Slutrapport

Energimyndighetens titel på projektet – svenska
Allmänhetens acceptans av policyer för energieffektiva byggnader

Energimyndighetens titel på projektet – engelska
Public Acceptance of Policies for Energy Efficient Buildings

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Förord

This report presents the results of the project Public Acceptance of Building Decarbonisation, which examines how public attitudes, preferences, and behavioural responses shape the feasibility of climate policies in the building sector. As Europe moves toward climate neutrality, buildings have emerged as a central arena for transformation. Yet while technical solutions for energy efficiency, electrified heating, and demand-side flexibility are increasingly mature, their real-world implementation depends on the willingness of households and building users to accept, adopt, and engage with these measures. The project was motivated by a recognition that technological feasibility alone is insufficient. Decarbonisation policies that overlook social acceptance risk limited uptake, uneven distributional effects, and public resistance. By synthesising a large and rapidly growing body of international research, this project seeks to clarify the factors that drive or hinder public support for building-related climate measures and to translate these insights into guidance for policy design and future research. The report is structured around three thematic reviews—demand-side flexibility, low-carbon heating, and renovation—followed by a cross-cutting synthesis and a methodological toolkit. Together, these components aim to strengthen the empirical foundation for socially robust building decarbonisation strategies and to contribute to more effective, equitable, and durable policy implementation.

Innehåll

Sammanfattning

Att minska koldioxidutsläppen från Europas byggnadsbestånd är avgörande för att uppnå klimatneutralitet. Byggnader står för cirka 40 procent av den slutliga energianvändningen i EU och nästan en tredjedel av utsläppen av växthusgaser. Även om tekniska lösningar för energieffektivisering, elektrifiering av uppvärmning och efterfrågeflexibilitet är brett tillgängliga, är deras framgång i slutändan beroende av allmänhetens acceptans. Detta projekt behandlar en central fråga: vad driver eller hindrar allmänhetens acceptans av åtgärder för byggnadsdekarbonisering, och hur kan denna kunskap bidra till en mer effektiv utformning av politiska styrmedel?Projektet genomfördes som tre samordnade systematiska litteraturöversikter som omfattar mer än 300 empiriska studier från OECD-länder sedan 2015. Översikterna fokuserar på: (1) efterfrågeflexibilitet och automatisering; (2) omställning till koldioxidsnåla uppvärmningssystem; samt (3) renoveringar och förbättringar av byggnaders klimatskal. Därtill har metodologiska insikter identifierats och sammanställts i ett strukturerat metodverktyg för att vägleda framtida forskning om offentlig acceptans inom byggsektorn.

Inom samtliga tre områden framträder tydliga gemensamma mönster. För det första uppvisar hushåll en stark ovilja mot finansiell osäkerhet och höga initiala kostnader. Dynamisk realtidsprissättning, långa och otydliga återbetalningstider samt exponering för investeringsrisk minskar viljan att delta. Utlovade långsiktiga besparingar kompenserar sällan för upplevd kortsiktig ekonomisk belastning. Direkta bidrag och riskdelningsinstrument får betydligt starkare stöd än lån eller rent prisbaserade incitament. För det andra utgör upplevt krångel och administrativ komplexitet betydande hinder för genomförande. Att hitta installatörer, navigera i bidragssystem och hantera störningar lyfts ofta fram som barriärer. Policys som förenklar deltagande genom samordnad leverans, betrodda mellanhänder och så kallade “one-stop-shop”-lösningar ligger närmare användarnas preferenser. För det tredje är komfort, autonomi och tillit avgörande faktorer för acceptans. Inom efterfrågeflexibilitet föredrar hushåll ofta automatiserade lösningar med möjlighet att åsidosätta inställningar framför starkt volatil prissättning. I uppvärmnings- och renoveringssammanhang sätter driftsäkerhet och termisk komfort tydliga gränser för vad som uppfattas som acceptabel förändring. Miljöengagemang spelar en kompletterande men sällan dominerande roll.

Projektet bidrar med ny kunskap genom att integrera resultat över olika teknologier och policyområden och visar att motstånd i mindre utsträckning är ideologiskt och i större utsträckning strukturellt. Sammantaget pekar

resultaten på att en socialt hållbar byggnadsdekarbonisering kräver inte bara teknisk innovation utan även styrningsarrangemang som minskar risk och förenklar deltagande. Framtida insatser bör fokusera på vidareutveckling av systemnivåbaserade angreppssätt för efterfrågeflexibilitet, utforskning av finansieringsmodeller som minskar eller eliminerar höga initiala kostnader (såsom pay-as-you-save-modeller), samt forskning om offentligt samordnade och lågfriktionsbaserade genomförandemodeller för uppvärmnings- och renoveringsomställningen.

Summary

Decarbonising Europe's building stock is essential for achieving climate neutrality. Buildings account for roughly 40 percent of final energy use in the EU and nearly one third of greenhouse gas emissions. Yet while technical solutions for energy efficiency, heating electrification, and demand-side flexibility are widely available, their success ultimately depends on public acceptance. This project addresses a central question: what drives or hinders public acceptance of building decarbonisation measures, and how can this knowledge inform more effective policy design?

The project was carried out as three coordinated systematic literature reviews covering more than 300 empirical studies across OECD countries since 2015. The reviews focus on: (1) demand-side flexibility and automation; (2) low-carbon heating transitions; and (3) renovation and thermal envelope upgrades. In addition, methodological insights were extracted and synthesised into a structured toolkit to guide future research on public acceptance in the building sector.

Across all three domains, consistent cross-cutting patterns emerge. First, households exhibit strong aversion to financial uncertainty and high upfront costs. Dynamic real-time pricing, long and ambiguous payback periods, and exposure to investment risk reduce willingness to participate. Promised long-term savings rarely compensate for perceived short-term financial burden. Direct subsidies and risk-sharing instruments receive substantially stronger support than loans or purely price-based incentives. Second, perceived hassle and administrative complexity significantly deter adoption. Finding installers, navigating subsidy schemes, and managing disruption are frequently cited barriers. Policies that simplify participation through coordinated delivery, trusted intermediaries, and one-stop-shop models appear more aligned with user preferences. Third, comfort, autonomy, and trust are decisive mediators of acceptance. In demand-side

flexibility, households often prefer automation with override options to highly volatile pricing schemes. In heating and renovation contexts, reliability and thermal comfort set clear boundaries for acceptable change. Environmental concern plays a complementary but rarely dominant role.

The project contributes new knowledge by integrating findings across technologies and policy domains, demonstrating that resistance is less ideological than structural. Overall, the findings suggest that socially sustainable building decarbonisation requires not only technological innovation, but governance arrangements that reduce risk and simplify engagement. Future directions should target the further development of system-level approaches to demand-side flexibility; exploration of financing models that reduce or eliminate upfront exposure (such as pay-as-you-save mechanisms); and research on publicly coordinated, low-friction delivery models for heating and renovation transitions.

1 Inledning/bakgrund

Buildings constitute one of the most significant leverage points in Europe's transition toward climate neutrality. They account for approximately 40 percent of total final energy consumption in the European Union and close to one third of greenhouse gas emissions. The decarbonization of the building sector is therefore not only an environmental necessity but also a precondition for achieving EU climate and energy targets. Without substantial improvements in building performance, neither emissions reductions nor energy security objectives can be met.

