management, and energy storage. Research indicates that unmanaged high solar PV penetration can lead to grid instability, necessitating curtailment or infrastructure upgrades (Jayaraj et al., 2024). A critical solution to these issues is the integration of battery storage and demand response programs, which allow for better control over electricity supply and demand.

Battery storage adoption remains low due to high costs and unclear financial incentives. While technological advancements have significantly reduced battery prices over the last decade, many households still perceive storage as an expensive add-on rather than an essential component of solar PV systems (Andreolli et al., 2021). This hesitation is exacerbated by the uncertainty surrounding future energy prices and policy support, making households reluctant to invest in storage without clear economic benefits. Research suggests that battery adoption is likely to increase with significantly lower upfront costs, higher tariff differences between peak and off-peak pricing in TOU pricing plans, a lowering of flat grid export rates, or a combination of these factors (Spiller et al., 2023).

##### *3.2.4.2 Retrofitting Challenges*

Electrification of existing homes, particularly older housing stock, presents significant retrofitting barriers. Many homes were not designed to accommodate high electrical loads of new electric systems, necessitating costly upgrades to electrical panels, wiring, and insulation (Michelsen & Madlener, 2016). Research indicates that these additional costs can deter consumers, even when incentives for the core technology are available (Michelsen & Madlener, 2016).

### 3.2.5. Geographical Factors

#### 3.2.5.1 Regional Infrastructure

Infrastructure availability has an impact on the feasibility and attractiveness of electrification technologies. Rural areas, for instance, often experience unreliable grid access or longer service wait times, which can both hinder and motivate electrification. Research also highlights differing motivations for adoption between rural and urban consumers. In rural areas, where grid reliability is often poor or non-existent, households are more inclined to invest in off-grid solar PV and battery storage systems as a means of achieving energy security (Best & Nepal, 2022; Jayaraj et al., 2024). In contrast, urban residents tend to adopt solar PV primarily to reduce electricity bills, with less emphasis on independence from the grid (Kyere et al., 2024; Zander, 2020). In some cases, off-grid solutions like solar PV and battery storage are more attractive in rural areas due to lack of alternatives (Jayaraj et al., 2024).

#### 3.2.5.2 Climate Suitability

Climate also plays a role in determining the suitability of renewable technologies. Areas with high solar exposure show higher uptake, while areas with frequent cloud cover show lower uptake (Wang et al., 2017). Heat pump adoption, for instance, varies across climates, with studies showing higher adoption in moderate climates where heat pumps operate efficiently year-round and lower adoption in regions with extreme cold, where additional heating support is required (Michelsen & Madlener, 2016).

In conclusion, the thematic analysis has identified a range of economic, policy, social, technological, and geographic factors that influence residential electrification decisions. While each factor influencing residential electrification has been examined independently in the thematic analysis, real-world adoption decisions are shaped by complex interactions between such factors, making it critical to understand the strength, hierarchy and interplay of these factors in developing effective electrification strategies. The following chapter draws these insights together to explore their interplay and hierarchy.

## Chapter 4: Discussion

### 4.1. Hierarchy and interplay of factors influencing residential electrification

This chapter discusses the findings from the thematic analysis in relation to the overarching aim of this dissertation: to understand the factors that influence residential customers' decisions to adopt electrification and how these insights can be applied within the New Zealand context. Specifically, it addresses our third research question:

*Research Question 3: How can these global insights be adapted to develop a framework for customer participation in electrification within New Zealand's socio-economic, cultural, and geographic context?*

The chapter begins by establishing the interplay and hierarchy of factors influencing consumer decisions to electrify their homes, drawing on cross-study insights from the analysed papers to show how economic, policy, social, technological, and geographic dimensions interact. Building on this foundation, it then proposes an integrated framework tailored to the New Zealand context, outlining practical actions across each dimension to support a more equitable and effective transition to residential electrification.

Figure 4.1 below indicates the hierarchy and interconnectedness of the factors influencing residential electrification decisions, in the following manner.

