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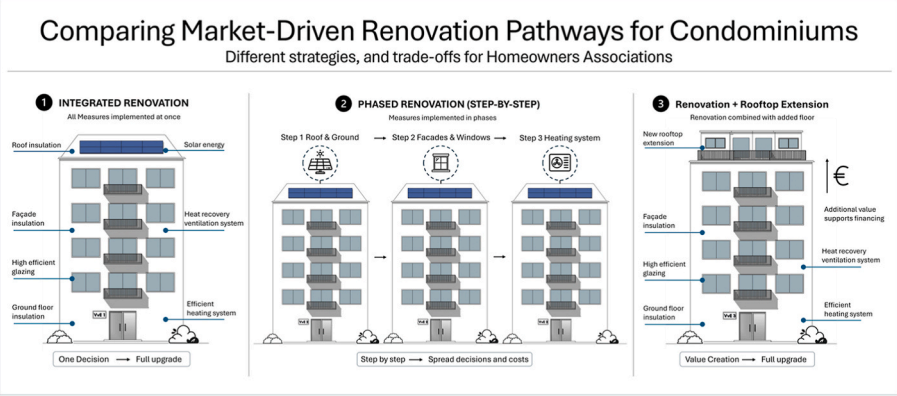
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Adoption dynamics of integrated home renovation pathways by homeowner associations: A multi-case study from the Netherlands

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GRAPHICAL ABSTRACT



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ABSTRACT

The uptake of deep energy renovations in European condominiums remains limited, despite the emergence of innovative Integrated Home Renovation Services (IHRS) that aim to reduce recognized barriers. Despite introducing new renovation possibilities, the extent to which these services are adopted is shaped by homeowners' views of their relevance, feasibility, and associated risks. The paper examines homeowners' experiences with market-driven renovation pathways and highlights the key conditions required to enable their wider adoption. This study aims to answer the question: How are market-driven renovation pathways perceived and adopted by homeowner associations, and how do different renovation pathways shape these adoption dynamics? The study draws on four Dutch case studies representing different pathways for energy renovation. These include two integrated renovation concepts built around a living-cost-neutral approach, a phased pathway combining completed and planned renovation measures, and a financing strategy based on densification through rooftop extensions. Empirical material was gathered through semi-structured interviews with private IHRS providers and homeowners, together with document review and expert workshops. Homeowners differed in how they experienced financial risks, governance issues, trust, and uncertainty during the process. The cases showed that progress was often slowed by the need for collective agreement, long and demanding processes, and a lack of

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alignment between institutions. Based on these findings, the study identifies implications for IHRS service and business-model design and for policy support, with lessons for adapting market-driven renovation pathways to other European condominium contexts.

1. Introduction

Recent policy frameworks like the European Green Deal, the revised Energy Performance of Buildings Directive (EPBD), and national climate strategies increasingly stress the need to accelerate deep energy renovation rates (Fetting, 2020; BPIE, 2024; EPBD, 2024). With the aim of decarbonizing the built environment by 2050, particularly in response to the energy crisis and the substantial contribution of the built environment to greenhouse gas emissions. The housing stock in Europe shares some similarities but also differences in ownership and governance structures. For example; In the Netherlands, a considerable share of dwellings is located in multi-apartment buildings governed by homeowner associations (HOAs) (CBS, 2024), which is similar in many European Cities. For HOAs, renovation decisions are often more complex than for individual homeowners, as they involve collective agreement between residents who may differ in financial means and priorities, making ambitious renovation plans harder to move forward (Ebrahimigharehbaghi et al., 2019; Streimikiene and Balezentis, 2019; Elgendy et al., 2024b). Research on HOAs has shown that renovation uptake is often hindered by financial uncertainty, complex governance arrangements, limited organizational capacity, and poor coordination between stakeholders (D'Oca et al., 2018; Ebrahimigharehbaghi et al., 2019; Elgendy et al., 2024a).

In response to these challenges, the EU has facilitated the establishment of one-stop shops (OSS) that provide Integrated Home Renovation Services (IHRS), which have developed as a promising approach to accelerate energy renovations in Europe (Bertoldi et al., 2021; Boza-Kiss et al., 2021; Milin and Bullier, 2021; Elgendy et al., 2024b). These services bring together different forms of support, including technical guidance, project coordination, financing options, and stakeholder management, with the aim of making renovation processes easier for homeowners and reducing the complexity of decision-making.

Parallel to these developments across Europe, some member states of the EU have developed mechanisms (Financial, regulatory, etc.) to support and facilitate the whole process. One of those member states that has a considerable share of HOAs and has already introduced several financial and policy instruments to encourage energy renovations in the residential sector was the Netherlands. Next to subsidies and financing schemes, initiatives such as the HOA Acceleration Agenda have been developed to address procedural, financial, and organizational issues that often slow down collective renovation decisions (BZK, 2023). Together, national information and advisory platforms—such as Milieu Centraal—have expanded their guidance and tools specifically for HOAs, improving access to independent technical and financial advice. Changes in regulation have also been introduced to make collective renovation decisions easier. One important adjustment was the reduction of the voting threshold for sustainability-related investments in HOAs, changing from a qualified majority to a simple majority (50% + 1) in an effort to ease governance-related barriers. In addition, Dutch municipalities can access national funding schemes to support and guide HOAs through the energy renovation process. Together, these instruments reflect a concerted effort by the Dutch government to increase renovation rates and to stimulate the renovation market in order to meet national climate and energy targets, as well as broader European objectives.

As a result, Dutch HOAs can rely on a relatively wide range of public support measures intended to stimulate energy renovations (RVO, 2025). Examples include dedicated subsidy schemes for energy renovations (e.g., *Subsidieregeling Verduurzaming voor Verenigingen van Eigenaars*), government-backed energy-saving and low-interest loans, as well as complementary support mechanisms such as the VvE Ledenle ning from the Nationaal Warmtefonds to help individual members cope with increased contributions and prevent the "renoviction" dilemma.

Nevertheless, empirical evidence shows that the availability of public support alone has not been sufficient to overcome all barriers to renovation uptake (Elgendy et al., 2024b). Challenges related to risk allocation, insufficient savings for maintenance, long-term affordability, decision-making complexity, trust between stakeholders, and the coordination of multiple actors often persist, particularly for more ambitious or innovative renovation pathways (Elgendy et al., 2024a).

In recent years, several OSS initiatives in Europe have been developed to support homeowners in navigating renovation processes, including Dutch initiatives such as Stroomversnelling, Reimarkt, Slim Wonen in Leeuwarden, Huizenaanpak, WoonWijzerWinkel, and De Woonpas (Pardalis et al., 2025). More recently, digital renovation tools, such as renovation passports and building-specific roadmaps (e.g. De Groene Menukaart), have also gained prominence as instruments to support decision-making and long-term planning (Hwang et al., 2025).

Previous research on IHRS has mainly examined public-led OSS initiatives, service configurations, and business models (Pardalis et al., 2022; Elgendy et al., 2026). However, less is known about what happens when the market is stimulated and starts to provide Market-Led IHRS that introduces market-driven renovation pathways specifically to HOAs. In particular, empirical evidence remains limited on how co-owners perceive these pathways, why some pathways progress while others stall or are discontinued, and how differences between renovation pathways shape the collective adoption process. This represents a gap between existing research on the design and provision of renovation services and the understanding of their adoption by HOAs.

To address this gap, this study examines the following research question: How are market-driven renovation pathways perceived and adopted by homeowner associations, and how do different renovation pathways shape these adoption dynamics? This main research question is addressed through three sub-questions: SQ1. How do the characteristics of different renovation pathways influence their perceived adoption by HOAs? SQ2. Which HOA-specific conditions and collective decision-making dynamics enable or constrain adoption? SQ3. How do IHRS providers act as change agents in the adoption process, and what does this imply for the design of their services and business models?

Rogers' Diffusion of Innovations theory (2003) is used to analyze how the characteristics of the pathways are perceived by homeowners, together with the role of communication, prior conditions, and IHRS providers as change agents. The study contributes by comparing adoption dynamics across different private renovation pathways and by identifying the conditions that support or constrain their adoption within the collective governance context of HOAs. The diffusion of innovation theory by Rogers has been applied previously to the design and renovation of housing concepts by scholars (Mlecnik, 2010; Van Oorschot et al., 2020).

In this study, the HOA is treated as the adopting unit, while private IHRS providers are examined as change agents that seek to influence and support the collective adoption process.

The paper is structured as follows. Section 2 provides an overview of market-driven renovation pathways. Section 3 outlines the theoretical framework, focusing on diffusion of innovation theory and its relevance to energy renovation in HOAs. Section 4 describes the research design, case selection, and data collection and analysis methods. Section 5 presents the empirical findings from the four case studies. Section 6 discusses the results in relation to existing literature and derives policy

implications. Section 7 concludes with key lessons and directions for future research.

2. Market-driven renovation pathways for Homeowners Associations

Financing remains one of the main barriers to energy renovation in HOAs (D'Oca et al., 2018; Elgendy et al., 2024a). In response, private market actors have developed different renovation pathways that seek to reduce upfront financial pressure, redistribute investment over time, or generate additional value to finance renovation. Some approaches focus primarily on technical innovation to reduce energy demand, such as passive house concepts, which have seen wider uptake in countries such as Austria and Germany but remain limited in the Netherlands. Others rely on integrated technical packages designed to lower energy consumption, including subsidized concepts for HOAs such as energy-efficient packages (Zeer energiezuinig pakke, ZEP), service-based models such as renovation-as-a-service (e.g., façade-a-s-a-service), and energy service models such as ESCOs. In addition, previous studies highlight the role of collective renovation approaches (Fawcett and Killip, 2014), performance-based guarantees (Moschetti and Brattebø, 2016; Bagaini et al., 2020; Bertoldi et al., 2021), and intermediary support mechanisms (Kivimaa, 2014).

Within this broader landscape, this paper focuses on three renovation innovations that are currently emerging in the Dutch context and are also increasingly visible in other European countries. First, integrated living-cost-neutral concepts that seek to offset renovation investments through expected reductions in energy expenditure and maintenance costs (Mlecnik, 2022; van Steenis et al., 2025). Second, phased renovation approaches that distribute investments over time, lowering upfront financial pressure while enabling gradual learning and trust-building (Mlecnik, 2010; Fawcett and Killip, 2014; Van Oorschot et al., 2020). Third, densification-based models that generate renovation capital through rooftop extensions and the sale of additional units, thereby reducing the financial burden on existing owners (Ferrante et al., 2017).