The transformation of Europe's building stock requires a broad and integrated strategy. It involves improving energy efficiency through better insulation and envelope performance, replacing fossil-based heating systems with low-carbon alternatives such as heat pumps and district heating, reducing heating loads, and enhancing the capacity of buildings to contribute to demand-side flexibility. As the electricity system becomes increasingly reliant on variable renewable generation, buildings must evolve from being passive consumers of energy to becoming active and flexible components of the energy system. Technologies such as smart thermostats, smart electric vehicle chargers, automated heating systems, and digital energy management platforms make it technically possible for buildings to adjust electricity consumption in response to grid conditions. Such flexibility is critical for maintaining system stability, reducing peak loads, and limiting the need for costly grid expansion.

However, the decarbonization of buildings is not purely a technical or infrastructural challenge. It is deeply social and institutional. Most energy use in buildings is directly shaped by the decisions and behaviours of owners, tenants, housing associations, and facility managers. Policies aimed at improving building performance therefore depend on varying degrees of public participation and consent. Measures such as deep retrofits, installation of new heating systems, adoption of smart technologies, or participation in demand-response schemes require investments, behavioural adjustments, and trust in implementing actors. Even well-designed policy instruments may face resistance if they are perceived as costly, inconvenient, unfair, or imposed without adequate consultation.

Public acceptance is therefore a central condition for the successful implementation of energy and climate policy in the building sector. Acceptance influences whether households invest in new technologies, whether tenants support renovation projects, whether users are willing to share data or allow automated control of appliances, and whether voters

support regulatory reforms. A lack of acceptance can slow down policy implementation, increase political opposition, and generate distributional conflicts. Conversely, policies that are perceived as fair, transparent, and beneficial are more likely to generate durable support and sustained behavioural change.

Despite its importance, the knowledge base on public acceptance of building-related energy policies remains fragmented. A large body of research evaluates the technical performance and cost-effectiveness of specific measures, such as retrofitting programs or heating system replacements. Considerably less attention has been paid to how these measures are perceived by affected groups. Where acceptance has been studied, the focus is often limited to a single technology or instrument—such as attitudes toward building retrofits or preferences for dynamic pricing—without situating these findings within a broader comparative framework. As a result, policymakers lack an integrated overview of the patterns that shape public responses across different interventions.

Existing studies nevertheless suggest that acceptance is influenced by several recurring factors. These include perceived upfront costs and payback periods, trust in the implementing actor, perceived fairness in the distribution of costs and benefits, convenience and disruption to everyday life, clarity of information, and the degree of autonomy retained by users. Preferences may also vary regarding the desired role of the citizen in the energy transition. Some policies implicitly frame individuals as “active consumers” who monitor prices and adjust behaviour in real time, while others offer more automated, “fit-and-forget” solutions that minimize daily engagement. Understanding how different groups perceive these roles is crucial for designing policies that align with lived realities and practical constraints.

Another challenge concerns methodological diversity. Research on public acceptance employs a wide range of approaches, including surveys, discrete choice experiments, qualitative interviews, field trials, and behavioural experiments. Yet there has been limited effort to synthesize methodological lessons across domains. In adjacent policy fields—such as carbon taxation or sustainable consumption—more extensive methodological discussions have emerged regarding framing effects, fairness perceptions, and trust formation. Insights from these areas may be transferable to the study of energy-efficient buildings but have not yet been systematically reviewed in this context.

Against this background, there is a clear need for a comprehensive synthesis of existing knowledge. Such a synthesis can clarify what is already known about public responses to energy-efficiency and flexibility measures in buildings, identify common drivers and barriers to acceptance, highlight knowledge gaps, and provide methodological guidance for future research. By integrating findings across technologies, policy instruments, and contexts, it becomes possible to distil general principles for designing socially robust building decarbonization strategies.

Ultimately, the transition of the building sector must be understood as both a technical and social transformation. Achieving climate neutrality in this domain requires not only improved technologies and regulatory frameworks, but also policies that are perceived as legitimate, equitable, and aligned with citizens' preferences and capacities. A stronger evidence base on public acceptance is therefore essential for ensuring that building decarbonization policies are not only technically effective but also politically and socially sustainable.

2 Genomförande

Systematic literature reviews have emerged as a rigorous alternative to traditional narrative reviews, particularly in fields where fragmented findings and heterogeneous methodologies make cumulative knowledge building difficult. Unlike narrative reviews—which are often selective, descriptive, and shaped by implicit author judgments—systematic reviews aim to identify, evaluate, and synthesize the full body of relevant evidence in a transparent and reproducible manner. In management research, Tranfield, Denyer and Smart argue that traditional reviews frequently lack explicit procedures, clear inclusion criteria, and critical appraisal standards, thereby limiting their reliability and usefulness for policy and practice [1]. Inspired by developments in medical science, they propose that systematic review methodologies can help create a more evidence-informed knowledge base by introducing explicit protocols, structured search strategies, and transparent synthesis procedures.

The rise of systematic reviews is closely linked to the broader evidence-based paradigm. Originating in medical science, where systematic reviews and meta-analyses became central tools for informing clinical decision-making by reducing bias and enhancing reproducibility, the approach gradually spread to management and social sciences in response to increasingly fragmented and sometimes contradictory bodies of evidence. Importantly, systematic reviews are not limited to statistical meta-analysis.

In many fields, including management and policy research, evidence is heterogeneous and often qualitative. Guidance on narrative synthesis and thematic synthesis demonstrates how structured procedures—such as systematic thematic grouping, transparent coding, exploration of relationships between findings, and assessment of robustness—can enable rigorous integration even when results are interpretive rather than quantitative [2].

Central to systematic literature reviews is the use of a review protocol. Bandara and Syed define a literature review protocol as a predetermined, detailed plan that functions as a "road map" for the entire review process [3]. The protocol clarifies the review's goals, defines inclusion and exclusion criteria, specifies search strings and databases, outlines coding and analysis procedures, and anticipates reporting formats. Complementing this planning function, the PRISMA framework (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) provides structured guidance for transparent and complete reporting of the review process [4]. Such registration mechanisms aim to reduce selective reporting, make deviations from the original protocol transparent, and allow third parties to assess whether the review was conducted as planned.

Although the project was originally conceived as a single, comprehensive systematic literature review on public acceptance of energy-related building policies, it became clear during the scoping phase that the breadth of the topic risked limiting analytical precision. The literature spans multiple technologies, policy instruments, and behavioral dimensions, each characterized by distinct research traditions, terminologies, and methodological approaches. In order to maintain conceptual clarity and methodological rigor, it was therefore decided to divide the project into three separate, though closely related, systematic literature reviews. This restructuring allowed each review to develop more focused research questions, tailored search strategies, and more precise coding frameworks, while still contributing to the overarching aim of synthesizing knowledge on public acceptance in the building sector.

The first literature review focuses on demand-side flexibility in buildings. This includes dynamic electricity tariffs, demand response programs, automation technologies, direct load control, smart thermostats, electric vehicle smart charging, and other forms of load-shifting. The central question in this strand concerns the willingness of households and building users to adapt consumption patterns, accept automation, or delegate control to third parties such as aggregators or grid operators. The literature in this area often addresses issues such as perceived loss of control, trust in

implementing actors, comfort trade-offs, financial incentives, and data privacy. By isolating demand flexibility as a distinct field of inquiry, the review systematically synthesizes drivers and barriers to acceptance of flexible and automated energy practices, thereby clarifying under what conditions buildings can effectively function as active components of a renewable electricity system.

