POLICY INNOVATION IN THE HEAT TRANSITION

Assessing Policy Innovation in the Sustainable Heating Transition in the Dutch Built Environment

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By

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Executive Summary

This master's thesis explores the role of policy innovation of policies, programs, and policy instruments within the domain of heat transition in the built environment in the Netherlands, focusing specifically on the role of municipalities in navigating this complex transition towards a natural gas-free future by 2050, as mandated by the National Climate Agreement (2019).

Introduction

The research starts by outlining the ambitious goal of the Dutch government to significantly reduce CO2 emissions by 2050, emphasizing the critical target of reducing natural gas usage in the built environment in the Netherlands. The introduction highlights the urgent need for innovative policy approaches to accelerate the heat transition, especially in light of geopolitical factors such as the crisis in Ukraine, which underscore the urgency of energy independence.

Theory

Starting with a literature review regarding the different conceptual defnitions of (policy) innovation and the framework provided by Schaffrin et al. (2015), the study delves into the concept of policy innovation, exploring its significance in the context of the heat transition in the built environment. The research identifies the multifaceted nature of innovation, encompassing the novelty of policies, their adoption, and eventual impact. The theoretical foundation emphasizes the importance of analyzing policy output to gauge the extent of innovation within municipalities' strategies for the heat transition.

Methodology

An exploratory study design using qualitative research methods is outlined, focusing on a case study analysis of Transition Vision Heat (TVH) documents from ten of the most populous municipalities in the Netherlands. The research adapts and modifies Schaffrin et al.'s (2015) framework to assess policy output and innovation to fit the context of the heat transition in the built environment in the Netherlands, employing Atlas.ti software for document analysis. The methodology section discusses the selection criteria, data collection, and analysis processes, highlighting the study's systematic approach to evaluating policy documents.

Results

The results section presents a detailed analysis of policy output across eight categories, revealing a spectrum of innovation levels among the analyzed municipalities. Amsterdam is noted for its high scores in integration, target groups, and alternative technologies, showcasing a proactive approach to the heat transition. Furthermore, TVHs were scored using the modified framework of Schaffrin et al (2015). This research identifies significant differences in policy integration, stakeholder involvement, and the

specificity of alternative solutions across municipalities. Despite these differences, commonalities include a shared commitment to updating the TVH every five years and aiming for a gas-free environment by 2050.

Conclusion

The thesis concludes that while Dutch municipalities exhibit a range of innovative strategies in their approach to the heat transition, there is room for improvement, particularly in setting concrete targets and detailed implementation procedures. The study advocates for municipalities to take a more directive role in leading the heat transition, emphasizing the need for tailored and innovative solutions that reflect local contexts. The research suggests that a comprehensive, collaborative, and context-specific approach is essential for successfully navigating the complexities of the heat transition toward a sustainable, natural gas-free built environment in the Netherlands.

Discussion

The discussion emphasizes the scientific added value of adapting Schaffrin et al.'s (2015) framework to the context of the heat transition in the built environment, underlining the importance of scope on alternate technology solutions and the target groups involved. Limitations such as the subjective nature of measuring policy innovation and the representativeness of the sample size are acknowledged. The section also suggests the need for future research to include broader samples and expert validation to enhance the framework's reliability. Furthermore, the role of local initiatives and the inclusion of residents' opinions and viewpoints in TVHs are emphasized as crucial for developing tailored, context-specific policy solutions. The involvement of residents (e.g., in the form of communities) can contribute to a more appropriate approach that contributes to the advancement of the heat transition in the built environment in the Netherlands.

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With warm regards and best wishes,

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1. Introduction

To reach a climate-friendly energy system in the Netherlands, the government has set a goal that in 2050 as little as possible CO_2 will be emitted (RVO, 2018). This means that the total CO_2 emissions must be at least 80% lower than in 1990. One of the regulations to achieve this goal is to decrease the use of natural gas in the Netherlands (RVO, 2018). However, natural gas use in the Netherlands is exceptionally prominent, the gas is (among other things) used: to generate electricity, heat residences, and as raw material for the petrochemical industry (Hier, 2018). Moreover, the ongoing crisis in Ukraine has implications for the heat transition in the Netherlands. This crisis has resulted in geopolitical shifts, prompting a desire to reduce energy dependency (de Boer, 2022). Consequently, there is increased pressure to accelerate the heat transition, particularly for governmental agencies. Furthermore, the heat transition is accelerated as the Dutch Government strives to reduce dependence on Russian gas (Ministry of Economic Affairs and Climate, 2022).