Following Rogers (2003), innovation is understood in relation to its perceived newness to the adopting unit rather than whether an approach is entirely new in an absolute sense. The pathways examined here are therefore considered innovative in the Dutch HOA context because they introduce alternative ways of organizing and financing energy renovation.

Although the three pathways differ in their financial logic, they all seek to reduce or redistribute the financial burden associated with HOA renovation. Their adoption, however, remains dependent on wider organizational, governance, and decision-making conditions within HOAs.

In this study, financial innovation is examined at the level of the financing logic introduced by each renovation pathway rather than through a detailed assessment of financial contracts or calculations. The three pathways differ mainly in how they reduce or redistribute the financial burden: through expected energy and maintenance savings, by spreading investments over time, or by generating additional value through rooftop extension. Detailed assumptions, guarantees, and contractual risk allocation vary between projects and are therefore not systematically compared in this study. Fig. 1 provides a conceptual overview of the three renovation pathways and their main differences in investment logic, implementation approach, and value creation.

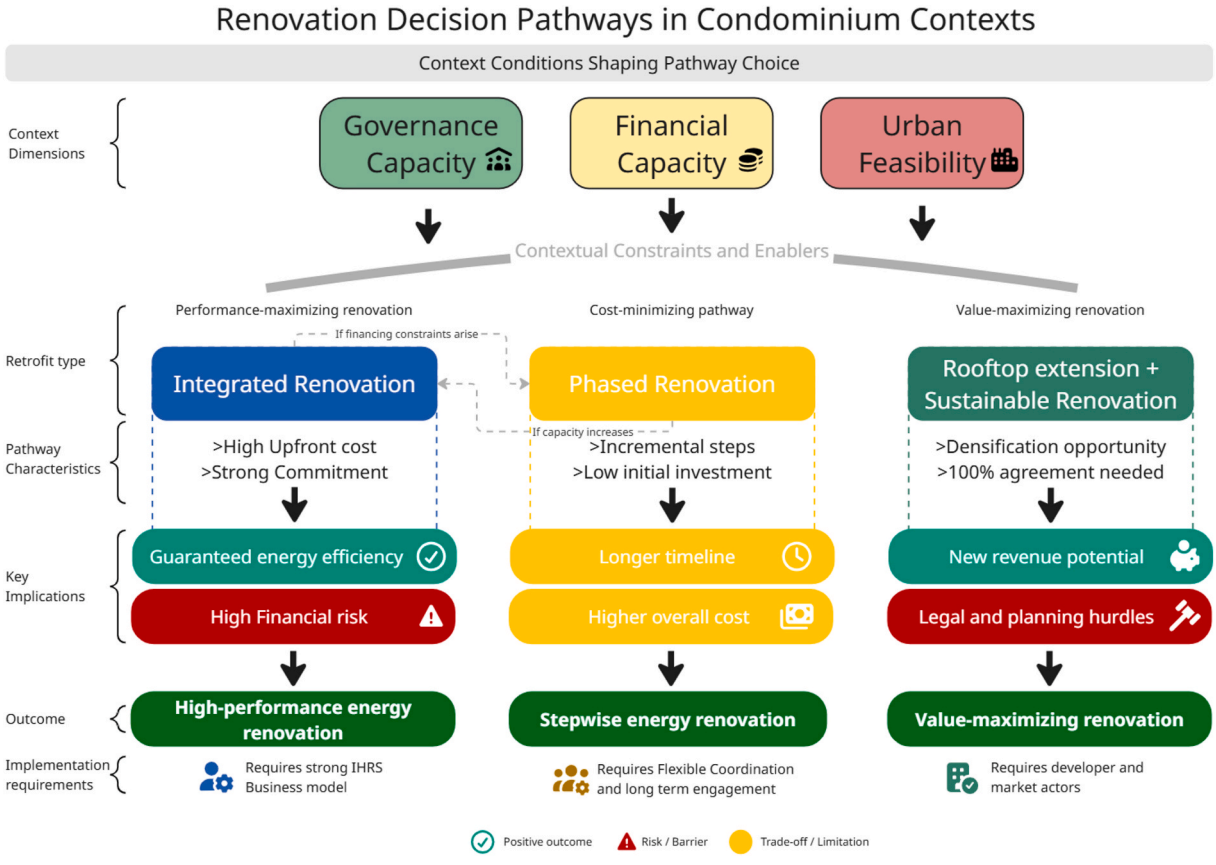


Fig. 1. Conceptual overview of the market-driven renovation pathways examined in this study.

3. Theoretical framework

3.1. Energy renovation in homeowner associations as an adoption challenge

Energy renovation in HOAs can be understood as a collective adoption process in which co-owners must assess and agree on innovations that affect shared financial and physical assets. While previous research identifies affordability, governance and organizational capacity as important barriers (D'Oca et al., 2018; Mlecnik, 2022; Elgendy et al., 2024a; Liu et al., 2025; Zhang et al., 2025), the present study focuses on how these conditions shape the perception and adoption of different renovation pathways. Renovation decisions, therefore, represent a form of socio-technical and financial change that must align with existing governance structures, budgeting practices, and risk perceptions within HOAs. Therefore, understanding energy renovation in HOAs requires an analytical focus on adoption dynamics rather than on technical performance alone.

3.2. Private Integrated Home Renovation Services as innovation intermediaries

In the context of condominium energy renovations, IHRS providers can be understood as change agents (Rogers, 2003) that seek to accelerate the adoption of renovation innovations by reducing uncertainty, translating technical and financial complexity, and facilitating collective decision-making among homeowners. Beyond providing technical solutions, private IHRS providers introduce new ways of organizing financial flows, allocating risks, and sequencing investments. In doing so, they function simultaneously as innovation intermediaries, operating at the interface between homeowners, financial institutions, construction actors, and public authorities (Howells, 2006; Kivimaa et al., 2019; Elgendy et al., 2025). Their effectiveness, therefore, depends not only on the design of their business models but also on their ability to increase perceived compatibility, reduce complexity and uncertainty, and build trust in renovation pathways that fit the organizational and financial realities of HOAs.

Following Rogers (2003), the adoption of energy renovations depends not only on the perceived attributes of the innovation but also on communication channels (one of the four key elements of diffusion) through which information and trust are transmitted. In the context of HOAs, where renovation decisions involve collective agreement and high perceived uncertainty, interpersonal communication channels become particularly important. IHRS providers therefore act as change agents not only by introducing technical and financial solutions, but also by facilitating communication, translating complexity, and connecting homeowners to trusted networks and peer examples that support collective decision-making.

3.3. Financial innovation as the core innovation dimension

As described in Section 2, the three pathways primarily differ in how renovation investments are financed or distributed over time. Financial innovation is therefore treated as a central dimension of the pathways examined in this study. However, its adoption remains dependent on how these financial propositions are perceived and whether they are compatible with the organizational and governance conditions of HOAs.

3.4. Diffusion of Innovations theory

To evaluate how HOAs perceive and adopt these renovation pathways, this study draws on Rogers' Diffusion of Innovations theory. According to Rogers, adoption is influenced by how potential adopters perceive five key attributes of an innovation: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003).

In this study, Rogers' five innovation attributes are interpreted in relation to the specific financial and governance realities of HOAs. Relative advantage is assessed in terms of whether the proposed renovation pathways are perceived to improve homeowners' situations compared to existing practices, particularly through stabilizing costs, reducing financial risks, or enhancing comfort. Compatibility refers to the extent to which these innovations fit with established HOA values, decision-making structures, and financial routines. Complexity captures how easily homeowners and board members can understand and manage the proposed solutions, including the perceived administrative burden and transparency of financial arrangements. Trialability is examined through the possibility of incremental implementation, allowing HOAs to test renovation measures or financial commitments over time. Finally, observability relates to the extent to which outcomes—such as cost impacts, energy performance, or successful examples in comparable HOAs—are visible and credible to homeowners during the decision-making process.

3.5. Analytical framework

Rogers' adoption attributes are used as a primary analytical dimension to assess how homeowners perceive these innovations across several Dutch case studies. Next to how communication channels are used by IHRS providers as change agents to reduce challenges while supporting the diffusion of such innovations, see Fig. 2.

Renovation decisions are shaped not only by individual perceptions, but also by governance rules, power dynamics within boards, trust between stakeholders, financial regulations, and policy frameworks. These dimensions extend beyond the original individual-level focus of Rogers' model. Therefore, while Rogers' attributes form the core evaluative framework, the analysis remains open to additional enabling or constraining factors that emerge from the empirical data. This allows the study to identify potential gaps in the explanatory power of the theory and to propose complementary considerations relevant to collective housing contexts.

By linking homeowner perceptions, intermediary roles, institutional conditions, and financial innovation design, the framework supports the identification of missing or weak elements that constrain adoption.

4. Methodology

4.1. Research design

This study adopts a qualitative multiple case study design to examine how market-driven integrated renovation concepts are perceived and adopted by HOAs in the Netherlands through semi-structured interviews with homeowners who have dealt with the three defined renovation pathways. A case study approach is particularly suitable for investigating innovation adoption in complex, real-world settings where financial arrangements, collective governance structures, and multi-actor interactions are closely intertwined (Yin, 2017). A qualitative design therefore enables an in-depth exploration of how innovation attributes are interpreted, negotiated, and translated into collective decisions. Rather than aiming for statistical generalization, the study seeks analytical generalization by applying Rogers' Diffusion of Innovations theory as a guiding framework for cross-case comparison.

In addition to case-based empirical data, the research design incorporates insights from three expert workshops conducted within the EU LIFE-CondoReno project. The integration of workshop insights strengthens the analytical depth of the study by enabling triangulation between adopter perspectives and broader sectoral reflections on enabling and constraining factors for adoption.