- *Economic & Financial Feasibility (Primary Factor)*: Financial considerations such as upfront costs, energy prices, and access to incentives are the most critical driver of residential electrification, as they directly influence household decision-making.
- *Policy & Regulation (Enabling Factor)*: Policy acts as a key enabler by shaping economic conditions, providing long-term certainty, technological readiness, thus influencing nearly all dimensions of adoption.
- *Social & Behavioural Influences (Supporting Factor)*: Social norms, trust, and consumer awareness reinforce adoption decisions but typically rely on favourable economic and policy environments to be effective.
- *Technological Readiness (Practicality Factor)*: The practicality of electrification depends on technological readiness, including grid stability, storage solutions, and the ease of retrofitting existing homes.
- *Geography (Contextual Factor)*: Geographic factors, such as infrastructure availability and climate suitability, influence the applicability and effectiveness of electrification efforts within different regions.

Below, I will discuss the interconnectedness and hierarchy of the factors in more detail.

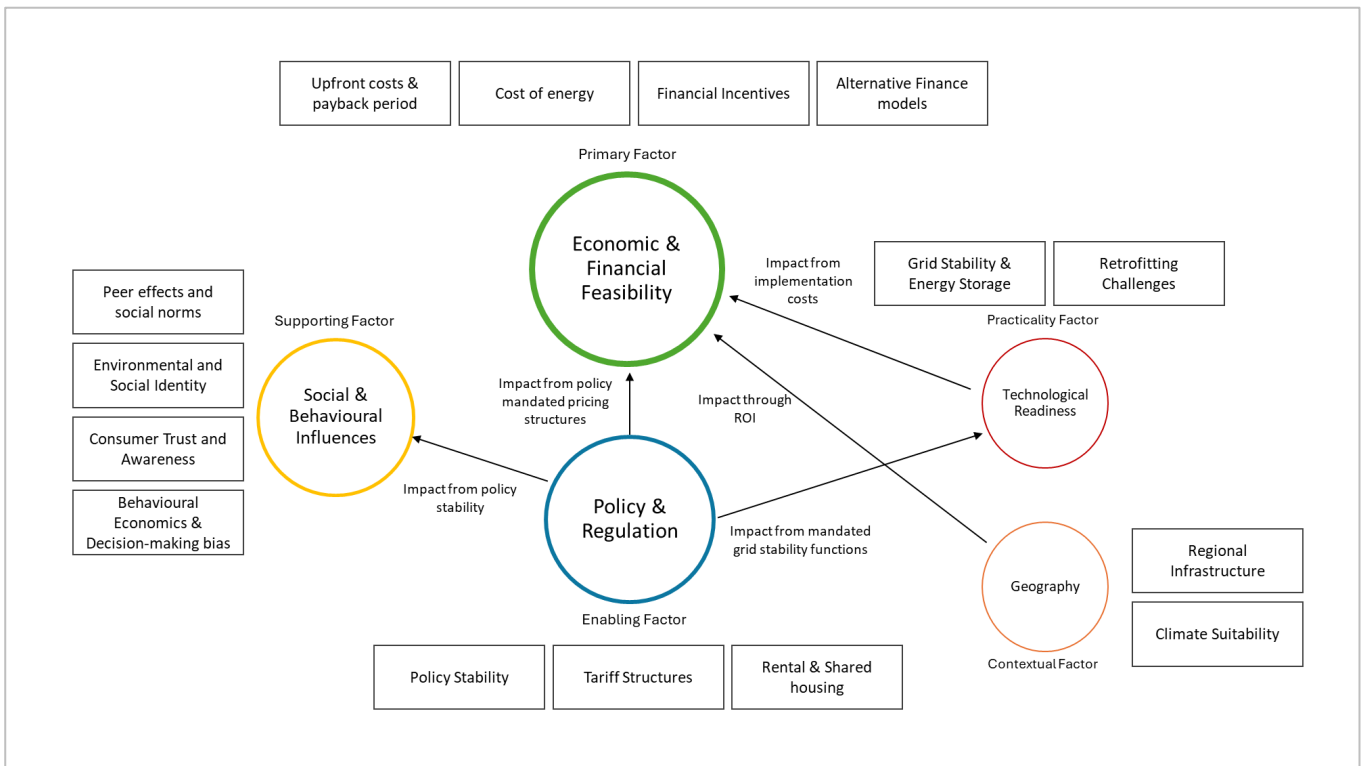


Figure: 4.1: Hierarchy and Interplay of factors influencing residential electrification