The 2019 National Climate Agreement in the Netherlands focuses on reducing reliance on natural gas and lowering emissions from heating. It targets diverse heating sources, expanding natural gas applications, and involves various policies and programs. These include the National Program for insulation and heat pumps, gas-free neighborhood initiatives, and regional energy strategies. The approach integrates different government levels and organizations, promoting sustainable, low-emission heating solutions, with SDE++ subsidies as key financial instruments for supporting these sustainable projects.

Local government bodies, such as municipalities, play a significant role in this transition, both at the regional level through the Regional Energy Strategy and at the municipal level through the Transition Vision Heat (TVH) and the Neighborhood Implementation Plan (RVO, 2019). These policy frameworks establish goals and strategies to accelerate and achieve the heat transition. However, additional incentives are needed for homeowners and housing associations to move away from natural gas, which is why the district-oriented approach has been developed (National Climate Agreement, 2019). The National Climate Agreement (2019) sets out a framework of policies, measures, and targets aimed at achieving the Dutch climate goals, including reducing greenhouse gas emissions and transitioning to a sustainable and low-carbon economy. The agreement outlines specific sectoral plans and actions across various areas, such as energy, transportation, industry, and agriculture.

The National Climate Agreement's (2019) chapter on the heat transition focuses on sustainably transforming the Dutch built environment, targeting insulation and sustainable energy in over 7 million homes and 1 million buildings. It includes ending natural gas extraction in Groningen and engaging stakeholders in sustainability efforts. Municipalities are required to adopt the Heat Transition Vision by 2021, emphasizing a neighborhood-oriented approach and district-heating systems, supported by the Gas-Free Districts Innovation Program (Ministry of Domestic Affairs and Kingdom Relations, 2022; Natural Gas-Free Neighborhoods, n.d.). Furthermore, this chapter emphasizes that municipalities should take the lead in the heat transition in the built environment in order to steer the transition to success. Because this National Policy is established in the agreement, municipalities have an obligation to pursue this policy.

It can be argued that governmental bodies are actively exploring innovative approaches to achieve these objectives, evidenced by the fact that three-quarters of Dutch municipalities are actively seeking innovative solutions for the heat transition (Grid Management Netherlands, 2022). Further, a recent news article highlights the urgent requirement for improved policies and increased funding to achieve the fossil-free transformation of Dutch homes and buildings (Dijkstra, 2021). The article emphasizes that without such measures, the goal of transitioning to sustainable heating remains difficult to attain. The urge to develop and implement new ways to achieve certain goals relates to policy innovation. The term 'innovation' can encompass multiple aspects, including the novelty of emerging policies, their widespread adoption, and the impact they have (Jordan & Huitema, 2014). The inherently interdisciplinary nature and normative allure of innovation have led to a notable extent of conceptual ambiguity (Fagerberg, 2005).

The International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), and REN21 in 2020 have highlighted the critical need for supportive infrastructures like gas grids and district heating networks, combined with effective policies for deployment and integration enable the shift towards renewable energy for heating. REN21, standing for the Renewable Energy Policy Network for the 21st Century, is a worldwide network that brings together governments, research entities, industries, and communities. Its goal is to promote renewable energy growth and implementation through sharing policy insights and expertise. And so the link is made between the municipalities and the effective and innovative policies. Since municipalities are taking the governing role, as a means the policy the TVH should be drafted to guide the heat transition in the local context. In addition, municipalities are applying innovative solutions in that policy in order to make the transition successful.

Nevertheless, despite the growing emphasis on innovative policies to attain these goals, there remains a limited understanding of the true essence of policy innovation within the energy transition context. This research will examine the role of policy innovation, starting by defining it based upon relevant theory and also conduct an analysis of the extent to which policy documents are innovative in the context of the heat transition in the built environment in the Netherlands.

1.1 Problem definition

To understand exactly what policy innovation means, the problem definition will begin with a brief introduction about the growing need for "innovation," then this chapter will continue on the terminology of the concept of "policy innovation. It will then link to the energy transition, after which it will concretize to the heat transition (in the built environment). Ultimately, this leads to a brief overview of the current state and issues of policy innovation, and specifically in the heat transition. Following this survey, then, the main research question is introduced. The theory section discusses these topics in further detail.

In light of the inefficacy of traditional solutions, Head (2022) emphasizes the growing call for innovation to address social, economic, technological, and health challenges. The author emphasizes the need for better knowledge to foster and regulate new technologies. Specifically, Head examines recent design methodologies focusing on local contexts and discusses the benefits of social experimentation and collaborative design in addressing complex problems. In domestic policy, complex issues emerge due to entrenched inequalities and conflicting visions regarding societal welfare, economic sustenance, and environmental conservation. These challenges are complex and contentious to comprehend. Focused on policy, there's a growing consensus advocating for fresh perspectives and innovative policies to address these intricate issues.

