Project Report

Role of Energy Labels in Decarbonising the Dutch Housing Sector

Integrated Sustainability Project
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RICS®

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Table of General Abbreviations

Abbreviation	Meaning
EPC	Energy Performance Certificate
EPBD	Energy Performance of Buildings Directive
GHG	Greenhouse gas
ISA	Integrated Sustainability Assessment
ISDE	Sustainable energy investment subsidy scheme
KfW	Kreditanstalt für Wiederaufbau
MCA	Multi-Criteria Analysis
NGO	Non-governmental Organisation
TPB	Theory of Planned Behavior

Table of Abbreviations for Identified Actors

Abbreviation	Meaning
4.TU	4.TU Built Environment
BZK	Dutch Ministry of the Interior and Kingdom Relations
DGBC	Dutch Green Building Council
ILT	Human Environment and Transport Inspectorate
ING	ING Group
IPO	Interprovinciaal Overleg
NEN	Royal Netherlands Standardization Institute
NVM	Royal Dutch Cooperative Association of Real Estate Agents and Appraisers in Real Estate
PBL	PBL Netherlands Environmental Assessment Agency
RICS	Royal Institution of Chartered Surveyors
RVO	Netherlands Enterprise Agency, RVO

Note. The actors for which no abbreviation is used: Aedes, Nationaal Warmtefonds, Natuur & Milieu, Vereniging Eigen Huis, and Woonbond.

Executive Summary

This assessment project was conducted by a group of students from the Master Programme Sustainability Science, Policy and Society at Maastricht University, between March and May 2024. In collaboration with the client Royal Institution of Chartered Surveyors (RICS), the goal was to explore and identify solutions to enhance the contribution of energy labels to the decarbonisation of the Dutch housing sector. The team proposed a total of 11 solution options, organised into four categories: 1) Energy label improvement options, 2) Behavioural options, 3) Policy options, and 4) Financial options – plus a baseline scenario involving no changes to the current system.

These options were evaluated based on six established criteria, through the means of a Multi-criteria Analysis (MCA) involving 15 relevant actors and the client. The six criteria were: 1) feasibility of implementation, 2) time frame of implementation, 3) effectiveness of improving energy label levels, 4) degree of complexity added to the Dutch energy label system, 5) public awareness of energy label importance, 6) motivation to improve the energy label. The MCA was conducted via an Excel spreadsheet distributed to actors through email. Due to a limited response rate, the research team employed role-playing to assume the perspectives of relevant actors for completing the MCA.

Results of the MCA showed that the three most highly scored options were option 5 (presenting purchasing decisions to other consumers), option 6 (presenting average EPC scores to homeowners), and option 7 (promoting awareness of energy label impacts) – all of which belong to the category of Behavioural options. Furthermore, a sensitivity analysis strengthened the results of the MCA and revealed the potential significance of option 8 (implementing minimum energy label requirements), as it was the highest rated option amongst the actor responses. Lastly, it was analysed which options the client is able to implement. Based on all of the findings, specific recommendations for RICS were provided, focusing on actionable steps they can take to implement the identified options.

1. Introduction

1.1. Problem context

The urgent need for sustainable development and environmental stewardship has propelled the discourse surrounding the decarbonisation of the built environment to the forefront of global agendas. With the housing sector accounting for 39% of global carbon emissions annually (Architecture2030, 2023), the imperative to transition towards low-carbon housing solutions has never been more pressing (RICS (2023b). Against this backdrop, the Royal Institution of Chartered Surveyors (RICS) commissioned an Integrated Sustainability Assessment (ISA) aimed at exploring opportunities to strengthen the contribution of energy labels to the decarbonisation of the Dutch housing sector until 2030. A sustainability assessment in general can be defined as the process of identifying, measuring, and evaluating the potential impacts of alternatives for sustainability (Devuyst, 2000), while the integrated sustainability assessment focuses heavily on problem structuring, and introduces the concept of learning (de Kraker & Dijk, 2016).

The Netherlands, renowned for its progressive stance on sustainability, presents a fertile ground for innovative approaches to address the dual challenge of climate change mitigation and energy efficiency enhancement within the housing sector (NFIA, 2023). Energy labels, providing consumers with information about the energy performance of buildings, play a pivotal role in incentivizing investments in energy-efficient technologies and driving market transformation towards sustainable housing practices (Brounen & Kok, 2011). Furthermore, they empower individuals and organisations to make informed choices that not only reduce their carbon footprint but also contribute to long-term cost savings and environmental sustainability. However, the efficiency of energy labels in facilitating the decarbonisation of the Dutch housing sector remains a subject of scrutiny due to challenges related to enforcement and compliance. While energy labels are intended to guide consumers towards more sustainable choices, issues such as inconsistent enforcement of regulations and varying levels of compliance among homeowners have been observed (Brounen & Kok, 2011). This inconsistency can undermine the overall impact of energy labels on driving meaningful energy efficiency improvements. Addressing these enforcement and compliance issues is crucial to ensuring the effectiveness of energy labels in achieving decarbonisation goals and fostering a more sustainable housing sector.

Thus, this ISA delved into the multifaceted dimensions of this issue – encompassing economic, social, and policy aspects. By adopting a systems thinking approach, the researchers aimed to unravel the complex interdependencies within the Dutch housing sector and elucidate

potential synergies and trade-offs associated with energy label interventions. Furthermore, the assessment strived to engage with a diverse array of stakeholders, including the Dutch national government, real estate agents, lobbyists, standardisation institutes and others, to ensure a holistic understanding of the challenges and opportunities at hand.

1.2. Client Introduction

The Royal Institute of Chartered Surveyors (RICS), which sets global standards and provides certifications to companies in the built and natural environment, is a globally recognized professional organisation and served as the client for this ISA. With a rich heritage dating back to 1868, RICS has been at the forefront of promoting ethical practices, fostering professional excellence, and advancing sustainability within the built environment (RICS, 2024). Driven by its commitment to fostering sustainable development and promoting best practices in the real estate sector, RICS commissioned this sustainability assessment to fulfil its strategic objectives and contribute to the collective efforts aimed at mitigating climate change impacts (RICS, 2023b). Recognising the pivotal role of energy labels in shaping consumer behaviour, informing investment decisions, and driving market transformation, RICS seeks to harness the potential of energy labels to accelerate the transition towards low-carbon housing solutions in the Netherlands.

To summarise, this assessment represented a collaborative endeavour between RICS, stakeholders, and students from Maastricht University to chart a course towards a more sustainable future for the Dutch housing sector. Through rigorous analysis, stakeholder engagement, and strategic recommendations, the researchers aimed to unlock the full potential of energy labels and catalyse transformative change in pursuit of a low-carbon, resilient, and equitable built environment, specifically for the residential housing sector.

1.3. Project Report Outline

Section 2 of the report gives an overview and discusses the methodologies used for the ISA, guided by the four-step ISA framework by De Ridder et al. (2007). The third section of the report focuses on the initial problem description, entailing step 1 of the ISA framework – which includes the actor- and systems analysis. Section 4 explains the identified solution options (step 2), and while the assessment thereof is described in section 5 (step 3). The sixth section of the report concludes the report and gives recommendations to the client, including the options that RICS is able to implement, as well as possible monitoring and follow-up of the implementation of the proposed options (step 4). Finally, section 7 reflects on the ISA process, the expected results, as well as the collaboration within the research team and with the client.

2. Research Methodology

In order to answer the research question, the first three ISA steps according to De Ridder et al. (2007) were applied, while step four was only advised. This framework guides the search for applicable tools to address the overall aim, while simultaneously incorporating the perception of possible users and stakeholders (De Ridder et al., 2007).

2.1. Step 1 – Integrated Problem Description

In the context of an ISA, the step of defining the problem is fundamental to comprehensively understand and analyse the issue at stake. This initial part involved identifying the core challenges and opportunities, delineating its boundaries, and establishing the scope of the assessment (Enserink et al., 2022). The aim was to frame the problem in a way that enables effective analysis and solution development. For this specific case, defining the problem entailed uncovering the complexities and dynamics surrounding the adoption, effectiveness, and implications of energy labels within the housing sector. To achieve a comprehensive understanding of the problem, an actor analysis and systems analysis approach was employed. The two analyses can be found in sections 3.1 and 3.2 respectively. First, the actor analysis entailed identifying and understanding the perspectives, interests, and influence of relevant actors involved in the issue at hand. Second, the systems analysis involved deconstructing the issue into its constituent parts and examining the interrelationships, feedback loops, and dynamics within the system (Meadows, 2008).

The choice of actor and systems analysis was well-suited to this case due to the complex and multidimensional nature of the problem. Energy labels operate within a dynamic system shaped by various organisations, policies, and market forces. Actor analysis enabled us to engage with and incorporate diverse perspectives, ensuring that proposed solution options are inclusive, feasible, and aligned with actors' needs and aspirations. The approach by Enserink et al. (2022) was followed, and included identifying relevant actors, exploring the actors' problem perceptions, identifying critical actors, as well as a power/interest matrix to delineate their relation to the problem. These are described in detail in section 3.1. Meanwhile, systems analysis allowed us to unravel this complexity and discern the underlying mechanism driving energy label usefulness. For this, the approach by Enserink et al. (2022) was also followed, and entailed delineating the level of the problem analysis, and the creation of a means-ends diagram, objectives tree, causal map, and finally a system diagram – which are thoroughly explained in section 3.2.

By employing these complementary analytical approaches, the researchers could effectively define the problem and lay the groundwork for developing targeted interventions to enhance the role of energy labels in decarbonising the Dutch housing sector, with RICS possibly playing a role in driving positive change.

2.2. Step 2 – Identification of Solution Options

In the second step of the sustainability assessment, the aim was to determine all potential options to tackle the identified problem (De Ridder et al., 2007). In addition to the insights gained from the systems and actor analysis, two different methods were used, namely a literature review and brainstorming, to derive possible methods and strategies (i.e. solutions). First, the literature review was performed using keywords like “housing sector”, “decarbonisation”, and “energy label”, and the available resources were examined for relevance, quality and trustworthiness (Snyder, 2019). Furthermore, an Excel sheet was used to organise the information and authors. The list of literature researched and used for brainstorming to identify options can be found in Appendix A. Literature review was a suitable method for this particular assessment case, as it enabled us to gain knowledge about the state-of-the-art methods and strategies which currently exist in using energy labels to help decarbonise the housing sector – not only in the Netherlands but worldwide (Snyder, 2019). Furthermore, collective evidence was gathered, which helped in selecting options relevant in tackling the clients’ complex problem (Snyder, 2019). A third benefit of the literature review was that it is a time-efficient method, which was in line with the time constraints of the project. Finally, a broad variety of sources could be considered – such as existing literature reviews, journals and scientific studies, books on energy labels, as well as conference proceedings and reports from governmental bodies/NGOs (Snyder, 2019). Hence, a systematic literature review made it possible to derive an unbiased and broad range of options.

Second, after being educated about the existing alternatives, the researchers brainstormed with an open mind for further realistic, as well as creative and out-of-the-box options which may not have been identified by previous literature (De Haan & De Heer, 2012). Through a combination of literature review and brainstorming, every researcher added at least four ideas in a shared document, which were shortly named and explained. The number of ideas in the end amounted to a total of 26, and can be found in Appendix B. These were checked for accuracy and feasibility, whether they had already been implemented, and similar ideas were combined. Through this process, the ideas were merged into 11 comprehensive options. For organisational purposes, the options were divided into 4 thematic categories. While

the first option implied no changes to the current system, options one to four aimed for an energy label improvement, options five to seven were behavioural solutions, eight and nine were policy solutions, while 10 and 11 were considered financial solutions.

2.3. Step 3 – Assessment of Alternative Options

In order to assess the solution options, a multi-criteria analysis (MCA) was conducted. MCA is a method widely used in the literature for tackling complex and unstructured problems (Gerber et al., 2013). The MCA was chosen due to its effectiveness in addressing stakeholder engagement. Following the approach outlined by the Department for Communities and Local Government (2009), the MCA process systematically assesses the various criteria and solution options. The aim of the MCA was to determine to which extent options create value by achieving the objectives outlined as part of the systems analysis. While acknowledging the challenges arising from having to make highly subjective decisions during each stage, an MCA offers a structured and transparent approach for decision-makers (Hobbs & Meier, 2000) – which aligns with the objectives of this project. Further elaboration on the stages involved in an MCA can be found below.

1. Establishing the decision context

The first stage of MCA generally aims to establish the decision context along with the goals of the analysis and identification of the key players. For this report, the aims of the MCA were determined as part of step 1 of the ISA. The actors who were identified during the actor analysis were contacted for the MCA, through emails and phone calls. Therefore, to establish the context, an actor- and systems analysis was conducted – as explained in section 2.1.

2. Identifying the options

The second stage of the MCA generally involves identifying the solution options. In this case, they were identified as part of step 2 of the ISA (see section 2.2).

3. Identifying the criteria

The third stage of the MCA was to identify criteria. Several criteria were determined as part of step 1 of the ISA as a result of creating the objectives tree. Furthermore, 18 experts from different universities and research organisations were contacted by email to provide input for possible criteria. However, only one expert replied, and unfortunately the input was deemed too technical and specific, considering the scope of the project. Therefore, solely the criteria derived from the objectives tree and feedback thereof from the client were considered.

4. Scoring the options

The fourth stage of the MCA involved evaluating the options based on the established criteria. For this, a likert scale from -2 to +2 was used, and the actors were asked to assign for each criteria a score to the options. The advantage of this approach was that it allowed for a consistent and transparent assessment process (Department for Communities and Local Government, 2009). All identified actors were contacted via email, and upon giving detailed instructions, they were asked to fill out the Excel form. This step was explained thoroughly in section 5.1. As only three actors (ING, NEN, and NVM) in addition to the client completed the MCA, the research team conducted a role-play, to fill out the MCA for the non-responses. For this roleplay, the perspectives of the respective actors were taken by the researchers and the Excel form was filled out accordingly.

5. Weighting the criteria

The fifth stage of the MCA was to assign weights for each of the criteria based on their relative importance to the decision. Choosing the most suitable weighting method was crucial as different weighting methods may lead to different weights, and consequently to different outcome decisions (Weber and Borcherding, 1993). As part of this step, the actors were asked to indicate how important they believe each criteria to be by dividing a score of 100% between the six criteria. Similarly to stage 4 of the MCA, the weights for the actors who did not respond were decided by the researchers during the role-play. Following this, all criteria scores were averaged (Balasubramaniam et al., 2007). A detailed description of the process can be found in section 5.2.

6. Calculating the criteria scores

Eventually, as part of stage 6 of the MCA, the average weighted scores were calculated by multiplying an option's score on a criteria by the importance weight of the criterion. This process was repeated for all the criteria and the sum of these was the overall preference score for a specific option.

7. Assessing results

In stage 7, the results obtained from the evaluation and weighting of the options were examined (see section 5.3).

8. Conducting a sensitivity analysis

In the final stage, a sensitivity analysis was conducted, thereby analysing the change in results by adjusting the initial conditions (Muñoz et al., 2016). For this project, it involved four distinct

scenarios by which the weights (and the scores in one case), were adjusted. The four scenarios were chosen based on different perspectives (only actor responses, equal weighting, focusing on means, and focusing on ends – see section 5.4). The objective of sensitivity analysis was to determine the extent to which the optimal option is affected by the change in weights, and how changes in the criteria weights or scores impact the ranking of options (Muñoz et al., 2016).

Based on the results from the MCA responses and the sensitivity analysis, a general conclusion was drawn, the research question answered, and recommendations proposed – see section 6. To conclude, by evaluating various criteria and options, the MCA made it possible to identify the most effective options to enhance the contribution of energy labels in decarbonising the Dutch housing sector by 2030, thus directly answering the main research question of this project.

2.4. Step 4 – Monitoring, Evaluation and Learning

The last phase of the ISA served two key purposes: to reflect on the assessment process, and to evaluate the outcomes of sustainability measures to understand their effectiveness (De Ridder et al. 2007). Regrettably, the scope of this project did not encompass this stage. Nonetheless, it is recommended to conduct this step – including monitoring, evaluation and learning. For this purpose, recommendations were developed on how to implement this step for the proposed solution options in section 6.2.2. This was done via additional research as well as insights gained during the project.

2.5. Overview of Methods

Table 1 provides a summary and overview of the methodology, as well as the involved inputs and outputs of all steps taken.

Table 1

Overview of Assessment Methodology with Inputs and Outputs

Step	*Activity*	*Input*	*Output*
Step 1 *Integrated Problem Description*	**1) Actor Analysis**		
	Identification of relevant Actors	• Scope of project • A list featuring stakeholder categories from the client • Desk research	• Identification of relevant actors (individuals and groups) • Relations/interlinkages of actors
	Actors and Problem Perceptions	• Assumptions based on desk research	• Overview Table of Actors and their Problem perceptions: perspectives, interests, objectives
	Identification of Critical Actors	• Assumptions based on desk research	• Overview of critical actors
	Power/interest Matrix	• Overview of critical actors for the power dimension • Desk research for the interest dimension • Impressions from communicating with actors	• Power/interest matrix: actors categorised a “Key players”, “Context setters”, “Subjects”, and “Crowd”
	2) Systems Analysis		
	Understanding the Problem Boundaries	• RICS’ policy paper • RICS’ 2023 Sustainability Report • Academic literature on housing sector	• Spatial, temporal, and organisational boundary • Challenges and opportunities • Internal and external factors
	Means-ends Diagram	• Client’s initial goal: to “decrease GHG emission in the Dutch housing sector”	• Means-end diagram (Identification of means and ends) • Identification of focal objective: to “Strengthen the contribution of energy labels”
	Objectives Tree	• Focal objective: to “Strengthen the contribution of energy labels” • Information about the use of energy labels	• Objective tree • Identification of lower-level objectives
	Causal Map	• Identified means, objectives, and criteria	• Causal map • Interrelationships, feedback loops, and dynamics within the system
	System Diagram	• Means and objectives of the client • Internal & external factors • Criteria of client	• System diagram

Step	*Activity*	*Input*	*Output*
Step 2 *Identification of Solution Options*	**1) Literature Review to Identify Options**	• Variety of sources and data (e.g. scientific literature, governmental websites, and reports) • Keywords (e.g. 'housing sector', 'decarbonisation', and 'energy labels')	• Excel sheet containing information and authors • List of possible solution options
	2) Brainstorming for further Options	• Information from actor analysis • Remarks from client	• Generation of additional options in a shared Word file
	3) Narrowing down Options	• List of 26 possible options from literature review and brainstorming	• Selection of 11 relevant options grouped in four different categories • Identification of option for maintaining the status quo (option 0)
Step 3 *Assessment of Alternative Options*	**1) Multi-Criteria Analysis (MCA)**		
	Identification of Criteria	• Objectives tree • Scope of the research	• Six criteria developed
	Contacting Actors to participate in MCA	• List of relevant actors from actor analysis	• Email contact with actors, reminder sent via email, and phone call in case of no response
	Scoring of Options against Criteria	• List of 11 relevant options • List of six criteria • Participatory method: scoring by actors • Role-playing: scoring by researchers for actors who did not respond	• Scored options ranging from -2 to 2
	Weighting of Criteria	• List of six criteria • Participatory method: weighting by actors • Role-playing: weighting by researchers for actors who did not respond	• Normalised scoring of criteria ranging from 0 to 100
	Combining Weights and Scores for Options	• Scored options ranging from -2 to 2 • Normalised scoring of criteria ranging from 0 to 100	• Average weighted scores for options
	Examining MCA Result	• Average weighted scores for options	• Composition of total scores for solution options • Formulated recommendations
	2) Sensitivity Analysis	• Assigning different weights and scores	• Consideration of four different scenarios • Top three options: 5, 6, and 7

Step	*Activity*	*Input*	*Output*
Step 4 *Conclusion and Recommen-dations (including follow-up and monitoring)*	**1) Recommendations**	• Results from MCA • System diagram • Research into implementation of options	• List of options RICS can implement themselves • Recommendations for RICS for implementation
	2) Monitoring, Evaluation and Learning	• Gather feedback from stakeholders through surveys and data gathering (theoretical)	• Evaluation of effectiveness of strategies and satisfaction • Outcome measurements
	3) Reflection of Assessment Process	• Results • Project group reflection meeting	• Evaluation of effectiveness and overall satisfaction with assessment process • Identification of strengths and weaknesses in methodology • Reflections on Client and Group collaboration • Reflections on Results

Note. The steps are structured according to the four “generic steps of integrated assessment” by De Ridder et al. (2007).