#### 4.1.1 Economic and Financial Feasibility: The Primary Factor

The findings indicate that economic and financial feasibility remains the key consideration for households when choosing to electrify. As discussed in the previous chapter this includes both the upfront affordability of technologies and the expectation of positive long-term returns on investment. Factors such as energy prices, the availability of financial incentives, and accessible financing options all play a major role in shaping feasibility (Andreolli et al., 2021; Chesser et al., 2018; Lau et al., 2020; Sahari, 2019; Shen et al., 2022; Wim Van Opstal & Smeets, 2023; Tsvetanov, 2019; Zander, 2020)

It is important to consider that financial considerations are not uniform across all households. Lower-income groups, for instance, may find even modest upfront costs prohibitive, despite potential savings over time concerns (Aydin et al., 2018; Dilek Uz & Mamkhezri, 2024; Sovacool et al., 2022). My analysis shows that these households are more responsive to upfront discounts or no-cost financing models than to incentives that require delayed claims, such as tax rebates. Conversely, higher-income households, who are generally better positioned to absorb upfront costs, are more comfortable navigating longer payback periods and complex incentive structures. While financial feasibility is the pivotal threshold, it is shaped by a household's socio-economic status, and ability to engage with available support mechanisms. Tailoring financial solutions to different demographic realities is critical to expanding the reach of electrification initiatives.

#### *4.1.2 Social and Behavioural Influences: The Supporting Factor*

Social and behavioural influences play an important supporting role in the decision to adopt electrification technologies. As seen in the previous chapter, my analysis shows that while these factors rarely drive adoption independently, they can act as powerful catalysts or constraints once the financial conditions are favourable.

When households perceive electrification as socially desirable, normalised, or consistent with their values, they are more likely to move forward with adoption (Abdulkarim Alsulami et al., 2024; Best & Nepal, 2022; Gillingham & Bollinger, 2021; Lau et al., 2020). Peer effects, in particular, have a strong influence- seeing neighbours or peers successfully adopt technologies can increase perceived legitimacy and reduce hesitation (Irwin, 2021). This effect is particularly strong in collectivist cultures and close-knit communities (Best & Nepal, 2022; Chen et al., 2021; Lindgren, 2024). Similarly, environmental identity, trust in technology providers, and confidence in government initiatives can all strengthen the likelihood of action once economic hurdles have been addressed (Dong & Sigrin, 2019; Zobeidi et al., 2022). Conversely weak or negative social cues, such as hearing of poor technology performance, or lack of trust in providers or government policies may lead to delayed adoption even when it makes financial sense (Chen et al., 2021; Dilek Uz & Mamkhezri, 2024; Eslami & Krishnan, 2023; Su et al., 2018). Social and behavioural factors shape motivation, trust, and perceived risk, potentially enhancing or diminishing the effectiveness of economic and policy interventions. Recognising and leveraging these influences is crucial for encouraging uptake across diverse communities.

#### *4.1.3 Policy and Regulation: The Enabling Factor*

Policy and regulation serve as the critical enabling forces within the electrification system, exerting influence across nearly all other factors. Well-designed policies not only directly shape the economic feasibility of adoption but can also impact social confidence and technological readiness.

One of the most direct ways policy shapes adoption is through its effect on the financial equation. For instance, policy mandated pricing structures, such as time-of-use tariffs, net metering arrangements, and feed-in tariffs, can directly influence the perceived cost-benefit of technologies like solar PV (Spiller et al., 2023). Policy stability is another critical influence, particularly on social and behavioural factors. Stable and long-term policies can increase trust in government initiatives, reinforcing motivation to adopt. Conversely, frequent changes to subsidy programs or abrupt policy reversals can erode trust and lead to widespread scepticism, even among financially capable households (Bennett et al., 2020). Policy can further exert influence on technological factors such as grid stability, by making energy storage and demand response solutions financially attractive or necessary to participate in (Andreolli et al., 2021; Spiller et al., 2023).