As mentioned in the introduction, effective policy is essential in the transition to a natural gas-free system. Effective policy design is foundational to addressing specific problems through a deliberative process. This involves creating policies that are not only able to solve the intended problem but also adapt to changing conditions over time, thereby maintaining their effectiveness (Azad, Capano & Ramesh, 2019).

Innovative policies are needed to address various challenges, including technological integration, social acceptance, economic feasibility, and infrastructural changes. Municipalities within their local context, with their unique built environment and existing energy infrastructure, requires tailored policy approaches. Innovative policies can foster the adoption of renewable heating technologies, such as heat pumps, solar thermal systems, and district heating networks. Furthermore, policy innovation is essential to align different stakeholders' interests, manage the transition's socioeconomic impacts, and ensure a just and equitable shift towards sustainable heating solutions (World Bank, ESMAP, 2023).

While there is a growing need to apply policy innovation, its role in the heat transition is not always clear yet. For instance, the EBN (n.d.) report highlights the role of public-private partnerships and sustainable heating technologies such as geothermal energy but doesn't explore the innovative policy that support these efforts. Similarly, Deltares's 2023 report underlines the integration of sustainable heating systems from technical and social perspectives without examining the specific policies that enable or restrict this process. Furthermore, the discussion in Solarthermalworld (2020) about the challenges and regulatory aspects of district heating in the Netherlands raises questions about how innovative these regulatory frameworks are in adapting to new heating solutions and market dynamics. Additionally, de Bruin's thesis (2022) on renewable district heating's impact on the Dutch energy system underscores the uncertainty and regional implications of the heat transition but does not specifically address policy innovation driving this transition. This research will focus on the meaning and role of policy innovation in the heat transition and use this to analyze the extent of policy innovation in the context of heat transition in the built environment in the Netherlands.

1.2 Main Research Question

This research focuses on innovations within policies, programs, and policy instruments in the context of heat transition in the built environment in the Netherlands. The aim is to analyze the essence of innovation within this field and explore how this concept manifests in the outlined context. To achieve this, the following research question has been formulated:

"How innovative are policies, programs, and policy instruments in the domain of the heat transition in the built environment within the Netherlands?"

To facilitate a thorough exploration of the research question and to give the study a clear organizational structure, the following sub-research questions were devised and are outlined below.

1.2.1 Sub-Research Questions

1. What is policy innovation in the context of the heat transition in the built environment?

Given the often-praised perception of innovation, this study aims to provide a more objective and impartial portrayal of this conceptual term within this sector. Consequently, this research will contribute to a comprehensive understanding of the concept policy innovation in the context of the heat transition. Especially on the local level, since this research focusses on the TVH to asses policy innovation and how this innovation manifests in the difference between municipalities. The result of the research on policy innovation within the heat transition in the built environment provides an insight into the role of policy innovation in this sector. The research also reflects the progression of the heat transition within a context to be determined. The role of policy innovation is linked to the progress of the heat transition. What exactly this role entails is clarified in the analysis. Based on this context, this research aims to explore the role of policy innovation in the transition to sustainable heating in the built environment in the Netherlands.

2. How innovative is the policy output of Dutch municipalities in the context of the heat transition in the built environment?

To measure policy innovation and then answer the main research question, an adapted framework from (Schaffrin, Sewerin & Seubert, 2015). is used. This framework is generally used to measure policy effectiveness. In this context, policy effectiveness refers to the degree to which a policy achieves its intended goals and produces desired outcomes (Schaffrin et al., 2015). It is a measure of the impact and success of a policy in addressing the problem or issue it was designed to tackle. One of the indicators is policy output, this output is measured and analyzed using the adapted framework. On this basis, innovation is determined through the definition and theory regarding policy innovation.

3. What are the main differences between municipalities concerning the heat transition in the built environment in the Netherlands?

Finally, this sub-question has been drawn up to provide a comprehensive overview of the differences and similarities of municipalities in their policy approach that manifests itself in the TVH. In addition, this overview can provide a solid basis from which lessons can be learned and in which areas municipalities can learn from each other.

The first research question is answered in the theory section. The conceptualization serves as a guideline for answering sub questions two and three. Finally, the main research question is answered in the conclusion section.