3. Integrated Problem Description

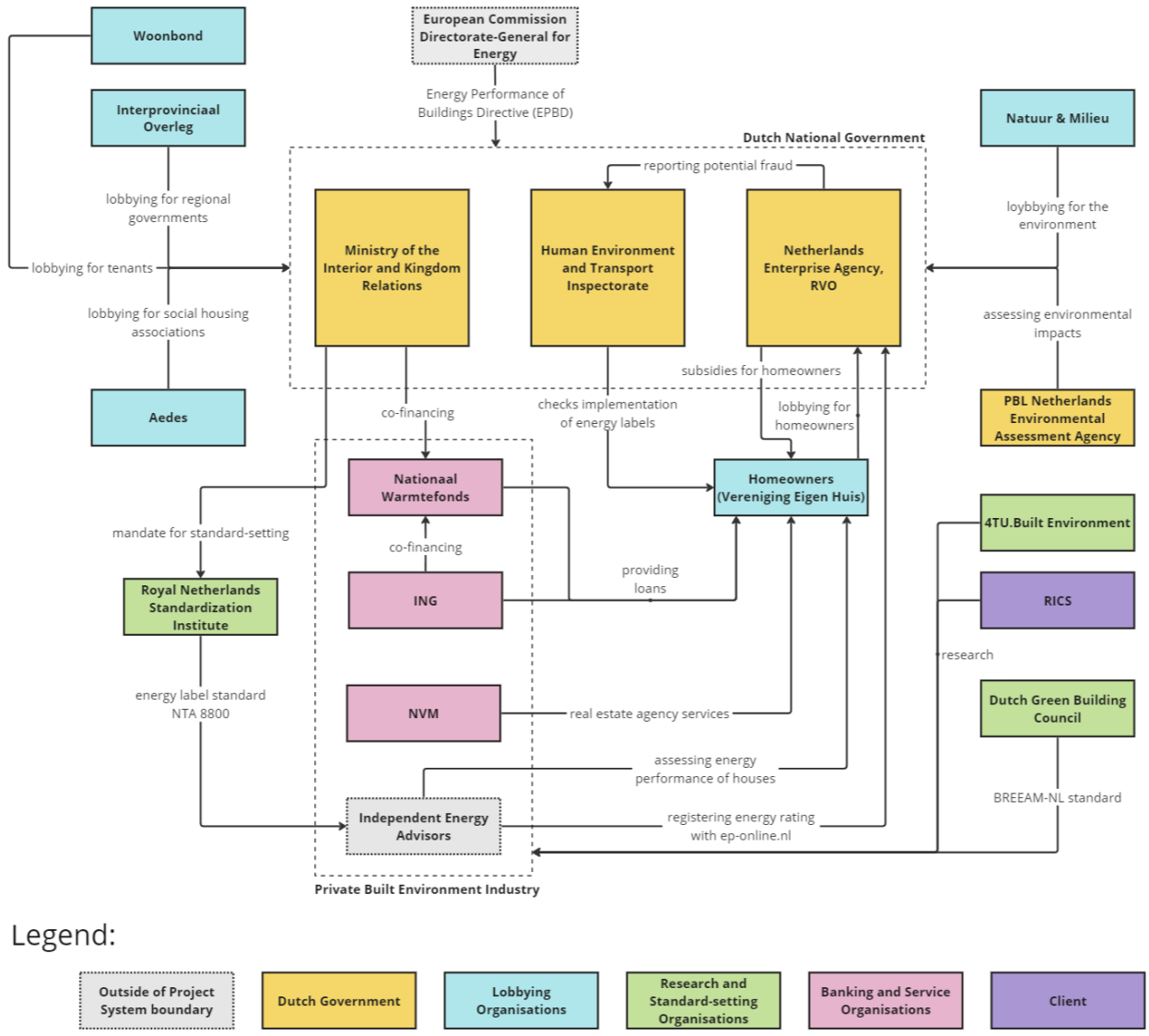
3.1. Actor Analysis

First, the relevant actors and stakeholders in the Dutch energy label system had to be identified. The reason for this is that the problem owner, RICS, does not have sufficient means to solve the problem on their own, thus other actors need to be involved in the policy process (Enserink et al., 2022). A desk research was performed by the authors in order to gather data on potential actors. As a starting point, a list featuring stakeholder categories from the client was used to brainstorm and gather ideas for the actor identification process. Afterwards, extensive research into the energy label system and housing sector in the Netherlands was conducted to get an idea of the processes and key actors involved, which was necessary to gain a comprehensive understanding of the landscape and to eventually find meaningful solution options to the problem statement. For determining these individual actors, a combination of interest-based and institutional approaches (Enserink et al., 2022) was utilised. Moreover, the actors identified were discussed with the client, who provided additional insights for potential actors to contact.

Since the spatial boundary was set to be at the national level, only appropriate actors operating at that level needed to be included (Enserink et al., 2022) – which is why local and regional actors were excluded from the analysis. As a result, it was assumed that the actors operating within the spatial boundary of this project are easier to identify than on, for example, local scales. Because of this, and the extensive research conducted, the researchers were confident that most, if not all, of the most important actors involved in the energy label system had been considered – even though additional data gathering methods such as snowballing were not utilised. The result of the identification of actors is presented in Figure 1. It shows the individual actors (-groups) and their interlinkages, which gives insight into how the Dutch energy label system functions as well as how the actors are involved in these processes. Each of the actor groups, including why they were chosen, have been described in detail below.

Figure 1

Identified Actors and Formal Relations chart



Note. Author creation. The client is also part of research and standard-setting organisations, highlighted in purple for better visibility only.

Dutch Government

Included in this group are the Ministry of the Interior and Kingdom Relations (BZK), which is the responsible ministry for all things related to the built environment in the Netherlands; the Netherlands Enterprise Agency (RVO), which acts as a support to businesses in the country and operates the EP-Online database, where the energy labels for all buildings in the Netherlands

are saved; the Human Environment and Transport Inspectorate (ILT), which enforces the proper usage and implementation of energy labels; and lastly the PBL Netherlands Environmental Assessment Agency (PBL), which is responsible for assessing the various environmental impacts of major industries in the Netherlands, including the built environment. In general, it has to be acknowledged that the Dutch government is dependent on EU legislation, for example the Energy Performance of Buildings Directive (EPBD). However, the EU was not part of the list of actors due to being outside of the geographic system boundary (national level).

Lobbying Organisations

Grouped here were four very different organisations, whose main purpose is to lobby for their stakeholders. As a stand-in for homeowners on the national level, the association Vereniging Eigen Huis was chosen, which represents and lobbies for its members (homeowners). The Interprovinciaal Overleg (IPO) is a collaboration between all provinces of the country in order to lobby for their specific interests, including the housing sector. The organisation Aedes is a network of social housing associations across the country, while Woonbond is an association representing individuals and tenant organisations on a national level. Lastly, Natuur & Milieu is an environmental NGO, with one of their main themes being sustainable living – which includes topics like energy efficiency.

Research and Standard-setting Organisations

Apart from the problem owner, RICS, which was introduced in section 1, other, similar organisations were put into this group. The organisation 4.TU Built Environment is part of the 4.TU Federation, a research collaboration between four major Dutch universities and focuses, among other topics, on energy-efficient infrastructure and emission reductions in the built environment industry. The Royal Netherlands Standardization Institute (NEN) is the official national standard-setting organisation and developed on behalf of the BZK the energy efficiency standard NTA 8800. However, there is also a voluntary standard for the built environment, BREEAM-NL, developed by the Dutch Green Building Council (DGBC) – which at the same time acts as a research organisation for all aspects of sustainability.

Banking and Service Organisations

Two financing institutions specifically for sustainable housing renovations were identified. First, Nationaal Warmtefonds is an initiative co-financed by the BZK, which provides affordable mortgage loans to homeowners. Likewise, ING, the largest banking company in the Netherlands (Statista, 2023), provides similar loans for renovations. Another important organisation is the

real estate agency association NVM (translated as Royal Dutch Cooperative Association of Real Estate Agents and Appraisers in Real Estate), which claims that 75 percent of all houses sold in the Netherlands are done so by their members and operates the largest rental market database in the Netherlands.

In a second step, after identifying relevant actors, an overview table of the actors and their problem perceptions was created (Enserink et al. 2022), see Table 2. The purpose of this was to get an impression of the perceptions amongst identified actors regarding the energy label system. This was important in order "to help identify[ing] the similarities and differences, as well as common objectives and shared interests, or potential conflicts" (Enserink et al. 2022, p. 94) for determining the power/interest dimensions of each actor. Due to time constraints and the aforementioned limitations in contacting actors on a national level, there was no actor involvement at this point. As such, the table was filled out based on assumptions made by the authors on the basis of publicly available information, such as the websites of the relevant actors, and perceived stereotypes of such organisations brainstormed by the authors. Furthermore, for organisations representing specific stakeholders (e.g. Woonbond representing tenants – marked red in Table 2), the desired situation, gap, causes, and solutions are assumed from the represented stakeholders' perspective, not from the organisation itself. This approach was chosen due to the representative nature of these organisations, who do not have (apparent) missions or grand objectives of their own.

After completing the table of actors' problem perceptions, it became clear that multiple actors have common objectives and similar interests, which was important for finding solution options in the next step of the ISA. The following step of the actor analysis was to determine whether the identified actors are critical for the problem owner in order to solve the problem. These actors could either be critical for implementing solutions to the problem, or for blocking efforts to implement solutions to the problem (Enserink et al., 2022). Highlighted in Table 3 are 1) the identified actors, 2) the importance of their resources with regards to the problem, 3) how replaceable these resources are, 4) based on the previous factors, the dependency of the problem owner towards the actor[1] and lastly, 5) whether an actor constitutes as critical (i.e. high dependency, marked in red). The way this data was gathered was the same as for identifying the actors' problem perceptions in Table 2. Curiously, out of the six identified critical actors, four are part of the Dutch government. This shows that in the case of a problem on the national level, the government is seemingly the most important actor to drive change.

[1] moderate importance and easy replaceability equals low dependency and high importance and limited replaceability equals high dependency

Table 2

Overview of Actors and their Problem Perceptions

Actors	*Interests*	*Desired Situation*	*Expected Situation*	*Perceived Causes*	*Possible Solutions*
RICS	Decarbonisation of the Dutch housing sector; acquiring new members; entering new markets	Energy labels effectively contributing to decarbonising the Dutch housing sector	Lack of incentives to invest in energy efficient measures despite low energy label rating	Housing crisis lowers consumer demand in energy efficiency; high adoption costs reduces homeowner demand in renovations	Reducing housing crisis; introducing cheaper energy efficiency measures
4.TU Built Environment	Making an impact in the built environment sector; securing funding for research projects; increasing outreach and influence	Being at the forefront of new and impactful energy efficiency innovations	Lack of funding and collaboration for more impactful research	Energy efficiency innovations low priority for public and private groups	Spreading awareness of the importance of energy efficiency
Aedes	Representing and furthering the interests of social housing associations (their members); increasing memberships	Cheap and efficient solutions to improve energy efficiency of social houses	Effective energy efficiency measures expensive to implement	Lack of affordable measures; lack of subsidies for renovations - loans might not be feasible for everyone	introducing cheaper energy efficiency measures; introducing pure subsidies for renovations
BZK	Adhering to EU legislation and Climate Agreement; regulating the industry; increasing overall energy efficiency; making housing more affordable	Compliance with EU legislation; high energy efficiency rates of the existing building stock	Off-track to meet EU targets; lack of large-scale adoption of energy efficiency measures	Lack of mandatory legislation to improve energy energy efficiency for residential housing	Introducing mandatory legislation to improve the energy efficiency/label within a certain time frame (similar to the requirements for office buildings)
DGBC	Furthering the sustainability transition in the built environment industry; increasing credibility and members of the BREEAM-NL standard;	High adoption and effectiveness of the BREEAM-NL standard to further the sustainability transition	Voluntary BREEAM-NL standard still niche product next to the mandatory energy label	Lack of awareness of the standard; following a voluntary standard in addition to the mandatory not feasible for everyone	Spreading awareness of the BREEAM-NL standard; harmonising or simplifying the process when mandatory energy label already present

Actors	*Interests*	*Desired Situation*	*Expected Situation*	*Perceived Causes*	*Possible Solutions*
ILT	Enforcing proper energy label usage	Usage of energy labels which reflects true and actual circumstances	Existing energy label fraud which is difficult to detect	Lack of administrative capacities to comprehensively check proper usage of energy labels	High penalties for energy label fraud; improved reporting system to help detect suspected fraud
ING	Selling green loans; increasing customer base; gaining reputation as a green bank	High interest in taking out loans for renovating buildings	Lack of interest in taking out green loans	Conditions not favourable for everyone; homeowners with existing loans not taking on more loans	Financial support by government to improve conditions for loans; better conditions for people with multiple loans
IPO	Furthering interests of regional governments; enhancing public administration in the Netherlands	Effective and coherent energy efficiency legislation between national and regional government level	Lack of coherency between national and regional policy-making	Little consideration of the challenges on a regional level by the national government; limited capacity to influence national policy-making	Improved vertical collaboration between national and regional levels of government
Nationaal Warmtefonds	Furthering energy transition; selling more mortgage loans; securing co-financing support;	High interest in taking out loans for renovating buildings	Lack of interest in taking out green loans	Conditions not favourable for everyone; homeowners with existing loans not taking on more loans	More financial support n general to improve conditions for loans; better conditions for people with multiple loans
Natuur & Milieu	Advocating for sustainability issues; securing financial support	High progress in improving energy efficiency rates and environmental issues of the existing buildings	Limited and slow progress in renovating and improving existing buildings	Lack of proper legislation on energy efficiency measures; lack of public pressure on government	Introducing mandatory legislation to improve the energy efficiency/label within a certain time frame (similar to the requirements for office buildings); spreading awareness of the importance of energy efficiency
NEN	Updating the NTA 8800 standard annually; optimising standard-setting processes	Few change needed for the NTA 8800 each year	Rapidly changing legislative landscape; effective energy efficiency measures getting more and more important	Climate change; growing national energy security concerns	Integrating long-term planning in the standard setting process to account for future developments;

Actors	*Interests*	*Desired Situation*	*Expected Situation*	*Perceived Causes*	*Possible Solutions*
NVM	Supporting members in selling or renting properties; acquiring new members	High energy efficiency of properties to boost attractiveness on the market	Energy efficiency not considered important on the market; cost-benefits of renovations not high	Housing crisis lowers consumer demand in energy efficiency	Solving or mitigating housing crisis ideally – however also benefits from housing crisis: high demand for housing without much investment needed / consumers willing to pay high prices due to low availability of housing
PBL	Assessing environmental impacts; influencing policy-making	Compliance with EU legislation; high progress in reducing GHG emissions	Off-track to meet EU targets; limited progress in reducing GHG emissions of existing buildings	Lack of mandatory legislation to improve energy energy efficiency for residential housing	Introducing mandatory legislation to improve the energy efficiency/label within a certain time frame (similar to the requirements for office buildings)
RVO	Supporting Dutch businesses; operating ep-online.nl platform	Effective process to issue and receive energy labels	Many different independent energy advisors to choose from with varying quality	Decentralised system of energy label issuers	Monitor compliance of independent energy advisors
Vereniging Eigen Huis	Furthering interests of homeowners and homeowner associations in the Netherlands; supporting members; increasing memberships and financing	Cheap and efficient solutions to improve energy efficiency	Effective energy efficiency measures expensive to implement	Lack of affordable measures; lack of subsidies for renovations - loans might not be feasible for everyone	Introducing cheaper energy efficiency measures; expanding pure subsidies for renovations
Woonbond	Furthering interests of housing tenants (their members); supporting members; increasing memberships and financing	High energy efficiency in order to reduce utility bills	Generally low energy efficiency and high energy bills; landlords not willing to invest	High renovation costs; lack of market pressure in demanding energy efficiency	Introducing cheaper energy efficiency measures; solving or mitigating housing crisis; spreading awareness of the importance of energy efficiency

Note. Organisations representing specific stakeholders are marked red.

Table 3

Identifying Critical Actors

Actors	Importance of Resources (moderate / high)	Replaceability of Resources (easy / difficult)	Dependency (limited / medium / high)	Critical Actors (Y/N)
4.TU Built Environment	Moderate – Technological knowledge from research projects; existing networks with other stakeholders in the industry	Difficult. There are plenty research organisations in the built environment sector, however 4.TU is unique in the sense that it includes four major universities, including research staff and networks with other stakeholders	Medium, despite being a large network of multiple universities, the importance of innovative research in energy efficiency measures is currently limited, with the literature seeing importance more on implementation and behavioural challenges	No
Aedes	Moderate – Social knowledge from collaborating and representing social housing associations	Difficult, due to the fact that there is no other organisation representing social housing associations on a national level – however insights might be replaceable with those of homeowner associations (Vereniging Eigen Huis)	Medium. While not as numerous as homeowners (/associations), insights from social housing associations should not be neglected for the decarbonisation of the housing sector – especially considering that low energy efficiency could be more prevalent in cheaper rental houses.	No
BZK	High – Policy-makers in the built environment industry	Difficult, there is only one ministry responsible for the built environment industry	High, the only government body in the Netherlands who can mandate changes for the housing sector on a national level	**Yes**
DGBC	Moderate – Knowledge of implementing standards for the built environment; partner of many industry players	Difficult, as no other relevant standards in the built environment industry were observed	Medium. Apart from the government, there is no other entity in the Netherlands with experience in implementing an energy label – however it is only a voluntary label.	No
ILT	High – Mandate for enforcing proper energy label usage in case of fraud	Difficult, due to the fact that this is the primary supervising organ of the government to enforce energy label usage in case of fraud	High. In order to effectively decarbonise the Dutch housing sector using energy labels, proper implementation has to be enforced.	**Yes**
ING	Moderate – Capabilities for providing loans with better conditions for renovation projects	Easy, due to the fact that there are many banks in the Netherlands offering green loans	Limited, as providing green loans is an important tool for increasing affordability of energy efficiency measures – however not the only possible tool, and many institutions are capable of providing loans	No

Actors	Importance of Resources (moderate / high)	Replaceability of Resources (easy / difficult)	Dependency (limited / medium / high)	Critical Actors (Y/N)
IPO	Moderate – Knowledge on the regional challenges in energy efficiency	Difficult, as it is the only network of all the provinces operating on a national level	Medium, due to the fact that regional governments have more insights into the challenges of different regions in adopting energy efficiency measures on a large scale, but it is questionable whether these topics are a priority for the provinces	No
Nationaal Warmtefonds	Moderate – Capabilities for providing loans with better conditions for renovation projects	Easy. Even though the Nationaal Warmtefonds is a non-profit organisation and an initiative by the national government, there are many private banks which provide green loans.	Limited, see explanation for ING	No
Natuur & Milieu	High – Important public voice for sustainability concerns in the Netherlands; has the BZK as one of the partners	Easy, as there are numerous societal advocacy groups regarding environmental concerns	Medium, due to the fact that spreading awareness of sustainability issues such as energy efficiency is important for implementing projects	No
NEN	Moderate – Technical expertise in standard-setting	Difficult, as it is the national standard-setting organisation in the Netherlands	Medium. While it is important to have technical experience in standard-setting, NEN does not implement nor monitor the standard in practice.	No
NVM	High – Social knowledge of rental agencies and buying/selling or renting houses; extensive knowledge of the Dutch real estate market due to operating the real estate database	Difficult, due to NVM being the biggest association of rental agencies in the Netherlands	High. The rental market seemingly thrives in the Dutch housing crisis, as prices for properties rise up and the power asymmetry between supplier and consumer increases. Therefore, it is unclear whether an organisation such as NVM would be a supporter or an opponent of improving energy efficiency.	**Yes**
PBL	High – Experience in monitoring and evaluating environmental issues in the Netherlands; knowledge of the state of the sustainability transition in the built environment industry; influence on policy-making by issuing reports	Difficult, as PBL is the national environmental assessment agency, although private consulting companies such as KPMG do also issue reports on the environmental state of industries	High, due to the unique position of PBL as an independent but governmental agency	**Yes**

Actors	Importance of Resources (moderate / high)	Replaceability of Resources (easy / difficult)	Dependency (limited / medium / high)	Critical Actors (Y/N)
RVO	High – Operating the energy label database ep-online.nl; monitoring energy label usage	Difficult, only government body to operate the database and monitor energy label implementation	High, as the RVO is responsible for monitoring and issuing energy labels to homeowners – which is a crucial part of the effectiveness of energy labels	**Yes**
Vereniging Eigen Huis	High – Social knowledge of the challenges facing homeowners with regards to improving energy efficiency	Difficult, as this is seemingly the only association for homeowners operating at a national level	High. Homeowners are the most crucial aspect of the decarbonisation of the housing sector, as they are responsible for actually improving the energy efficiency. The insights and perspectives of homeowners are important for considering feasible and effective solutions.	**Yes**
Woonbond	Moderate – Social knowledge of the challenges facing tenants with regards to rental properties with poor energy efficiency	Difficult, as this is seemingly the only association for tenants operating at a national level	Medium. While important insights can also be gained from the perspective of tenants, they are not the ones responsible for investing in- and improving the energy efficiency of the houses they live in.	No

Note. Critical actors are marked red.

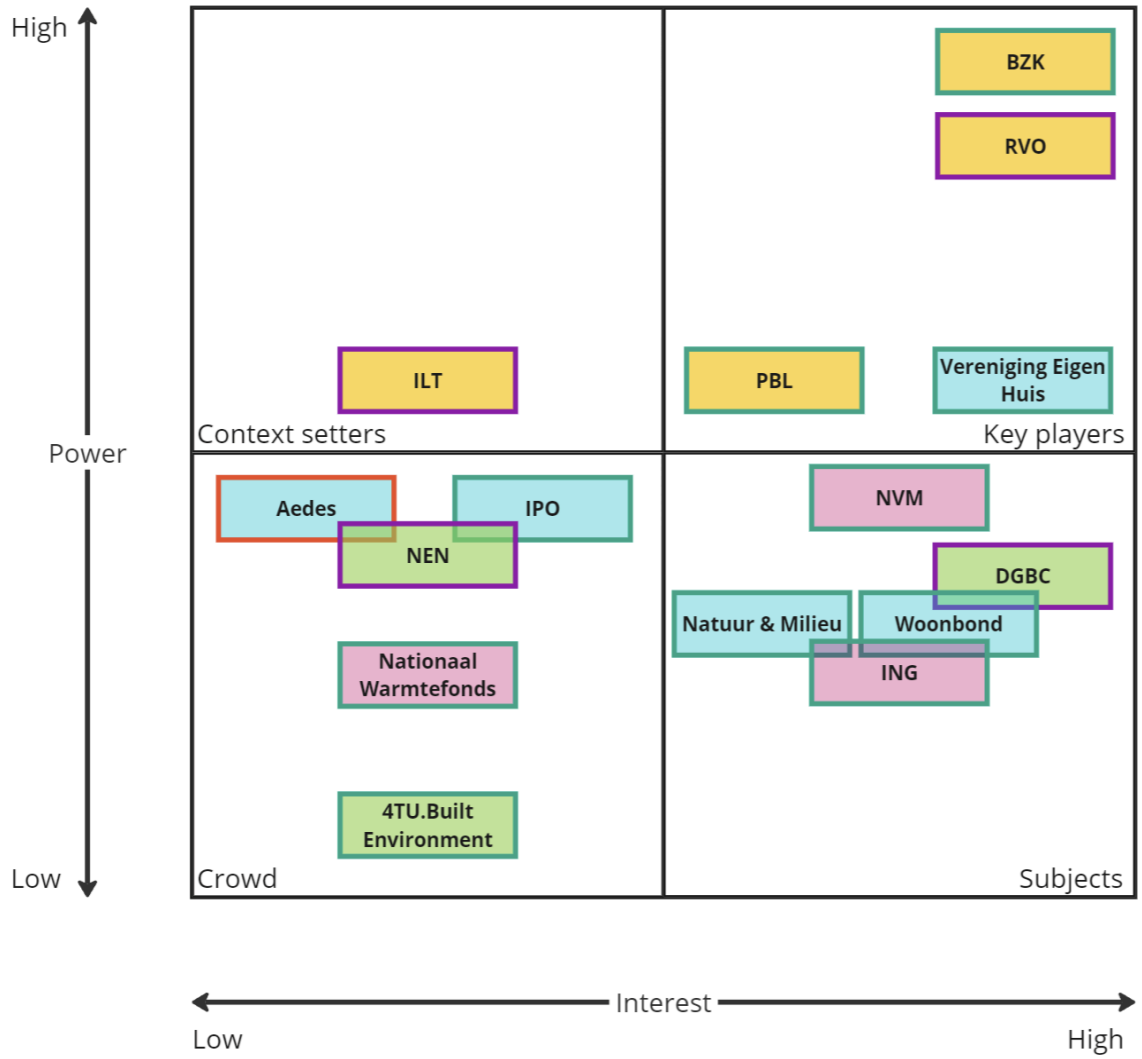
As for the last step of the actor analysis, a power/interest matrix was created based on the level of power (i.e. critical or non-critical) and level of interest, determined by whether the actor is affected by clear costs or benefits (Enserink et al., 2022) – see Figure 2. By categorising the actors into the four dimensions of ‘‘Key players” (high power, high interest), ‘‘Context setters’’ (high power, low interest), ‘‘Subjects’’ (low power and high interest) and ‘‘Crowd’’ (low power and low interest), the engagement of the individual actors were determined, and the insights used for the next steps of the ISA (Reed et al., 2009), specifically for role-playing the MCA for the actors which did not respond to the inquiry. In addition to the power/interest dynamics of the actors, it was determined whether an actor can be considered a “supporter” or an “opponent” for the implementation of solution options (Enserink et al., 2022). Assumed supporters were marked with a green outline in the power/interest matrix, while those with a purple outline were considered a “wildcard”. For those, no assumptions could be made due to insufficient input. Moreover, because of limited expertise in the Dutch housing sector, the researchers wanted to avoid a “self-fulfilling prophecy”, where actors start behaving in a particular way because it is expected of them (Enserink et al., 2022). The considerations for determining wildcards were the following:

- DGBC: Since their voluntary energy label “rivals” the mandatory label, strengthening the energy label could make the BREEAM-NL standard obsolete.
- ILT: Since they have limited capacity to enforce proper usage of energy labels, strengthening energy labels might strain their capacities even further.
- NEN: As optimising the annual review of the NTA 8800 is likely a priority, making extensive changes to the energy label system could lead to resistance.
- RVO: As RVO is responsible for supporting businesses, increased bureaucracy by strengthening energy labels might also lead to resistance.