4.2. Case selection

To maintain analytical focus, this study therefore limits its scope to three market-driven IHRS providers that explicitly target HOAs and offer

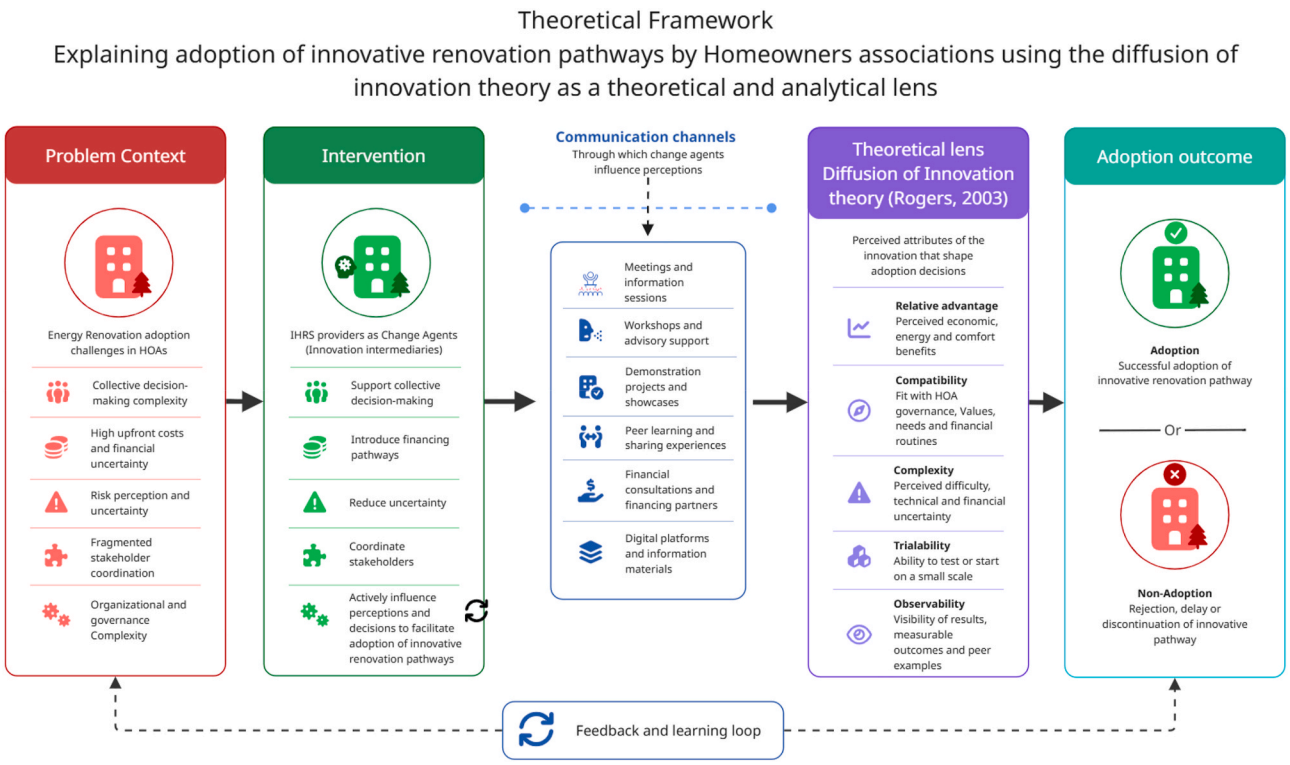


Fig. 2. Theoretical framework for analyzing the adoption of innovative renovation pathways by homeowner associations.

those three renovation pathways. By focusing on these financially innovative IHRS models, the study aims to generate in-depth insights into adoption dynamics while acknowledging the broader ecosystem of renovation support initiatives operating in the Dutch context. The study was limited to private IHRS providers explicitly targeting HOAs and representing the three renovation pathways identified in Section 2. Cases were purposively selected to provide variation in both pathway type and observed adoption trajectory (see Table 2).

The three IHRS providers also differed in their service and business-model characteristics. Table 1 summarizes the main characteristics relevant to the present study. A more detailed analysis of these business models is provided in Elgendy et al. (2024b)

Four Dutch case studies were selected through purposive theoretical sampling to capture variation in financially innovative renovation pathways and corresponding adoption trajectories within HOAs. In line with Rogers' (2003) "notion of *prior conditions*", cases were selected to reflect variation in organizational readiness, governance dynamics, perceived urgency, financial constraints, stakeholder involvement, and previous renovation experiences. The aim was not to achieve statistical representativeness of the Dutch building stock, but to examine how different types of financial innovation interact with collective decision-making processes in comparable institutional settings.

The cases were chosen to reflect variation along two analytical dimensions: (1) the type of financial innovation strategy employed, and (2) the observed adoption outcome at the time of study (progressing, partially implemented, or discontinued). This variation enables a

Table 1
Business model and change-agent characteristics of the IHRS providers.

Characteristic	Provider A – Integrated living-cost-neutral pathway (Cases 1 & 2)	Provider B – Phased renovation pathway (Case 3)	Provider C – Rooftop extension pathway (Case 4)
Core value proposition	Integrated renovation aiming to improve energy performance while limiting increases in total monthly living costs	Stepwise renovation that distributes investments and decisions over time	Generation of additional value through rooftop extension to finance renovation of the existing building
Revenue/ service model	Commercial service fee for integrated technical, financial and organizational support	Commercial service fee linked to long-term renovation coordination and temporary organizational support to the HOA	Development-oriented model in which value created through additional dwellings supports the renovation business case
Financial/risk approach	Uses long-term energy and maintenance cost calculations to develop the living-cost-neutral proposition; detailed contractual guarantees were not analyzed in this study	Reduces immediate homeowner exposure by dividing investment and implementation into phases; no formal financial guarantee identified	Reduces the direct renovation burden on existing owners through value generation, but depends strongly on development feasibility, planning approval and owner agreement
Duration of engagement	Long-term engagement throughout decision-making; in Case 1 the provider remained involved even after the paid project phase had ended	Intensive engagement over several years; provider reported temporarily taking over several HOA management and meeting-related tasks for about two years	Engagement from feasibility and owner consultation through project development and planning/permit procedures
Level of service integration	**High** – technical, financial, organizational, and stakeholder coordination	**High** – technical planning, sequencing, stakeholder coordination and organizational support	**High, development-oriented** – renovation planning combined with financial value creation and legal/planning coordination
Target HOA/ context	Mainly medium and larger HOAs; intensive service provision becomes difficult to finance for small HOAs	Mainly medium and larger HOAs able to sustain a longer renovation trajectory; service costs limit suitability for small HOAs	Less dependent on HOA size and more on urban location, property value, spatial feasibility and rooftop development potential

Table 2
Overview of the four Dutch Case Studies.

Case study Code & location	Key characteristics	Key prior conditions (Rogers, 2003)	Facts	Picture
Case study 1 North-west Amsterdam	Number of housing units: 64 Building year: 1942 Heating system: Individual-gas system Ratio of owners to tenants: 31 - 33 Condominium manager: Yes	Strong board leadership High urgency due to poor building conditions Presence of a social housing actor Previous renovation experience by one of the board members	Challenges: The social housing association requires a lot of time to reach internal decision-making. The building has thermal bridges at balconies, poor airtightness, and natural ventilation. The floor, façades, and roof are poorly insulated, and outdated window frames—some still with single glazing—cause significant draughts and heat loss. The co-owners have agreed to the IHRS proposal, and they are currently waiting for the social housing company's agreement, which has different agendas and regulations to follow.	
Case study 2 Brunssum	Number of housing units: 176 Building year: 1969 Heating system: Individual-gas system Ratio of owners to tenants: 151 - 35 Condominium manager: Yes	Limited homeowner consensus Financial concerns High Perceived uncertainty Organizational complexity No Urgency Municipal planning support	Challenges: The HOA decided not to continue with the proposal from the IHRS provider. The large scale of the building and the huge number of owners are making the communication difficult. The board members have decided to take over part of the condominium manager role.	
Case study 3 South-East Amsterdam	Number of housing units: 114 Building year: early 1990s Heating system: Individual-gas system Ratio of owners to tenants: 60 - 54 Condominium manager: Yes	Strong homeowners community Higher willingness to test solutions Prior knowledge of renovations happening in the area Trust between the board and the new Condominium manager	Challenges: The HOA encountered several challenges throughout the renovation process. Compliance with ecological regulations resulted in additional costs of approximately €100,000. An ongoing issue has been the complexity of coordinating multiple stakeholders, particularly as one party has not yet fulfilled its commitment regarding the completion of ground floor and entrance insulation.	
Case study 4 South Amsterdam	Number of housing units: 29 Number of storage/ garage: 8 Building year: 1964 Heating system: Individual-gas system Ratio of owners to tenants: NA Condominium manager: Yes	High real estate value Spatial feasibility Strong board commitment Municipal planning support	Challenges: Top-floor owners are hesitant due to potential loss of benefits and uncertainty about the impact of an added floor. The project requires unanimous owner approval (100%), creating a key barrier. Municipal approval is also needed, including compliance with potential parking requirements. Most of the owners have agreed to the sustainability and the extension proposal by the IHRS provider.	

structured comparison of contrasting pathway designs and adoption trajectories within the same national institutional context.

The selection of four cases is considered sufficient for analytical generalization, as each case represents a distinct configuration of financial innovation and adoption dynamics. The comparative design prioritizes depth of analysis over breadth, enabling detailed exploration of mechanisms rather than surface-level coverage of a larger sample.

The purpose of the comparative design was not to compare identical renovation projects, but to examine how different renovation pathways interact with HOA-specific adoption conditions. The cases therefore differ intentionally in pathway type and adoption outcome, while remaining comparable through a common analytical framework based on Rogers' prior conditions, communication processes, and five perceived innovation attributes. The comparison focuses on recurring adoption mechanisms across the cases rather than attributing differences in outcomes solely to the renovation pathway itself.

4.3. Data collection

Empirical data were collected between 2023 and 2026 using a combination of semi-structured interviews, document analysis, and structured expert focus groups (see Fig. 3). The multi-source approach was adopted to capture both adopter-level perceptions and broader sectoral reflections on innovation scalability.

4.3.1. Semi-structured interviews

The primary data source consists of semi-structured interviews with private IHRS providers and representatives of HOAs, including board members and co-owners directly involved in renovation decision-making. A summary of interviewees and data sources is presented in Table 3.

Two semi-structured interview guides were used, one for HOA representatives and one for IHRS providers. The interviews with HOA representatives covered the characteristics and prior renovation experience of the HOA, perceptions of the proposed renovation pathway, perceived advantages and disadvantages, financial considerations, decision-making and communication within the HOA, trust in involved actors, and factors supporting or constraining adoption. Interviews with IHRS providers focused on the development and financial logic of the renovation pathway, interaction with HOAs, communication and decision-making processes, challenges experienced during adoption, and the role of the provider in supporting the process. The interview guides and transcripts are provided in Appendix A.

4.3.2. Expert workshops

In addition to case-level interviews, insights were drawn from three annual Dutch national advisory board workshops organized within the EU LIFE-CondoReno project (see Table 4). These workshops brought together private IHRS providers, municipal representatives, financial actors, researchers, and sector experts to discuss emerging renovation innovations and their practical scalability.