Building on the suggestions of Jordan & Huitema (2014), and supported by their own findings, this study contributes to further defining and understanding the concept of policy innovation through a schematic approach. Through the utilization of the conceptual framework from Schaffrin et al. (2015), empirical knowledge is gained about the concept of policy innovation, specifically in the context of the heat transition in the built environment in the Netherlands.

1.3 Relevance to CoSEM program

This master thesis was conducted as a conclusion of the Complex Systems Engineering and Management program. This research addresses a complex socio-technical issue: the heat transition of the built environment. This problem involves technical aspects related to energy systems and building infrastructure, institutional frameworks, economic considerations, and social dynamics. By exploring the policy challenges and policy innovation within this context, the research aims to develop a comprehensive understanding of the multi-faceted aspects of the problem-related policy innovation within the heat transition of the built environment within the Netherlands. The heat transition in the built environment is a key energy challenge in the Netherlands, involving the shift from natural gas to sustainable and climate-neutral heat sources for building heating. Researching policy innovation in this context provides valuable insights into the effectiveness of policy measures and innovative approaches in accelerating the heat transition, fitting the topics within the Energy track of the master Complex Systems Engineering and Management.

1.4 Context of the Research

1.4.1 Heat transition

In the 2019 Climate Agreement, governments, market entities, and civil society organizations pledged to achieve a 49% reduction in CO_2 emissions compared to 1990 levels by the year 2030 (VNG, n.d.). In short, the heat transition involves switching homes and buildings in the Netherlands to an alternative to natural gas. As mentioned in the introduction, natural gas is a widely used means of heating buildings, but also for cooking. Alternatives to natural gas include geothermal energy, residual heat from industry, heat networks, or a heat pump.

1.4.2 Built environment

The Climate Agreement (2019) stipulates that by 2050, a total of 7 million homes and 1 million buildings should transition away from using natural gas. The homes and buildings fall together under "built environment”. However, the focus of this study will not be on the quantity of buildings, but rather on the policy innovations surrounding the transition. Specifically, the built environment is included in the case study, though, because policies are frequently drafted to bring heat transition into this. In addition, a clear distinction can be made between the large gas users in the industry compared to the many "individual" cases within the built environment.

1.4.3. Policies, programs, and policy instruments

To evaluate policy innovation within the heat transition, a distinction is made between policies, programs, and policy instruments. The three policy forms are arranged hierarchically.

Policy: A policy is a broad, overarching plan or course of action adopted by a government or organization to address a specific issue or achieve goals. Policies provide a framework for decision-making and often include statements of intent, objectives, principles, and guidelines. Policies are high-level and set the direction for action.

Program: A program is a more specific and detailed initiative that is designed to implement a policy. It is a way to operationalize the goals and objectives outlined in a policy. They can target a specific population, geographic area, or issue and involve a range of activities, services, or projects.

Policy Instruments: Policy instruments are the tools or means through which policies and programs are implemented. They are the specific methods employed to achieve policy objectives. Policy instruments can take various forms, such as regulations, laws, incentives, subsidies, taxes, grants, standards, guidelines, or information campaigns.

1.4.4. Transition Vision Heat

To comprehend the role of policy innovation in the context of the heat transition and to systematically conduct research within the designated timeframe, one specific type of policy is examined: Transition Vision Heat. Section 3.2.2 explains the rationale behind selecting this policy as the focal point.

The heat transition vision of municipalities can be considered a type of policy. The TVH is a strategic document that outlines a municipality's vision and ambitions for the transition to sustainable heating within the built environment. The TVH often includes various policy instruments and programs aimed at achieving specific goals related to the heat transition in the respective municipality.

The TVH encompasses general objectives, guidelines, and plans a municipality has to facilitate the transition to sustainable heating. The heat transition vision forms an integral part of the overarching policy the National Climate Agreement (2019), defining priorities and strategies to achieve the heat transition but in the local context. The TVH includes various policy instruments and programs employed to support the (shared) objectives of the heat transition. This integration of other policy instruments is also included in the analysis and is discussed later in this study. Within the heat transition vision, various policy instruments are utilized. These include regulatory measures like laws and regulations for sustainable heat sources, financial incentives, collaborations, or informational and awareness campaigns.

The heat transition vision also encompasses specific programs aimed at implementing certain measures or initiatives within the transition to sustainable heating in the built environment within the respective municipality. These could be programs for greening buildings, promoting heat pump installations, or developing heat networks.

2. Theory

In this theory section, the first sub-question is answered. This question is answered through a literature review. As described in the introduction, there is little understanding of the concept of policy innovation, specifically in the context of the heat transition. This section argues that policy innovation can be related to policy effectivity and policy output. Policy output relates to policy innovation in multiple ways, as it reflects the outcomes of the policy-making process and the effectiveness of the policies implemented.