Thus, the design and delivery of policies and regulation is a critical consideration for its potential to impact affordability, trust, practicality, and accessibility of electrification pathways.

#### *4.1.4 Technological Readiness: The Practicality Factor*

Technological factors form the practical foundation for residential electrification. They do not typically drive adoption on their own, but they can significantly impact the ease and cost of implementation.

Advancements in battery storage, for instance, enhance the financial viability of solar PV by improving self-consumption and reducing reliance on grid exports (Andreolli et al., 2021). Similarly, technologies enabling demand response can help households optimise their energy use in response to price signals, strengthening the financial benefits of electrification (Spiller et al., 2023). On the other hand, technological barriers can raise costs. Retrofitting older homes to support high electrical loads often requires expensive upgrades, which can discourage adoption even where financial incentives exist (Michelsen & Madlener, 2016). Thus, although technological factors feature lower in the hierarchy of factors influencing electrification decisions, it must be considered for its potential to unlock or undermine the financial benefits.

#### *4.1.5 Geography: The Contextual Factor*

Regional factors act as contextual modifiers that influence how beneficial or feasible electrification appears to households. Infrastructure quality, climate conditions, and geographic characteristics all shape the local opportunities and barriers to adoption.

Regions with high solar irradiance, for instance offer greater potential for solar PV systems to deliver strong financial returns through increased self-generation (Wang et al., 2017). Similarly, regions with unreliable or weak grid infrastructure may find electrification technologies, particularly off-grid solar and battery systems, more appealing as a way to improve energy security. Climate also plays a role (Best & Nepal, 2022; Jayaraj et al., 2024). Heat pump performance, for example, is optimal in moderate climates but can decline in extreme cold, affecting both effectiveness and cost savings. These variations highlight the need for targeted approaches when promoting electrification. Tailoring incentives, infrastructure upgrades, and communication strategies to the specific regional conditions can help maximise adoption outcomes and ensure that electrification efforts are equitable and effective across diverse communities.

## **4.2 Proposed Framework for Supporting Residential Electrification in New Zealand**

While global studies provide valuable insights into the drivers and barriers of residential electrification, the effective application of these findings requires adaptation to New Zealand's unique context. This section draws on the thematic analysis and my interpretation of the hierarchy of influencing factors, to propose a

tailored framework for encouraging residential electrification in New Zealand (see figure 4.2 below). The framework recognises that improving financial feasibility and strengthening policy stability are the most critical levers for enabling residential electrification. Financial and policy measures form the foundation upon which social and behavioural enablers, technological readiness, and regionally tailored strategies can be effectively built for achieving broad and equitable uptake. Below, I will discuss each factor in detail.