The main aim of those workshops was to bring together experts from several fields, all working towards the same goal: energy renovations for HOAs. Challenges, concepts, and ideas were presented to them to

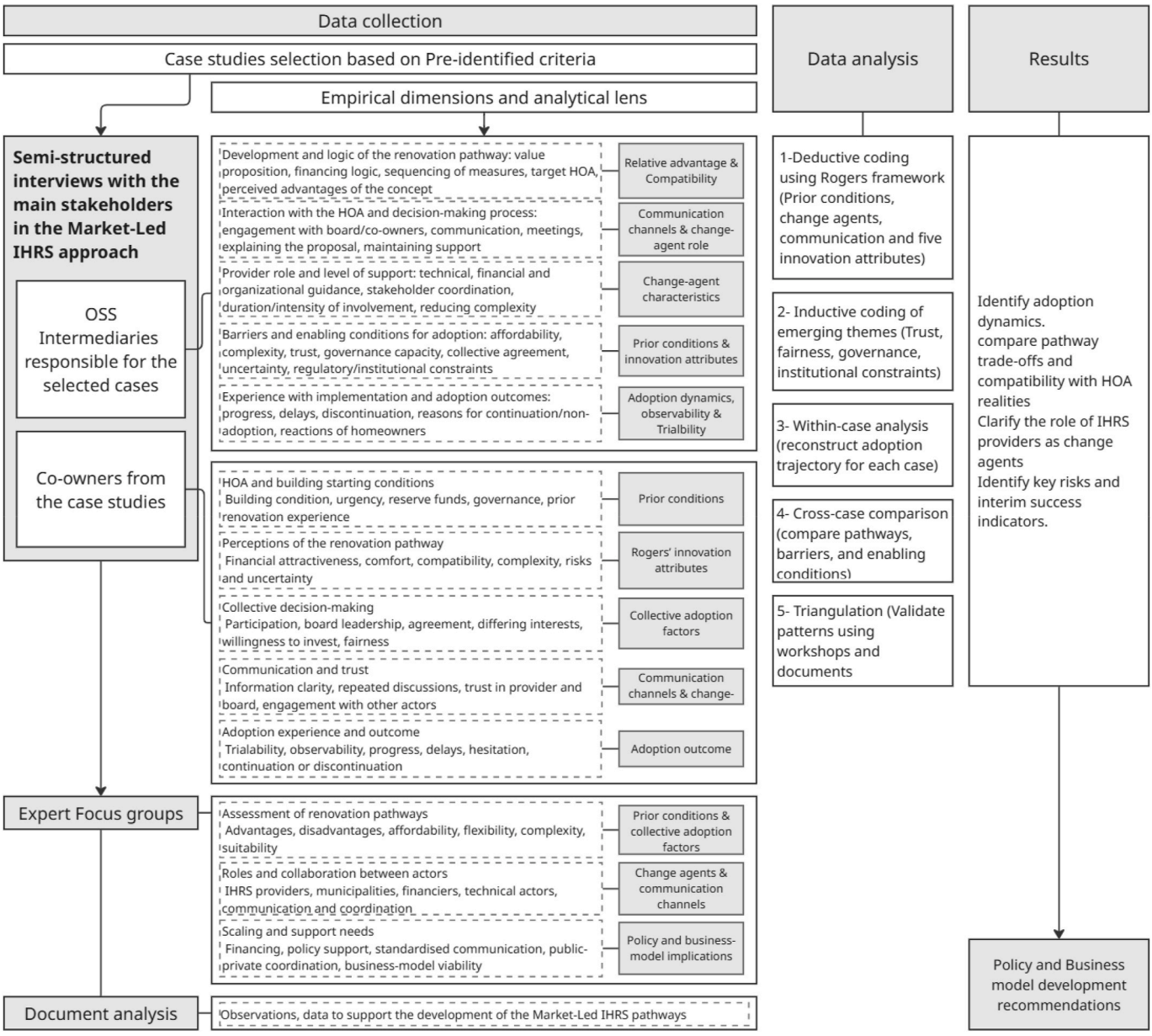


Fig. 3. Overview of the qualitative data collection and analysis workflow, illustrating how empirical materials were coded and structured through viability criteria to generate cross-case analytical results and policy-relevant insights.

stimulate discussions on how HOAs can be supported in an integral way through a defined customer journey and by establishing a clear role for every stakeholder. In addition, discussions focused on how new innovations, such as the three examined in this study, could be better implemented in the Dutch context. Representatives of the three IHRS providers participated in these workshops to discuss their innovations with the rest of the expert group, while we, as researchers, observed the opinions raised and the challenges such innovations may face. In this sense, the workshops functioned as focus groups where experts discussed the three pathways alongside broader topics related to condominium renovation policies and financing. Detailed notes and synthesis reports were produced following each session.

4.4. Data analysis

The empirical material was analyzed using a theory-guided qualitative approach informed by Rogers' framework. The analysis followed five consecutive stages, as summarized in Figs. 3 and 4.

First, the interview transcripts, workshop material, and available project documents were organized by case and stakeholder type. The empirical dimensions differed slightly between co-owners, IHRS providers, and expert workshops, reflecting their different roles in the renovation process. For co-owners, the analysis focused on HOA starting conditions, perceptions of the renovation pathway, collective decision-making, communication and trust, and adoption outcomes. For IHRS providers, the focus was on the renovation proposition, interaction with HOAs, provider support, adoption barriers and enabling conditions, and implementation and scalability. The expert workshops were used to capture broader perspectives on barriers, pathway characteristics, actor roles, risks, and scaling needs.

Second, the material was coded deductively using the analytical framework developed in Section 3. The main analytical dimensions included prior conditions, Rogers' five perceived innovation attributes, communication channels, and the role of IHRS providers as change agents. Relevant statements were assigned to these dimensions to examine how the renovation pathways were perceived and how

Table 3
Profile of the conducted interviews.

Code	Date	Stakeholder	Case study	Method	Duration
I-1	13-5-2025	Co-owner and board member	Case study 1	Semi-structured interview (in Person)	1h
I-2	4-6-2025	Co-owners and board members	Case study 1	Semi-structured interview (in Person)	1h & 10m
I-3 & 4	31-3-2025	Co-owner and board member	Case study 2	Semi-structured interview (online)	52m
I-5 & 6	4-4-2025	Co-owner and board member	Case study 3	Semi-structured interview (online)	1h
I-7	15-1-2026	Co-owner and board member	Case study 4	Semi-structured interview (online)	1h & 10m
I-8	4-4-2025	IHRS provider	Case study 3	Semi-structured interview (online)	1h 41m
I-9	14-7-2025	IHRS provider	Case study 1 & 2	Semi-structured interview (online)	52m
I-10	22-12-2025	IHRS provider	Case study 4	Semi-structured interview (online)	42m

Table 4
Workshops conducted.

Expert workshop	Title	Number of participants	Date
1	Acceleration Workshop: Deeper Renovations for More HOAs	16	22-11-2023
2	Stakeholders, training material, and activities needed for IHRS for HOAs	22	27-11-2024
3	Evaluation of IHRS providers' business models	15	26-11-2025

different conditions influenced the adoption process.

Third, the coded material was reviewed inductively to identify recurring themes that were not sufficiently captured by the initial framework. The inductive analysis therefore complemented the theory-guided coding and allowed additional HOA-specific adoption dynamics to emerge from the data.

Fourth, the analysis proceeded from within-case to cross-case comparison. A within-case analysis was first conducted for each of the four cases to reconstruct the adoption trajectory and identify the main barriers, enabling conditions, and perceptions associated with the renovation pathway. The cases were subsequently compared using the same analytical dimensions to identify similarities and differences across pathways and adoption outcomes. This cross-case comparison formed the basis for the findings presented in Section 5 and Table 6.

Fifth, The expert workshops and project documents were used for triangulation. They were compared with recurring patterns identified in the case analysis to assess whether similar barriers, enabling conditions, actor roles, and support needs were recognized by a broader group of actors involved in HOA renovation.

The Results are therefore organized according to the main analytical dimensions and emerging themes rather than as four separate case descriptions, allowing findings from the cases to be compared directly (see Table 5) .

5. Results

5.1. Prior conditions and compatibility with HOA realities

The adoption of renovation pathways in HOAs was greatly shaped by prior conditions and the degree to which proposed solutions aligned

Table 5
Steps of the qualitative data analysis.

Analytical stage	Material	Analytical purpose
Data organization	Interview transcripts and project documents	Organize evidence by case and stakeholder
Deductive coding	Interviews and documents	Analyze prior conditions, communication/change agents and Rogers' five innovation attributes
Inductive coding	Coded empirical material	Identify additional recurring themes not fully captured by Rogers
Within-case analysis	All case-specific evidence	Reconstruct adoption trajectory and identify barriers/enablers
Cross-case comparison	Four case analyses	Compare pathways and adoption dynamics using common dimensions
Triangulation	Expert workshop discussions and reports	Contextualize and validate recurring patterns

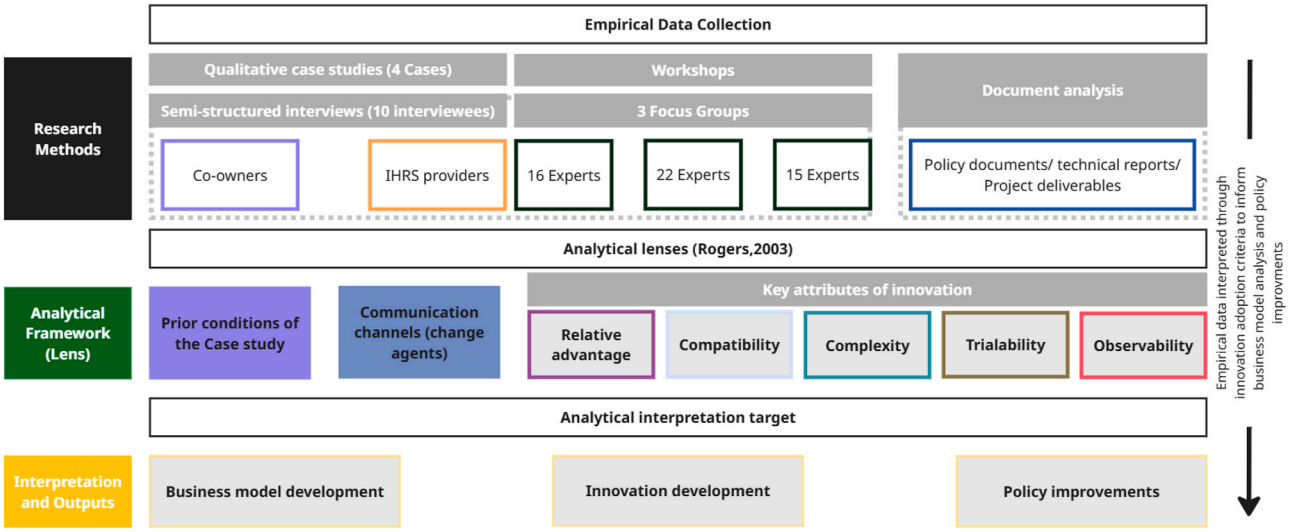


Fig. 4. Analytical framework linking qualitative research methods, adoption criteria, and business model interpretation in the evaluation of Market-Led Renovation pathways for Homeowners Associations.