Interestingly, the only outlier marked in red is the actor Aedes, who – during email correspondence – mentioned that they would oppose changes to the energy label system due to expected uncertainty in the outcome, as well as a highly administrative workload connected to changes in the energy label system. Thus, Aedes was considered an opponent to implementing options.

Figure 2

Power/Interest Matrix



Note. Author creation. Green outline represents a potential supporter of options to strengthen energy labels, purple outline represents an unclear alignment – either for or against options, and red outline represents opponents to options.

3.2. Systems Analysis

In order to comprehensively understand the problem presented, it was necessary to define the system related to the perceived issue. According to Matson et al. (2016), a system consists of variables interacting with each other within a temporal and geological boundary. In the context of an ISA, the system is also actor-dependent – containing the objectives, criteria, means, and

factors (both internal and external in relation to the actor) (Walker, 2000). In section 1, it was explained that the client seeks to leverage the benefits of energy labels in the Dutch housing sector. According to Economisch Instituut voor de Bouw, Metabolic, & SGS Search (2020), 65% of operational energy use from the built environment in the Netherlands comes from residential buildings. Coupled with the housing crisis (NL Times, 2024), the housing sector presents a considerable challenge in decarbonising the built environment. Therefore, even though RICS' expertise encompasses the built environment as a whole, the emphasis of this ISA was placed on the housing sector specifically. As such, the problem demarcated the spatial boundary as the national level of the housing sector, specifically that of the Netherlands. For the temporal boundary, in their policy paper, RICS (2023a) proposed mandates and actions to be adopted by 2030. Therefore, in maintaining alignment with the organisational recommendations, the temporal scope of this assessment was chosen to be 2024-2030. Finally, seeing as RICS is the de-facto problem owner, the client also represents the organisational boundary for this project.

Means-ends Analysis

With regard to the goal of the client, RICS's ambition is to decarbonise the Dutch housing sector – a complex and multi-layered problem. To understand the appropriate level of analysis, a means-ends analysis was conducted. This began with the client's initial goal: to decarbonise the housing sector (labelled as "Decrease GHG emission in the Dutch housing sector" in the means-ends analysis). Then, to reach RICS' fundamental goal, the rationale behind each goal was persistently inquired until a comprehensive understanding was achieved. Subsequently, the approach involved working backwards to identify viable means to achieve this goal by addressing each endpoint with a "How?" query. This tool was based on the approach by Enserink et al. (2022) and chosen for its ability to explore in-depth whether the problem accurately reflects the client's final goal and to contextualise the issue within a broader picture. Figure 3 shows the result of the means-ends analysis. In this diagram, the scope was marked by the dotted line, which is "Strengthen the contribution of energy labels" and its three direct means and their seven additional means. The figure indicates that the client's problem of decarbonising the housing sector is not the end goal, but rather a means goal that contributes to the sustainability of energy usage, construction, maintenance, and urban planning. Ultimately, this contributes to the sustainability of the housing sector in the Netherlands. Additionally, the emphasis on energy labels fell a step below the client's primary goal. Therefore, during the ISA process, it was crucial to maintain a focus on the overarching goal of enhancing sustainability in the housing sector.

Objectives Tree

Following the means-ends analysis, an objectives tree was created (see Figure 4). This was chosen because our focal objective, “Strengthen the contribution of energy labels”, was quite abstract. The objectives tree allowed for developing tangible criteria to assess the means in realising the desired situation, i.e. the solution options. To achieve this, the focal objective was further developed into specific criteria. From three key studies on energy label usage in the Dutch housing market (Brounen & Kok, 2010, Stangenberga, 2020, and Murphy, 2014), three main factors and six sub-factors were identified that supported the focal objective, resulting in a three-level objective tree. From this objective tree, the high-level objective of “high contribution of energy labels in reduction of GHG emissions in the Dutch housing sector” was operationalised into lower-level objectives of acceptance of energy label, energy efficiency level, and energy label system. These objectives are measured by six criteria, highlighted in green.

Causal Map

Having identified the means, objectives, and criteria, it was essential to also understand the factors related to this system and how they were interconnected. Other than the criteria mentioned above, additional criteria such as “stakeholder involvement”, or “housing price” were identified based on the research on energy certificate adoption by Murphy (2014). Hence, a causal map was constructed (Figure 5) to visualise the relations among the factors. For constructing the map, an underlying assumption was that through higher exposure to energy labels (either through usage, promotion, or education), the perceived usefulness by stakeholders would increase.

The key variable (contribution of energy label to decarbonisation) is influenced by three factors: positively by “effectiveness of energy label policies”, and ”usefulness of energy labels”, and negatively by “complexity in energy label system”. Subsequently, each factor is influenced by other factors. For example, “usefulness of energy labels” is positively influenced by homeowner-related variables, (e.g. “acceptance of energy label usage” and “energy efficiency awareness”).

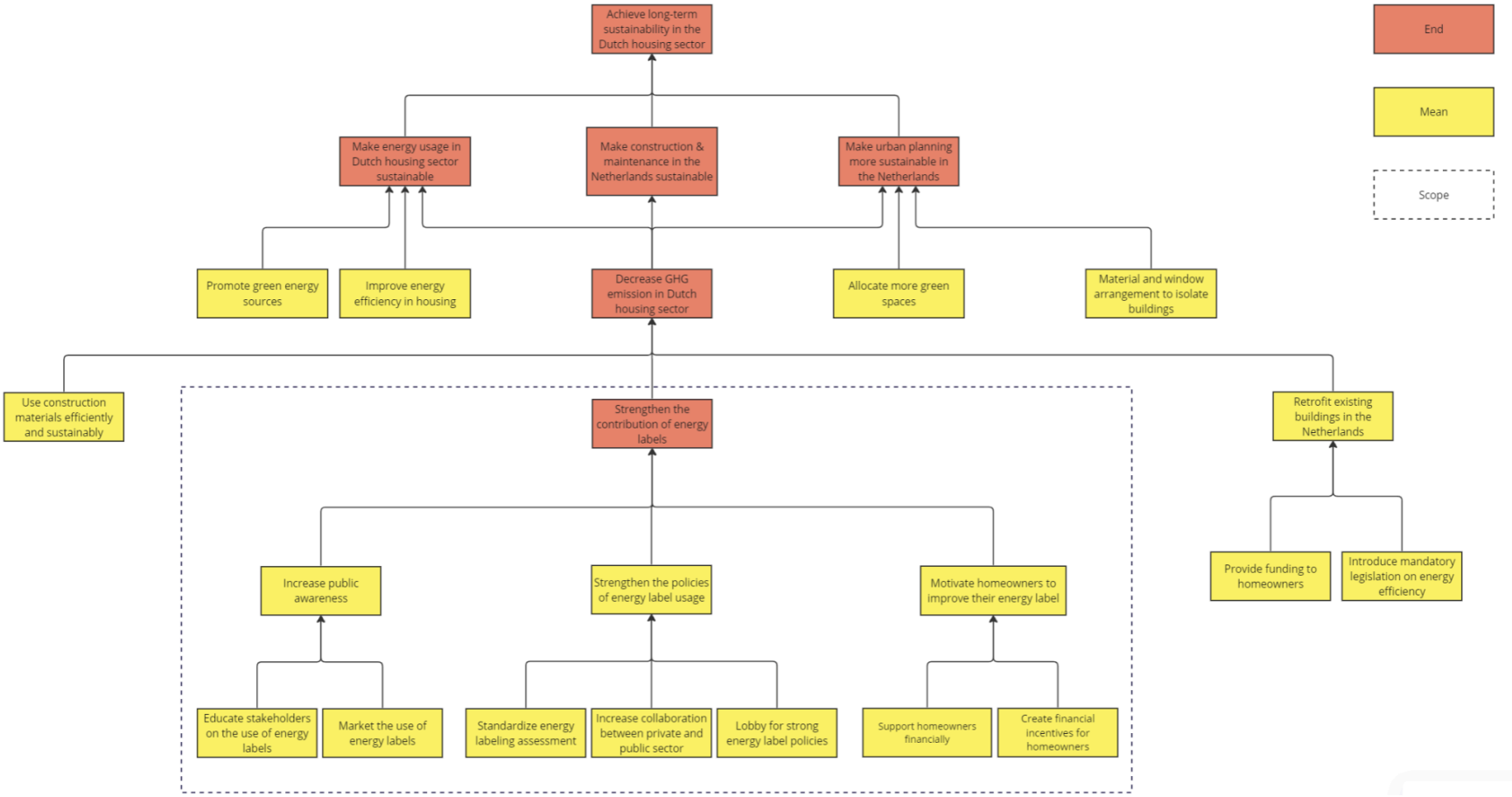
Overall, the key variable is reinforced through a feedback loop with “usefulness of energy labels”. Notably, this factor has two feedback loops, one reinforcing, and one balancing. The reinforcing loops involve the key variable and “acceptance of energy label usage”. Meanwhile, the balancing loop is related to the housing market situation, showing that if energy labels increase their usefulness, investments in houses will also increase, leading to a rise in housing prices. This would eventually decrease the number of affordable homes, and lead to a

decrease in the usefulness of energy labels (through a decrease in public's perception and subsequent awareness).

For the causal map, the problem's organisational boundary was considered. RICS, whose main activities are standard-setting and knowledge production and diffusion (RICS, 2024), can only influence factors such as stakeholder involvement, promotional and educational activities, and lobbying campaigns regarding energy labels. Therefore, these factors are considered internal factors from RICS' perspective, while the rest are considered external factors for RIC's system diagram.

Figure 3

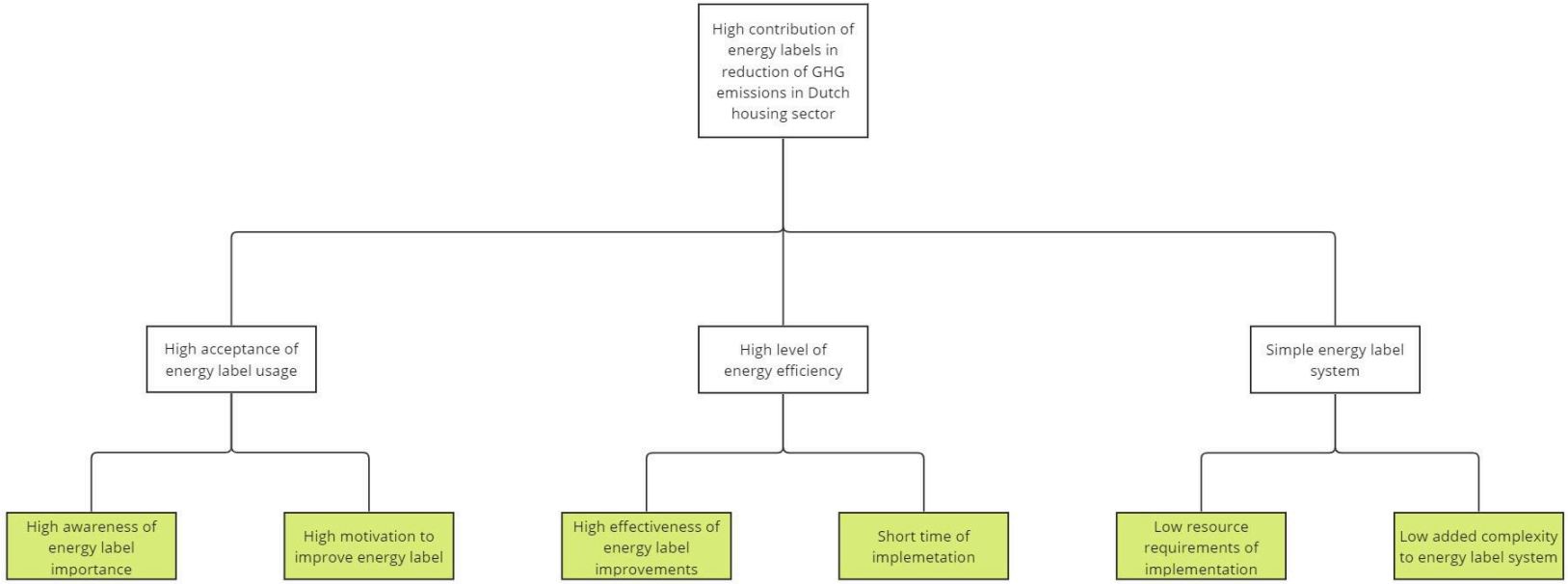
Means-ends Diagram



Note. Author creation. Red represents the end goal, yellow represents the means. The dotted line represents the scope of the problem. The diagram is constructed based on Enserink et al. (2022).

Figure 4

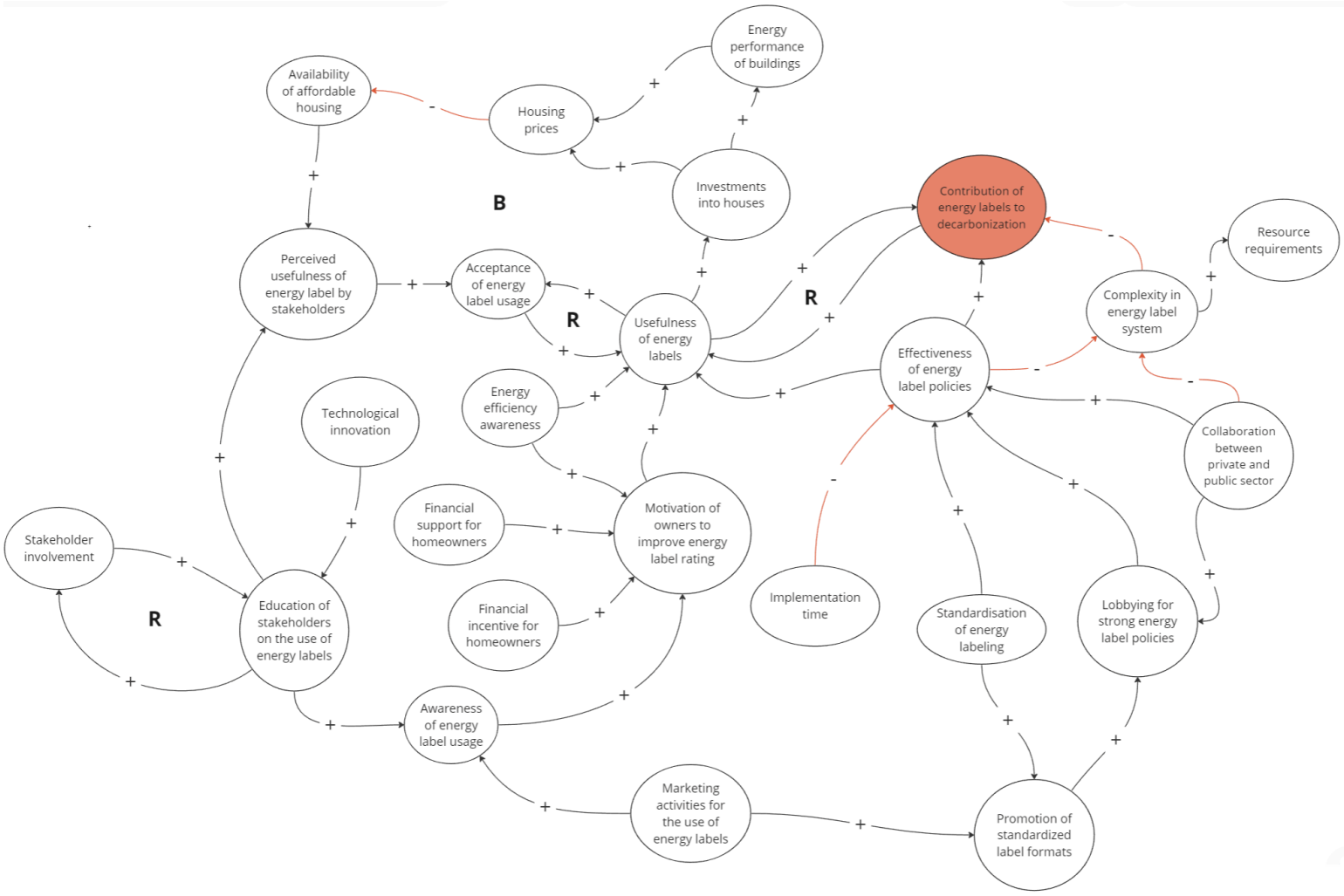
Objectives Tree



Note. Author creation. The objective tree is constructed based on the framework by Enserink et al. (2022).

Figure 5

Causal Map



Note. Author creation. The causal map is constructed based on Enserink et al. (2022).

System Diagram

Finally, after identifying the key components through the use of mean-end analysis, objective tree, and causal map, the system diagram was constructed (see Figure 6). This diagram represents the conceptual model of the problem's relevant system from the client's perspective (for the whole energy label system diagram in the Netherlands, see Appendix C). For the diagram to maintain its clarity, not all factors, means, and objectives were included. As such, when a cluster of means or objectives could be represented by its higher level means or objectives, these were presented accordingly. Regarding external factors, most of them can be influenced by internal factors, however "technological innovation," "collaboration between the private and public sectors," and "standardisation of energy labelling" directly influence internal factors without being influenced in return. Therefore, these factors are considered in the system diagram. In this diagram, the three means of the client are situated on the left, influencing the internal factors within RICS, which eventually affect the criteria or objectives of the client. As mentioned before, three external factors are also relevant to this system as they can affect the actions within RICS.

Looking at the system diagram, "increase public awareness" is the mean that can impact two internal factors that lead to achieving two criteria. Additionally, two internal factors, namely "education of stakeholders on the use of energy labels" and "lobbying for stronger energy label policies" are influenced by two external factors, showing how they can be affected by various external events and trends. In general, positive interrelations exist among the criteria, as the improvement of one criteria positively correlates to the improvement of others. By tracing the paths from the means like motivating homeowners to improve their energy label ratings, increasing public awareness, and strengthening the policies of energy label usage, we can assess how these contribute to the motivation of homeowners and the overall policy and energy label effectiveness.

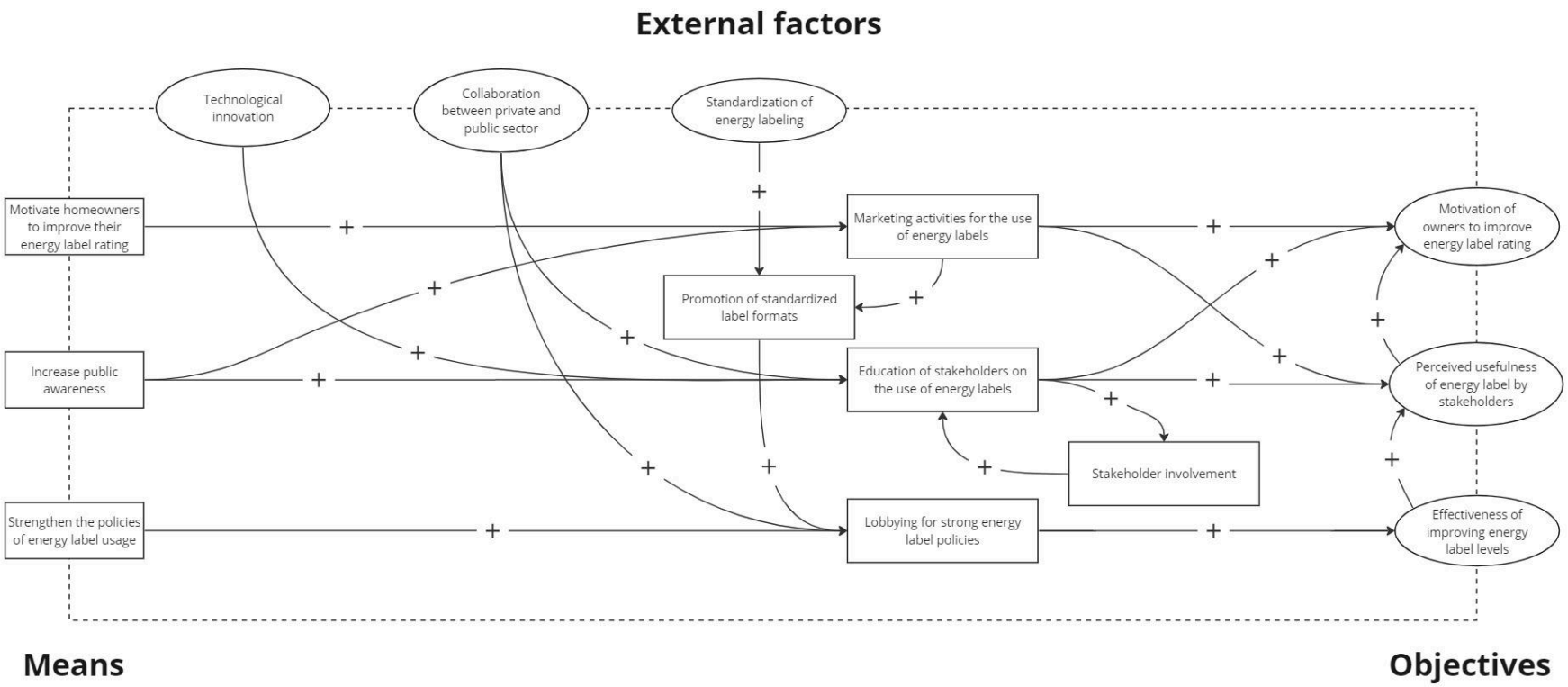
3.3. Problem Statement

Based on the actor and systems analysis, as well as the initial research question given by the client, the concrete problem statement was derived:

What are the opportunities in strengthening the contribution of energy labels to the decarbonisation of the Dutch housing sector until 2030, and what role can RICS play in it?