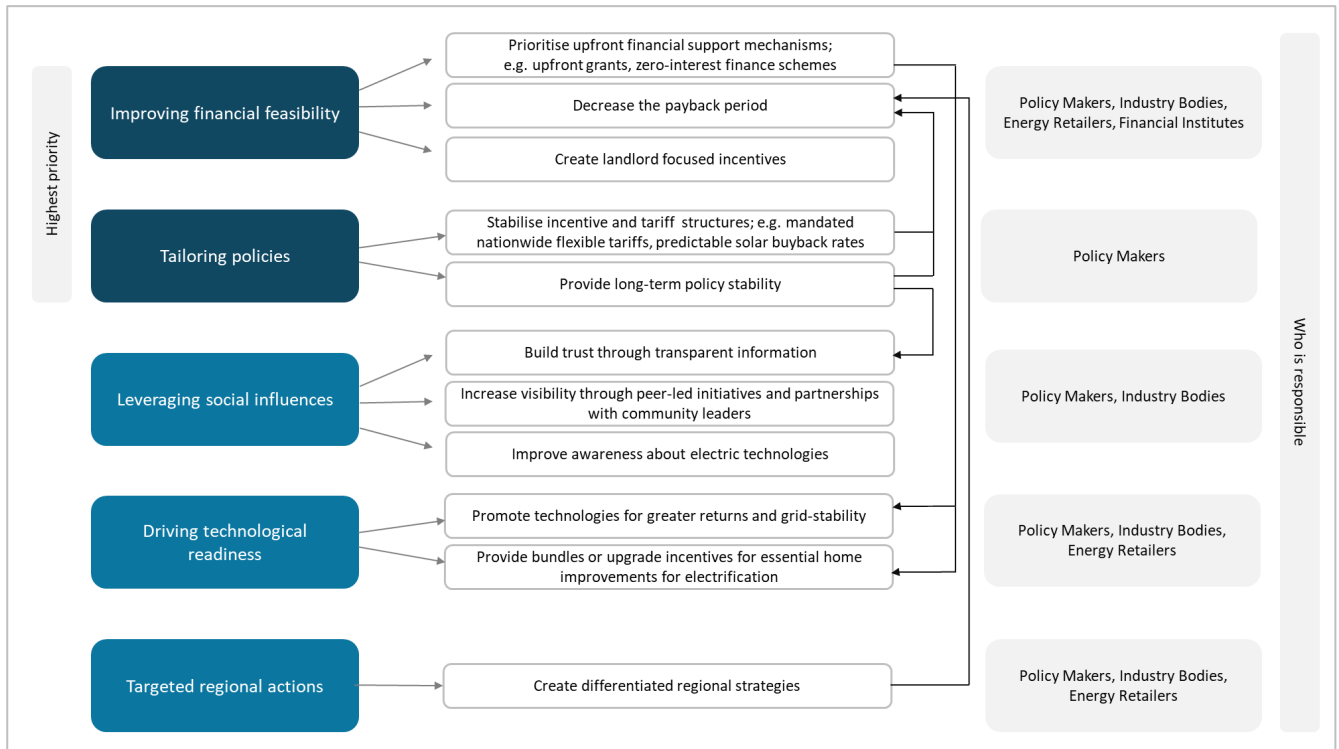


Figure 4.2. Proposed Framework for Supporting Residential Electrification in New Zealand

#### 4.2.1 Economic and Financial Feasibility in the New Zealand Context

New Zealand's socio-economic landscape highlights significant challenges related to affordability and equitable access to electrification technologies. Rising housing costs, high debt-to-income ratios, and growing wealth disparity underscore the need for targeted financial solutions (Stuff, n.d.; Just Transition | Ministry of Business, Innovation & Employment, n.d.) Additionally, renters, who now make up roughly 35% of households, face particular barriers to electrification, as they have limited control over property upgrades and have few financial incentives targeted at them (New Analysis Shows 110,000 Households Unable to Afford to Heat Their Homes, 2023).

To address these disparities, the framework recommends prioritising upfront financial support mechanisms over rebate-based schemes to ensure lower-income and rental households can also take advantage of the incentives. Options include upfront grants, zero-interest financing schemes, and landlord-focused incentives to drive rental property upgrades. Simplifying access to such incentives and communicating the long-term financial gains clearly across diverse socio-economic groups is also critical.

Ensuring that financial feasibility is not limited to high-income, owner-occupier households is fundamental to building an inclusive electrification transition.

#### *4.2.2 Policy and Regulatory Environment in the New Zealand Context*

New Zealand's deregulated electricity market offers consumers choice but also results in variability in pricing structures, tariff access, and incentive offerings across regions and providers (Improving Pricing Plan Options for Consumers: Time-varying Retail Pricing for Electricity Consumption and Supply, 2025). The lack of a nationally standardised approach to net metering, feed-in tariffs, and time-of-use pricing can weaken the economic case for household investments in solar PV and batteries (Improving Pricing Plan Options for Consumers: Time-varying Retail Pricing for Electricity Consumption and Supply, 2025).

A coherent policy and regulatory strategy is critical. The framework recommends stabilising incentive structures, such as ensuring predictable solar buy-back rates and expanding access to flexible tariffs nationwide. Long-term policy consistency is essential to avoid boom-and-bust cycles of adoption that arise from sudden changes to subsidy schemes. Policy design must prioritise equity, transparency, and long-term stability to build household confidence and create a supportive environment for electrification investment.