Table 6
Cross-case risks and interim indicators of adoption progress.

Case/pathway	Main risks identified	Actors exposed to/managing the risk	Interim indicators of progress	Warning signs
Case 1 – Integrated living-cost-neutral	Financial uncertainty; dependency on agreement of social housing owner; long decision process	HOA/co-owners, social housing actor, IHRS provider	HOA owner agreement reached; continued engagement with provider	External agreement still pending
Case 2 – Integrated living-cost-neutral	Financial concerns; unequal perceived benefits; weak consensus; organizational complexity	HOA/co-owners, IHRS provider	Proposal developed and assessed by HOA	Proposal discontinued; no subsequent collective pathway identified
Case 3 – Phased renovation	Regulatory delays; additional costs; coordination between multiple actors, renovation quality	HOA, IHRS provider, implementation actors	Measures partly/completely implemented; continued renovation trajectory	Ecological requirements caused major additional cost and delay
Case 4 – Rooftop extension	Unanimity requirement; planning and permitting uncertainty; unequal impacts on owners	HOA/co-owners, IHRS/ developer, municipality	Majority support; project development continuing	Unanimity and municipal approval not yet secured

with the current conditions and realities of the HOAs. Through the four cases, differences in building condition, ownership dynamics, financial readiness, and governance structures influenced both the perceived feasibility of renovation and subsequent adoption outcomes.

In Cases 1 and 2, prior conditions like aging building components, thermal discomfort, and growing maintenance needs necessitated renovation. However, compatibility challenges emerged due to uncertainty about financial obligations and the collective agreement. Homeowners found it difficult to understand the renovation implications and to align on shared priorities. As one homeowner in Case 1 explained, “at some point, we didn't really know what the next step was anymore” (I-1), illustrating how process uncertainty constrained readiness despite willingness to improve building performance. In Case 2, differing priorities and limited alignment among co-owners weakened support, as one homeowner explained, “We've had discussions with residents. Some are open to it, but others expect everything to be covered — new balconies, automatic doors, raised walkways. But those aren't part of the sustainability project. People need to understand that. The focus is insulation, ventilation, and window frames — not luxury upgrades.” (I-4). Another challenge for Case 2 was the low participation of the co-owners, as one homeowner explains: “finding people willing to join the board is really difficult. Our board is just three people” (I-3), those conditions ultimately contributing to the discontinuation of the pathway regardless the urgent need for a renovation as one homeowner mentioned the current condition of the window frames “our window frames are rotten” (I-4).

In Case 3, prior conditions favored a more gradual approach for couple of reasons, one was that the HOA had already a reserve fund that can allow them to implement some renovation measures without taking a loan “Because we ourselves — the HOA — had some money, but it was like €700,000”(I-5) and second was the current condition of the building that required maintenance or change as one homeowner highlighted the condition of the current windows “these windows would always leak” (I-5) and another homeowner mentioned “I had single glazing here, so that also motivated me.” (I-6). Rather than pursuing a comprehensive renovation package, financial and organizational limitations made incremental investments more compatible with homeowner capacities. As one board member explained, “doing everything at once was simply too much for many owners” (I-6). The phased pathway aligned more closely with HOA decision-making processes and contributed to the implementation of several measures. The phased pathway also appeared to strengthen collective alignment by allowing co-owners to gradually converge around a shared approach. As one homeowner reflected, *“It was a long process … but step by step, people started to understand.”* (I-5), suggesting that gradual implementation helped build consensus over time.

Case 4 was characterized by a distinct starting condition: the opportunity to finance renovation through rooftop extension. The possibility to generate financial value through densification increased homeowner interest and reduced direct financial burden. However, compatibility challenges emerged due to governance implications, as rooftop additions affected ownership arrangements and required unanimity. As one provider explained, “maybe you bought the apartment because you wanted to be on the top floor” (I-10), this was the same observation by the homeowner who explained “people who live on the top floor have some doubts, because they chose to live on the top floor, and with rooftop extensions they will no longer be on the top floor.” (I-7) illustrating how personal preferences influenced collective decisions.

Across the cases, adoption trajectories differed not solely due to technical or financial feasibility, but because pathways varied in their compatibility with homeowner expectations, governance structures, and perceptions of affordability and fairness.

5.2. Relative advantage of the three renovation pathways

The perceived relative advantage of renovation pathways strongly influenced homeowner willingness to proceed. While providers emphasized long-term energy savings and technical improvements, homeowners primarily evaluated advantages in relation to comfort, affordability, financial predictability, and perceived fairness.

In Case 1, homeowners perceived clear benefits in addressing poor thermal performance and rising heating costs. One homeowner explained: “Yeah, I think it's very important because this is an old building. And I don't think it's very well insulated …. I live on the ground floor, and I've noticed a huge loss of heat, especially through my floor.” (I-1). At the same time, perceived benefits remained conditional upon affordability and confidence that financial savings would materialize.

Although Case 2 followed a similar living-cost-neutral model, relative advantage was perceived less positively. While expected energy savings initially appeared attractive as one homeowner explained: “The promise of up to 90% savings on energy costs was compelling” (I-2). Concerns emerged regarding unequal benefits and higher monthly costs. One interviewee reflected: “a homeowner said they already live as frugally as possible. They never turn on the heat, use LEDs, wear sweaters indoors—they wouldn't benefit much from lower energy bills, but would still be hit by higher service costs. That really struck a chord with me.” (I-2). This weakened perceived relative advantage, as some co-owners questioned whether renovation benefits justified increased monthly contributions.

In Case 3, the phased pathway demonstrated stronger relative advantage because investments could be distributed over time, reducing immediate financial pressure while enabling homeowners to gradually observe benefits. As one homeowner explained, “But then they calculated that if we do it now, we save on our energy bills for heating” (I-5). Prior conditions and new installations was a motivation for renovation as one homeowner highlighted “I had single glazing here, so that also motivated me ……everybody really wanted new windows” (I-6).

For Case 4, the rooftop extension model introduced a different value proposition by shifting renovation from cost-sharing toward value generation. As the IHRS provider explained: “they can earn around 1.1

million, 1.2 million euros with this rooftop extension and of course, the most tax efficient way is to put all that money back into the building." (I-10). This was similarly felt by the HOA, as one homeowner mentioned "rooftop extension brings new possibilities, because the HOA can also earn money." (I-7) this substantially increased homeowner support, although implementation remained dependent on governance approval and municipal permitting as the IHRS provider explained: "So we will need to go to the municipality to see if they agree with it." (I-10).

Overall, relative advantage was shaped less by technical performance alone and more by whether renovation pathways reduced perceived risks, aligned with homeowner priorities, and distributed benefits in ways considered sufficiently fair.

5.3. Complexity, communication, and IHRS providers as change agents

Complexity emerged not only from technical interventions, but also from the coordination of financial arrangements, legal procedures, collective decision-making, and communication among multiple homeowners.

In Cases 1 and 2, the living-cost-neutral pathway was often perceived as difficult to understand due to uncertainties regarding financing structures, technical reports, and procedural steps. As one homeowner in Case 2 described difficulties in interpreting renovation implications and complexity of the solution provided which was supported by their local municipality as one homeowner explained: "But it became clear that they only wanted to go fully gas-free. That was the only goal. And that comes with a lot of requirements — pipes going into apartments, installation challenges. Some residents were really against it." (I-3) contributing to slower progression and reduced support for continuation.

In Case 3, complexity was partly reduced through the phased nature of the renovation pathway. By implementing measures incrementally rather than through a single comprehensive package, homeowners were able to process decisions gradually and reduce perceived risks. Nevertheless, coordinating multiple actors and sustaining collective agreement remained challenging. As the IHRS provider explained: "It's hard to do business with condominium associations." (I-8). Across the cases, this difficulty was related to lengthy collective decision-making, differing homeowner interests, the coordination required throughout the process, and the relatively high service costs for smaller HOAs.

In Case 4, complexity was strongly linked to governance and regulatory procedures. In addition to technical and financial considerations, rooftop extension required unanimity among co-owners and municipal approval. According to the provider: "Everybody has to agree … because their ownership changes." (I-10).

Communication channels played an important role in reducing these uncertainties and shaping persuasion throughout the adoption process. Rather than relying solely on formal technical reports, homeowners frequently depended on repeated discussions with board members, neighbors, and IHRS providers to evaluate renovation pathways as one homeowner mentioned the importance of having an open-line communication with the service provider "somebody that everybody could relate to. A young guy who was easy to reach — you could call a telephone number and tell him your worries, or if something was wrong. (I-5). Providers adapted communication strategies to improve understanding through summaries, booklets, and simplified explanations. As one provider explained: "We created a 25-page booklet … to explain everything in a way that is relatable to homeowners." (I-10).

Beyond communication, IHRS providers acted as change agents by coordinating fragmented actors, maintaining momentum, and reducing organizational burden. In Cases 1, 2, and 3, providers acted as intermediaries between homeowners, technical experts, and financial actors. As one provider explained: "We take over the HOA management for about two years … we handle the rest—make the agendas, run the meetings." (I-8). However, Change agents alone cannot support all condominium typologies as two service providers highlighted that small HOAs are difficult to support "we see that we don't serve the smaller condominium associations because they simply can't afford it" (I-9). "Our approach is too expensive for small HOAs" (I-8). This is due to the service fee, and work does not differ so much between bigger and smaller HOAs.

Overall, the regulatory constraints, such as the flora and fauna in the Netherlands, have led to a longer process, longer than expected, and this was observed in Cases 2 and 3, as one homeowner explains, "It took nearly two years to finish that process. There were bats and swallows identified, and we had to apply for exemptions. Only once that approval comes in can we actually begin the renovation work." (I-6) And another mentioned that such regulations have led to a longer process and extra costs, "everything took longer …. We used to joke about the owls, which cost €100,000." (I-5).