Figure 6

System Diagram



Note. Author creation. The system diagram is constructed based on Enserink et al. (2022).

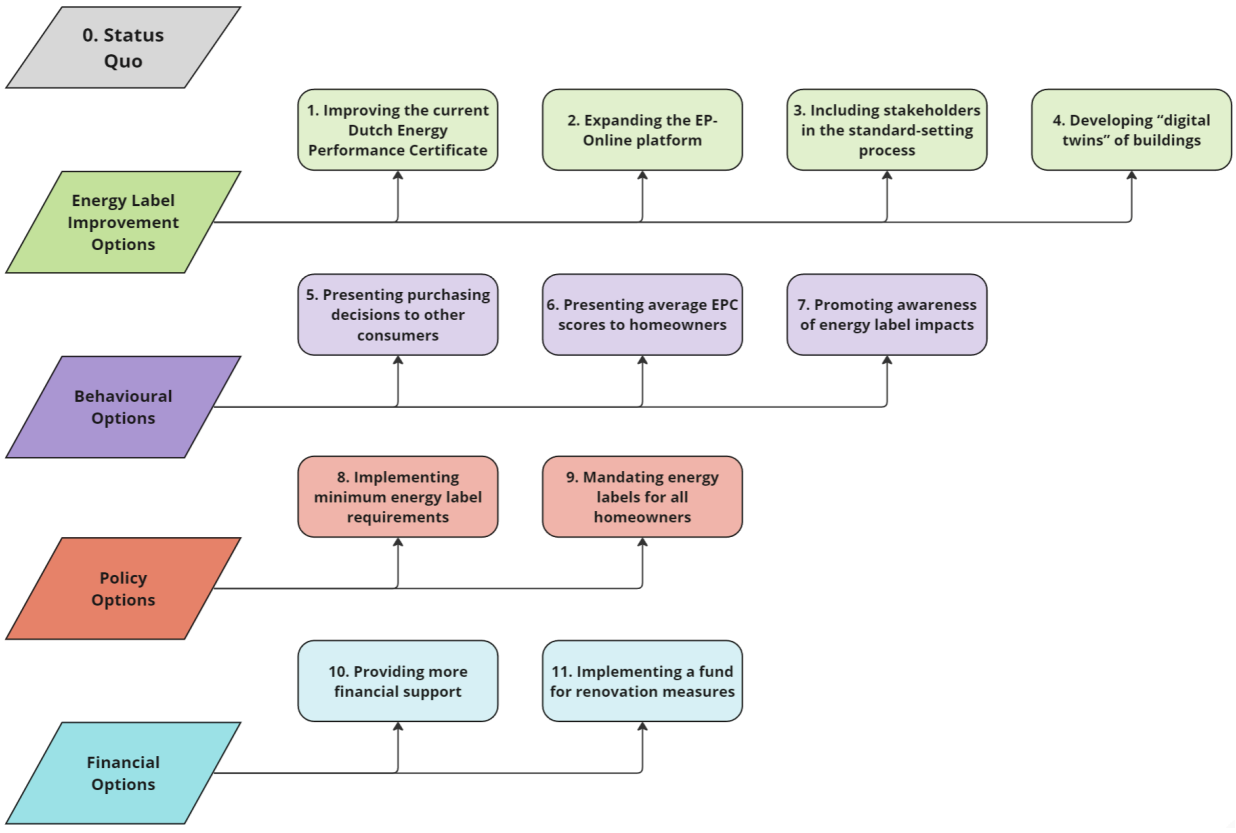
4. Identification of Solution Options

4.1. Proposed Options

After the literature review and brainstorming session, 11 relevant options were identified. Moreover, an option for maintaining the status quo was included as option 0, since it was important to investigate whether the actors see a need for change in the first place. After gathering all of the options, they were grouped into four different categories: 1) energy label improvement options, which target the operating environment around energy labels; 2) behavioural options, which aim to nudge homeowners to engage with energy labels; 3) policy options, which are about regulations regarding energy label use; and 4) financial options, which present options for increasing financial incentives to invest in renovation measures. For a summary of all the options, see Figure 7. Below, the different options are explained in detail as well as the justification of why they were chosen.

Figure 7

Proposed Options



Note. Author creation.

Option 0: Maintaining status quo

This option entails not making any changes to the current use of energy labels. At the moment, only households which are rented, sold, or built need to have an energy label (Netherlands Enterprise Agency, 2023). After commissioning an energy advisor, homeowners receive an energy performance certificate (EPC) with information on the level of energy label, some general recommendations for improvements, and information on the average monetary value of saved energy in case of increasing your energy label (Ministerie van Algemene Zaken, 2024). The contents of an EPC typically include:

- Energy Efficiency Rating: Rating from A++++ to G, with A++++ being the most energy-efficient and G being the least.
- Energy Usage: The expected amount of energy the building consumes (kWh/year).
- CO2 Emissions: CO2 emissions associated with the property.
- Potential Energy Savings: The EPC also outlines recommendations for improving the building's energy efficiency. This could include suggestions like insulation improvements, heating system upgrades, or the installation of energy-efficient lighting.
- Building Characteristics: Information about the building's features that affect its energy performance, such as insulation, window types, and heating systems, is also provided.

This option mainly relies on the legislative changes that have already been made or are currently developed, such as the Energy Performance of Buildings Directive (EPBD) revision by the European Commission. The revised EPBD mandates that all member states, including the Netherlands, should reduce the average energy consumption of the housing sector (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024). For the Netherlands, this would mean a reduction of 16% by 2030 and 20 to 22% by 2035, compared to the 2020 level of energy consumption. Furthermore, the agreement specifies that half of these reductions will be achieved through the renovation of the worst-performing homes. However, homeowners will not be obligated to renovate (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024). Furthermore, the revised EPBD entails harmonising the energy label classes, as well as a new template of energy performance certificates.

Furthermore, the BZK aims to implement a new public supervisor position to improve the quality of energy labels, for which a bill is going to be presented to the Dutch parliament (Tweede Kamer) by 2025. This involves checking whether all involved parties comply with the regulations regarding recording, registering and inspecting energy labels. On top of that, other smaller measures will be implemented to improve the quality and accuracy of energy labels,

such as increasing the number and scope of energy label audits, as well as various measures to increase compliance of energy advisors and reduce energy label fraud (Tweede Kamer der Staten-Generaal, 2023).

4.1.1. Energy Label Improvement Options

Option 1: Improving the current Dutch Energy Performance Certificate

As mentioned before, after commissioning an energy advisor in the Netherlands, homeowners receive an EPC. An example of such an EPC can be found in Appendix D. In order to improve this EPC, two specific measures were developed; first, streamlined consultation, and second, a simplified energy label scale. First, while the EPC includes the current energy label and some general recommendations for improvements, homeowners would have to pay an energy advisor once more for receiving consultation on personalised renovation measures for improving their energy label. Hence, it is recommended that the initial energy performance assessments not only examine the current energy label of the house, but also provide personalised potential renovation measures, including estimated investments needed and future cost savings, as well as the potential energy label after implementing these measures (Comerford et al., 2018). This provides clear and concise information to the homeowners, reduces information asymmetry and improves transparency. Otherwise insufficient information may lead to consumers underestimating the significance of energy efficiency (Newell & Siikamäki, 2014). In order to present the information on renovation measures effectively, it is suggested that to utilise a traffic light colour scheme (with the most beneficial measures presented in green, towards the least beneficial measures presented in red) (Brazil & Caulfield, 2017). It is noteworthy to mention that in the revised EPBD by the EU, the national EPCs have to align with the new template provided by the European Commission (2023). However, the recommendations provided in this option are not included within that template and are, therefore, still advised to be included in addition to adopting the EU template.

Second, it was found that consumers do not differentiate between the higher classes of the energy label scale (A, A+, A++, A+++, A++++), even though there are significant differences in energy efficiency (Lucas & Galarraga, 2015). In order to stimulate investment into more deep-cutting renovation measures, it is recommended that the existing scale of the energy label is to be split up between the classes A to G instead of A++++ to G already. Since, as mentioned before, the current grading will be streamlined on EU level into the classes A to G as of 2030, with the member states having the option to add further differentiation to class A, namely A0, and A+ in addition to the A class (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties,

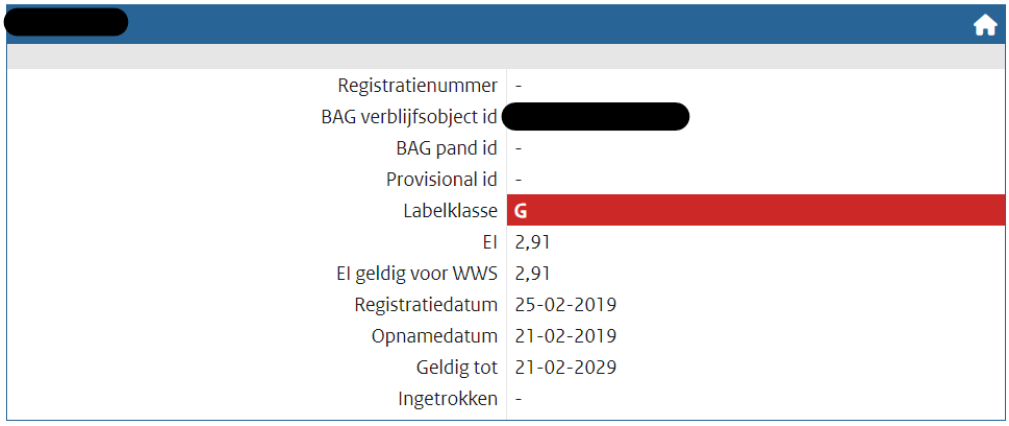
2024). However, it is still unclear whether and how the Dutch government will implement such classes. Based on the recommendations of this option, the proposed streamlined scale by the EU should be followed, instead of adding further A classes.

Option 2: Expanding the EP-Online platform

In order to store publicly available information regarding the energy labels of houses in the Netherlands, the Netherlands Enterprise Agency operates the EP-Online database (https://www.ep-online.nl/). This database provides basic information of the energy labels of buildings, such as registration date and energy label class (see Figure 8). By expanding the database with additional information such as the progress of energy label classes (e.g. from D to A), as well as the measures taken to improve energy label classes (e.g. adding solar panels), monitoring of the national housing stock through big data analysis can be facilitated (Li et al., 2019). Implementing this recommendation would involve close cooperation between homeowners and energy advisors, as well as the Netherlands Enterprise Agency, and would increase the reliability and accuracy of energy labels, as well as to help ensure that energy efficiency policies are effectively implemented and contribute to reducing carbon emissions and energy consumption. Furthermore, if such information would be made publicly available through EP-Online, it would increase transparency and could stimulate engagement and interest in energy efficiency measures by homeowners.

Figure 8

Example of EP-Online Entry



Note. Screenshot of EP-Online entry, address and object number blackened for data privacy reasons.

Option 3: Including stakeholders in the standard-setting process

Engaging stakeholders from the public and private sectors such as government agencies, industry associations and energy service providers in collaborative initiatives can foster a holistic approach to decarbonising the housing sector (Koengkan et al., 2023). This involves integrating stakeholders into the standard-setting process, which includes clarifying and updating assessment methods. For example, the transition from the old NEN 7120 standard to the NTA 8800 calculation method, effective since January 1, 2021, reflects such a standard updating process (Netherlands Enterprise Agency, n.d.). However, it was identified that stakeholdersonly had an advisory role (Van Der Gugten, 2017). In order to ensure a holistic process of reflecting different perspectives within the energy label standard, it is important that the advisory role of stakeholders is turned into meaningful influence and decision-making power. Thus, this option involves giving stakeholders within the task groups the power to influence the direction in the standard-setting process through, for example, voting power.

Option 4: Developing "digital twins" of buildings

The BZK is currently investigating the possibilities of developing a government building dossier with energy labels, which could contribute to the accuracy of energy labels (Tweede Kamer der Staten-Generaal, 2023). Currently, the Ministry of the Interior and Kingdom Relations has already developed the platform Smart Twin (n.d., where homeowners can view or build a digital dossier of their house. However, the models lack historical records and integration with other platforms. Using technologies such as 3D scans and infrared cameras are recommended to develop a proper building dossier within the Kadaster (i.e. recording digital twins of buildings), in order to improve reliability and effectiveness of the EPCs. This record would store a comprehensive characteristic depository of the building, including historical assessment criteria for its energy label, and would be centrally managed so that the information sources can be verified for reliability. This would help energy advisors to suggest energy efficiency improvements that are effective and relevant to the homeowners. Additionally, auditing authorities could conduct large-scale inspections and improve their reports by basing their calculations on the house model, instead of disjointed building information. Moreover, surveyors could expedite EPC assessments by using the digital twin in addition to the on-site visit. This option requires tight cooperation between the Dutch government and relevant industries such as energy advisors and building surveyors, but could also include homeowners themselves through voluntary programs.

4.1.2. Behavioural Options

Option 5: Presenting purchasing decisions to other consumers

As increasing the energy efficiency of one's home may entail higher expenses with novel technologies or renovation costs, homeowners should be motivated to take on this financial burden. According to the Theory of Planned Behavior (TPB), an individual's behaviour is formed by their *intention*, which is informed by perceived *subjective norms*, *perceived behavioural control*, as well as *attitude* (Ajzen, 1991). The perceived subjective norm describes a person's belief of what actions others find appropriate or respectable, which in turn influences their behavioural intention (Ajzen, 1991). Hence, this option intends to highlight the wide-spread use of energy labels in society, nudging individuals' aspiration to become part of that social group. For instance, a website detailing different renovation measures would display influencing statements for specific measures, such as "By implementing this measure, XX% of homeowners improved their energy label, which saved them XX€ on utility bills per month and increased their property value by at least XX%". Another way would be to display such percentages directly on the Energy Performance Certificate as part of the renovation recommendations (e.g. "XX% of others in your neighbourhood/municipality reached the estimated improved energy label after implementing this particular recommendation"). Alternatively, marketing campaigns for specifically efficient renovation measures could be enhanced by including such percentages. The idea is to illustrate the wide-spread use of energy labels as an indicator for energy efficiency, and a tool to save costs and increase the value of properties – which nudges other homeowners to influence their purchasing decisions. Since this option is very broad on purpose, many different actors are able to implement it in different ways.

Option 6: Presenting average EPC scores to homeowners

Just like option 5, this option is also based on the Theory of Planned Behavior (Ajzen, 1991). This option involves providing homeowners with access to the information on the average energy labels within their neighbourhood (i.e. energy label scores). This provides a basis for comparison regarding energy consumption patterns of neighbours with comparable houses. This information could be integrated into existing platforms such as EP-Online or included as part of the initial EPC report. In practice, homeowners receiving an energy label (e.g., Label C) would also be informed about the distribution of labels among comparable houses in their neighbourhood—such as 81% having Label B and 11% having Label A. This comparative data can serve as a motivator for homeowners to undertake efforts to improve their own energy label. As a potential synergy with option 1, additional information would then display what renovation

measures could achieve a higher energy label, and how much these would cost. The rationale behind this option lies in leveraging social norms and peer influence to drive behavioural change. By highlighting the energy performance of neighbouring properties, homeowners gain a clearer understanding of where they stand relative to their community (Qalati et al., 2022). This transparency fosters a sense of competition or peer pressure, encouraging individuals to strive for higher energy efficiency standards in their own homes[2].

Option 7: Promoting awareness of energy label impacts

In accordance with the TPB, households' willingness to invest in energy efficiency measures may be increased through tackling their attitude. For example, it was found that consumers' purchasing behaviours were positively influenced by environmental values (Zhang et al., 2020). Hence, public awareness campaigns may be efficient in enhancing pro-environmental attitudes and increasing awareness for energy labels amongst households. The Dutch government has launched several campaigns in the energy domain, such as the "Flip the Switch" campaign from 2022, which informed households about the importance of saving energy and simple measures of doing so (UsersTCP, n.d.), as well as the "Save Energy Now!" campaign, which educated homeowners about energy-saving renovation measures (e.g. floor insulation) to increase the energy-efficiency of their homes (Ministerie van Algemene Zaken, n.d.). However, to the researchers' knowledge, there has not been a specific campaign focused on energy labels.

Therefore, this option focuses on launching a public awareness campaign specifically for the energy label domain. The proposed campaign should educate homeowners about the importance and benefits of energy labels for the environment while highlighting individual's power to make an environmental impact (Brounen & Kok, 2011). Next to the positive impact of energy conservation on the environment, the financial benefit for the households is suggested to be stressed as well to further help increase the uptake of energy labels in the housing market (Brounen & Kok, 2011). Similar to the "Flip the Switch" campaign, media channels such as "full-page ads in national newspapers", as well as "radio, TV, and online media (Google, LinkedIn, X, Instagram)" are suggested to be used (UsersTCP, n.d., p.1).

[2] As part of the MCA, one actor provided a diverging but nonetheless interesting perspective on this: "it can motivate if you are 'behind' but there is a risk in this approach; it can also work the other way and create the thought; 'I am doing better than most others, I do not have to invest any more'"

4.1.3. Policy Options

Option 8: Implementing minimum energy label requirements

According to the minister of BZK, the government will ban renting out homes with energy labels E or lower from 2030, for both housing associations and private homeowners (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023). Therefore, all rented properties will have to improve their label to at least D until then. To enhance the policy's effectiveness, mandating a minimum energy label level of C instead of D is recommended. Additionally, this requirement would extend to houses that are being sold or newly built. Consequently, all buildings in the Netherlands intended for sale, rent, or new construction, will have an energy label of at least level C by 2030. Implementing such regulation requires support from different actors such as homeowners, financial providers, and lobbying organisations to prevent backlash. For this, there is potential synergy by implementing option 7 alongside this option. By implementing this option, homeowners will be required to improve their energy label, especially those that previously fell outside the scope of attention. This would lead to a total reduction in energy usage, and thus supporting the goal of housing decarbonisation.

Option 9: Mandating energy labels for all homeowners

Currently, only houses which are rented, sold, or newly built, need to have an energy label. This option foresees simply mandating every homeowner to get an energy label (Brounen & Kok, 2011). This would result in increased awareness of the energy efficiency levels by homeowners already living in a house, and potentially stimulate investment by environmentally conscious homeowners. As concerns may emerge regarding increasing property taxes after energy label improvements (De Waarderingskamer, n.d.), exemptions for property value increases resulting from energy efficiency measures are suggested to be made during tax calculations. This option could further be enhanced by combining it with option 8, and thus reaching a far larger base of homeowners who now are required to improve their energy labels. However, arising equity issues would have to be properly addressed in this case.

4.1.4. Financial Options

Option 10: Providing more financial support

Providing higher grants to homeowners increases the incentive to carry out energy-efficient building renovations (Li et al., 2019). Currently, the Dutch government operates the grant scheme for energy efficiency measures called Sustainable energy investment subsidy scheme (ISDE – Investeringssubsidie duurzame energie en energiebesparing). There are different amounts of grants depending on the renovation measure, with the different categories being

insulation measures, heat pumps, solar water heaters, connections to a heat network, and electric cooking facilities (Netherlands Enterprise Agency, 2017). However, the existing grant structure offers a flat amount for each type of renovation, which may not adequately align with varying household needs and the complexity of different projects. This option proposes to enhance the ISDE by implementing a tiered grant system that takes into account key factors such as household income, the current energy label of the house (i.e. lower energy label equals higher grants), and the current condition of the property.

Increasing the grants based on household income levels recognizes the financial constraints that different households face and aims to make energy-efficient renovations more accessible and attractive to a wider range of homeowners. Moreover, linking grant amounts to the energy label of the house encourages investments in properties with lower energy performance – thereby targeting improvements where they can yield the most significant energy savings and environmental benefits. Lastly, considering the current condition of the house ensures that grants are allocated efficiently to address specific renovation needs and promote the overall sustainability of residential buildings. By tailoring grant amounts to these specific criteria, the Dutch government can ensure that financial support is directed where it is most needed and where it will have the greatest impact on improving energy efficiency. Therefore, the implementation of this option would involve the Dutch government adjusting (i.e. increasing) the ISDE for energy-efficiency renovations based on the aforementioned factors, thereby optimising the effectiveness of financial incentives to drive sustainable housing practices across the nation.

Option 11: Implementing a fund for renovation measures[3]

In order to support homeowners afford the financial costs of renovation measures, it is recommended that a subsidised fund per participating household is implemented. In Germany, the Kreditanstalt für Wiederaufbau (KfW) offers a range of financing options aimed at promoting energy-efficient renovations among homeowners (Kreditanstalt für Wiederaufbau, 2024). Through programs like the 'Energy Efficient Renovation' initiative, the KfW provides low-interest loans, grants, and subsidies to support various renovation measures, such as insulation upgrades, heating system improvements, and renewable energy installations. By studying the structure and effectiveness of programs like the KfW, insights could be integrated into the design and implementation of similar initiatives in the Netherlands. For instance, monthly instalments, depending on the energy label and household income, could be paid into the fund, where interest is accumulated over time. Once a certain renovation measure is deemed

[3] As part of the MCA, one actor again provided an intriguing insight: “this could work for apartments (VVE's) since this is how they already work, only not specifically labelled for sustainability investments”

affordable, the fund will be used to finance the investment/cover the cost. In case of an apartment complex, all tenants would pay into a common fund, which will be used for the complex where needed. This measure could be set up as a mandatory measure by the government, or as voluntary programmes by either government agencies or other interested institutions such as banks or the Nationaal Warmtefonds.