The second literature review concentrates on heating and cooling systems in buildings, with particular emphasis on the decarbonization of space heating. This includes technologies such as heat pumps, district heating, hybrid systems, and other low-carbon alternatives to fossil-based boilers. Unlike flexibility measures, heating system transitions typically involve high upfront investment costs, long payback periods, and significant infrastructural or behavioral adjustments. The acceptance literature in this domain frequently revolves around affordability, risk perceptions, trust in installers and government actors, perceived reliability, disruption during installation, and concerns related to comfort and performance. By focusing specifically on heating and cooling technologies, this review synthesizes what is known about how households evaluate system replacement decisions and how policy instruments—such as subsidies, loans, mandates, or leasing models—shape acceptance dynamics.

The third literature review addresses thermal envelopes and energy efficiency retrofits, including insulation measures, window replacements, façade upgrades, and deep renovation of building shells. These interventions differ from heating system changes in that their benefits are often less visible and more long-term, while their implementation can be highly disruptive in multi-family or rented housing contexts. The acceptance literature in this area frequently highlights issues of split incentives between landlords and tenants, perceived disruption, aesthetic concerns, fairness in cost allocation, and uncertainty regarding actual energy savings. The methodological design and execution of the reviews were carried out in close collaboration with the Uppsala University Library. A subject librarian provided dedicated support in refining search strategies, identifying appropriate databases, and constructing robust search strings tailored to each of the three thematic strands. This included iterative testing and calibration of Boolean operators, keyword combinations, truncation strategies, and database-specific syntax in order to balance sensitivity (capturing all relevant studies) with specificity (excluding irrelevant material). The librarian also supported the design of the PRISMA-based screening process, ensuring that study identification, screening, eligibility assessment, and final inclusion followed transparent and replicable procedures. This collaboration strengthened the methodological rigor of the

project, enhanced reproducibility, and reduced the risk of unintentional selection bias in the identification of relevant literature.

Although the original project design included two distinct goals—first, to synthesize research on public acceptance of building decarbonization policies, and second, to conduct a separate literature review on methods used in the broader study of public acceptance in sustainability contexts—the latter objective was reconsidered during the course of the project. As the empirical review progressed, it became evident that the methodological approaches employed in studies of public acceptance of building-related interventions substantially overlapped with those used in adjacent sustainability domains. Conducting a fully separate systematic review on methods would therefore have entailed screening and synthesizing largely the same body of studies, resulting in significant redundancy.

Instead, methodological insights were systematically extracted from the studies included in the three substantive literature reviews and synthesized into a structured methodological toolkit. This approach preserved the original ambition of strengthening the methodological foundation for future research, while avoiding duplication of effort. The toolkit distills common research designs, data collection methods, analytical strategies, operationalizations of acceptance constructs, and typical measurement instruments observed across the literature. In doing so, it provides future researchers with a consolidated and context-sensitive methodological resource tailored specifically to the study of public acceptance in energy-related building interventions.Thus, while the format of the second goal evolved, its underlying purpose was fulfilled. The project not only maps and synthesizes what is known about public acceptance in the decarbonization of buildings, but also offers structured methodological guidance that can support the design of future empirical studies.

3 Resultat

The results of the project are presented in three distinct but interrelated sections, corresponding to the three thematic strands identified in the methodological design: demand-side flexibility and automation; heating and cooling system transitions; and structural energy efficiency measures related to building envelopes and retrofits.

1. Acceptance of Demand-side Flexibility (Manuscript in review)

This section summarizes the findings of a systematic review of 136 empirical studies examining social acceptance of demand-side flexibility (DSF) across OECD countries between 2015 and 2025 . The dataset is geographically concentrated in Europe, with additional contributions from North America, Australia, and parts of Asia. The literature is dominated by survey-based studies, supplemented by qualitative interviews, focus groups, discrete choice experiments, and a smaller number of field trials. Together, these studies provide the most comprehensive synthesis to date of how households perceive and evaluate dynamic pricing, manual load-shifting, automation and direct load control, smart charging, and vehicle-to-grid (V2G) technologies.

Across this body of evidence, three overarching findings stand out. First, there is a persistent gap between the "active consumer" envisioned in policy frameworks and the largely passive, convenience-oriented role that most households ascribe to themselves. Second, automation and load control are often more acceptable to users than the dynamic pricing schemes that are meant to activate them. Third, electric vehicle (EV) charging represents a partial exception, with EV owners displaying greater openness to flexibility—though V2G remains more contested.

Dynamic pricing and manual load-shifting: structural reluctance

A central pillar of many DSF strategies is dynamic electricity pricing, including time-of-use (ToU), critical peak pricing (CPP), and real-time pricing (RTP). Across the reviewed studies, households consistently show a preference for stable, predictable pricing structures. Fixed tariffs remain dominant in practice, and in stated-preference settings, most respondents favour less volatile and more comprehensible pricing options. ToU tariffs are sometimes accepted, particularly when differences between peak and off-peak prices are moderate and clearly structured. However, highly dynamic and volatile forms such as RTP rarely receive strong support. In no study do respondents clearly prefer highly volatile tariffs over fixed alternatives.

This reluctance reflects a broader aversion to price risk and uncertainty. Households frequently report that the potential financial gains from dynamic pricing are unclear, unpredictable, or insufficient to justify exposure to fluctuating costs. Even when pricing schemes are carefully explained in surveys or experiments, willingness to switch remains limited. These findings suggest that lack of awareness alone cannot explain the low uptake of dynamic tariffs observed across OECD countries.

Manual load-shifting—the behavioural response expected under dynamic pricing—also appears limited in scope. Across contexts, households are generally willing to shift only a narrow set of activities, primarily laundry and dishwashing

(and EV charging among EV owners). Activities such as cooking, heating, showering, or entertainment are widely perceived as non-negotiable. Even where financial incentives are offered, many respondents indicate that they are unwilling to reorganize daily routines for modest savings. Furthermore, behavioural changes often fade over time, as participants report inconvenience, forgetfulness, or low perceived benefits. Taken together, the evidence suggests that manual flexibility is unlikely to deliver large-scale or sustained load shifts across the broader population.

Automation and direct load control: conditional openness

Given the limitations of manual load-shifting, many policy frameworks assume that automation—through smart appliances, home energy management systems, or direct load control (DLC)—can facilitate flexibility without imposing behavioural burdens on users. The review finds that automation is frequently viewed more favourably than dynamic pricing. In numerous studies, households express conditional openness to automated control of heating systems, EV charging, or other appliances, even when they show little enthusiasm for volatile tariffs.

However, this openness is highly conditional. The most consistent determinant of acceptance is the retention of user control. Override functionality—allowing households to intervene or opt out at any time—emerges as one of the strongest predictors of support. When users perceive that they retain ultimate authority, opposition declines markedly. Conversely, automation perceived as intrusive or externally imposed generates resistance, even when financial compensation is offered.

Thermal comfort constitutes another critical boundary condition, particularly in the context of heating control. Field trials indicate that small and well-managed temperature adjustments can often be implemented without noticeable discomfort. Yet other studies document dissatisfaction, perceived loss of control, or baseline concerns about indoor temperatures. Acceptance therefore depends on safeguarding comfort within narrow limits and ensuring transparent communication about system operation.

Trust in implementing actors—utilities, aggregators, or distribution system operators—also plays a central role. Low baseline trust is associated with reduced willingness to participate, while confidence in local actors can facilitate enrolment and retention. Financial incentives matter, but they rarely compensate for perceived risks to comfort, autonomy, or fairness.