These findings suggest that renovation complexity in HOAs is shaped not only by the innovation itself, but by how information is communicated and coordinated among homeowners. Communication channels functioned not merely as tools for information exchange, but as mechanisms for persuasion, trust-building, and collective alignment. In this context, IHRS providers played a critical role as change agents that helped move homeowners from awareness toward adoption decisions.

5.4. Observability, trialability, and enabling conditions for adoption

The findings indicate that adoption in HOAs was supported when homeowners could gradually test renovation approaches or observe outcomes in practice. In Case 3, the phased renovation pathway demonstrated the clearest form of trialability, allowing co-owners to implement measures incrementally and observe benefits over time as one homeowner mentioned: "The other option would be to wait 10 years and put money into savings accounts and not enjoy anything" (I-5). Another interviewee explained, it would only be possible if it's done in a phased way: "doing everything at once was simply too much for many owners" (I-6). This gradual approach reduced financial uncertainty and contributed to the implementation of several measures.

Observability also influenced adoption. In Case 4, nearby rooftop extension projects reduced uncertainty and increased homeowner interest in the densification model. As the provider explained: "They saw that project … and were very interested." (I-10). Visible examples helped homeowners better understand potential outcomes and increased confidence in feasibility. Case 3 acted as a pilot project for the neighboring HOAs as some neighbors have observed the change happening, as one homeowner mentioned "Apparently people from other buildings were coming here and filming what was going on and investigating, like, look, they are changing this and that." (I-5).

Trust between the homeowners and the IHRS emerged as an important enabling condition that have enabled adoption in case 1, 3 and 4 as two homeowners from Case 3 highlighted: "we know him personally and we always felt that he is the right guy. He will give us a good price." (I-5) and "You also do it based on personal trust and how somebody informs you." (I-6) this was similar to what the homeowners felt in case 1 and 4. In Case 1, homeowners particularly valued the provider's continued involvement throughout the process, even during periods of uncertainty. As one homeowner explained: "Even though they weren't being paid anymore—the second phase had ended—they stayed committed." (I-2). This continuity appeared to strengthen homeowner confidence in both the provider and the renovation process. Similarly, in Case 4, trust was an important condition to move forward with the IHRS provider, as one homeowner highlighted the importance of collaboration with public entities: "They also have good contacts with the municipality of Amsterdam." (I-7).

Across the cases, adoption emerged when several enabling conditions were met: when renovation pathways aligned with homeowner priorities, benefits outweighed risks, communication was present and able to reduce uncertainty, and trust was built through sustained interaction between homeowners and intermediaries, and by

collaborating with public institutions, which adds credibility.

5.5. Cross-case reflections from expert focus groups

The findings from the case studies were further reflected upon through the three expert focus groups. Across the workshops, experts consistently highlighted that financial attractiveness alone was insufficient to stimulate adoption in HOAs. Instead, successful renovation trajectories were seen to depend on reducing complexity, strengthening communication, and building homeowner trust throughout lengthy decision-making processes. Experts repeatedly emphasized that many HOAs struggle not only with energy renovation, but also with basic maintenance planning, low reserve funds, and limited organizational capacity, reinforcing the importance of phased support and process guidance.

Expert discussions further reflected trade-offs between pathways: integrated renovation was valued for its technical ambition but considered difficult to implement without strong homeowner commitment; phased renovation was seen as more realistic for many HOAs due to lower entry barriers and gradual decision-making; while rooftop extension was recognized as a promising financing mechanism but highly dependent on local regulatory and governance conditions.

Discussions further reinforced the importance of communication and tailored guidance, particularly in helping homeowners understand financial implications, collective benefits, and long-term value. Several experts stressed that decision-making could not be accelerated through pressure alone, as trust-building and gradual alignment among co-owners remained essential for adoption. These reflections largely supported the patterns observed across the four case studies, particularly regarding the importance of compatibility with HOA realities, collective alignment, and the role of intermediaries in facilitating adoption.

Across the four cases, adoption progress was accompanied by different financial, organizational, regulatory, and implementation risks. Since several cases were still ongoing, final implementation alone was not used as the only indicator of adoption success. Table 6 therefore summarizes the main risks identified in each case, the actors primarily exposed to or involved in managing these risks, and the interim indicators and warning signs observed at the time of data collection.

6. Discussion

6.1. Financial innovation alone does not explain adoption in HOAs

The comparison of the four cases suggests that financially attractive renovation concepts alone do not guarantee adoption in HOAs. While affordability is widely recognized as a major barrier to condominium renovation (D'Oca et al., 2018; Elgendy et al., 2024a), the cases reveal that pathways with seemingly strong financial propositions produced substantially different outcomes. Case 1 progressed toward implementation, Case 2 was discontinued, Case 3 successfully implemented measures through a phased approach, and Case 4 secured majority support but remained constrained by governance and permitting requirements. These differences suggest that adoption depends not only on financial logic, but on how renovation pathways align with organizational realities, governance structures, trust, communication, and homeowner expectations.

This finding aligns with previous research on split incentives and affordability challenges (D'Oca et al., 2018; Ebrahimigharehbaghi et al., 2019), but extends prior work by showing that affordability in HOAs is interpreted primarily through a monthly cost lens rather than lifecycle cost optimization.

The comparison of pathways further highlights important trade-offs. Rooftop extension in Case 4 presented the strongest financial proposition by generating capital through densification, yet remained dependent on homeowner alignment and municipal approval. Integrated renovation offered higher technical performance but faced lower compatibility due to high upfront commitment and limited flexibility. By contrast, the phased pathway in Case 3 aligned more closely with homeowner capacities by reducing immediate financial burden and enabling gradual decision-making. Although phased renovation (compared to other approaches) is increasingly adopted across Europe, Previous research highlights the risk of lock-in effects, where poorly sequenced interventions reduce future renovation potential and overall energy savings (Galvin and Sunikka-Blank, 2013).

Although individual income levels were not available, the cases indicate that perceived financial capacity and affordability influenced adoption differently across HOAs, particularly through existing reserve funds, expected monthly costs, and differences in the perceived distribution of costs and benefits.

Taken together, the findings suggest that financially innovative renovation concepts should be evaluated not only by their technical or economic performance, but by their compatibility with the collective realities/preferences of HOAs.

6.2. Beyond Rogers: collective adoption in homeowner associations

While Rogers' Diffusion of Innovations theory provides a useful framework for understanding renovation adoption, the findings reveal additional dynamics specific to collective ownership settings. Although Rogers acknowledges collective and organizational innovation decisions, the theory has predominantly been applied to individual adoption processes. In HOA settings, however, renovation depends on alignment among multiple households with different priorities, financial capacities, and risk perceptions. Across the cases, governance structures strongly influenced whether positive perceptions translated into implementation. This was particularly evident in Case 4, where majority support was insufficient without unanimity and municipal approval, and in Case 2, where technical feasibility and projected savings failed to sustain adoption due to weak homeowner alignment and external pressure.

The findings further highlight the importance of perceived fairness. This was primarily related to how costs and benefits were distributed among co-owners. In Case 2, for example, homeowners with already low energy consumption expected limited financial savings while still facing higher service costs. Fairness also concerned differences in homeowners' existing positions and interests, as illustrated in Case 4, where top-floor owners could lose a valued characteristic of their apartment through rooftop extension. The interviews provided less direct evidence on procedural fairness, and this was therefore not analyzed as a separate dimension.

Across the cases, adoption appeared more likely where homeowners showed stronger alignment, trust, and willingness to pursue collective benefits, while fragmented interests and weak engagement constrained progress. This suggests that in HOAs, individual perceptions of an innovation need to develop into sufficient collective alignment before adoption can take place. Similar patterns have been observed in Dutch and Belgian condominium renovations, where proactive board leadership and continuous engagement with co-owners were important for successful renovation trajectories (Steenkamp, 2024; Elgendy et al., 2026). While this study identifies collective alignment and social cohesion as important emerging conditions, further research is needed to understand their role in collective adoption.

6.3. IHRS providers as change agents in collective adoption

IHRS providers influenced adoption by reducing uncertainty, coordinating fragmented actors, and maintaining momentum throughout collective decision-making processes. Their contribution proved particularly important in HOA settings, for example, limited organizational capacity, heterogeneous homeowner preferences, and procedural complexity frequently constrained renovation progress.

This finding aligns with literature on innovation intermediaries and

OSS models, which emphasizes the role of intermediaries in facilitating socio-technical transitions through coordination and knowledge exchange (Howells, 2006; Kivimaa et al., 2019). However, the findings extend this literature by demonstrating that in condominium settings, providers play a broader role than technical or administrative coordination alone. They also function as collective facilitators who support negotiation processes among homeowners and adapt communication strategies to varying levels of knowledge, risk perception, and willingness to invest.

The comparative cases further illustrate that the effectiveness of change agents depends on their ability to align renovation pathways with HOA realities and be available when needed, which requires more "probably" unpaid time and effort. These findings suggest that in collective ownership settings, the effectiveness of renovation pathways requires the capacity of change agents to facilitate trust, communication, and collective convergence. Those agents do not necessarily mean the private sector but can also be professional renovation coaches working at the municipalities or the local energy houses.

The findings also show that the design of the IHRS service influences its ability to support adoption. Long-term engagement and integration of technical, financial, and organizational support helped providers remain involved throughout lengthy HOA decision-making processes. However, this level of involvement also requires substantial provider capacity and can be difficult to sustain commercially, particularly for smaller HOAs.

The comparison of the three providers suggests that their ability to act as change agents was influenced by how their services were organized. Rogers (2003) highlights sustained client contact, credibility, compatibility with client needs, and support in evaluating an innovation as important characteristics of change agents. Across the cases, these functions were reflected in continued engagement with HOA boards, translation of technical and financial information, organization of meetings, and coordination with external actors. Provider B, for example, became strongly embedded in the HOA process and temporarily supported organizational tasks normally carried out by the association itself. Provider A maintained involvement throughout lengthy decision-making processes, while Provider C relied on accessible communication and municipal networks to reduce uncertainty surrounding a more complex development model. However, the contrasting outcomes also show that change-agent effort alone could not overcome structural constraints such as weak collective agreement, affordability concerns, unanimity requirements, or planning approval.