4.2. Selected Criteria

To assess the options proposed, a set of six criteria was developed on the basis of the objectives tree – see Table 4. Apart from the objective tree, the authors also took into consideration the temporal and spatial scope of the problem. The purpose of these criteria was to be as precise as possible, while still taking into consideration the broad geographic scope of the whole of the Netherlands. In order to create a standardised measuring scale to compare the criteria in step 3 of the ISA, a likert scale from -2 to +2 was chosen, with -2 typically representing the worst outcome for the criteria, 0 representing a moderate outcome or uncertainty, and +2 representing the best outcome possible. As the scoring measures are qualitative in nature, it is acknowledged that every actor might have different perceptions of what, for example low resource requirements, means. However, this approach was deemed necessary due to the inherent uncertainty in the implementation and outcome of those solution options. Therefore, reliance on the expertise of the actors was considered key for determining the optimal solution.

Table 4

Overview of Assessment Criteria for the MCA

Criteria 1: Feasibility of Implementation	
Definition: The amount of monetary and non-monetary resources required to implement the option.	**Scoring measures:**
Description: Due to the national scale of the problem framing, significant resources might be necessary to change existing structures or implement potential options. These could include for example costs of implementation, or organisational and administrative capacities. In order to determine the feasibility of implementing an option, it is necessary to gain insights into the perceived resource intensity of each option.	– 2 Excessive resource requirements render implementation almost impractical – 1 Significant resource requirements 0 Moderate resource requirements + 1 Relatively low resource requirements + 2 Minimal resource requirements

Criteria 2: Time frame of Implementation	
Definition: The possibility of the option being fully implemented by 2030. **Description:** Considering the proposed options are supposed to strengthen the contribution of energy labels for decarbonising the Dutch housing sector until 2030, it is imperative for potential options that they can be implemented within that time frame.	**Scoring measures:** – 2 Implementation until 2030 almost impossible – 1 Implementation until 2030 unlikely 0 Implementation until 2030 uncertain + 1 Implementation until 2030 likely + 2 Implementation until 2030 almost guaranteed
Criteria 3: Effectiveness of improving energy label levels	
Definition: The extent to which the proposed option leads to actual renovation actions that improve the energy label levels of residential properties in the Netherlands. **Description:** In order to achieve the objective of strengthening energy labels in decarbonising the Dutch housing sector, the options need to lead to improvements in energy labels. Therefore, the perceived increase of energy label levels is an important indicator to determine the optimal option.	**Scoring measures:** – 2 Almost no expected improvements in overall energy label levels – 1 Very low expected improvements in overall energy label levels 0 Improvements in overall energy label levels uncertain + 1 Slight improvements in overall energy label levels expected + 2 Very high improvements in overall energy label levels expected

Criteria 4: Degree of Complexity added to the Dutch energy label system	
Definition: The extent to which the option affects the complexity of the whole energy label system in the Netherlands. **Description:** Since the energy label "ecosystem" is a complex, multi-level, multi-actor policy field, potential options to strengthen the contribution of energy labels to decarbonise the Dutch housing sector need to improve the energy label system as a whole, without needlessly adding further complexity or confusion for all actors involved.	**Scoring measures:** – 2 Large increase in complexity to the energy label system – 1 Slight increase in complexity to the energy label system 0 Increase in complexity to the energy label system uncertain + 1 Slight decrease in complexity to the energy label system + 2 Large decrease in complexity to the energy label system
Criteria 5: Awareness of energy label importance	
Definition: The extent to which the option leads to an increased awareness of the importance of energy labels within Dutch households. **Description:** With homeowners being the ones who have to implement the actual change in their homes, it is of utmost importance to increase their awareness and connected knowledge of energy labels. Therefore, it is important to understand the perceived increase of awareness that results as part of implementing an option.	**Scoring measures:** – 2 Little to no increase in overall awareness – 1 Very low increase in overall awareness 0 Increase in overall awareness uncertain + 1 Slight increase in overall awareness + 2 Large increase in overall awareness

Criteria 6: Motivation to improve energy label	
Definition: The extent to which the option leads to an increased motivation to improve the current energy label within Dutch households.	**Scoring measures:** – 2 Little to no increase in overall motivation – 1 Very low increase in overall motivation 0 Increase in overall motivation uncertain + 1 Slight increase in overall motivation + 2 Large increase in overall motivation
Description: Connected to criteria 5, homeowners also have to be motivated to implement measures to increase the energy label of their home to a higher level. Hence, it is also important to measure the perceived increase in motivation to engage with renovation measures after implementing an option.	

5. Assessment of Alternative Options

As explained in step 3 (section 2.4.), the researchers conducted an MCA to find the best options which can increase the effectiveness of energy labels in decarbonisation of the Dutch housing sector. First, the scoring of the options as well as the importance weighting were established. For that purpose, an Excel sheet was created (an excerpt can be found in Appendix E), that contained instructions for the actors together with the task of weighting the criteria and the scoring of options. Lastly, the results of the MCA were analysed, as well as a sensitivity analysis conducted in order to test the strength of these results.

5.1. Scoring of Options

After establishing 11 options and 6 criterias (see section 4), the next step in the MCA process was to score each solution option against the criteria. Each actor was tasked with individually scoring the solution options based on their alignment with each criteria. The actors were to assess the options according to their expertise and perspective, in order to ensure a diverse and comprehensive evaluation. The aim was to evaluate how well each option performed across the specified criteria, using a relative likert scale of -2 to +2. For instance, if an option strongly addressed a specific criterion, it would receive a higher positive score, and conversely, if it poorly or negatively addressed the criterion, it would receive a negative score. In order to make it as accessible as possible for the actors, a dropdown-menu for each criteria with the aforementioned scale was implemented so that no other values could be entered, as well as a pop-up note of the meaning behind each of the criteria scales in order to avoid switching to the criteria tab.

Scores were calculated for each option based on stakeholder assessments against individual criteria. The scoring process involved multiplying the assigned score for each criterion by the criterion's weight (established in the weighting phase – section 5.2). Scores across all criteria were then aggregated to generate a comprehensive score for each option. The results can be found in results section 5.3. These aggregated scores provided a holistic view of each option's performance across multiple criteria. Higher scores indicated options that were well-aligned with the overarching sustainability objectives and stakeholder priorities, highlighting the most promising solutions for enhancing energy labels' role in decarbonising the Dutch housing sector.

As mentioned in section 2.4, not all actors gave a response. Because it was essential to get as many diverse opinions and perspectives into the MCA as possible, and only one of the critical actors responded, it was decided to do a team role-play for each of the non-respondents.

Since each of the researchers had a potentially different interpretation of what a specific actor might think, discussing the different viewpoints and scoring the options together was deemed the best approach. In total, out of the 16 MCAs used for the analysis, 12 were conducted by the researchers through a role-play.

5.2. Weighting of Options

Some criteria may be more relevant than others in scoring the options regarding their contribution to decarbonise the Dutch housing sector and should, therefore, be weighted more strongly. As the perceived relevance is expected to be different for various actors due to their context, aims, and concerns, every actor was asked to independently assign a weight to each criteria. To carry out the weighting, the second tab of the MCA Excel file displayed the six criteria with an explanation of each, their corresponding scoring, as well as a blank cell to fill in the weight. Actors were instructed to indicate how important they believe each criteria to be by dividing a score of 100% between the 6 criteria. If, for example, they valued all criteria to be equally important, each criteria was to be assigned a weight of 16.67% (100/6). Thus, in the end, the weights of all criteria had to add up to 100%. To help respondents with the calculation, the sum of all filled out cells was displayed on the top of the Excel tab. In case the sum exceeded 100%, this was signalled in red.

As with the scoring, for the non-respondent actors the researchers also decided for corresponding weights during the role-plays, based on a thorough discussion of the different potential viewpoints that each actor might have. To conduct the final calculation of the MCA, the assigned criteria weights from all MCAs were averaged and this average criteria weight was used to calculate the total weighted score for each option.

5.3. Results of the MCA

Upon receiving the responses, the scores and weights were compiled with the role-played MCAs in order to calculate the final results. On average, actors considered criteria 3 – effectiveness of improving energy label levels – most relevant, closely followed by criteria 1 – feasibility of implementation. The calculated average weighting for the criteria across all actors are shown in Table 5.

Table 5

Average Weighting for Assessment Criteria

Criteria	Average assigned weighting out of 100%
Criteria 1: Feasibility of Implementation	21.69%
Criteria 2: Time frame of Implementation	12.50%
Criteria 3: Effectiveness of improving energy label levels	23.44%
Criteria 4: Degree of Complexity added to the Dutch energy label system	16.56%
Criteria 5: Awareness of energy label importance	10.94%
Criteria 6: Motivation to improve energy label	14.88%

The final calculation and results of the MCA are presented in Table 6. Based on this, option 7 – promoting awareness of energy label impacts – was identified as the most favourable, achieving a score of 13.52. Subsequently, option 6 – presenting average EPC scores to homeowners – followed with a score of 12.93. In contrast, option 5 – presenting purchasing decisions to other consumers – while ranked third, achieved a significantly lower score of 6.93 points, about half the score of the first and second options. This was due to the low scoring of the means to achieve the implementation (criteria 1, 2, and 4). Interestingly, the three highest scoring options all belong to the category of behavioural options, which suggests that behavioural change is essential to enhance energy efficiency effectively.

The results also revealed a disparity among the scores of the least preferred options. Option 4 – developing ‘digital twins’ of buildings – received a particularly low score of -9.20, indicating a distinct lack of preference among participants. This can be explained by a very low feasibility in resources as well as time, coupled with mixed responses regarding the outcome – which was not surprising, considering this was the most technical out of all the options. Option 11 – implementing a fund for renovation measures – while still among the least preferred, recorded a significantly better score of -3.44 points. Meanwhile, option 9 – mandating energy labels for all homeowners – attained the highest score within the least preferred options at -0.54. Most notably, option 0 – maintaining the status quo – placed 8th on the scoring, outperforming options 3, 4, 9, and 11.

Yet, as mentioned before, it must be acknowledged that only responses from NEN, NVM, and ING were collected, as the remaining actors either declined to participate or did not respond to the invitation. Additionally, one response was completed by the client, while the

remainder was conducted by the research team through role-playing. This outcome highlights the difficulty in contacting and working with nation-wide actors on such short notice, but also means that the results are subject to a large amount of uncertainty – they may be influenced by the assumptions of the researchers and not accurately reflect the perspectives of all actors involved. However, the researchers tried to mitigate this uncertainty as much as possible by extensively studying the actors and discussing their viewpoints within the whole team during the scoring, as well as conducting a sensitivity analysis with diverse scenarios.

Table 6

Composition of Total Scores for Solution Options

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Criteria 1	20	5	-6	3	-20	-3	21	14	-13	-4	-18	-20
Criteria 2	22	16	3	17	-21	11	23	26	-21	-2	1	-23
Criteria 3	-8	10	10	3	2	5	10	7	24	0	19	14
Criteria 4	-2	-12	-8	-9	-13	-7	-1	10	-2	-6	-7	-14
Criteria 5	-8	6	13	-3	-1	24	10	21	7	13	4	8
Criteria 6	-5	13	12	-10	-3	24	15	11	20	1	25	13
Total Scores	19	38	24	1	-56	54	78	89	15	2	24	-22
Weighted Criteria 1 (21.69%)	4.34	1.08	-1.30	0.65	-4.34	-0.65	4.55	3.04	-2.82	-0.87	-3.9	-4.34
Weighted Criteria 2 (12.50%)	2.75	2	0.38	2.13	-2.63	1.38	2.88	3.25	-2.63	-0.25	0.13	-2.88
Weighted Criteria 3 (23.44%)	-1.88	2.34	2.34	0.7	0.47	1.17	2.34	1.64	5.63	0	4.45	3.28
Weighted Criteria 4 (16.56%)	-0.33	-1.99	-1.33	-1.49	-2.15	-1.16	-0.17	1.66	-0.33	-0.99	-1.16	-2.32

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Weighted Criteria 5 (10.94%)	-0.88	0.66	1.42	-0.33	-0.11	2.63	1.09	2.3	0.77	1.42	0.44	0.88
Weighted Criteria 6 (14.88%)	-0.74	1.93	1.79	-1.49	-0.45	3.57	2.23	1.64	2.98	0.15	3.72	1.93
Total Weighted Scores	**3.26**	**6.03**	**3.3**	**0.17**	**-9.2**	**6.93**	**12.93**	**13.52**	**3.59**	**-0.54**	**3.67**	**-3.44**

Note. Negative values highlighted red. Top 3 options based on total weighted scores marked yellow.

5.4. Sensitivity Analysis

As mentioned before, in order to reduce the uncertainty in the outcome of the MCA, and to see whether the top options are still highly scored considering different perspectives, a sensitivity analysis was conducted. For this, four different scenarios were considered. First, since only four actors provided a response to the MCA, with the rest being filled out by the researchers, the first scenario considers only the weights and scores given by the actors. This scenario was chosen in order to mitigate potential biases from the researchers. The second scenario considers all criteria equally important, as such the same weights were given for each criteria (100% divided by 6). The third scenario focuses only on the means in order to achieve the objectives. Therefore, solely criteria 1 (feasibility), criteria 2 (timeline), and criteria 4 (complexity) were considered in the weighting – 100% divided by 3. In contrast, the fourth scenario focuses only on the ends, meaning how well the options contribute to achieving the objectives. For this, scenario 3 (effectiveness), scenario 5 (awareness), and scenario 6 (motivation) were given equal weights (100% divided by 3). The detailed calculation tables for these scenarios can be found in Appendix F.

Scenario 1 – Only Actor Responses

Based solely on the responses received from actors, the top three options changed slightly. The top scoring option was option 8 – implementing minimum energy label requirements – instead of option 7. The reason for this was that the feasibility and timeline criteria were more negatively rated during the actor role-playing than from the actors themselves. It remains questionable therefore, if this option might have been higher ranked in the MCA if all the actors provided

responses. Consequently, option 8 might be worth considering when implementing the solution options. Options 6 and 7 placed second and third place, respectively.

Scenario 2 – Equal Weights

When setting all the weights equally (16.67%), the top three options did not change at all. This could be partially explained by the fact that the average weights used for the calculation were not too far off of the equal weights. However, it can be seen in Table 6 that there is a big disparity between the top three and the rest of the options for the total unweighted scores, which means that there needs to be a significant change to the criteria weights in order for them to not come out at the top.

Scenario 3 – Focus on Means

This scenario focuses on the practicality and feasibility of implementing the options. Surprisingly, even by setting criteria 1, 2, and 4 to 33.33%, and the rest to 0%, the top three options did not change drastically. The highest and second highest scoring options remain the same (7 and 6, respectively), however the third highest option changed from option 5 to option 0 – maintaining status quo. Seeing as practically no effort is required to maintain the current situation, it makes sense for option 0 to rank high in this scenario. However, options 6 and 7 remain at the top and can be thus considered practical and feasible even when disregarding the outcome.

Scenario 4 – Focus on Ends

Unlike scenario 3, the changes in weights to focus only on the outcome of implementing the solutions, affect the top three options significantly. The highest scoring option was in this scenario option 5 – presenting purchasing decisions to other consumers. The second and third highest scoring options were option 8 and option 10 – implementing minimum energy label requirement and providing more financial support – respectively. Due to the drastic change in the top three, it can be assumed that there are options which may contribute more to achieving the objectives than the top three of the main MCA, however they might be too resource-intensive to be practical.

Based on this sensitivity analysis, it can be concluded that the resulting top three options of the MCA – options 5, 6, and 7 – are not sensitive to changes in the weighting, unless focusing on only the ends specifically. However even then, options 6 and 7 placed fifth and fourth, respectively. Additionally, option 8 might also be considered a top solution option, however further research into actors' perceptions, specifically the Dutch government, needs to be conducted for such a conclusion.

6. Conclusion and Recommendations

6.1. General Conclusion

The results of the MCA show that actors rated the effectiveness of improving energy label levels and the feasibility of implementation as the most important criteria. Option 7 – promoting awareness of energy label impacts – received the highest score, followed closely by option 6 – presenting average EPC scores to homeowners. However, a sensitivity analysis revealed that certain options shifted in importance depending on the weighting scenarios, suggesting potential variations in effectiveness and feasibility perceptions among stakeholders. Furthermore, the limitations of this project, including partial participation and reliance on perceptions rather than first-hand data, indicate potential biases in the results and highlight the need for caution in interpreting them as reflecting actual effectiveness.

To align the research findings with the objectives as outlined in the objectives tree (Figure 4), the high-level objective – strengthening the contribution of energy labels to reduce GHG emissions in the Dutch housing sector – could be approached through three specific lower level objectives: strengthening energy label policies, increasing public awareness, and motivating homeowners to improve their energy labels. Notably, the latter two objectives are addressed by the top three preferred options identified by the MCA – these objectives align closely with the strategies presented by options 5 – presenting purchasing decisions to other consumers – option 6 – presenting average EPC scores to homeowners – and option 7 – promoting awareness of energy label impacts. The objective of strengthening the policies of energy label usage is not directly addressed by the top three preferred options. However, as mentioned in the sensitivity analysis, there is a potential for option 8 – implementing minimum energy label requirements – as this option scored highest among the actor responses. As such, it is advised for policy-makers to conduct more research on its feasibility and take into consideration the potential implementation of that option. Therefore, by extending the top three results from the MCA to include option 8, all the three objectives in order to strengthen the contribution of energy labels to reduce GHG emissions in the Dutch housing sector could be addressed.

Returning to the research question of this project **–** what are the opportunities in strengthening the contribution of energy labels to the decarbonisation of the Dutch housing sector until 2030, and what role can RICS play in it? **–** the identified opportunities were translated into actionable solutions by the researchers, and the most feasible ones were selected through the MCA. The subsequent section delves into the specific roles that RICS can play in implementing the proposed options.

6.2. Recommendations and Follow-Up Measures

In order to provide useful recommendations to the client, it was necessary to find out what role RICS can play in strengthening energy labels in the Dutch housing sector. First, it was determined which options could be implemented by RICS, based on its capabilities as a private business organisation. Afterwards, insights and recommendations on the implementation of the options available to the client were described. Furthermore, steps for following-up the implementation of these options were developed, as mentioned in section 2.4.

First of all, it was concluded that not all options are worth implementing, according to the results from the MCA. This is because four options (3, 4, 9, and 11) had lower scores than option 0 – maintaining the status quo – which essentially implied that doing nothing is more attractive than implementing these options. Thus, they were not considered for the next steps. For the rest of the options, it was individually determined whether RICS is able to implement these by themselves, reflecting on RIC's system diagram:

- Option 1 – Improving the current Dutch Energy Performance Certificate: **No**, since changing the EPC requires changes to the legislative environment.
- Option 2 – Expanding the EP-Online platform: **No**, since the RVO is managing the platform, and expanding it in the proposed way makes legislative changes potentially necessary.
- Option 5 – Presenting purchasing decisions to other consumers: **Yes**, since this option is broad enough to be implemented by various actors across the industry.
- Option 6 – Presenting average EPC scores to homeowners: **No**, since as with option 2, this involves primarily the RVO and how they handle the diffusion of information from the EP-Online platform.
- Option 7 – Promoting awareness of energy label impacts: **Yes**, since information awareness campaigns can be implemented by a wide variety of actors.
- Option 8 – Implementing minimum energy label requirements: **No**, since this option relies on far-reaching changes to the current legislation.
- Option 10 – Providing more financial support: **No**, since the proposed option foresees changes to the current grant system, which can only realistically be adapted by the government.

Based on this overview, the two options that the client can implement are option 5 and option 7. However, that does not mean that other options should be disregarded. There may be other ways for RICS to contribute to the implementation of these other options – for example,

political lobbying or collaboration with RVO/BZK could lead to stronger engagement of the national government and result in minimum energy label requirements or changes to the EP-Online platform (options 8 and 2 respectively). For the next steps, options 5 and 7 were recommended to the client, as they were determined to be possible for RICS to implement. Although it has to be acknowledged that option 5 scored low on the sensitivity analysis focusing on the means, and option 7 scored only medium on the sensitivity analysis focusing on the ends. However, they are both in the top three of the overall MCA results, and were thus considered as prime solutions to implement in general.

6.2.1. Implementation of Solutions

Option 5

Presenting purchasing decisions to other consumers links back to the system diagram (Figure 6), and the internal factor of “education of stakeholders on the use of energy labels”. This option involves collecting large amounts of data on the possible renovation measures and how much these influence the energy label, utility bills, and property values. Furthermore, a well accessible database needs to be developed for homeowners to make use of this information. It is not surprising, therefore, that the means of this option scored low. However, when only considering the outcome, it was determined to be the most favourable option.

In order to make the implementation more feasible, collaborations could be established. For instance, a collaboration with Milieu Centraal could be set up, as this government initiative already operates a website with basic information on energy efficiency measures. Additionally, there are databases with information on energy labels and energy consumption in the Netherlands, such as the SHAERE database operated by Aedes, which contains 60% of the social housing stock, and the CBS (Dutch Statistics) data, which contains the actual energy consumption of buildings (van den Brom, 2020). These databases could be used to gather information on the energy performance and labels of buildings. Furthermore, collaboration with energy advisors and building surveyors could be facilitated to gain insights into how renovation measures impact the energy label and property values respectively.

For determining the impact on utility bills, there is a significant disparity between theoretical and actual household energy consumption (van den Brom, 2020). It was found that buildings with the energy labels D to G have a far lower actual than theoretical consumption. The findings suggest that reductions in energy labels do not necessarily correlate to lower energy consumption – and that household behaviour plays an important part in saving energy. Moreover, it was found that new buildings typically consume less energy than renovated

buildings, even with the same energy label. In practice, these findings highlight that when communicating the impacts of renovation measures, expectations of homeowners should be managed effectively in order to avoid disappointments and a resulting decrease in trust in the energy label system. Furthermore, the contribution of household practices to saving energy should be emphasised.

Option 7

Similar to the previous option, promoting awareness of energy label impacts also links back to the system diagram, namely to the internal factor of “marketing activities for the use of energy labels”. When conducting a marketing campaign, it is important to target the right audience with the right channels. For instance, people in the Netherlands aged 20 to 34 unsurprisingly consume mostly new forms of media, such as social media or online TV, instead of more traditional forms of media such as television and newspapers (Commissariaat voor de Media, 2023). At the same time, the average age of first-time homeowners is decreasing, from 36 in 2019 to 34 in 2023 (Kemezyte, 2023).