EV charging and V2G: a differentiated case

Electric vehicle charging represents a distinct domain within DSF. Compared to the general population, EV owners tend to be more technologically engaged and more responsive to financial incentives. Smart charging—where charging is shifted to off-peak hours or adjusted automatically—is broadly accepted under certain conditions. Financial savings are the primary motivator, and many EV users actively monitor prices and adjust charging accordingly.

As in other domains, autonomy remains important. Users consistently prefer self-managed charging or automated schemes that include override options. Acceptance declines when charging is fully controlled by external actors without user intervention rights.

Vehicle-to-grid (V2G), which involves discharging electricity from the vehicle battery back to the grid, presents a more complex acceptance landscape. While some users express interest, many voice concerns related to range anxiety and battery degradation. In contrast to smart charging, financial incentives alone are often insufficient to secure support. Functional guarantees—such as minimum battery levels or guaranteed range—are frequently more influential than monetary rewards. Across studies, safeguarding mobility and protecting battery longevity emerge as primary conditions for participation. As a result, V2G acceptance remains more fragile and context-dependent than smart charging.

Cross-cutting drivers and barriers

Across all DSF measures, financial considerations are consistently cited as important motivators. However, the broader pattern indicates that money is necessary but not sufficient. Households weigh potential savings against perceived inconvenience, reduced comfort, and loss of autonomy. In many cases, comfort and control are prioritized over moderate financial gains.

Trust, fairness perceptions, and clarity of communication further shape acceptance. Respondents are more willing to engage when they perceive that benefits are shared equitably and that programmes are transparent. Environmental concern can function as a complementary motivator, particularly among climate-conscious groups, but rarely outweighs practical considerations.

Overall, the findings reveal a structural tension within prevailing DSF strategies. Policy frameworks frequently rely on activating consumers through increasingly cost-reflective and dynamic price signals. Yet the evidence indicates that most households prefer simplicity, predictability, and minimal disruption. Automation and system-level load control—when designed to preserve comfort and user

authority—appear more tolerable. These insights provide a foundation for rethinking how flexibility policies can be designed to better reflect behavioural realities and enhance public acceptance at scale.

2. Acceptance of Heating Decarbonization Measures (Manuscript in preparation)

This section summarizes the findings of the systematic review on social acceptance of low-carbon heating and cooling technologies, including heat pumps, district heating and cooling, hybrid systems, hydrogen heating, renewable heat obligations, and associated retrofit requirements. Compared to demand-side flexibility, heating system transitions are characterized by high upfront investment costs, long lifetimes, infrastructural dependency, and significant household disruption. As a result, acceptance dynamics differ in important ways. Across the literature, five major patterns emerge: inertia driven by satisfaction with incumbent systems; low awareness and knowledge; the dominance of cost considerations; the complementary role of environmental motives and trust; and strong expectations of government involvement.

Inertia and satisfaction with existing systems

A consistent finding across countries is pronounced inertia in residential heating. Large-scale comparative surveys across Europe show very high levels of satisfaction with existing heating systems, particularly natural gas boilers. In a survey of more than 10,000 households across five European countries, fewer than 10% reported dissatisfaction with their current system, and most respondents indicated that they were unlikely to switch technologies in the near future [5]. In several contexts, respondents appear largely indifferent to the specific technology providing heat, focusing instead on the service it delivers: warmth, reliability, convenience, and predictable cost.

Qualitative studies reinforce this pattern. In UK focus groups, participants frequently describe gas heating as familiar, reliable, and affordable, while low-carbon alternatives are perceived as unfamiliar and risky [6]. Age effects are notable, with older homeowners particularly reluctant to consider system replacement. This inertia does not necessarily reflect strong opposition to low-carbon heating; rather, it reflects satisfaction with the status quo combined with low salience of heating as a policy issue. Heating systems are often “background technologies” that receive little attention unless they fail.

Low awareness and knowledge

A second pervasive finding concerns low levels of awareness and knowledge. Across countries, many households report limited familiarity with low-carbon heating technologies, installation requirements, or available policy support. Surveys in Greece [10], the UK [11], and Germany [12] show that large shares of respondents are unfamiliar with basic aspects of heat pump functioning, installation procedures, or retrofit readiness. In one English survey, nearly 90% of homeowners reported low or no awareness of what is required to make their home heat-pump-ready.

Importantly, awareness gaps extend beyond technologies to policy instruments. In several UK studies, awareness of national subsidy schemes and low-interest loan programmes is strikingly low . Similar patterns are observed in other countries, where respondents often report uncertainty about whether specific regulatory or support mechanisms even exist.

Experimental evidence suggests that information provision can increase short-term stated willingness to adopt heat pumps. Normative framing, financial information, and clear communication of benefits can raise support levels in survey settings . However, the effects are heterogeneous and sometimes technology-specific. In some cases, more detailed information reduces interest, particularly where installation complexity or disruption becomes more salient. Moreover, most of this evidence is based on short-term attitudinal shifts rather than observed long-term adoption behavior. Information alone appears insufficient to overcome structural financial barriers.

At the same time, several studies indicate substantial latent support for heat pumps when framed in hypothetical replacement scenarios. In France, Germany, Switzerland [7], Ireland [8], and Canada [9]., between roughly one-third and over half of homeowners state that they would consider installing a heat pump when replacing their existing system. However, this stated willingness coexists with low actual replacement rates, suggesting that intention does not automatically translate into action in the presence of cost, hassle, and uncertainty.

Environmental motives, trust, and perceived hassle

While financial considerations dominate, environmental concern plays a complementary role. Among existing adopters of heat pumps, environmental motivations are often cited as important drivers. However, in broader population surveys, environmental attributes typically rank

below cost and comfort in importance. Economic considerations consistently outweigh purely environmental motivations in shaping stated preferences.

Trust in implementing actors further conditions acceptance. Studies from the Netherlands [15] and the UK [16] show that support for heating decarbonisation is closely linked to trust in municipalities, housing corporations, and energy providers. Even where general support for decarbonisation exists, low institutional trust can undermine willingness to engage with specific projects.

Perceived hassle and disruption also play a non-trivial role. Installation-related inconvenience, uncertainty about required home modifications, and fear of performance problems amplify financial concerns and increase perceived risk. In choice experiments, high installation hassle significantly reduces willingness to pay, even when long-term savings are substantial . Hassle thus operates less as an independent barrier and more as a multiplier of cost sensitivity.

Expectations of government involvement

Finally, a recurring theme is the expectation that government should play a central and active role in managing the heating transition. Across contexts, households widely view public financial support as a prerequisite for large-scale adoption. Subsidies consistently receive strong support, while more coercive instruments such as carbon taxes or mandatory regulations face greater resistance .

Importantly, expectations extend beyond financial support. Studies highlight calls for clearer regulatory frameworks, coordination of retrofit readiness, reform of electricity-to-gas price ratios, improved information provision, and structured advisory services such as “one-stop shops” for homeowners. Heating decarbonisation is frequently perceived not as a purely individual choice but as a system-level transformation requiring coordinated public leadership.

Taken together, the evidence suggests that heating decarbonisation faces structural inertia rooted in satisfaction with existing systems, limited knowledge, high upfront costs, and risk perceptions. While stated support for low-carbon technologies is often substantial, actual adoption remains constrained by financial realities and practical barriers. Policies that combine meaningful cost reduction, risk mitigation, clear communication, and visible public coordination are therefore more likely to achieve durable acceptance than approaches relying solely on information provision or voluntary market uptake.