#### *4.2.3 Social and Behavioural Factors in the New Zealand Context*

New Zealand's cultural landscape is characterised by a relatively high level of environmental concern, with broad public support for renewable energy and sustainable practices (Better Futures 2025 Report | SBC, n.d.). This cultural alignment presents an opportunity to position residential electrification as both an economic and environmental good. Adoption behaviour is also shaped by trust in information sources, peer influence, and community engagement.

Trust remains a significant barrier for some groups, particularly Māori, Pasifika, and lower-income communities, who have historically experienced marginalisation in broader energy and housing policies (New Analysis Shows 110,000 Households Unable to Afford to Heat Their Homes, 2023). Building trust requires culturally tailored communication strategies, partnerships with trusted community leaders, and transparent, accessible information about the costs and benefits of electrification.

The framework recommends that the residential electrification programmes should be co-designed and delivered with trusted intermediaries. For instance, partnering with iwi/hapū organisations, Māori and Pasifika providers, community housing providers (including Kāinga Ora), councils and local NGOs, to co-design culturally safe support that reduces complexity and builds confidence. Further, instead of broad awareness campaigns, use segment-specific messaging and NZ-relevant proof points (local "before/after" case studies that show realistic bill impacts under local tariffs, consumption behaviours and climate

conditions), and combine this with hands-on demonstrations led by local champions. Integrating these social and behavioural levers alongside financial and policy measures will be essential to achieving broad and equitable uptake.

#### *4.2.4 Technological Readiness in the New Zealand Context*

While the country's renewable generation base is strong, residential technology uptake, particularly for solar PV and battery storage, remains comparatively low (EECA, n.d.). Many households still perceive batteries as prohibitively expensive, and concerns around integration complexity or retrofit costs further deter adoption (Sahng et al., 2024). The ageing housing stock poses additional challenges. A significant proportion of New Zealand's homes were built before modern energy efficiency standards were introduced, making them less suitable for electrification without costly retrofitting (Existing Homes Roadmap, 2024). Upgrading wiring, improving insulation, and installing heat pumps often entail expenses that extend beyond the cost of the primary electrification technology itself.

The framework recommends direct support for technologies that unlock greater financial value for households as well as facilitate grid stability agendas, such as battery storage incentives linked to solar PV installation and schemes promoting demand response participation. Policies can also target retrofitting barriers by subsidising necessary upgrades or offering bundled support packages that integrate electrification technologies with essential home improvements. Ensuring that technological pathways are accessible, affordable, and future-proofed will be essential to expanding adoption across diverse household types.

#### *4.2.5 Geographical Variation in the New Zealand Context*

New Zealand's diverse geography and climate conditions significantly influence the feasibility and attractiveness of residential electrification technologies. Sunshine hours, heating needs, and grid resilience vary notably across regions, requiring tailored approaches to maximise adoption.

Northern and eastern regions of the North Island, in addition to Nelson and central Otago benefit from high solar irradiance levels (My Solar Quotes, n.d.). These areas are naturally suited to rooftop solar PV uptake, providing stronger financial returns through higher energy generation potential. In contrast, regions in the lower South Island experience cooler climates and fewer sunshine hours, making investments in solar PV less financially compelling without complementary technologies such as battery storage or hybrid heating systems (My Solar Quotes, n.d.). Further, grid resilience issues are more prevalent in rural and remote communities, particularly in parts of Northland (Renewable Energy Zones: Bridging the Gap for Northland's Electricity Resilience and Reliability, n.d.). In these areas, distributed energy resources, such as solar-plus-battery systems and standalone microgrids, can offer a pathway to greater energy independence and reliability.

The framework recommends a “regional archetype” model rather than a one-size-fits-all approach. For instance, in high-irradiance areas prioritise solar PV paired with load shifting (controlled hot water and daytime use) and, where justified, storage or community batteries. In colder regions lead with insulation and correctly sized, cold-climate-performing heat pumps to prevent winter bill shock. In rural and remote communities prioritise resilience-oriented solutions such as solar-plus-battery, backup-ready community hubs (e.g., marae/schools) and targeted support where outages are longer. Programmes should be guided by local network hosting-capacity information and delivered through regional partners who understand local conditions, such as councils, iwi organisations, local trusts and community providers to ensure access and implementation beyond major cities.