Therefore, when targeting the upcoming generation of homeowners, new forms of media need to be considered. Furthermore, the interests of the different generations might also be worth considering. For example, due to the increase in environmental awareness of younger generations (Business Wire, 2021), those target groups might be more receptive towards advertisements of environmental benefits of implementing renovation measures and improving the energy label. On the other hand, older generations might focus more on affordability, cost savings, or property value increases (Square, 2017). Therefore, advertisements towards these target groups should focus on the financial benefits of improving the energy label. To conclude, for a marketing campaign it is essential to be aware of the target group, as well as their interests and behaviour.

An important thing to note is that there is a clear synergy between options 5 and 7. In order to implement option 5 effectively, homeowners need to be made aware of the information presented. For this, a marketing campaign promoting the impacts of energy labels could include references to purchasing behaviour. Likewise, in order to promote the impacts of energy labels using marketing campaigns effectively, the information needs to be well researched, as well as trusted by the target groups. For this, an underlying platform of information on renovation measures would provide the necessary legitimacy. Seeing as both of the options complement each other very well, it is recommended to implement both of these options at the same time.

6.2.2. Monitoring, Evaluation and Learning

The final stage of the ISA process was monitoring, evaluation and learning. This stage serves two key purposes: reflecting on the assessment process itself (learning), as well as monitoring and evaluating the outcomes of sustainability measures to understand their effectiveness (De Ridder et al. 2007). In this report, the reflections on the assessment process are detailed in section 7. Moreover, as mentioned in section 2.4, due to the scope of this project, the researchers could not evaluate the outcomes of implementing the sustainability measures. Nevertheless, an approach for guiding this process was developed, based on the proposed options for the client. This approach was structured based on the six criteria that were developed, as they contribute to the objective of strengthening the contribution of energy labels to the decarbonisation of the Dutch housing sector (see Figure 4 – objectives tree).

Generally however, for evaluating the outcome of an option, RICS may conduct periodic reviews to assess progress against targets and milestones. Data could be collected by using surveys, interviews, and data analytics to gather both quantitative and qualitative feedback on the impact of each option. Additionally, engaging stakeholders, including homeowners, policymakers, and industry experts, could provide diverse perspectives and valuable insights into the effectiveness of these initiatives.

Criteria 1

The client is advised to begin by monitoring the feasibility of implementing both options. For option 5, this involves tracking the allocation of resources towards platforms or campaigns facilitating peer influence in purchasing decisions. Similarly, for option 7, the financial and administrative requirements needed to launch and sustain a public awareness campaign should be assessed, as different target groups necessitate different targeting methods. Of course, for both options an additional resource assessment should be conducted before implementing the options.

Criteria 2

Setting a clear timeline is essential to ensure full implementation of these options by 2030. Therefore, RICS is advised to establish milestones and regularly track progress against these timelines to prevent delays and adjust strategies if needed.

Criteria 3

In order to gauge the effectiveness of these options in improving energy label levels, RICS could establish key performance indicators and use data analytics or surveys to measure actual post-implementation improvements in energy labels resulting from the marketing campaigns and presentation of purchasing decisions of other customers. For this step, it is advised to collaborate with other actors identified in the energy label system, because as mentioned, there are several existing databases where information could be gathered from, for example RVO and NVM (not an actor but CBS is also one suggestion).

Criteria 4

In terms of complexity, RICS may conduct stakeholder consultations to understand how these options impact the complexity and clarity of the energy label system. It is advised to primarily consult stakeholders that are targeted by the options – in this case consumers and homeowners. Furthermore, seeing as the proposed options intend to affect the behaviour of people, it is essential to monitor and potentially counteract any unintended consequences arising from increased awareness or peer influence of purchasing decisions. Risks could include public distrust in a private business, hostile media outlets or actors, or achieving the opposite effect than intended.

Criteria 5

To assess changes in awareness of energy labels among Dutch households, RICS could employ pre- and post-campaign surveys to quantify shifts in understanding. Regarding digital media platforms, media reach and engagement metrics could also be analysed to evaluate the effectiveness of communication strategies in raising awareness.

Criteria 6

Finally, the client could measure changes in homeowners' motivation towards improving energy labels by implementing surveys or behavioural studies. The uptake of energy-efficient renovation measures could also serve as an indicator of increased motivation.

7. Reflections

As previously mentioned, this section aimed to reflect on the experiences of the researchers during implementing the ISA. First, reflections were made on the assessment methodology, including conducting the MCA. Second, the collaboration internally between within the research team, as well as externally with the client, is reflected upon. Lastly, the end results of the project are compared with the goals set out in the beginning of the project. The purpose of this section is to enhance learning, which is especially critical for improving upon future sustainability projects (Bond et al., 2012).

7.1. Reflections on Assessment Methodology

Regarding the assessment methodology, there are three important points of reflection that the researchers wanted to highlight. First, while the client had the possibility to share their opinion on the systems analysis and expressed their content with the work, this feedback session occurred only after the project plan was submitted. Hence, it may have been useful to already involve them during the model design process in the planning stage of the project report. This would have fostered a deeper collaboration and may have enriched the model with a further expert perspective.

Second, the main limitation of this project was the fact that only three actors and the client filled out the MCA form. For one, this led to the research team having to fill out the MCA forms themselves by adopting viewpoints that the individual actors might hold. While these were adopted based on desk research on the actors, it was a challenging process – and the end results may have ultimately steered towards the subconscious beliefs and attitudes of the research team. On another note, some actors responded to our inquiry that the MCA form was too long or that the descriptions of the options/criteria were too complicated to understand. It is unclear whether this was the result of a language barrier, or an inherent fault of the MCA form. Hence, it may have helped to keep the MCA shorter by making the explanations of criteria and options even more concise and easier to understand. This could have reduced the necessary effort to take part in our MCA next to the actors busy work schedule. The challenge hereby would be, however, to shorten the original message of the option/criteria without sacrificing crucial context. Regarding the execution of the role-plays, it was unfortunately only afterwards realised that the discussions and viewpoints taken by the researchers should have been recorded, transcribed, and summarised in order to improve the academic rigour of the process and enhance transparency of the choices taken for the non-respondent actors.

Third, one of the actors who participated, remarked in the MCA that they perceived the context of option 3 to be flawed and provided an elaboration of their point – which was taken into consideration for the final description of the option. This kind of feedback was incredibly valuable for the research team, and it would have been of great value to receive such feedback prior to sending out the MCA. Furthermore, in the project plan, it was originally aimed to include first-hand data from interviews with actors for the actor analysis to identify further (critical) actors, to better grasp the actor's problem perception, as well as to properly adjust the power/interest matrix. However, due to severe time constraints and difficulties in reaching out to actors operating on a national scale, such interviews were unfortunately not conducted – and the actor analysis remained primarily based on desk research. Thus, it is suggested to get in contact with actors before the actual start of the project, optimally after performing the desk research for the actor analysis during the project planning. This actor involvement from the very beginning may not only have led to receiving constructive feedback on proposed options and criteria, but also to increased motivation of the actors to participate in the MCA.

To conclude, most suggestions for improving the assessment methodology aim for an increased client, expert, or actor involvement. While this would have been valuable, it is important to add that this involvement was mostly hindered by the time constraints of the project, as it was generally a time intensive process to contact the actors and wait for their responses.

7.2. Reflections on Client and Group collaboration

The collaboration between the researchers and the client proved to be highly efficient throughout the project. While the initial meeting and project discussion took place in person, the subsequent two meetings shifted to an online format, presenting both advantages and challenges. While the online meetings could be arranged flexibly, one notable challenge was the difficulty in ensuring everyone shared the same understanding, which in a few instances led to diverging interpretations of the meetings afterwards. For this, it would have helped to include everyone actively in the discussion, and paraphrase what was said if anything was unclear. Nevertheless, the client was responsive and promptly responded to emails and inquiries. Furthermore, the client provided their list of suggested actors to include, which served as a solid foundation for researching relevant actors for this project. The client actively tried to support the project by facilitating connections with RICS's head of sustainability and other potential actors. Regrettably, despite their best efforts, these connections remained unfruitful.

Within the research team, collaboration was effective and efficient, characterised by regular meetings and internal deadlines. Notably however, it was realised that collaboration and communication was more effective in-person than in online meetings. Therefore, important parts of the project were worked on together in-person or at least in a hybrid form (in-person with some members joining online). Communication among team members happened primarily via the messenger service “WhatsApp” and remained open and transparent throughout the project, as doubts and opinions were expressed and addressed constructively whenever they occurred – which contributed positively to the end results.

7.3. Reflections on Results

As part of the initial project plan, five desired and expected end-results for this project were outlined. To reflect upon the results, each expected end-result was revisited and discussed.

1. Research into the opportunities to strengthen the contribution of energy labels to the decarbonisation of the Dutch housing sector

In the course of this project, the researchers investigated literature on energy labels and studies on behavioural patterns to develop the 11 solution options. These options ranged from innovative options such as “digital twins” (option 4) or a renovation fund (option 11), to more traditional ones such as presenting peer performance (option 5 and 6) or raising awareness among homeowners (option 7). Other options explored making changes to the EPC system and to the policies relating to energy label requirements. Furthermore, the options typically did not solely rely on one actor, but rather a diverse and collaborative group of governments, associations, NGOs, and private institutions to carry out. Thus, this end-result was achieved.

2. Identification and inclusion of relevant actors in the assessment process

Using the client’s list of potential actors as the starting point, the researchers conducted a thorough desk research on the energy label system to identify actors critical to solving the problem. Moreover, the researchers contacted all the identified actors and tried to include them in the MCA. However, not every actor responded to the inquiry, despite best efforts. Therefore, this end-result was only partially achieved.

3. Presentation of actors’ perspectives on energy labels

The original intent of this end-result was to provide insights into actors’ perceptions, including their perception of the usefulness of energy labels, their willingness to contribute to the energy transition in the built environment, and the challenges that prevent them from the desired situation. These insights were to strengthen the desk research conducted for the actor analysis.

Furthermore, only 3 out of 15 actors excluding the client completed the MCA for assessing the potential solution options, leading to the research team having to fill out the MCAs by adopting the perspectives of the non-responding actors – which may have introduced subconscious biases. Therefore unfortunately, this end-result was not achieved.

4. Finding out the role that RICS can play in strengthening energy labels in the Dutch housing sector

In section 6.2, the role of RICS in the use of energy labels for the decarbonisation of the Dutch housing sector was detailed. Out of the MCA results that fared better than option 0, the client is able to implement two options (5 and 7). Incidentally, these two are also options that scored highly in the MCA. Thus, this end-result was achieved.

5. Providing recommendations to the client, RICS

In addition to highlighting the role of RICS, it was recommended how the options could be implemented, as well as monitored and evaluated. The researchers suggested specific recommendations relevant to the proposed options, along with particular insights from additional research on the implementation of such options. Furthermore, a monitoring and evaluation guide is devised to advise the client on follow-up measures after implementing the options. Consequently, this last end-result was also achieved.

Overall, three out the five end-results were achieved, one was partially achieved, and one was not achieved. Nonetheless, the research team was satisfied with the outcome, and hopes that the report contributes to decarbonising the Dutch housing sector – even if only a little bit – as well as that the learning from this project might benefit future projects or the implementation of similar solutions in the future.

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Appendices

Appendix A – Literature list for Solution Options

For the literature/sources not included in the main text and references section, a link was added.

Option	Literature/Sources consulted for brainstorming and drafting the options
Option 0 – Maintaining status quo	Revised EPBD (https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_1966) Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024 Netherlands Enterprise Agency, 2023 Tweede Kamer der Staten-Generaal, 2023
Option 1 – Improving the current Dutch Energy Performance Certificate	Amecke, 2011 (https://hdl.handle.net/10419/65874) Brazil & Caulfield, 2017 Comerford et al., 2018 European Commission, 2023 Gonzalez-Caceres et al., 2020 (https://doi.org/10.1016/j.enbuild.2020.110065) Lucas & Galarraga, 2015 Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024 Newell & Siikamäki, 2014 Solà et al., 2020 (https://doi-org.mu.idm.oclc.org/10.1007/s12053-020-09918-9)
Option 2 – Expanding the EP-Online platform	Bian & Fabra, 2020 (https://doi.org/10.1016/j.eneco.2020.104813) EP-Online database (https://www.ep-online.nl) Li et al., 2019
Option 3 – Including stakeholders in the standard-setting process	Koengkan et al., 2023 Netherlands Enterprise Agency, n.d. Van Der Gugten, 2017
Option 4 – Developing “digital twins” of buildings	Tweede Kamer der Staten-Generaal, 2023
Option 5 – Presenting purchasing decisions to other consumers	Ajzen, 1991
Option 6 – Presenting average EPC scores to homeowners	Ajzen, 1991 Qalati et al., 2022 Zuhaib et al., 2022
Option 7 – Promoting awareness of energy label impacts	Brounen & Kok, 2011 Ministerie van Algemene Zaken, n.d. UsersTCP, n.d. Zhang et al., 2020
Option 8 – Implementing minimum energy label requirements	Brounen & Kok, 2011 Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023 Netherlands Enterprise Agency, 2023 Ramos et al., 2015 (https://doi.org/10.1016/j.eneco.2015.08.022)

Option	Literature/Sources consulted for brainstorming and drafting the options
Option 9 – Mandating energy labels for all homeowners	Brounen & Kok, 2011 De Waarderingskamer, n.d. Netherlands Enterprise Agency, 2023
Option 10 – Providing more financial support	Li et al., 2019 Netherlands Enterprise Agency, 2017
Option 11 – Implementing a fund for renovation measures	Kreditanstalt für Wiederaufbau, 2024 Rodríguez González et al., 2012 (https://doi.org/10.1016/j.enpol.2012.08.050)

Appendix B – Initial list of Ideas

As mentioned, the following table contains the initial set of 26 ideas that led to the 11 (plus 0) options. Some of the ideas were discarded during the brainstorming, while others were similar and thus merged. Some ideas on the other hand served only as an inspiration and ended up as a completely different option or part of an option. They are not sorted in any particular order.

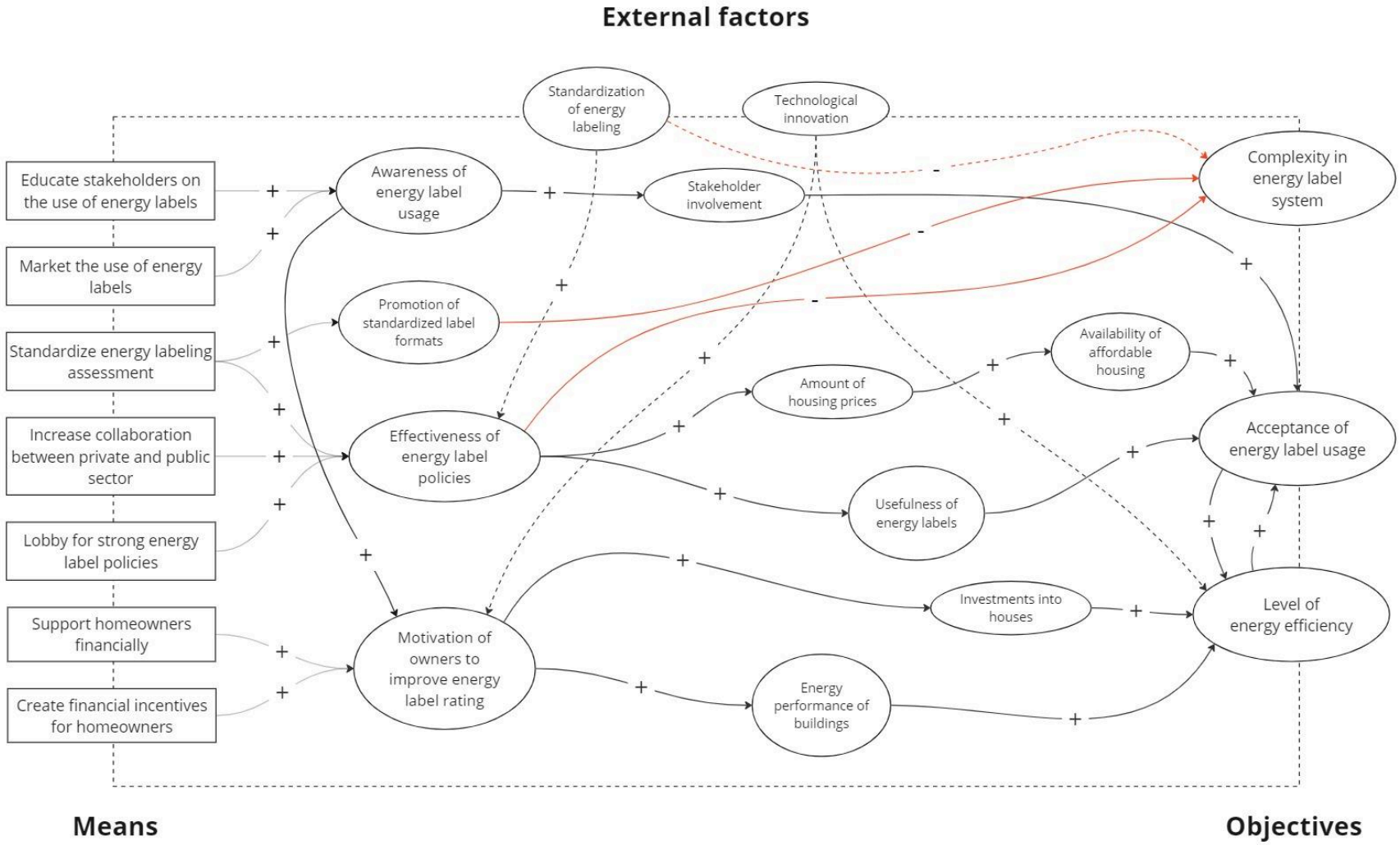
Number and name of idea	Short description	Turned into option
1 – information on the monetary value of saved energy	An elaborative insight and breakdown of the monetary savings calculation (e.g. regarding electricity, heating, etc.) is recommended to create an economic incentive for households	Option 1
2 – Information on the carbon dioxide	Include clear indications on how much carbon dioxide is on average used.	discarded
3 – Percentage of others using energy labels	Based on *subjective norms* of the Theory of Planned Behavior (TPB): when informing oneself about energy labels, it could be noted how many percent of others use these labels to make purchasing decisions.	Option 5
4 – campaign on impact of housing energy sector for global warming	Based on *attitude* of the Theory of Planned Behavior (TPB): a (municipal) campaign could be used to stress the impact of the housing energy sector in global warming, connected with the power of the individual to make an environmental difference.	Option 7
5 – Information on energy labels effectiveness in traffic light colour coding style	Summarise the most important information regarding the energy label in a traffic light colour coding style to increase households' attitude regarding the effectiveness of the energy labels	Option 1
6 – Policy regulation to mandate minimum energy performance standards for buildings	Implementing policies that mandate minimum energy performance standards for buildings, such as the requirement for a minimum EPC rating in rented properties.	Option 8
7 – Promotion of standardised labelling system	Through promotion of one standard labelling technique, the system becomes standardised and transparent and easy to understand. It can help consumers make informed decisions as the system would be standardised, transparent, and easy to orient in.	discarded
8 – Higher financial support	Providing higher grants to encourage property owners to carry out energy-efficient building renovation.	Option 10
9 – Leveraging big data analysis	Monitoring building energy performance through big data analysis enables tracking the progress of policy implementation related to building energy efficiency. This helps in ensuring that energy efficiency policies are effectively implemented and contribute to reducing carbon emissions and energy consumption.	Option 4
10 – Ensuring accurate and reliable energy performance assessments (e.g. through research)	Improving the quality and reliability of EPCs is crucial for building trust in the certification process. Ensuring accurate and reliable energy performance assessments can increase the credibility of EPCs and drive adoption of energy-efficient practices in the housing sector.	Option 1

Number and name of idea	Short description	Turned into option
11 – Collaboration and stakeholder engagement	Engaging stakeholders from the public and private sectors, including government agencies, industry associations, and energy service providers, in collaborative initiatives can foster a holistic approach to decarbonizing the housing sector.	Option 3
12 – Market valuation	Studying the impact of energy performance certificates on housing prices and rental markets can provide insights into how energy labels influence consumer behaviour and investment decisions, thereby incentivizing energy-efficient property upgrades.	discarded
13 – Include financial implication in the EPC	EPC only displays information in kWh/m2. With lack of access to a conversion tool, users mostly likely do not have information on the financial gain from energy improvement. Including an approximate financial implication will make this information evident for users.	Option 1
14 – Include the energy performance score of similar buildings nearby of house owners	Homeowners find information on their neighbourhood average EPC useful to their energy consumption reduction.	Option 6
15 – Improve the quality of the recommendation list of energy improvement measures in EPC	The recommendation list homeowners receive on how to improve their home is considered obvious. Most home renovations do not follow the recommended actions. Recommend personalised and practical measures.	Option 1
16 – Mandatory energy label for every house	Currently, only houses which are rented, sold, or built need an energy label. Therefore, mandating every homeowner to get an energy label increases the usage and relevance of energy labels in general.	Option 9
17 – Minimum energy efficiency level	As with office buildings over 100m², introducing a minimum energy efficiency level of C after a certain deadline (2030), increases incentives to invest into renovation measures - either for rental properties or for all houses.	Option 8
18 – Tax on energy inefficiency	Implementing a tax on energy inefficiency, based on the level of the energy label, would create an additional incentive to invest in renovation measures.	discarded
19 – Fund for energy efficiency measures	Similar to the tax on energy inefficiency, a mandatory (or voluntary) fund per house could be set up with mandated monthly payments into the fund, depending on the energy efficiency level. At a certain amount of money it will be used for a renovation measure.	Option 11
20 – Private Carbon Trading System	Inspired by the UKs CRC and the EU Emissions Trading System, a carbon trading mechanism between private households based on the carbon emissions of a household (estimated by the energy label) would create additional incentives to invest in renovation measures.	discarded

Number and name of idea	Short description	Turned into option
21 – Energy label based on actual usage	There is a significant difference between the estimated energy usage based on the certified energy label, and the actual household energy usage. Therefore, implementing a label based on, for example smart meter information, would influence the perception of households and stimulate interest in energy efficient behaviour and renovation measures. These could be mandatory (implemented by the government), or voluntary (implemented by the labelling organisation).	discarded
22 – Audits on energy label improvement options	Free or subsidised energy audits could examine the current energy label, potential renovation measures, their costs and cost savings, and potential energy label after implementing these measures. This provides clear and concise information of homeowners, reduces information asymmetry and improves transparency.	Option 1
23 – Differentiating the high energy efficiency levels	A study found that consumers do not differentiate between A, A+ and A++ energy labels, even though there are significant differences in energy efficiency. Therefore, in order to stimulate investment into more renovation measures, the existing energy label could be split up into more differentiated levels, i.e. A to I instead of A++ to G.	Option 1
24 – Increase transparency of energy labels	Presenting the energy label of a rental property is critical for an informed consumer choice and the effectiveness of the energy label system. Therefore, information on the energy label should have to be indicated in the rental adverts, regardless of level.	Option 2
25 – Do nothing	As the title suggests.	Option 0
26 – Integration of energy labels in smart home technology	Integration of energy labels in the smart home technology. The role of energy labels for houses within smart home systems would involve providing homeowners with information regarding the energy efficiency of their entire home. And as a next step, this information could be integrated into smart home applications such that homeowners could monitor and manage their overall energy usage more effectively. By implementing intelligent energy management, homeowners could use energy label data to identify areas where their home is less energy-efficient and prioritise energy-savings accordingly. Additionally, energy labels could inform smart home systems to optimise energy usage based on the home's energy performance rating.	discarded

Appendix C – System Diagram (excluding Project Boundaries)

The presented system shows the whole energy label system in the Netherlands, without restrictions to the client.