3. Acceptance of Renovation and Thermal Envelope Upgrades (Work in progress)

This thematic strand remains the least developed of the three reviews and is still being refined. Nevertheless, the current synthesis, drawing on more than one hundred empirical studies across nearly thirty countries, reveals consistent structural patterns in how households and other actors perceive and engage with renovation and thermal envelope upgrades. Compared to heating system replacement or demand-side flexibility, renovation measures—such as insulation, window replacement, façade upgrades, and deep retrofits—are more disruptive, multi-actor, and institutionally complex. Acceptance is therefore shaped not only by financial considerations, but also by tenure arrangements, life-course events, aesthetics, transaction costs, and lived post-renovation experiences.

Tenure, Income, and Life-Course Effects in Renovation Decisions

Across countries, renovation activity is highly uneven. Owner-occupiers—particularly those in detached or older dwellings—are significantly more likely to undertake energy-related upgrades than renters. Private tenants consistently exhibit the lowest uptake, reflecting the well-documented landlord–tenant split incentive. Multifamily buildings present additional coordination challenges, including collective decision-making constraints and difficulties mobilising capital.

Income and housing tenure are strong predictors of adoption of high-cost measures such as façade insulation or window replacement. Lower-income households tend to focus on incremental or low-cost measures unless generous subsidies are available. Renovation is also frequently linked to life-course events—such as home purchase, childbirth, or retirement. Energy upgrades are rarely undertaken as stand-alone “climate decisions”; instead, they are embedded in broader home improvement projects driven by comfort, aesthetics, or functional needs. This suggests that policy interventions may be more effective when aligned with natural renovation cycles rather than framed solely around energy performance targets.

Cost is decisive—but intertwined with risk and hassle

As in the heating review, cost emerges as the most consistent determinant of renovation decisions. High upfront investment requirements, long perceived payback periods, liquidity constraints, and debt aversion frequently deter households from undertaking envelope upgrades. Direct grants and subsidies consistently receive the strongest support across contexts, while loan-based instruments are viewed more cautiously, particularly among lower-income and older households.

However, financial barriers cannot be reduced to affordability alone. Risk perception and uncertainty play a central role. Households express concern about contractor reliability, unforeseen costs, and uncertain performance outcomes. Even when long-term savings are acknowledged, present bias and loss aversion often dominate decision-making. Modest advisory fees or complex administrative procedures can deter participation, indicating that transaction costs are highly salient.

Evidence from large-scale retrofit programmes shows that simplifying processes and reducing friction—through coordinated delivery, trusted intermediaries, and minimal administrative burden—can significantly increase participation. Financial support appears most effective when combined with institutional arrangements that reduce uncertainty and cognitive load.

Comfort and aesthetics drive motivation

While cost determines whether renovation occurs, comfort is often the primary reason why it occurs. Across studies, households frame renovation in terms of improved thermal stability, reduced drafts, better indoor air quality, noise reduction, and overall liveability. Energy savings and climate mitigation are rarely cited as primary motivations, though they reinforce decisions once comfort improvements are recognized.

Aesthetic considerations further shape acceptance. Homeowners frequently resist measures perceived to alter the architectural character of their homes, particularly in heritage contexts. External wall insulation and window replacement may face opposition when visual change is deemed intrusive. This suggests that renovation policy framed exclusively in energy or carbon terms risks misalignment with household priorities. Integrating design quality, comfort narratives, and architectural sensitivity appears critical for broader acceptance.

Post-renovation experiences: benefits and risks

Post-occupancy evaluations reveal generally positive outcomes but also important caveats. Many households report improved winter comfort, reduced dampness, and lower energy bills following renovation. In some contexts, health improvements are observed, particularly in previously cold or poorly insulated homes.

At the same time, unintended consequences are common. Overheating in summer, ventilation challenges, usability frustrations, and discrepancies between predicted and actual energy savings are frequently documented. A recurring “comfort–performance paradox” emerges in some cases: households report higher satisfaction and warmth but do not necessarily reduce energy consumption as

expected. These findings highlight that technical compliance with energy standards does not automatically translate into intended energy outcomes. User training, ventilation integration, and realistic performance modelling are therefore crucial.

Governance and structural barriers

Renovation acceptance is deeply embedded in governance structures. The landlord–tenant dilemma remains a major barrier, with landlords lacking incentives to invest and tenants lacking authority to decide. Some evidence suggests cautious support for stronger regulation, such as minimum energy performance standards, provided cost burdens are perceived as fair and predictable.

Across contexts, households and building owners frequently expect active public coordination. Beyond subsidies, there are calls for clearer regulatory frameworks, stable long-term policy signals, improved information provision, and "one-stop-shop" advisory services. The evidence suggests that renovation is widely perceived not as a purely private consumption choice, but as a system-level transformation requiring coordinated institutional support.

Preliminary conclusions

Although still under development, this review indicates three overarching patterns. First, renovation decisions are primarily framed as housing-quality decisions rather than environmental ones. Comfort, aesthetics, and liveability dominate motivations, with energy and carbon considerations playing a secondary role. Second, cost is a real and structural barrier, not merely a perception issue. However, financial support must be paired with friction reduction, trust-building, and administrative simplification to be effective. Third, social acceptance depends heavily on lived experience. Performance gaps, overheating, and poorly managed installations risk undermining trust in future retrofit waves.

Taken together, the evidence suggests that accelerating envelope renovation requires more than financial incentives or technical standards. It requires an integrated approach that combines meaningful cost reduction, simplified delivery structures, user-centred design, and stable governance frameworks capable of aligning climate objectives with everyday housing realities.

4. Methodological Toolkit for Future Research on Public Acceptance in Building Decarbonization (Work in progress)

One of the original objectives of this project was to provide methodological guidance for future research on public acceptance of energy-related interventions in buildings. Rather than conducting a separate and largely overlapping systematic review of methods in sustainability research more broadly, methodological insights were systematically extracted from the empirical studies included across the three thematic strands of this project.

Drawing on more than three hundred empirical studies across OECD contexts, this section distils recurring methodological patterns, strengths and limitations of existing approaches, and design recommendations for future research. The aim is not to prescribe a single "best" method, but to provide a structured and context-sensitive toolkit that can guide researchers in designing robust and policy-relevant studies of public acceptance in the building sector.

Conceptualising and Operationalising "Acceptance"

A first methodological challenge concerns the conceptualisation of acceptance itself. Across the reviewed literature, "acceptance" is operationalised in multiple ways, often without clear distinction. Some studies measure general attitudes or support for a policy; others assess willingness to pay (WTP), willingness to switch tariffs, willingness to adopt a technology, or stated behavioural intentions. A smaller subset examines actual behaviour in field trials or revealed adoption data.

These constructs are not interchangeable. Positive attitudes toward a technology do not necessarily translate into willingness to incur costs, and stated willingness does not guarantee actual uptake. For example, in heating studies, substantial stated openness to heat pumps coexists with low real-world adoption rates. Similarly, in demand-side flexibility research, positive attitudes toward automation do not always lead to enrolment in programs.

Future research should therefore:

- Explicitly define which dimension of acceptance is being measured (attitude, intention, WTP, behavioural uptake, persistence).
- Distinguish between hypothetical and revealed behaviour.
- Clarify whether the focus is on short-term support or long-term behavioural commitment.
- Where possible, combine attitudinal and behavioural measures to better capture intention–action gaps.

Research Design Typologies: Strengths and Limitations

The literature on public acceptance in building decarbonization employs a diverse set of research designs. The most common are cross-sectional surveys, discrete choice experiments (DCEs), qualitative interviews and focus groups, field trials, and mixed-method approaches. Each design has distinct advantages and limitations.