### 4.3 Theoretical and Practical Implications

Firstly, the review contributes to the theoretical understanding of residential electrification by highlighting the limitations of single-factor explanations. While much of the existing research focuses narrowly on economic, behavioural, or policy variables (Abdulkarim Alsulami et al., 2024; Andreolli et al., 2021; Best & Nepal, 2022; Gong et al., 2020; Jayaraj et al., 2024; Zander, 2020; Zander 2021), this synthesis shows that electrification decisions emerge from the interplay of multiple influences — shaped by context, policy design, household characteristics, and perceptions of risk and value. Rather than proposing a new theory, this review offers an integrative conceptual framework that can support future theorisation. It encourages scholars to move beyond reductionist models toward more holistic and layered approaches that reflect real-world complexity.

Second, the review reconceptualises ‘economic feasibility’ as a marketing value proposition problem, where adoption depends not only on objective costs but on consumers’ perceived benefits, perceived sacrifice, and perceived risk. A common implicit assumption in parts of the existing literature is that households behave as relatively stable payback calculators, with adoption primarily driven by objective costs and savings (Aydin et al., 2018; Bauner & Crago, 2015). The evidence synthesised here suggests a more marketing-consistent explanation: households evaluate electrification through perceived value, perceived risk, and decision effort. In particular, policy instability, administrative burden (e.g., complex eligibility criteria, multiple applications, installer coordination), and the timing of cashflows reshape the perceived attractiveness of electrification even when long-run savings exist. This extends work on time discounting and subsidy design by showing that liquidity constraints and uncertainty amplify perceived sacrifice, meaning that adoption is often constrained by the customer experience of the offer.

Lastly, this review strengthens the integration of equity and justice into adoption theorising for electrification, instead of treating it as downstream implementation issue (Sovacool et al., 2022), the literature indicates that perceived fairness, access to trusted information, and the ability to mobilise upfront capital operate as core mechanisms shaping adoption—particularly for renters and households experiencing energy hardship. This extends marketing research on perceived value and perceived risk by showing that

inequity increases perceived sacrifice and uncertainty, suppressing adoption even when the objective economics appear favourable.

For policymakers, this review demonstrates that residential electrification is not just a matter of technological readiness, but fundamentally a question of perceived financial feasibility. It highlights the importance of interpreting household decisions not as static cost–benefit calculations, but as responses to the structure and stability of the policy environment. In doing so, it reinforces the idea that long-term policy consistency is not only administratively useful but behaviourally essential, as households tend to delay action under uncertainty.

The findings also contribute to social insight by showing that enabling conditions must be interpreted through the lens of equity, trust, visibility, and accessibility. Electrification uptake cannot be fully explained without accounting for how people perceive fairness, complexity, and credibility — dimensions that are often underexplored in technical policy design. In this way, the review expands practical understanding toward a more integrated view of what it takes to support meaningful participation.

#### **4.4 Limitations of the study**

As a systematic literature review, this study is inherently shaped by the scope and focus of the existing body of research. By excluding grey literature and non-English publications, the review may underrepresent practical innovations or region-specific barriers that fall outside the academic mainstream.

While the review provides a foundational understanding of the key factors influencing residential electrification, it does not offer detailed prescriptions on specific design parameters — such as optimal incentive levels, duration of policy stability, or cost–benefit thresholds for different household types. These nuances are often context-dependent and underexplored in the existing literature. As such, the findings are best viewed as a high-level framework for understanding drivers of adoption, which requires further empirical investigation to inform operational and policy-level decision-making.

#### **4.5 Suggestions for future research**

This review offers a high-level synthesis of factors influencing residential electrification, but further research is needed to translate this foundational understanding into actionable design parameters. For example, while policy stability consistently emerges as an important enabler, there is little empirical evidence on how long policies must remain in place to maintain consumer confidence, or what level and structure of incentives yield the greatest uptake across different household types. Future studies should explore these practical thresholds through longitudinal, experimental, or policy evaluation methods, ideally within specific national or regional contexts.