Appendix D – Example of a Dutch EPC

Example of A Dutch EPC with the energy label C. Retrieved May 10, 2024, from https://www.rijksoverheid.nl/documenten/publicaties/2021/10/28/energielabel-woningen-voorbeeld

Energielabel woningen	Registratienummer	Datum registratie	Geldig tot	Status
	123456789	1-03-2024	1-03-2034	Definitief

Deze woning heeft energielabel C

Isolatie

1	Gevels		+/-	+	++
2	Gevelpanelen	n.v.t.			
3	Daken		+/-	+	++
4	Vloeren		+/-	+	++
5	Ramen		+/-	+	++
6	Buitendeuren	-	+/-	+	++

Installaties

7	Verwarming	HR-107 ketel	Verbeteradvies
8	Warm water	Combiketel	Verbeteradvies
9	Zonneboiler	Geen zonneboiler	Verbeteradvies
10	Ventilatie	Natuurlijke toever met mechanische afzuiging	Verbeteradvies
11	Koeling	Geen koeling	
12	Zonnepanelen	Geen zonnepanelen	Verbeteradvies

Deze woning wordt verwarmd via een aardgasaansluiting

Warmtebehoefte in de wintermaanden

Laag | **Gemiddeld** | Hoog

Risico op hoge binnentemperaturen in de zomermaanden

Laag | **Hoog**

Aandeel hernieuwbare energie

0,0 %

Toelichtingen en verbeteradviezen vindt u op pagina 2 en verder

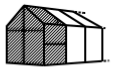
Over deze woning

Adres
Voorbeeldstraat 18
1234 AB Voorbeeldstad
BAG-ID: 1728010000084575

Detailaanduiding

Bouwjaar	1990
Compactheid	1,99
Vloeroppervlakte	93 m²

Woningtype
Hoekwoning



Opnamedetails

Naam
Pieter Hendrik van Leeuwwardingen

Examennummer
99999

Certificaathouder
Janssen-De Vries Energielabelcerticaten en inspecties B.V.

Inschrijfnummer
123.45.678

KvK-nummer
12345678

Certificerende instelling
Energielabelcertificerende instelling b.v.

Soort opname
Basisopname

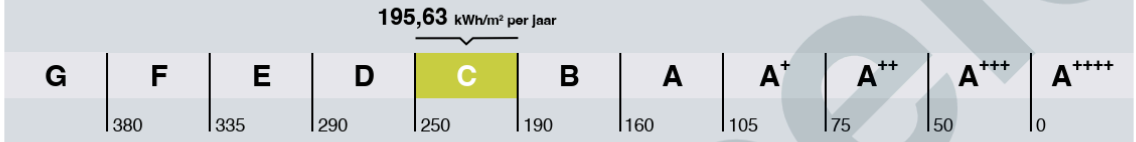
U kunt de geldigheid van dit energielabel controleren op www.ep-online.nl/ControlerenEchtheid

Energielabel woningen **2** van **10**

Toelichting bij dit energielabel

Voor uw woning is het energielabel bepaald. Dit label geeft aan hoe energiezuinig uw woning is. De energiezuinigheid wordt bepaald door de mate van isolatie en de energiezuinigheid van de installaties die nodig zijn voor verwarming, koeling, warm water en ventilatie. Ook de eventuele opbrengst van zonnepanelen wordt meegenomen in de berekening van het energielabel.

Hoe minder fossiele energie uw woning gebruikt, hoe beter uw energielabel. Hierbij is G het slechtste energielabel en A++++ het beste. Fossiele energie komt van kolen, olie en aardgas. **Uw woning gebruikt 195,63 kWh/m² fossiele energie per jaar. Dit komt overeen met 36,75 kg CO_2/m² per jaar.** De hoeveelheid fossiele energie die uw woning gebruikt, hangt af van de isolatie, de aanwezige installaties en de compactheid van uw woning. Hoe compacter een woning is, des te lager is de waarde voor de compactheid. Een compacte woning heeft relatief weinig buitenmuren en verliest daardoor minder energie. Het gebruik van hernieuwbare energie – denk aan zonnepanelen, zonneboilers en warmtepompen – vermindert ook de fossiele energie die u nodig hebt. Isolatie en hernieuwbare energie zijn nodig voor de transformatie naar een duurzame gebouwde omgeving tot 2050. Heeft u nog een aardgasaansluiting voor verwarming van uw woning, dan moet u zich voorbereiden op deze overgang. Op dit energielabel vindt u adviezen hoe u dit kunt doen.



Hoe is het energielabel berekend? Hierbij is uitgegaan van een gemiddeld aantal bewoners, gemiddeld bewonersgedrag en het gemiddelde Nederlandse klimaat. Het energiegebruik voor huishoudelijke apparatuur – zoals tv, wasmachine en koelkast – telt niet mee. Dit is omdat het energielabel alleen gaat over hoe energiezuinig de woning zelf is. Het energiegebruik op het energielabel is daarom niet hetzelfde als het elektriciteitsverbruik op uw energierekening.

Warmtebehoefte in de wintermaanden

Voldoet aan de Standaard voor woningisolatie?

ja **nee**

De warmtebehoefte is de hoeveelheid warmte die gemiddeld per jaar nodig is om uw woning voldoende warm te krijgen. Een woning die goed geïsoleerd en kierdicht is en een energiezuinig ventilatiesysteem heeft, heeft een lage warmtebehoefte. **De warmtebehoefte van uw woning is 113,16 kWh per vierkante meter vloeroppervlakte.** Bij een warmtebehoefte van maximaal 83 kWh per vierkante meter vloeroppervlakte voldoet de woning aan de Standaard voor woningisolatie. Uw woning is dan in veel gevallen klaar voor de overstap naar een duurzame warmtevoorziening die warmte levert op ongeveer 50 graden in de woning, zoals warmtepompen.

Risico op hoge binnentemperaturen in de zomermaanden

Het risico op hoge binnentemperaturen in uw woning in de zomermaanden is hoog. Maatregelen zoals buitenzonwering, zonwerende beglazing en dakisolatie beperken het risico op hoge binnentemperaturen.

Aandeel hernieuwbare energie

Het aandeel hernieuwbare energie dat u benut voor uw woning, is 0,0%. Hernieuwbare energie is afkomstig uit zon, biomassa, buitenlucht en bodem. Zonnepanelen, zonneboilers, warmtepompen en biomassaketels vergroten het aandeel hernieuwbare energie.

Indicatie energierekening

Prijspeil december 2022

Onderstaande tabel geeft een indicatie van de energierekening per maand, gebaseerd op vergelijkbare woningen in Nederland. Uw energierekening wordt behalve door de energiezuinigheid van de woning ook door uw gedrag beïnvloed. Als u de verwarming veel aan hebt staan, veel warm water gebruikt en veel elektrische apparatuur in gebruik heeft, dan is uw energierekening hoger. Er is in de tabel daarom onderscheid gemaakt in laag, gemiddeld en hoog.

	G	F	E	D	C	B	A	A+	A++	A+++	A++++
Laag	€115	€110	€105	€100	€90	€80	€75	€70	€70	€65	€60
Gemiddeld	€170	€165	€160	€155	€140	€130	€120	€110	€110	€105	€100
Hoog	€250	€240	€235	€225	€205	€190	€175	€165	€160	€155	€150

Kenmerken en maatregelen

Op de voorkant van dit energielabel staat een samenvatting van de belangrijkste energetische kenmerken van uw woning. Op deze en de volgende pagina's vindt u een gedetailleerder overzicht van de isolatie en installaties in uw woning. Ook leest u welke energiebesparende maatregelen u nog kunt treffen. Bij de toelichting over isolatie, staat telkens een streefwaarde. Deze streefwaarde geeft aan naar welk isolatieniveau u kunt streven als u wilt gaan na-isoleren. Als u alle bouwdelen isoleert tot de streefwaarde, dan hoeft u in de toekomst niet nog een keer te isoleren en wordt de Standaard voor woningisolatie ruimschoots gerealiseerd. Door het voldoen aan de Standaard zorgt u ervoor dat uw woning op de toekomst is voorbereid.

Op basis van de energetische kenmerken van uw woning is een aantal mogelijke maatregelen bepaald. Hiermee kunt u de energieprestatie van uw woning verbeteren. Let op: het gaat om mogelijk kosteneffectieve maatregelen. Of deze maatregelen daadwerkelijk verantwoord toegepast kunnen worden – uit oogpunt van bijvoorbeeld binnenklimaat, comfort, gezondheid, technische haalbaarheid en kosteneffectiviteit – is afhankelijk van de specifieke eigenschappen van uw woning. Een energiedeskundige kan u hier over adviseren.

Vaak is ook veel energiewinst te halen door het correct inregelen, gebruiken en onderhouden van uw woning en de installaties. Het zorgt, behalve voor een lager energiegebruik, ook voor een gezonder en comfortabeler binnenklimaat.

Isolatie

1 Gevels

Hieronder ziet u de oppervlakken en R_c-waarden (isolatiewaarden) van de gevels van **uw woning**. Hoe hoger de R_c-waarde, hoe beter de isolatie. Niet of slecht geïsoleerde delen zijn rood gemarkeerd.

Zuidoost		Zuidwest		Noordwest	
Opp.	R_c	Opp.	R_c	Opp.	R_c
0 6		0 6		0 6	
18,2 m²	**2,14**	**49,3 m²**	**2,14**	**8,4 m²**	**2,14**

Toelichting

Buitenmuren worden aangeduid als gevels. De isolatiewaarde van gevels wordt uitgedrukt in een R_c-waarde. Hoe hoger de R_c-waarde, hoe beter de isolatiewaarde. Een hogere isolatiewaarde houdt de warmte beter in de woning in de koude maanden. Hoe groter de oppervlakte van een gevel, hoe meer effect een goede of slechte isolatiewaarde zal hebben op de energetische kwaliteit van uw woning.

Dankzij goede gevelisolatie verliest uw woning minder warmte. U bespaart op uw energiekosten en vermindert de uitstoot van het broeikasgas CO_2. Ook zorgt goede gevelisolatie voor een verhoging van het comfort in de woning. De woning is gelijkmatiger warm doordat de muren minder kou afgeven.

In nieuwere woningen is een goede isolatie standaard aanwezig. Bij oudere woningen is er vaak sprake van een niet-geïsoleerde spouwmuur. In dat geval is spouwmuurisolatie een, in verhouding, goedkope manier om de gevel te isoleren. Met het na-isoleren van de spouw wordt een matige isolatiewaarde gehaald (R_c = 1,0 tot 1,7 m²K/W). Er zijn ook andere mogelijkheden. Denk aan isolatie aan de binnenkant of de buitenkant van de gevel. Deze geven een betere isolatiewaarde, maar zijn ook duurder.

Hoogstwaarschijnlijk worden gevels maar één keer na-geïsoleerd. Het is dan verstandig om de gevels direct goed te isoleren. Isoleer daarom meteen richting de streefwaarde (R_c 6 m²K/W).

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Energielabel woningen **4** van **10**

3 Daken

Hieronder ziet u de oppervlakken en R_c-waarden (isolatiewaarden) van de daken van **uw woning**. Hoe hoger de R_c-waarde, hoe beter de isolatie. Niet of slecht geïsoleerde delen zijn rood gemarkeerd.

Zuidoost

Opp.	0	8	R_c
21,6 m²			**2,00**

Noordwest

Opp.	0	8	R_c
40,4 m²			**2,00**

Toelichting

Daken kunnen bestaan uit horizontale of hellende delen. De bovenkant van een dakkapel wordt ook beschouwd als een dak. De isolatiewaarde van daken wordt uitgedrukt in een R_c-waarde. Hoe hoger de R_c-waarde, hoe beter de isolatiewaarde. Een hogere isolatiewaarde houdt de warmte beter in de woning in de winter. Met dakisolatie blijft vooral de bovenverdieping ook in de zomer koeler. Hoe groter het dak, hoe meer effect een goede of slechte isolatiewaarde heeft op de energetische kwaliteit van uw woning.

Dankzij goede dakisolatie verliest uw woning minder warmte. U bespaart op uw energiekosten en vermindert de uitstoot van het broeikasgas CO_2. Afhankelijk van het type dak, schuin dak met pannen of een plat dak, is isoleren aan de binnenkant of buitenkant mogelijk. Het juiste gebruik van dampremmende folie is daarbij een middel om vocht en houtrot in het dak te voorkomen.

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Als uw dakbedekking aan vernieuwing toe is of u wilt het dak na-isoleren, isoleer dan meteen richting de streefwaarde (R_c 8 m²K/W).

4 Vloeren

Hieronder ziet u de oppervlakken en R_c-waarden (isolatiewaarden) van de vloeren van **uw woning**. Hoe hoger de R_c-waarde, hoe beter de isolatie. Niet of slecht geïsoleerde delen zijn rood gemarkeerd.

Vloeren

Opp.	0	3,5	R_c
41,8 m²			**1,30**

Toelichting

Hiermee worden vloeren bedoeld die grenzen aan de grond of buitenlucht. Dit zijn begane grondvloeren met of zonder kruipruimte eronder, maar ook vloeren boven een onderdoorgang. De isolatiewaarde van vloeren wordt uitgedrukt in een RC-waarde. Hoe hoger de RC-waarde, hoe beter de isolatiewaarde. Een hogere isolatiewaarde houdt de warmte beter in de woning in de koude maanden. Hoe groter de oppervlakte van een vloer, hoe meer effect een goede of slechte isolatiewaarde zal hebben op de energetische kwaliteit van uw woning.

Door goede vloerisolatie verliest uw woning minder warmte. U bespaart op uw energiekosten en vermindert de uitstoot van het broeikasgas CO_2. Goede vloerisolatie verhoogt het comfort in de woning. De woning houdt de warmte beter vast en de vloer voelt minder koud aan. Het gaat hierbij niet alleen om begane grondvloeren, maar ook om vloeren boven een onderdoorgang.

4 **Vloeren** (vervolg)

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Hebt u een vloer boven een kelder, een kruipruimte met een vrije ruimte onder de balken van minimaal 35 cm, of een vloer boven een onderdoorgang, dan kan de onderzijde van de vloer geïsoleerd worden. Bij de kruipruimte is het dan belangrijk om de bodem af te dekken met een kunststoffolie om te voorkomen dat isolatiemateriaal vochtig wordt. Hebt u vloeren op de volle grond of boven een lage kruipruimte, dan kan de bodem of de bovenzijde van de begane grondvloer geïsoleerd worden.

Als u uw vloer gaat na-isoleren, is het verstandig om meteen goed te isoleren. Isoleer daarom meteen richting de streefwaarde (R_c 3,5 m²K/W).

5 Ramen

Hieronder ziet u de oppervlakken en U_w-waarden (isolatiewaarden) van de ramen van **uw woning**. Hoe lager de U_w-waarde, hoe beter de isolatie. Niet of slecht geïsoleerde delen zijn rood gemarkeerd.

Zuidoost

Opp.	0 … 7	U_w
3,2 m²		**2,9**
1,8 m²		**2,9**
1,1 m²		**2,9**
1,0 m²		**2,9**
1,0 m²		**2,9**

Noordwest

Opp.	0 … 7	U_w
3,5 m²		**2,9**
1,0 m²		**2,9**
0,4 m²		**2,9**
0,4 m²		**6,2**

Toelichting

Dit betreffen alle ramen aan de buitenzijde van uw woning. Ook een buitendeur met veel glas (denk aan een balkondeur of keukendeur) telt voor het energielabel als een raam. Bij het bepalen van de isolatiewaarde van ramen, wordt gekeken naar de combinatie van het glas met het kozijn. De isolatiewaarde van ramen wordt uitgedrukt in de U_w-waarde. Hoe lager de U_w-waarde, hoe beter de isolatie is. HR⁺⁺-glas en triple-glas hebben een lage U_w-waarde en houden de warmte beter in de woning dan enkel glas en gewoon dubbel glas. Hoe groter de oppervlakte van de ramen in uw woning, hoe meer effect een goede of slechte isolatiewaarde heeft op de energetische kwaliteit van uw woning.

Door goed isolerend glas, zoals HR⁺⁺-glas, vacuümglas of triple (3-voudig) glas, verliest uw woning minder warmte. U bespaart op uw energiekosten en vermindert de uitstoot van het broeikasgas CO_2. Ook verhoogt goed isolerend glas het comfort in de woning. U heeft geen tocht en kou bij de ramen en geen condens aan de binnenkant van het raam. Door goed isolerend glas hoort u ook minder geluid van buiten.

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Als uw kozijnen aan vervanging toe zijn, is dat het ideale moment om de kozijnen en het glas in één keer goed te isoleren. Kies dan meteen voor een oplossing die richting de streefwaarde gaat (U_w van 1 W/m²K).

6 Buitendeuren

Hieronder ziet u de oppervlakken en U_d-waarden (isolatiewaarden) van de buitendeuren van **uw woning.** Hoe lager de U_d-waarde, hoe beter de isolatie. Niet of slecht geïsoleerde delen zijn rood gemarkeerd.

Zuidoost				Noordwest			
Opp.	0 – 4	U_d		Opp.	0 – 4	U_d	
2,1 m²		**3,4**		**2,1 m²**		**3,4**	

Verbeteradvies: geïsoleerde buitendeur(en)

In uw woning zijn (een deel van) de buitendeuren nog niet geïsoleerd. Met een geïsoleerde buitendeur kunt u de energieprestatie van uw woning verbeteren.

Toelichting

Een buitendeur met weinig glas (zoals veel voordeuren) telt in het energielabel als een buitendeur. Deuren met veel glas tellen voor het energielabel als een raam. Bij het bepalen van de isolatiewaarde van buitendeuren, wordt gekeken naar de combinatie van de deur met het kozijn.
De isolatiewaarde van buitendeuren wordt uitgedrukt in de U_d-waarde. Hoe lager de U_d-waarde, hoe beter de isolatie. Een geïsoleerde buitendeur houdt de warmte beter in de woning.

Met goed isolerende deuren verliest uw woning minder warmte. U bespaart op uw energiekosten en vermindert de uitstoot van het broeikasgas CO_2. Ook verhoogt een goed geïsoleerde deur het comfort in de woning. Belangrijk bij de plaatsing van een deur is dat deze in een geïsoleerd kozijn wordt gezet. Rondom de deur moet aan vier zijden een goede luchtdichting worden aangebracht.

Als u een buitendeur gaat vervangen, kies dan meteen voor een geïsoleerde buitendeur die richting de streefwaarde gaat (U_d van 1,4 W/m²K).

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

LET OP!

Besteed speciale aandacht aan kierdichting en ventilatie bij het isoleren van een woning

Om de overstap te kunnen maken naar duurzame warmtevoorzieningen, zoals bijvoorbeeld een warmtepomp, moet uw woning niet alleen goed geïsoleerd zijn, maar moet ook de luchtdichtheid van de woning in orde zijn. De luchtdichtheid wordt bepaald door kieren en naden waardoor warmte verloren gaat. Deze kieren en naden kunnen zitten bij de aansluiting van de ramen op de gevel, of bij de aansluiting van het dak op de gevel. Bij het verbeteren van de isolatie van vloeren, gevels, daken, ramen, deuren en/of panelen, is het belangrijk dat al deze onderdelen goed luchtdicht op elkaar aansluiten. Dit voorkomt warmteverlies en onaangename tocht. Door koude tocht zetten mensen de verwarming hoger en dat kost energie.

Als u kieren en naden dicht, komt er geen lucht van buiten meer de woning in. Dat voorkomt tocht. Maar de woning moet wel (op een gecontroleerde manier) frisse lucht binnen krijgen. Ventilatie is belangrijk voor de gezondheid en voorkomt vochtproblemen. Besteed bij de verbetering van de isolatie van de woning – en met name bij het dichten van naden en kieren – ook aandacht aan voldoende ventilatie. Laat u hierover informeren door een expert. Denk bijvoorbeeld aan het plaatsen van winddrukgeregelde roosters of een ventilatie-unit met warmteterugwinning.

Installaties

7 **Verwarming**

In de tabel hieronder staat welke toestellen in **uw woning** aanwezig zijn en welk gedeelte van de woning door die toestellen verwarmd wordt. In de meeste woningen is sprake van één verwarmingstoestel. Soms zijn er verschillende toestellen voor de verwarming van de woning.

Verwarmingstoestellen	Aangesloten opp.
HR-107 ketel	92,8 m²

Verbeteradvies: energiezuinig verwarmingstoestel voor verwarming en/of warm water
Is uw verwarmingsinstallatie aan vervanging toe? Dan kunt u het beste kiezen voor een energiezuinig en duurzaam systeem. Hieronder staat een aantal voorbeelden van energiezuinige systemen, ze variëren in hoe ze gebruik maken van duurzame energiebronnen. Elektriciteit als energiedrager is op dit moment ten dele duurzaam (een mix van groen en grijs), maar is op termijn duurzamer te maken.