Cross-sectional surveys are widely used to map attitudes, awareness, and general preferences across large populations. They offer statistical generalizability but are limited in capturing causal mechanisms or behavioural persistence. They are particularly suited for identifying broad patterns, such as levels of awareness of subsidy schemes or trust in implementing actors.

Discrete choice experiments are frequently used to estimate trade-offs between cost, comfort, environmental benefits, and other attributes. They are powerful tools for isolating preferences and estimating willingness to pay. However, they are vulnerable to hypothetical bias, framing effects, and simplified scenarios that may not reflect real-world complexity.

Qualitative interviews and focus groups provide rich insights into lived experience, perceived risk, and the meanings attached to technologies. They are particularly valuable for understanding inertia, trust, and perceived hassle. Their limitation lies in smaller sample sizes and limited statistical generalizability.

Field trials and pilot programs, though less common, provide the most direct evidence of behavioural responses. They can reveal rebound effects, comfort–performance gaps, and long-term engagement patterns. However, they are resource-intensive and often context-specific.

Mixed-method designs that combine quantitative and qualitative approaches appear particularly promising. Several studies demonstrate that pairing surveys or DCEs with follow-up interviews or field data enhances interpretive depth and strengthens conclusions.

Recurring Biases and Weaknesses

Several methodological weaknesses recur across the literature. First, there is an over-reliance on stated intentions. Many studies measure hypothetical willingness without tracking actual adoption or behavioural persistence. This risks overestimating public readiness for change. Second, samples are often skewed toward homeowners, higher-income households, or sustainability-engaged respondents. Lower-income groups and private

tenants—who face distinct barriers—are underrepresented. Third, longitudinal designs are rare. Behavioural fatigue, rebound effects, and evolving attitudes over time are insufficiently studied. Fourth, administrative and transaction costs are frequently abstracted away in survey experiments, even though qualitative evidence suggests that small bureaucratic burdens significantly deter participation.

Future research should seek to:

- Incorporate longitudinal elements where possible.
- Ensure broader demographic representation.
- Include realistic administrative and hassle components in experimental designs.
- Compare stated preferences with revealed behavioural data.

To further operationalize the methodological guidance developed in this section, a structured method–objective framework has been developed as a supplementary document to this report. The framework matches common research objectives in the study of public acceptance—such as measuring general attitudes, estimating trade-offs, testing behavioural response, evaluating lived experience, exploring resistance, or tracking change over time—with appropriate methodological approaches, including surveys, discrete choice experiments, field trials, post-occupancy evaluations, interviews, focus groups, workshops, longitudinal designs, and evidence synthesis methods. The framework is provided as a standalone supplementary document to facilitate practical use in research design, doctoral training, and future project development.

4 Diskussion

Cross-Cutting Patterns in Public Acceptance Across Building Interventions

Across demand-side flexibility, heating system transitions, and renovation measures, a set of strikingly consistent patterns emerges. Despite differences in technology and policy design, public responses appear to be structured by a small number of recurring concerns: financial uncertainty, upfront cost exposure, perceived hassle, risk of underperformance, and trust in implementing actors. Environmental concern, while present, rarely overrides these more immediate considerations.

A first cross-cutting pattern is a strong aversion to financial uncertainty. Households consistently prefer predictability over potential gains. In the context of demand-side flexibility, highly dynamic pricing schemes such as real-time pricing are viewed with scepticism, even when framed as cost-reflective or efficiency-enhancing. Fixed tariffs and clearly structured time-of-use models are consistently preferred to volatile arrangements. Similarly, in heating and renovation decisions, ambiguous payback periods, uncertain energy savings, and fluctuating future electricity prices weaken willingness to invest. The promise of long-term savings—particularly when framed over 15–20 years—rarely appears sufficient to offset perceived short-term financial risk.

Closely related is a second pattern: reluctance to incur significant upfront costs. Across all three domains, cost is the most powerful and consistent determinant of acceptance. Whether in the case of heat pump installation, façade insulation, or participation in flexibility programmes, households show limited willingness to commit capital without substantial financial support. Direct subsidies receive consistently stronger support than loans or price-based incentives. Even when long-term savings are demonstrable, liquidity constraints, debt aversion, and loss aversion appear to dominate decision-making. In practice, many households evaluate interventions not as investments with discounted future returns, but as immediate financial burdens with uncertain outcomes.

However, financial concerns alone do not fully explain resistance. A third recurring pattern concerns the perceived burden of hassle, complexity, and disruption. Across studies, respondents express concern not only about paying for technologies, but about navigating the process of adoption: identifying trustworthy installers, managing administrative procedures, tolerating installation-related disruption, and coping with uncertainty regarding performance. In heating and renovation contexts, perceived hassle often amplifies cost sensitivity. Even relatively modest administrative requirements or advisory fees can deter

participation. In demand-side flexibility, behavioural fatigue and inconvenience limit sustained engagement, particularly when financial rewards are modest.

A fourth cross-cutting theme is the central role of trust and comfort. Trust in utilities, municipalities, contractors, and government agencies consistently mediates acceptance. Low institutional trust reduces willingness to participate, even where financial incentives are substantial. At the same time, comfort expectations—particularly thermal comfort—set firm boundaries on acceptable intervention. Flexibility schemes that threaten indoor temperature stability or EV range provoke resistance unless robust safeguards are provided. Across domains, households prioritise reliability, autonomy, and stability over marginal economic gains.

Environmental concern, while frequently cited in surveys, rarely emerges as a decisive driver when weighed against cost, convenience, and risk. Among early adopters of technologies such as heat pumps, environmental motives often play a reinforcing role. Yet in broader populations, economic and practical considerations dominate. Climate arguments alone appear insufficient to generate large-scale voluntary uptake, particularly when interventions involve financial exposure or lifestyle disruption.

Taken together, these findings suggest that public acceptance of building decarbonization measures is shaped less by ideological opposition and more by risk management and pragmatism. Households evaluate interventions through the lens of financial exposure, administrative burden, comfort stability, and trust in delivery systems. Policies that assume households will respond enthusiastically to long-term efficiency gains or abstract environmental benefits underestimate the salience of short-term costs and practical constraints.Where interventions reduce uncertainty, limit upfront exposure, simplify participation, and safeguard comfort, acceptance increases. Where policies shift financial or operational risk onto households—whether through volatile pricing, ambiguous payback periods, or complex installation processes—resistance intensifies.

This cross-cutting pattern carries important implications. It suggests that the core challenge of building decarbonization is not primarily attitudinal, but structural. Acceptance depends less on persuading households of environmental urgency and more on designing interventions that minimise uncertainty, reduce friction, and align with the routines and risk perceptions of everyday life.

Implications for the Design and Governance of Building Decarbonization Policies

The cross-cutting patterns identified in this report carry clear implications for the design and governance of building decarbonization policies. Most importantly, they suggest that policy frameworks built on assumptions of active, risk-neutral, and financially optimizing consumers are unlikely to generate large-scale voluntary uptake. Instead, acceptance appears to increase when policies reduce uncertainty, lower upfront exposure, simplify participation, and embed flexibility or efficiency measures within stable institutional arrangements.

A first implication concerns the limits of price-based activation strategies. In demand-side flexibility policy, there has been a strong emphasis on increasingly granular and cost-reflective price signals intended to incentivize behavioural adaptation. Yet the evidence indicates that households prefer predictability over volatility and are reluctant to expose themselves to financial risk for modest gains. This suggests that highly dynamic pricing alone is unlikely to achieve broad-based flexibility. Greater reliance on automation, default enrolment, and system-level coordination—combined with strong user safeguards such as override options—may prove more consistent with observed preferences.