There is also considerable scope for research examining how different factors interact to shape adoption decisions. While this review identifies financial, social, behavioural, policy, technological, and geographic factors as influential, few studies explore the interdependencies between them. Future work could investigate, for instance, whether financial incentives are more effective in high-trust environments, or how tenure and household income modify the impacts of policy design. Exploring these relationships would help to move beyond siloed interventions towards more integrated, context-sensitive strategies.

Another critical research gap relates to the inclusion of household-level renewable technologies such as battery storage alongside solar PVs. While these technologies play an increasingly important role in the electrification of homes, they are often examined in isolation rather than as part of a broader household energy transition. Further research is needed to understand how integrating renewables with electrification affects household decision-making, perceptions of energy security, and the overall resilience of the electricity system. Understanding these dynamics will be essential for designing electrification pathways that alleviate pressure on national grids while maximising environmental and economic benefits.

Finally, greater attention is needed to the experiences of underrepresented populations and diverse housing contexts. Much of the current literature focuses on high-income, owner-occupied households in urban areas, limiting the generalisability of findings. Future research should prioritise renters, lower-income groups, Māori and other Indigenous communities, and those living in rural or geographically isolated areas. Comparative research across demographic groups, housing types, and regions would uncover context-specific barriers and enable the development of more inclusive, equitable electrification policies. Additionally, future studies should consider the social justice implications of electrification to ensure the transition does not exacerbate existing inequalities or create new forms of energy hardship.

## Chapter 5. Conclusion

This study offers a comprehensive thematic analysis of global literature on residential electrification, with a specific focus on translating those insights into a practical framework for the New Zealand context. To the best of my knowledge, this is the first systematic review to integrate global factors influencing electrification with a detailed, country-specific adaptation for New Zealand. The review covered 63 empirical studies spanning multiple geographies, socio-economic conditions, and technological contexts, providing a rich understanding of the multi-dimensional influences shaping residential electrification decisions. These studies draw from a broad range of disciplines—including energy policy, environmental and sustainability studies, behavioural economics, marketing, and consumer research—demonstrating the interdisciplinary nature of the topic. By integrating insights across these fields, the review bridges fragmented knowledge and brings valuable perspectives to inform both energy transition strategies and the marketing literature.

The findings reveal that while economic and financial feasibility remains the primary threshold for adoption, successful uptake depends on the intricate interplay between financial viability, stable and supportive policy settings, social and behavioural catalysts, technological readiness, and geographic variation. A clear hierarchy of influences emerged: affordability acts as the primary gateway, policy as the enabling environment, social influences as accelerators or constraints, technology as a practicality filter, and geography as a contextual modifier.

The proposed framework tailored for New Zealand emphasises the critical importance of equitable financial solutions, stable long-term policy design, culturally inclusive social engagement strategies, technological support for storage and retrofitting, and regionally adapted program delivery. These recommendations align closely with New Zealand's socio-economic realities, cultural diversity, technological readiness levels, and regional energy needs.

From a policy and industry standpoint, the findings reinforce that residential electrification strategies must be integrated, equitable, and locally adapted. While financial feasibility is the most immediate barrier, the review highlights that enabling long-term adoption requires coordinated action across multiple domains — including predictable and stable policy settings, socially inclusive engagement strategies, accessible technologies, and regionally responsive programme delivery. Stability and clarity in policy design, in particular, play a critical role in shaping household confidence and decision-making over time.

From an academic standpoint, the study contributes to the marketing literature by offering an integrated framework that captures the layered and interdependent nature of electrification decisions. It shifts the analytical lens away from siloed factors and toward a systems-oriented view that acknowledges how financial, social, regulatory, technological, and geographic influences converge at the household level.

In conclusion, residential electrification represents not only a technological shift but also a social, financial, and infrastructural transition. Success will depend on recognising and integrating these dimensions

holistically—an approach that this study proposes as essential for advancing equitable, large-scale electrification in New Zealand.

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