Hybride warmtepomp
Wilt u uw woning verwarmen met minder aardgas, dan kan dat met een hybride warmtepomp. Deze bestaat uit een combinatie van een (bestaande) cv-ketel op aardgas en een warmtepomp op elektriciteit. De warmtepomp zorgt het grootste deel van de tijd voor warmte in de woning. De cv-ketel springt alleen bij als het buiten erg koud is en zorgt voor warm water in de woning. Een hybride warmtepomp is een prima tussenstap als uw woning goed, maar nog niet zeer goed, is geïsoleerd. En dus nog niet volledig klaar is voor aardgasvrij wonen.

Warmtepomp
Met een volledig elektrische warmtepomp heeft u geen aardgasaansluiting meer nodig voor verwarming van uw woning. Warmtepompen halen met een warmtewisselaar warmte uit de bronnen zoals lucht, bodem of grondwater, en hebben in vergelijking met elektrische kachels een hoog rendement. Een warmtepomp kan de woning verwarmen en warm water leveren. Doordat de warmtepomp werkt met een lage verwarmingstemperatuur, is deze alleen geschikt voor zeer goed geïsoleerde woningen. Hij wordt gecombineerd met vloer- of wandverwarming, convectoren of met radiatoren met voldoende capaciteit voor verwarmingswater met een lage temperatuur.

Warmtenet
Nog een alternatief waarbij geen aardgasaansluiting voor verwarming van uw woning nodig is, is een warmtenet. Dit heet ook wel stadsverwarming. Bij dit systeem wordt er direct warmte geleverd aan de woning. Door buizen die onder de grond liggen, gaat het warme water naar de woningen, waar het via een warmtewisselaar gebruikt wordt voor verwarming en warm water. Het afgekoelde water gaat weer terug naar de verwarmingscentrale die het dan weer opwarmt. Hier wordt warmte gemaakt van overgebleven warmte van industrieën, afvalverbranding en afvalwater, biomassa, geothermie of oppervlaktewater. De warmte die aan de woning geleverd wordt kan van een hoge of een lage temperatuur zijn, dat verschilt per warmtenet. Als het warmtenet warmte van een lage temperatuur levert, dan is het van belang dat uw woning goed geïsoleerd is, en dat de radiatoren, convectoren en/of vloerverwarming geschikt zijn voor verwarmingswater met een lage temperatuur. Liggen er al warmtenetten in uw stad of dorp? Of zijn er plannen om deze in de toekomst aan te leggen? Overweeg dan om op dat net aan te sluiten. In afwachting van de definitieve plannen kunt u al wel aan de slag met het verbeteren van de isolatie en het ventilatiesysteem in de woning.

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

8 Warm water

In de tabel hieronder is weergegeven welke warmwatertoestellen in **uw woning** aanwezig zijn.
De meeste woningen hebben één warmwatertoestel. Soms is er sprake van meerdere verschillende toestellen die zorgen voor het warm water.

Warmwatertoestellen	Combitoestel
Douche met warmteterugwinning	Niet aanwezig

Verbeteradvies: warmteterugwinning uit douchewater
Met een douche-wtw gebruikt u de warmte van wegstromend douchewater om het koude water voor de douche alvast een beetje op te warmen. Het voorverwarmde water gaat naar de mengkraan van de douche en/of combitoestel. Hiermee bespaart u energie van uw warmwaterinstallatie. Om de warmte uit het douchewater terug te kunnen winnen, wordt in de afvoerpijp, douchebak of vloer van de inloopdouche een warmtewisselaar geplaatst.

Verbeteradvies: zonneboiler voor warm water en/of verwarming
Zonnecollectoren zetten de energie van de zon om in warm water. Een zonneboilerinstallatie bestaat uit verschillende onderdelen: zonnecollectoren op het dak, en een boilervat waarin het door de zon verwarmde water wordt opgeslagen. Een zonneboiler kan op jaarbasis gemiddeld de helft van het bad- en douchewater verwarmen. Een zonneboiler levert in de zomer bijna al het warme water. In de winter lukt dit niet en zorgt de cv-ketel, biomassaketel of warmtepomp voor warm water. Als de installatie groot genoeg is, kan het systeem ook worden aangesloten op het verwarmingssysteem. De opgevangen zonnewarmte kan dan ook worden gebruikt voor het (gedeeltelijk) verwarmen van de woning.

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

10 Ventilatie

Ventilatie is belangrijk voor frisse lucht in de woning en de gezondheid van bewoners. In het overzicht hieronder staat wat voor ventilatiesysteem **uw woning** heeft. In oudere woningen is vaak geen mechanisch ventilatiesysteem aanwezig: ventileren gebeurt alleen door roosters boven het raam, of door het openen van (klep)ramen. Bij woningen gebouwd na 1975, zorgt vaak een ventilator voor het toe- en/of afvoeren van frisse lucht. Deze ventilator kan een energiezuinige gelijkstroomventilator zijn, of een minder zuinige wisselstroomventilator. In het overzicht ziet u ook of de warmte uit de ventilatielucht teruggewonnen wordt en wordt hergebruikt in de woning.

Type ventilatiesysteem	Warmte-terugwinning	Wisselstroom-ventilator	Aangesloten oppervlakte
Natuurlijke toevoer met mechanische afzuiging	Nee	Nee	92,8 m²

Verbeteradvies: energie-efficiënt ventilatiesysteem
Ventilatie van de woning is nodig voor een gezond binnenklimaat, maar kost ook energie. Het is daarom verstandig om te zorgen voor een ventilatiesysteem dat voldoende ventileert én energiezuinig is. Hieronder vindt u voorbeelden van dergelijke systemen.

Vraag-gestuurde mechanische afzuiging
Bij een vraag-gestuurd mechanisch ventilatiesysteem zuigt een ventilatie-unit lucht af uit de keuken, badkamer en toilet. CO_2-sensoren in de woonkamer en slaapkamers, en een luchtvochtigheids-sensor in de badkamer, meten continu de luchtkwaliteit. Ze bepalen op basis daarvan hoeveel lucht er moet worden afgevoerd. Op deze manier wordt de woning altijd voldoende geventileerd.
Op momenten dat er niemand aanwezig is, schakelt het systeem naar een lagere stand, waardoor het energiegebruik verlaagd wordt.

10 **Ventilatie** (vervolg)

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Ventilatie met warmteterugwinning

Een andere manier om energiezuiniger te ventileren, is door een ventilatiesysteem met warmte-terugwinning toe te passen: per kamer of als systeem voor de hele woning. Zo'n systeem heeft twee ventilatoren. Eén ventilator zorgt dat er schone lucht de woning inkomt, de andere ventilator regelt de afvoer van vervuilde lucht naar buiten. Met een warmte-terugwin-unit in het ventilatie-systeem wordt de binnenkomende koude lucht opgewarmd met de warme lucht die naar buiten gaat. Dat gebeurt met een warmtewisselaar.

11 Koeling

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

Heeft **uw woning** een mechanisch koelsysteem, dan staat dit vermeld in het overzicht hieronder. Het nadeel van woningen met koelsystemen is dat deze systemen energie gebruiken (en ook een slechter energielabel hebben dan woningen zonder koelsysteem). In plaats van het aanbrengen van een koelsysteem, kunt u beter maatregelen treffen om de zomerse zonnewarmte buiten te houden. Bijvoorbeeld door het aanbrengen van buitenzonwering, overstekken of zonwerende beglazing.

Koeltoestellen	Aangesloten oppervlakte
Geen koeling	n.v.t.

12 Zonnepanelen

Meer informatie over energiebesparende maatregelen vindt u op **www.verbeterjehuis.nl**

In het overzicht hieronder staat de omvang van het zonnepanelensysteem aangegeven (uitgedrukt in de oppervlakte en het totale wattpiekvermogen). Hoe groter het systeem, des te meer elektriciteit ermee opgewekt kan worden. Daarbij is de oriëntatie van de panelen van grote invloed: hoe meer direct zonlicht op de panelen valt, hoe hoger de opbrengst.

Wattpiekvermogen	Oriëntatie	Oppervlakte
geen zonnepanelen	n.v.t.	n.v.t.

Verbeteradvies: zonnepanelen voor elektriciteitsopwekking

Zonnepanelen – ook wel PV-panelen genoemd – zetten de energie van de zon om in elektriciteit. Een PV-systeem bestaat uit panelen die (meestal) op een dak geplaatst worden, en een omvormer die in de woning staat. De zonnepanelen kunnen zowel op platte als schuine daken worden geplaatst. Plaats zonnepanelen bij voorkeur op het zuiden zodat ze zoveel mogelijk zonlicht opvangen. Maar ook met een andere oriëntatie is een goede opbrengst te halen. Voorkom gedeeltelijke beschaduwing van panelen – anders loopt de opbrengst terug.

Twijfels of klachten?

Bent u eigenaar van de woning? Neem dan eerst contact op met de energieadviseur als u het niet eens bent met uw energielabel. U kunt dan uitleggen waarom u het niet eens bent met uw energielabel. Mogelijk krijgt u een nieuwe opname of wijziging in de bestaande opname. Komt u er met uw energieadviseur niet uit? Neem dan contact op met de certificaathouder die het label geregistreerd heeft. De naam van de certificaathouder staat op de eerste pagina van dit energielabel.
Vindt u dat de certificaathouder uw melding niet goed afhandelt? Neem dan contact op met de certificerende instelling. Deze instelling controleert de certificaathouder. De naam vindt u ook op de eerste pagina van dit energielabel.

Bent u huurder? Twijfelt u als huurder of het geregistreerde energielabel wel klopt? Neem dan contact op met de verhuurder. De verhuurder kan dan contact opnemen met de certificaathouder om de melding te behandelen. Vindt u dat uw verhuurder uw melding niet goed behandelt en heeft het energielabel invloed op uw huurprijs? Dan kunt u de Huurcommissie inschakelen.

Meer informatie

Dit energielabel is afgegeven door Rijksdienst voor Ondernemend Nederland. Dit energielabel kunt u altijd verifiëren op www.zoekjeenergielabel.nl, www.ep-online.nl of in MijnOverheid. De genoemde besparingsmogelijkheden zijn maatregelen die op dit moment in de meeste gevallen kosteneffectief zijn, of dit binnen de geldigheidsduur van het energielabel kunnen worden.
Op www.verbeterjehuis.nl kunt u een indicatie krijgen hoeveel bovenstaande maatregelen kosten en wat zij u opleveren aan energiebesparing. Of de genoemde maatregelen daadwerkelijk verantwoord toegepast kunnen worden uit oogpunt van bijvoorbeeld comfort, gezondheid, kosten e.d., is afhankelijk van de huidige specifieke eigenschappen van uw woning. Er kunnen daarom geen rechten worden ontleend aan deze informatie. U wordt altijd geadviseerd om hiervoor professioneel advies in te winnen.

Dit document is digitaal ondertekend. U kunt de echtheid van het document controleren.
Hoe dat in zijn werk gaat leest u op www.ep-online.nl/ControlerenEchtheid.

Appendix E – Excerpts from the MCA form sent to Actors

Criteria Tab

Please fill in the blue boxes to indicate how important you believe this criteria to be. The total sum of all criteria should be 100. The current sum is:	0 /100
Criteria	**Scoring Measures**
1. Feasibility of Implementation Due to the national scale of the problem framing, significant resources might be necessary to change existing structures or implement potential solutions. For example, these could include costs of implementation, or organisational and administrative capacities. In order to determine the feasibility of implementing a solution, it is necessary to gain insights into the perceived resource intensity of each solution.	– 2 Excessive resource requirements render implementation almost impractical – 1 Significant resource requirements 0 Moderate resource requirements 1 Relatively low resource requirements 2 Minimal resource requirements
Assign weight to criteria here:	
2. Time frame of Implementation The possibility of the solution being fully implemented by 2030.	– 2 Implementation until 2030 almost impossible – 1 Implementation until 2030 unlikely 0 Implementation until 2030 uncertain 1 Implementation until 2030 likely 2 Implementation until 2030 almost guaranteed
Assign weight to criteria here:	
3. Effectiveness of improving energy label levels The extent to which the proposed solution leads to actual renovation actions that improve the energy label levels of residential properties in the Netherlands.	– 2 Almost no expected improvements in overall energy label levels – 1 Very low expected improvements in overall energy label levels 0 Improvements in overall energy label levels uncertain 1 Slight improvements in overall energy label levels expected 2 Very high improvements in overall energy label levels expected
Assign weight to criteria here:	
4. Degree of Complexity added to the Dutch energy label system Since the energy label "ecosystem" is a complex, multi-level, multi-actor policy field, potential options to strengthen the contribution of energy labels to decarbonise the Dutch housing sector need to improve the energy label system as a whole, without needlessly adding further complexity or confusion for all actors involved.	– 2 Large increase in complexity to the energy label system – 1 Slight increase in complexity to the energy label system 0 Increase in complexity to the energy label system uncertain 1 Slight decrease in complexity to the energy label system 2 Large decrease in complexity to the energy label system
Assign weight to criteria here:	
5. Awareness of energy label importance With homeowners being the ones who have to implement the actual change in their homes, this criterion measures the increase in public awareness of the benefits of energy labels due to implementing the solution.	– 2 Little to no increase in overall awareness – 1 Very low increase in overall awareness 0 Increase in overall awareness uncertain 1 Slight increase in overall awareness 2 Large increase in overall awareness
Assign weight to criteria here:	
6. Motivation to improve energy label Connected to criteria 5, homeowners also have to be motivated to implement measures to increase the energy label of their home to a higher level. Hence, this criterion measures the perceived increase in the number of people motivated to engage with renovation options after implementing the solution.	– 2 Little to no increase in overall motivation – 1 Very low increase in overall motivation 0 Increase in overall motivation uncertain 1 Slight increase in overall motivation 2 Large increase in overall motivation
Assign weight to criteria here:	

Option 1 Tab

Option 1: Improving the current Dutch Energy Performance Certificate	
After getting a household energy check-up in the Netherlands, homeowners get an Energy Performance Certificate. This document shows how energy efficient their home is and offers some tips for making it better. Now, this Option 1 wants to make the Energy Performance Certificate even more helpful. Instead of just general tips, it will give personalised advice based on each home. This means suggestions tailored to what each house needs, what repairs to make and how much they might cost. It will also show how these changes will affect the home's energy rating. To make it easy to understand, the advice will be colour-coded like traffic lights: green for the best changes and red for the least helpful ones. So, homeowners will know exactly what to do to make their homes more energy efficient. What's more, the energy label scale will be simplified to a scale from A to G, as consumers struggle to distinguish between the higher classes (A, A+, A++, A+++, A++++), despite significant energy efficiency differences.	
1. Feasibility of Implementation	
2. Time frame of Implementation	
3. Effectiveness of improving energy label levels	
4. Degree of Complexity added to the Dutch energy label system	
5. Awareness of energy label importance	
6. Motivation to improve energy label	
Additional comments:	

Hint: By hovering over the blue fields, the scoring criteria will be visible. The score can also be selected via a drop-down menu.

Option 7 Tab

Option 7: Promoting awareness of energy label impacts	
A public awareness campaign launched by the Dutch government is proposed in option 7, which educates homeowners about the importance and benefits of energy labels for the environment, while highlighting an individual's power to make an environmental impact. Next to the positive impact of energy labels on the environment, the financial benefit for the households should be stressed during the campaigns to further increase the uptake of energy labels in the housing market. Different media channels, such as full-page ads in national newspapers, as well as radio, TV, or online media (e.g. Google, LinkedIn, X, Instagram) could be used.	
1. Feasibility of Implementation	
2. Time frame of Implementation	
3. Effectiveness of improving energy label levels	
4. Degree of Complexity added to the Dutch energy label system	
5. Awareness of energy label importance	
6. Motivation to improve energy label	
Additional comments:	

Hint: By hovering over the blue fields, the scoring criteria will be visible. The score can also be selected via a drop-down menu.

Appendix F – Sensitivity Analysis Calculations

Scenario 1 – Actor Responses

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Criteria 1	8	-2	-2	3	-7	1	3	5	-1	-2	-6	-6
Criteria 2	7	1	0	1	-5	3	6	7	0	1	0	-6
Criteria 3	-7	3	1	-3	0	-2	3	-1	8	2	3	3
Criteria 4	0	-5	-3	-2	-4	0	3	3	3	0	-3	-2
Criteria 5	-6	0	2	-2	1	5	2	3	6	4	1	0
Criteria 6	-6	3	1	-2	0	5	4	2	7	1	4	2
Total Scores	-4	0	-1	-5	-15	12	21	19	23	6	-1	-9
Weighted Criteria 1 (16.75%)	1.34	-0.34	-0.34	0.5	-1.17	0.17	0.5	0.84	-0.17	-0.34	-1.01	-1.01
Weighted Criteria 2 (17.50%)	1.23	0.18	0	0.18	-0.88	0.53	1.05	1.23	0	0.18	0	-1.05
Weighted Criteria 3 (25.00%)	-1.75	0.75	0.25	-0.75	0	-0.5	0.75	-0.25	2	0.5	0.75	0.75
Weighted Criteria 4 (7.50%)	0	-0.38	-0.23	-0.15	-0.3	0	0.23	0.23	0.23	0	-0.23	-0.15
Weighted Criteria 5 (10.00%)	-0.6	0	0.2	-0.2	0.1	0.5	0.2	0.3	0.6	0.4	0.1	0
Weighted Criteria 6 (23.25%)	-1.4	0.7	0.23	-0.47	0	1.16	0.93	0.47	1.63	0.23	0.93	0.47
Total Weighted Scores	**-1.18**	**0.91**	**0.12**	**-0.89**	**-2.25**	**1.86**	**3.66**	**2.8**	**4.29**	**0.97**	**0.55**	**-0.99**

Scenario 2 – Equal Weights

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Criteria 1	20	5	-6	3	-20	-3	21	14	-13	-4	-18	-20
Criteria 2	22	16	3	17	-21	11	23	26	-21	-2	1	-23
Criteria 3	-8	10	10	3	2	5	10	7	24	0	19	14
Criteria 4	-2	-12	-8	-9	-13	-7	-1	10	-2	-6	-7	-14
Criteria 5	-8	6	13	-3	-1	24	10	21	7	13	4	8
Criteria 6	-5	13	12	-10	-3	24	15	11	20	1	25	13
Total Scores	19	38	24	1	-56	54	78	89	15	2	24	-22
Weighted Criteria 1 (16.67%)	3.33	0.83	-1	0.5	-3.33	-0.50	3.5	2.33	-2.17	-0.67	-3	-3.33
Weighted Criteria 2 (16.67%)	3.67	2.67	0.5	2.83	-3.5	1.83	3.83	4.33	-3.5	-0.33	0.17	-3.83
Weighted Criteria 3 (16.67%)	-1.33	1.67	1.67	0.5	0.33	0.83	1.67	1.17	4	0	3.17	2.33
Weighted Criteria 4 (16.67%)	-0.33	-2	-1.33	-1.5	-2.17	-1.17	-0.17	1.67	-0.33	-1	-1.17	-2.33
Weighted Criteria 5 (16.67%)	-1.33	1	2.17	-0.5	-0.17	4	1.67	3.5	1.17	2.17	0.67	1.33
Weighted Criteria 6 (16.67%)	-0.83	2.17	2	-1.67	-0.5	4	2.5	1.83	3.33	0.17	4.17	2.17
Total Weighted Scores	**3.17**	**6.33**	**4**	**0.17**	**-9.33**	**9**	**13**	**14.83**	**2.5**	**0.33**	**4**	**-3.67**

Scenario 3 – Focus on Means

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Criteria 1	20	5	-6	3	-20	-3	21	14	-13	-4	-18	-20
Criteria 2	22	16	3	17	-21	11	23	26	-21	-2	1	-23
Criteria 3	-8	10	10	3	2	5	10	7	24	0	19	14
Criteria 4	-2	-12	-8	-9	-13	-7	-1	10	-2	-6	-7	-14
Criteria 5	-8	6	13	-3	-1	24	10	21	7	13	4	8
Criteria 6	-5	13	12	-10	-3	24	15	11	20	1	25	13
Total Scores	19	38	24	1	-56	54	78	89	15	2	24	-22
Weighted Criteria 1 (33.33%)	6.67	1.67	-2	1	-6.67	-1	7	4.67	-4.33	-1.33	-6	-6.67
Weighted Criteria 2 (33.33%)	7.33	5.33	1	5.67	-7	3.67	7.67	8.67	-7	-0.67	0.33	-7.67
Weighted Criteria 3 (0%)	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Criteria 4 (33.33%)	-0.67	-4	-2.67	-3	-4.33	-2.33	-0.33	3.33	-0.67	-2	-2.33	-4.67
Weighted Criteria 5 (0%)	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Criteria 6 (0%)	0	0	0	0	0	0	0	0	0	0	0	0
Total Weighted Scores	**13.33**	**3**	**-3.67**	**3.67**	**-18**	**0.33**	**14.33**	**16.67**	**-12**	**-4**	**-8**	**-19**

Scenario 4 – Focus on Ends

	Opt. 0	Opt. 1	Opt. 2	Opt. 3	Opt. 4	Opt. 5	Opt. 6	Opt. 7	Opt. 8	Opt. 9	Opt. 10	Opt. 11
Criteria 1	20	5	-6	3	-20	-3	21	14	-13	-4	-18	-20
Criteria 2	22	16	3	17	-21	11	23	26	-21	-2	1	-23
Criteria 3	-8	10	10	3	2	5	10	7	24	0	19	14
Criteria 4	-2	-12	-8	-9	-13	-7	-1	10	-2	-6	-7	-14
Criteria 5	-8	6	13	-3	-1	24	10	21	7	13	4	8
Criteria 6	-5	13	12	-10	-3	24	15	11	20	1	25	13
Total Scores	19	38	24	1	-56	54	78	89	15	2	24	-22
Weighted Criteria 1 (0.00%)	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Criteria 2 (0.00%)	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Criteria 3 (33.33%)	-2.67	3.33	3.33	1	0.67	1.67	3.33	2.33	8	0	6.33	4.67
Weighted Criteria 4 (0.00%)	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Criteria 5 (33.33%)	-2.67	2	4.33	-1	-0.33	8	3.33	7	2.33	4.33	1.33	2.67
Weighted Criteria 6 (33.33%)	-1.67	4.33	4	-3.33	-1	8	5	3.67	6.67	0.33	8.33	4.33
Total Weighted Scores	**-7**	**9.67**	**11.67**	**-3.33**	**-0.67**	**17.67**	**11.67**	**13**	**17**	**4.67**	**16**	**11.67**