A second implication relates to the structure of financial support. Across heating and renovation contexts, cost remains the dominant barrier to adoption. Long-term savings framed over extended time horizons rarely compensate for high upfront costs and perceived risk. Policies that depend primarily on loans or future bill reductions place financial and cognitive burdens on households. In contrast, direct subsidies, risk-sharing mechanisms, pay-as-you-save models, and coordinated procurement schemes align more closely with the documented preference for low upfront exposure and predictable outcomes. This does not imply that public funding must cover all costs, but it does suggest that risk allocation and liquidity constraints must be explicitly addressed in policy design.

Third, governance arrangements that reduce administrative complexity and transaction costs are likely to enhance acceptance. The evidence consistently shows that perceived hassle—finding installers, navigating permits, understanding eligibility criteria—acts as a deterrent. “One-stop-shop” advisory services, standardized procedures, trusted intermediaries, and coordinated retrofit programs can significantly lower participation barriers. Policy design should therefore focus not only on financial incentives but also on delivery architecture.

Fourth, trust-building emerges as a core governance task. Acceptance is strongly mediated by confidence in implementing actors. Transparent communication, clear accountability, stable regulatory frameworks, and visible quality assurance mechanisms can mitigate perceived risk. Conversely, fragmented responsibilities, shifting policy signals, or poorly managed installations risk eroding trust and undermining future waves of implementation.

Finally, the findings suggest that building decarbonization should be governed as a system transformation rather than a series of isolated consumer choices. Heating transitions, renovation programs, and flexibility measures are frequently perceived not as discretionary lifestyle upgrades but as structural changes requiring coordination. Where governments provide clear long-term direction, stable support schemes, and coherent regulatory frameworks, acceptance appears more robust.

In sum, the evidence indicates that socially sustainable building decarbonization depends on shifting from a narrow focus on behavioural activation toward institutional design that minimizes risk, reduces friction, and embeds new technologies within trusted governance structures. Policies that internalize these principles are more likely to achieve durable acceptance and large-scale impact.

Methodological Lessons and Priorities for Future Research

The synthesis undertaken in this project also reveals important methodological lessons for the future study of public acceptance in building decarbonization. A first methodological pattern is the dominance of cross-sectional survey research. Surveys have been indispensable for mapping attitudes, awareness levels, trust, and stated willingness to adopt. However, the strong reliance on hypothetical responses risks overstating readiness for change. Positive attitudes toward low-carbon heating or flexibility measures do not consistently translate into adoption, and intention–action gaps are common. Future research should therefore move beyond attitudinal mapping and more systematically integrate behavioural and longitudinal components.

Second, discrete choice experiments have provided valuable insight into trade-offs between cost, comfort, autonomy, and environmental attributes. Yet these designs frequently abstract from administrative burdens, liquidity constraints, and the cumulative complexity of real decision-making. Experimental scenarios that omit installation hassle, financing friction, or uncertainty about performance may overestimate acceptance. Incorporating more realistic contextual constraints into stated-preference designs would improve policy relevance.

Third, longitudinal evidence remains limited. Few studies track how attitudes, satisfaction, or behavioural engagement evolve over time following implementation. Yet the literature on flexibility and renovation indicates that behavioural fatigue, adaptation processes, and performance gaps can significantly alter initial responses. Greater use of panel surveys, post-occupancy evaluations, and long-term field trials would strengthen understanding of persistence and durability.

Fourth, important population segments remain underrepresented. Lower-income households, private tenants, and residents of multifamily buildings face distinct structural constraints, yet are often absent or under-sampled in existing research. More inclusive sampling strategies and targeted subgroup analysis are necessary to avoid biased conclusions and to inform equitable policy design. Finally, the field would benefit from more integrated and mixed-method research designs. Combining surveys or discrete choice experiments with qualitative interviews, administrative data, or field trials can provide a more robust understanding of both preferences and behaviour.

Strategic Directions for Accelerating Socially Sustainable Building Transitions

The findings of this project suggest that accelerating building decarbonization requires not only technological innovation and financial incentives, but a reorientation of governance design toward risk reduction, institutional coordination, and friction minimization. Across flexibility, heating, and renovation domains, acceptance appears highest where policies reduce uncertainty, limit upfront exposure, safeguard comfort, and simplify participation. These patterns point toward strategic adjustments in how building transitions are structured and delivered.

In the area of demand-side flexibility, the evidence highlights a particularly important opportunity. While households demonstrate reluctance toward highly volatile, real-time price contracts, they are often more open to automation and direct load control—provided comfort and autonomy are protected. This suggests that resistance is directed less at flexibility itself than at the financial uncertainty and behavioural burden associated with price-based activation.

There are two complementary strategic paths for miving forward. The first involves expanding the deployment and study of explicit flexibility measures, such as automated load management, smart charging defaults, and coordinated heating adjustments, embedded within clearly defined comfort boundaries and supported by transparent override mechanisms. These measures appear socially more acceptable than highly dynamic

pricing, yet remain comparatively underdeveloped in both policy experimentation and research.

The second path concerns embedding flexibility more systematically at the system level [17]. Rather than relying primarily on households to interpret price signals and manually adjust consumption, flexibility could be coordinated through regulated technical standards, default automation, and regionally or municipally managed programs . Such approaches would shift the burden of optimization from individual users to institutional actors better equipped to manage system complexity. If designed to preserve user comfort and minimize costs, system-level coordination could enhance both grid performance and public acceptance.

For heating and renovation transitions, the strategic implications are similarly clear. The dominant barriers are not attitudinal opposition, but exposure to financial risk and procedural complexity. Long payback periods and uncertain savings do not resonate strongly with households facing high upfront costs and perceived installation risks. If acceptance depends on risk minimization, policy design must focus explicitly on reducing or eliminating downside exposure.

Future policy experimentation should therefore explore instruments that move beyond conventional loan-based support. Models such as pay-as-you-save schemes, regulated bill surcharges tied to verified performance, collective procurement mechanisms, or publicly guaranteed savings frameworks may better align with observed preferences. The critical principle is that households should not bear disproportionate financial risk for system-level transitions. Instruments that guarantee cost neutrality or clearly bounded financial exposure may significantly increase willingness to adopt.

Equally important is the reduction of administrative and cognitive burden. Across studies, the process of identifying installers, comparing offers, navigating subsidy schemes, and managing installation disruption constitutes a major deterrent. Publicly coordinated “one-stop-shop” models—providing standardized information, vetted contractors, bundled services, and long-term maintenance arrangements—could substantially lower participation barriers. In this context, governance design becomes as important as financial support.

A broader implication is that the state may need to assume a more active coordinating role in building transitions. Where programs include quality assurance, performance monitoring, maintenance guarantees, and clear accountability structures, perceived risk declines. Conversely, fragmented responsibility and market-based navigation can amplify uncertainty and

erode trust. Future research should therefore examine how publicly guided, system-oriented programs can be structured to reduce user burden while maintaining cost efficiency and technical performance.

Taken together, the evidence suggests that socially sustainable building transitions will depend less on persuading households to behave as active energy optimizers and more on designing institutional arrangements that align decarbonization objectives with everyday risk perceptions and comfort expectations. Policies that internalize these behavioural realities—by reducing uncertainty, simplifying engagement, and embedding coordination at the system level—are more likely to achieve durable acceptance and large-scale impact.