6.4. Learning from non-adoption and trade-offs between renovation pathways

Integrated living-cost-neutral renovation offers strong technical performance and energy savings but faces lower compatibility with HOA realities due to high upfront commitment, financial uncertainty, and limited trialability. The contrast between Cases 1 and 2 illustrates that even financially attractive concepts may fail when homeowner alignment weakens. By contrast, the phased pathway in Case 3 demonstrated greater compatibility, as incremental implementation reduced immediate financial burden and increased trialability, although at the expense of longer implementation periods and potentially lower technical optimization. This is similar to the concept of the building renovation passport, which encourages a step-by-step plan with implementing short and long-term measures towards a full deep renovation (Fabbri, 2017). The phased renovation pathway demonstrated the clearest form of trialability, allowing co-owners to implement measures incrementally and observe benefits over time.

The rooftop extension pathway introduced a different financial logic, thereby reducing direct homeowner contributions and increasing relative advantage. Similar approaches have been explored in Austria, where attic extensions have supported both renovation and housing expansion (Jaksch et al., 2016). However, this pathway remained highly context dependent due to governance requirements, municipal approval, and additional technical and social complexity.

Taken together, the findings suggest that no single renovation pathway can be considered universally optimal. Instead, pathways should be matched to specific HOA conditions, including governance maturity, financial readiness, building typology, and organizational capacity. As illustrated in Table 7, integrated renovation may offer higher technical performance, phased renovation higher compatibility and trialability, and rooftop extension stronger financial attractiveness under favorable urban conditions. This highlights the importance of tailoring support strategies to pathway-specific adoption dynamics rather than promoting a one-size-fits-all solution.

6.5. Policy implications for scaling condominium renovation

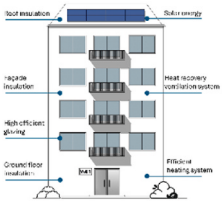
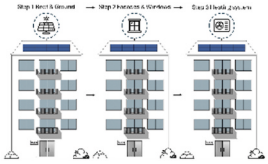
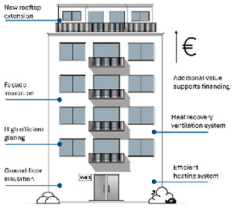
The findings highlight several policy implications for accelerating condominium renovation. First, support schemes should move beyond early-stage activation toward mechanisms that increase implementation certainty. Early-stage support could include technical and financial feasibility assessments and support for collective decision-making, while later-stage support should remain available as HOAs move towards contracting and implementation. Second, stronger coordination between public activation efforts and private implementation capacity is needed. Public IHRS and municipalities could provide clearer referral pathways towards private providers that can continue supporting HOAs during project development and implementation. Third, reducing institutional and regulatory uncertainty is particularly important for innovative pathways such as rooftop extension. Earlier coordination with municipalities and clearer guidance on planning requirements, ownership changes and permitting could reduce the risk of HOAs investing substantial time and resources before discovering that implementation is not feasible. Fourth, Communication support could also be standardized around a common renovation passport that integrates the building-state assessment, the multi-year maintenance plan, renovation scenarios, expected costs, and financing options, and agreed decision milestones. Such a document could provide boards, co-owners, IHRS providers, financiers and municipalities with a shared information basis throughout the renovation process and reduce repeated interpretation of technical and financial information. Finally, consistent with Rogers' concept of observability, reference projects and peer learning between HOAs may help reduce uncertainty and strengthen homeowner confidence in renovation pathways.

6.6. Transferability to other European contexts

The four cases were selected within the Netherlands to compare different renovation pathways under the same institutional context. Some conditions identified in the cases are therefore specific to the Dutch context, including available financing and subsidy schemes, HOA decision-making requirements, the relatively strong role of private market actors, and municipal planning procedures. The feasibility of the three pathways may consequently differ in countries with different ownership structures, financing systems, decision-making rules, or stronger public involvement in renovation.

At the same time, several adoption dynamics identified in this study are likely to be relevant beyond the Dutch context. The need to reach a collective agreement, build trust among co-owners, reduce uncertainty through repeated communication, and provide intermediary support are linked to the collective nature of condominium renovation rather than to one specific national system. The phased pathway may also be relevant where HOAs have limited financial or organizational readiness, while value-generation approaches such as rooftop extension will depend more strongly on local property markets and planning regulations. Transfer to other European contexts therefore requires adaptation of the pathways to national governance, financing and regulatory conditions rather than direct replication.

Table 7
Comparison between the three renovation approaches.

Description	Approach		
	Integrated renovation with a living cost-neutral concept	Phased renovation (Step by step)	Rooftop extension + energetic renovation
Illustration			
Core logic	Full renovation in one intervention with living cost-neutral concept	Incremental implementation over time	Financing renovation through densification and sale of new units
Implementation time	Medium to long (2-3 Years); requires substantial preparation and collective agreement before implementation	Long (5-10 years); measures are implemented gradually over several phases	Medium to long (2-5 Years); dependent on collective agreement, design development and municipal approval
Required HOA capacity	High; requires strong governance, financial readiness and collective commitment	Moderate; allows financial and organizational commitment to develop gradually	High; requires strong governance and collective agreement on changes to the building and ownership structure
Key advantages	High energy performance; cost efficiency; easier to demonstrate living-cost neutrality; avoids duplication of works	Lower entry barrier; aligns with homeowner preferences; allows learning and adaptation	Generates capital; reduces financial burden on homeowners; increases property value; supports urban densification
Key barriers	High upfront investment; strong need for collective agreement; high perceived financial risk	Higher total cost; technical inefficiencies; longer timelines; difficulty proving financial benefits	Requires 100% agreement; legal complexity (deed of division); municipal approval; parking and spatial constraints; higher coordination complexity
Relative advantage	Recognized by experts as technically and economically optimal, but often not perceived as advantageous by co-owners due to high upfront costs and financial risk	Perceived by co-owners as advantageous due to lower immediate financial burden and flexibility, despite lower long-term efficiency	Perceived as highly advantageous in specific cases, as it can offset or fully cover renovation costs through value creation
Compatibility	Limited compatibility in HOAs with heterogeneous financial situations and low collective readiness; requires strong governance and alignment	High compatibility with co-owners preferences for incremental decision-making and risk reduction; aligns with observed decision-making behavior	Conditional compatibility; depends on building characteristics, ownership structure, and local regulatory context; less compatible in fragmented or risk-averse HOAs
Complexity	High organizational and financial complexity, particularly in aligning all co-owners and structuring financing	Moderate complexity per intervention, but cumulative complexity over time due to repeated decision-making and coordination	Very high complexity, as highlighted in interviews, due to legal procedures, planning approvals, and coordination with external actors
Trialability	Low; difficult to test on a small scale before full commitment	High; allows step-by-step implementation and observation of outcomes	Low; requires full commitment and cannot be easily piloted
Observability	Moderate; benefits (energy savings, comfort) become visible after implementation, but are difficult for co-owners to anticipate beforehand	High; incremental improvements are visible and build confidence over time	Moderate; potential benefits are visible in successful examples, but uncertainty in planning approval and market conditions reduces perceived observability
Suitable context	Large HOAs with strong governance and financial capacity	HOAs with limited financial capacity or low readiness	Urban areas with densification potential; structurally suitable buildings; high property market value
Policy support needed	Access to suitable financing and subsidies, together with support during collective decision-making	Long-term renovation planning and financial support that can be accessed across different renovation phases	Clear municipal procedures and guidance for densification, permitting and changes in ownership arrangements

6.7. Limitations of the study

This study provides an in-depth qualitative evaluation of multiple IHRS approaches across a limited number of condominium case studies. While not statistically representative, the cases support analytical generalization by capturing variation in building types, governance conditions, and renovation pathways. The analysis combines semi-structured interviews, expert workshops, and documented activities within the EU LIFE-CondoReno project, strengthening validity through triangulation. Nevertheless, findings rely largely on stakeholder and homeowner perspectives, and several cases remain ongoing, limiting assessment of long-term outcomes.

As some of the cases were still ongoing at the time of the study, adoption outcomes should not be understood only in terms of final implementation. Intermediate outcomes, such as reaching homeowner agreement, continuing with the proposed pathway, securing financing, or progressing towards permitting and implementation, can also indicate progress in the adoption process. At the same time, prolonged decision-making, declining homeowner support, unresolved financial concerns, or dependence on external approvals can indicate risks of delay or discontinuation. The outcomes reported in this study therefore represent the adoption status of each case at the time of data collection rather than their final long-term success.

Importantly, most selected cases involved HOAs with at least an initial willingness or perceived need to explore renovation, which may limit applicability to less engaged associations. Many HOAs still struggle to finance basic maintenance and may have limited readiness for energy renovation. Future research should therefore examine how financially vulnerable or low-intention HOAs can be activated, including whether approaches such as total living cost models or alternative financing mechanisms (e.g., ESCOs, on-bill financing, or crowd-funding) could help increase feasibility and motivation for renovation.

Household income data were not collected as part of the study, and the financial situation of individual homeowners could therefore not be compared systematically across the four cases. Financial conditions were instead examined through indicators available in the case material, including HOA reserves, perceived affordability, willingness to take on additional costs, and homeowners' perceptions of how costs and benefits

were distributed.

7. Conclusion

This study investigated the adoption of financially innovative renovation pathways for HOAs through a comparative analysis of integrated living-cost-neutral renovation, phased implementation, and rooftop extension models.

The three pathways generated distinct adoption dynamics and tensions. Integrated renovation offered higher technical performance but faced resistance due to high upfront commitment, perceived financial uncertainty, and limited flexibility, as illustrated by the contrasting outcomes of Cases 1 and 2. Phased renovation proved more compatible with HOA realities by lowering immediate financial pressure and enabling gradual decision-making, although potentially at the expense of technical optimization. Rooftop extension introduced a promising value-generation mechanism that increased homeowner interest, yet remained highly dependent on unanimity, municipal approval, and acceptance of ownership implications.

The findings further suggest that while Rogers' Diffusion of Innovations theory provides a useful framework, adoption in HOAs extends beyond individual decision-making and depends on collective alignment among co-owners. Trust-building, repeated communication, and active mediation by IHRS providers emerged as essential conditions for moving homeowners from awareness toward implementation. In this context, IHRS providers acted not only as technical intermediaries but as change agents facilitating negotiation, reducing uncertainty, and aligning diverse homeowner interests.