5 Publikationslista

1. El Gohary, F. & Stikvoort, B., 2025. Public acceptance of building decarbonization measures: A systematic literature review. In: Proceedings of BEHAVE 2025 – Behaviour and Energy Efficiency Conference, [Paris, France], pp. 125–129.

2. El Gohary, F., Fairbrother, M., & Stikvoort, B. (2026). Understanding social acceptance of demand-side flexibility: Lessons from a decade of global research (2015–2025). **(Manuscript under review, Renewable & Sustainable Energy Reviews)**

3. El Gohary, F., Fairbrother, M., & Stikvoort, B. (2026). Social acceptance of low-carbon heating transitions: Evidence from a systematic review of international research. **(Manuscript in progress.)**

4. El Gohary, F. (2026). Public acceptance of building retrofits and thermal envelope upgrades: Drivers, barriers, and governance implications. **(Manuscript in progress.)**

5. El Gohary, F. (2026). Public acceptance and electricity governance in building decarbonisation. Paper accepted for presentation at the European Consortium for Political Research (ECPR) General Conference. Available at: https://ecpr.eu/Events/Event/PaperDetails/90874

6 Referenser, källor

[1] D. Tranfield, D. Denyer, and P. Smart, “Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review,” *British J of Management*, vol. 14, no. 3, pp. 207–222, Sep. 2003, doi: 10.1111/1467-8551.00375.

[2] J. Thomas and A. Harden, “Methods for the thematic synthesis of qualitative research in systematic reviews,” *BMC Med Res Methodol*, vol. 8, no. 1, p. 45, Dec. 2008, doi: 10.1186/1471-2288-8-45.

[3] W. Bandara and R. Syed, “The role of a protocol in a systematic literature review,” *Journal of Decision Systems*, vol. 33, no. 4, pp. 583–600, Oct. 2024, doi: 10.1080/12460125.2023.2217567.

[4] PRISMA-P Group *et al.*, “Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement,” *Syst Rev*, vol. 4, no. 1, p. 1, Dec. 2015, doi: 10.1186/2046-4053-4-1.

[5] B. K. Sovacool, C. Demski, and L. Noel, “Beyond climate, culture and comfort in European preferences for low-carbon heat,” *Global Environmental Change*, vol. 66, p. 102200, Jan. 2021, doi: 10.1016/j.gloenvcha.2020.102200.

[6] J. A. Gordon, N. Balta-Ozkan, and S. A. Nabavi, “Divergent consumer preferences and visions for cooking and heating technologies in the United Kingdom: Make our homes clean, safe, warm and smart!,” *Energy Research & Social Science*, vol. 104, p. 103204, Oct. 2023, doi: 10.1016/j.erss.2023.103204.

[7] E. Côté and C. Pons-Seres De Brauwer, “Preferences of homeowners for heat-pump leasing: Evidence from a choice experiment in France, Germany, and Switzerland,” *Energy Policy*, vol. 183, p. 113779, Dec. 2023, doi: 10.1016/j.enpol.2023.113779.

[8] T. H. Meles, L. Ryan, and S. C. Mukherjee, “Heterogeneity in preferences for renewable home heating systems among Irish households,” *Applied Energy*, vol. 307, p. 118219, Feb. 2022, doi: 10.1016/j.apenergy.2021.118219.

[9] A. Pardy, E. Rhodes, and M. Jaccard, “Characterizing air source heat pump market segments: A Canadian case study,” *Front. Sustain.*, vol. 3, p. 983454, Aug. 2022, doi: 10.3389/frsus.2022.983454.

[10] S. Karytsas, “An empirical analysis on awareness and intention adoption of residential ground source heat pump systems in Greece,” *Energy Policy*, vol. 123, pp. 167–179, Dec. 2018, doi: 10.1016/j.enpol.2018.08.001.

[11] R. Chitchyan, “Overcoming barriers to heat pump adoption among able-to-pay households,” *Energy Policy*, vol. 206, p. 114660, Nov. 2025, doi: 10.1016/j.enpol.2025.114660.

[12] C. C. Michelsen and R. Madlener, “Switching from fossil fuel to renewables in residential heating systems: An empirical study of homeowners’ decisions in Germany,” *Energy Policy*, vol. 89, pp. 95–105, Feb. 2016, doi: 10.1016/j.enpol.2015.11.018.

[13] M. A. Brown, S. Kale, M.-K. Cha, and O. Chapman, “Exploring the willingness of consumers to electrify their homes,” *Applied Energy*, vol. 338, p. 120791, May 2023, doi: 10.1016/j.apenergy.2023.120791.

[14] N. Lamb and D. Elmes, “Increasing heat pump adoption: analysing multiple perspectives on preparing homes for heat pumps in the UK,” *Carb Neutrality*, vol. 3, no. 1, p. 10, Dec. 2024, doi: 10.1007/s43979-024-00084-w.

[15] S. R. Jansma, J. F. Gosselt, and M. D. T. de Jong, “Kissing natural gas goodbye? Homeowner versus tenant perceptions of the transition towards sustainable heat in the Netherlands,” *Energy Research & Social Science*, vol. 69, 2020, doi: 10.1016/j.erss.2020.101694.

[16] W. Smith, C. Demski, and N. Pidgeon, “Public perceptions of heat decarbonisation in Great Britain: Awareness, values and the social circle effect,” *Energy Research & Social Science*, vol. 119, p. 103844, Jan. 2025, doi: 10.1016/j.erss.2024.103844.

[17] F. El Gohary, “Command and control: A systematic approach to demand-side flexibility,” *Utilities Policy*, vol. 99, p. 102137, Apr. 2026, doi: 10.1016/j.jup.2025.102137.

7 Bilagor

Method–Objective Matching Framework

1. Measuring general attitudes, sentiments, and stated preferences

→ Cross-sectional survey

Used to estimate population-level support, awareness, trust, perceived fairness, and stated willingness.

2. Measuring change in attitudes or normalization over time

→ Longitudinal survey (panel or repeated cross-section)

Used to track shifts in opinion, adaptation to policies, and evolving acceptance.

3. Estimating trade-offs, choices, and willingness to pay

→ Discrete Choice Experiment (DCE) / Conjoint analysis

Used to isolate how respondents weigh cost, comfort, autonomy, environmental impact, or risk.

4. Measuring actual behaviour and behavioural response

→ Field trials / Pilot programs

Used to observe real participation, load shifting, enrolment, persistence, and rebound effects under real-world conditions.

5. Evaluating lived experience and performance after implementation

→ Post-Occupancy Evaluation (POE)

Used to assess satisfaction, comfort, usability, unintended consequences, and performance gaps after heating or renovation interventions.

Particularly suited for studying comfort–performance paradoxes and long-term user adaptation.

This is distinct from general “field trials” because it focuses on post-implementation experience rather than immediate behavioural response.

6. Understanding mechanisms, resistance, and in-depth meaning

→ In-depth interviews

Used to uncover inertia, trust dynamics, risk perception, perceived hassle, identity effects, and the intention–action gap.

7. Exploring diverse or contested perspectives and social dynamics

→ Focus groups

Used to capture disagreement, collective framing, normative tensions, and group-level meaning-making.

Particularly useful when studying controversial policies or community-level interventions.

8. Co-producing knowledge, testing framing, or developing policy solutions collaboratively

→ Workshops / Participatory workshops

Used to explore stakeholder interaction, scenario testing, and co-design of policy instruments.

Particularly suited for transition governance contexts and multi-actor environments.

9. Synthesizing existing knowledge

→ Systematic literature review

→ Meta-analysis