Overall, accelerating condominium renovation requires pathways and stakeholder interactions that better align with HOA-specific governance, financial readiness, and organizational realities. Rather than pushing standardized solutions, greater emphasis should be placed on tailored communication, gradual consensus-building, and supporting intermediaries capable of fostering trust and collective alignment over time.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the author(s) used ChatGPT in order to improve readability. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

CRediT authorship contribution statement

Ragy Elgendy: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Erwin Mlecnik:** Validation, Supervision. **Henk Visscher:** Validation, Supervision. **Queena K. Qian:** Validation, Supervision.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ragy Elgendy reports financial support was provided by European Union. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2026.149888 and doi of the data set: 10.4121/d46ad3fe-0a81-4de1-9fd9-e44409e07e8b.

Data availability

The coding and transcripts are now shared in the manuscript with an identifiable DOI

References

Bagaini, A., Colelli, F., Croci, E., Molteni, T., 2020. Assessing the relevance of barriers to energy efficiency implementation in the building and transport sectors in eight European countries. Electr. J. 33 (8), 106820. https://doi.org/10.1016/j.tej.2020.106820.

Bertoldi, P., Boza-Kiss, B., Della Valle, N., Economidou, M., 2021. The role of one-stop shops in energy renovation—A comparative analysis of OSSs cases in Europe. Energy Build. 250, 111273. https://doi.org/10.1016/j.enbuild.2021.111273.

Boza-Kiss, B., Bertoldi, P., Della Valle, N., Economidou, M., 2021. One-Stop Shops for Residential Building Energy Renovation in the EU: Analysis & Policy Recommendations. Publications Office of the European Union, p. 109. No. JRC125380. https://data.europa.eu/doi/10.2760/245015.

BPIE, 2024. The EPBD decrypted: a treasure chest of opportunities to accelerate building decarbonisation. https://www.bpie.eu/publication/the-epbd-decrypted-a-treasure-chest-of-opportunitiesto-accelerate-building-decarbonisation/.

BZK, 2023. Versnellingsagenda verduurzaming gebouwen in beheer van Verenigingen van Eigenaars (VvE's). Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. https://www.rijksoverheid.nl/documenten/brieven/2023/09/05/vve-versnellingsagenda-verduurzaming.

CBS, 2024. 1,4 miljoen woningen onderdeel van Vereniging van Eigenaren [Webpagina]. Centraal Bureau voor de Statistiek. https://www.cbs.nl/nl-nl/nieuws/2024/14/1-4-miljoen-woningen-onderdeel-van-vereniging-van-eigenaren.

D'Oca, S., Ferrante, A., Ferrer, C., Pernetti, R., Gralka, A., Sebastian, R., Veld, P., 2018. Technical, financial, and social barriers and challenges in deep building renovation: integration of lessons learned from the H2020 cluster projects. Buildings 8 (12), 174. https://doi.org/10.3390/buildings8120174.

Ebrahimigharehbaghi, S., Qian, Q.K., Meijer, F.M., Visscher, H.J., 2019. Unravelling Dutch homeowners' behaviour towards energy efficiency renovations: what drives and hinders their decision-making? Energy Policy 129, 546–561. https://doi.org/10.1016/j.enpol.2019.02.046.

Elgendy, R., Mlecnik, E., Visscher, H., Qian, Q., 2024a. Barriers and solutions for homeowners' associations undertaking deep energy renovations of condominiums. Eceee Summer Studies. Eceee Summer Studies. In: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2024/5-sustainable-communities/barriers-and-solutions-for-homeowners-associations-undertaking-deep-energy-renovations-of-condominiums/.

Elgendy, R., Mlecnik, E., Visscher, H., Qian, Q., 2024b. Integrated home renovation services as a means to boost energy renovations for homeowner associations: a comparative analysis of service providers' business models. Energy Build. 320, 114589. https://doi.org/10.1016/j.enbuild.2024.114589.

Elgendy, R., Mlecnik, E., Visscher, H., Qian, Q., 2025. Intermediaries in action: how integrated home renovation service providers engage stakeholders in energy renovations for homeowner associations. IOP Conf. Ser. Earth Environ. Sci. 1554 (1), 012139. https://doi.org/10.1088/1755-1315/1554/1/012139.

Elgendy, R., Mlecnik, E., Visscher, H., Qian, Q., 2026. From policy to practice: evaluating public-led energy renovation processes in Belgian condominiums -lessons from five Flemish case studies. Energy Policy 214, 115216. https://doi.org/10.1016/j.enpol.2026.115216.

EPBD, 2024. Energy Performance of Buildings Directive. https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive_en.

Fabbri, M., 2017. Understanding building renovation passports: customised solutions to boost deep renovation and increase comfort in a decarbonised Europe. In: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/6-buildings-policies-directives-and-programmes/understanding-building-renovation-passports-customised-solutions-to-boost-deep-renovation-and-increase-comfort-in-a-decarbonised-europe/.

Fawcett, T., Killip, G., 2014. Anatomy of low carbon retrofits: evidence from owner-occupied Superhomes. Build. Res. Inf. 42 (4), 434–445. https://doi.org/10.1080/09613218.2014.893162.

Ferrante, A., Fotopoulou, A., Cattani, E., Semprini, G., 2017. Deep Renovation in Changing Cities: Densification and real-estate Value for cost-effective Energy Targets in the ABRACADABRA Strategy. GRC. https://cris.unibo.it/handle/11585/625467.

Fetting, C., 2020. The european green deal. from. https://www.esdn.eu/fileadmin/ESDN_Reports/ESDN_Report_2_2020.pdf. (Accessed 9 November 2023).

Galvin, R., Sunikka-Blank, M., 2013. Economic viability in thermal retrofit policies: learning from ten years of experience in Germany. Energy Policy, Decades of Diesel 54, 343–351. https://doi.org/10.1016/j.enpol.2012.11.044.

Howells, J., 2006. Intermediation and the role of intermediaries in innovation. Res. Pol. 35 (5), 715–728. https://doi.org/10.1016/j.respol.2006.03.005.

Hwang, S.-A., Çetin, S., Visscher, H., Straub, A., 2025. Advancing energy renovations through digitalisation: a critical review of EU policies and instruments. Energy Build. 336, 115627. https://doi.org/10.1016/j.enbuild.2025.115627.

Jaksch, S., Franke, A., Österreicher, D., Treberspurg, M., 2016. A systematic approach to sustainable urban densification using prefabricated timber-based attic extension modules. Energy Proc. 96, 638–649. https://doi.org/10.1016/j.egypro.2016.09.121.

Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system-level transitions. Res. Pol. 43 (8), 1370–1380. https://doi.org/10.1016/j.respol.2014.02.007.

Kivimaa, P., Boon, W., Hyysalo, S., Klerkx, L., 2019. Towards a typology of intermediaries in sustainability transitions: a systematic review and a research agenda. Res. Policy, New Front. Sci. Technol. Innov. Res. from SPRU's 50th Anniversary Conference 48 (4), 1062–1075. https://doi.org/10.1016/j.respol.2018.10.006.

Liu, Z., Qian, Q.K., Li, B., Jin, C., Visscher, H., 2025. Dutch householders' intentions to adopt shallow geothermal systems for energy transition of existing buildings: a theory of planned behavior approach. Energy Build. 347, 116386. https://doi.org/10.1016/j.enbuild.2025.116386.

Milin, C., Bullier, A., 2021. *Towards large-scale roll out of "integrated home renovation services" in Europe*. i. https://www.turnkey-retrofit.eu/wp-content/uploads/Integrated-home-renovation-services_MILIN-BULLIER_ECEEE-2021.pdf.

Mlecnik, E., 2010. Adoption of highly energy-efficient renovation concepts. Open House Int. 35 (2), 39–48. https://doi.org/10.1108/OHI-02-2010-B0006.

Mlecnik, E., 2022. Chances for the upscaling of living-cost neutral renovations in the Netherlands. IOP Conf. Ser. Earth Environ. Sci. 1085 (1), 1. https://doi.org/10.1088/1755-1315/1085/1/012040.

Moschetti, R., Brattebø, H., 2016. Sustainable business models for deep energy retrofitting of buildings: state-of-the-art and methodological approach. Energy Proc. 96, 435–445. https://doi.org/10.1016/j.egypro.2016.09.174.

Pardalis, G., Mahapatra, K., Mainali, B., 2022. A business model canvas framework for sustainable one-stop-shops. IOP Conf. Ser. Earth Environ. Sci. 1085 (1), 012048. https://doi.org/10.1088/1755-1315/1085/1/012048.

Pardalis, G., Mahapatra, K., Palm, J., 2025. From blueprint to reality: an ex-ante and ex-post evaluation of one-stop shops for building renovation. Energy Build. 328, 115149. https://doi.org/10.1016/j.enbuild.2024.115149.

Rogers, E.M., 2003. Diffusion of Innovations, 5th Edition. Simon and Schuster.

RVO, 2025. *Subsidies en financiering om energie te besparen voor VvE's*. RVO.Nl. https://www.rvo.nl/onderwerpen/verduurzamen-woningen/energie-besparen-vve.

Steenkamp, F., 2024. De Lange Hordenloop. VvENET. https://drive.google.com/file/u/0/d/1gq_FBlNQdmyGp-h4wsPD7KgB3qyEALau/view?usp=sharing&pli=1&usp=embed_facebook.

Streimikiene, D., Balezentis, T., 2019. Innovative policy schemes to promote renovation of multi-flat residential buildings and address the problems of energy poverty of aging societies in former socialist countries. Sustainability 11 (7), 2015. https://doi.org/10.3390/su11072015.

Van Oorschot, J.A.W.H., Halman, J.I.M., Hofman, E., 2020. Getting innovations adopted in the housing sector. Constr. Innov. 20 (2), 285–318. https://doi.org/10.1108/CI-11-2018-0095.

van Steenis, W., Mlecnik, E., Elgendy, R., Rose, C., Vanhove, A., 2025. Requirements Guarantee and financial fund: discussion document for speeding up renovations by condominium associations by reducing the financial risks: condoreno - deliverable D3.5. https://condoreno.org/guarantee-and-financial-fund-could-speed-up-condominium-associations-renovations/.

Yin, R.K., 2017. Case Study Research and Applications: Design and Methods. SAGE Publications.

Zhang, C., Hu, M., Sprecher, B., Sacchi, R., Yang, X., Yang, S., Verhagen, T.J., Zhang, C., Steubing, B., Tukker, A., 2025. Revealing the interplay between decarbonisation, circularity, and cost-effectiveness in building energy renovation. Nat. Commun. 16 (1), 7153. https://doi.org/10.1038/s41467-025-62442-1.