2.1 Policy Innovation

Starting with Rogers' perspective on innovation, he defines it in 2003 as “an idea, practice or object that is perceived as new by an individual or other unit of adoption”. This definition underscores the perception of novelty as a central element of innovation. Rogers also notes that innovation is often associated with a strong positive connotation. This positive association frequently leads to the oversight of its fundamental objectives and potential consequences, or to the automatic presumption of their benefit. This viewpoint on innovation is crucial, especially when considering the interdisciplinary nature and normative appeal of the concept, as Fagerberg (2005) highlights.

Regarding policy governance, besides the addition of the essential capacities of setting priorities, allocating resources, and managing political conflict, the possession of an innovative ability is ideally fundamental for all political systems (Weaver and Rockman, 1993, p. 6). Ideally, a governmental body should possess the capacity to innovate to cope with climate challenges. However, this ideology has proven to be inadequate for the worldwide problem related to climate change, caused by the misconception that the UNFCCC will lead and steer innovative policies to cope with these problems (Jordan & Huitema, 2014). This misconception led to changing patterns and processes within climate policy governance. Furthermore, the newly created structures are often studied in an ad hoc manner, with inadequate studies into the general process and underlying patterns (Jordan & Huitema, 2014). The literature on policy innovation recognizes that the term 'policy innovation' is often used loosely, occasionally referring to simple policy changes (Black, Lodge & Thatcher, 2006). However, to broaden the knowledge of this new development in policy studies, Jordan & Huitema (2014) bundled shared knowledge and concepts in a theoretical and more systematic way with the introduction of Policy Innovation. According to Jordan & Huitema (2014), policy innovation refers to the development and adoption of new policies or elements within policies at the national and sub-national levels. It involves the creation of new policy options and their subsequent diffusion for political purposes. Furthermore, Jordan & Huitema (2014) argue that policy innovation is to be distinguished into three levels: the origin of novel policy (invention), the widespread adoption (diffusion), and the anticipated or actual impact of policy innovation (evaluation). Jordan & Huitema (2014) also argues that further research should enhance these concepts and suggest a systemic analysis of policy innovation that contributes to the further understanding of policy innovation, especially in climate policy. Additionally, as Jordan & Huitema (2014) point out, within the realms of innovation and public policy, there is a notable absence of a singular, universally acknowledged theory or definition for policy innovation. They further observe that the structures emerging from policy innovation are often analyzed in an ad hoc manner, with a lack of comprehensive studies into the general process and underlying patterns.

According to Howlett (2014), policy innovation is a policy dynamic that involves changes to existing policy practices by introducing non-status quo policy components or combinations of components, resulting in new outcomes. The authors argue that truly novel policy inventions are rare, and most policy change involves only marginal or incremental alterations of the status quo. This limited policy innovation is attributed to factors such as cognitive limits of policymakers, bounded rationality, processes of bargaining among competing interests, and structural factors like routinization or institutionalization.

Further, according to Schaffrin (2013), policy innovation is a crucial element in the literature on policy innovation and new governance. It is defined as a program or policy that is new to the states adopting it, regardless of how old the program may be or how many other states have adopted it. The author emphasizes the importance of considering policy portfolios as a basis for assessing the innovative character of policies, as innovations are seen as a substantial trigger of policy change. The author also highlights the need to understand policy change from a qualitative perspective, relative to the existing policy context. Further, policy innovation refers to the introduction of a new program or policy that is adopted by states, regardless of its age or the number of states that have already adopted it. It is a concept discussed in the literature on policy innovation and new governance, emphasizing the importance of considering the impact of single or selected groups of policy instruments on the entire policy portfolio in a specific policy field. Schaffrin (2013) argues that policy innovation is an essential element in triggering policy change and is distinct from policy inventions, which are not necessarily new to the adopting states. The innovative character of policies is assessed by considering the policy portfolios and the qualitative perspective of policy change in relation to the existing policy context.

Goyal, Taeihagh & Howlett (2022) define policy innovation according to the definition from Jordan & Huitema (2014): a multidimensional concept involving three perspectives: policy invention, policy diffusion, and policy success. Policy invention refers to radical changes in policy objectives or instruments leading to new policies, while policy diffusion denotes the spread of policies from one jurisdiction to another. Policy success recognizes the diverse outcomes of public policy and emphasizes the need for ex-post evaluation. These perspectives are useful for understanding the relationship between public policy and energy transitions and for creating knowledge on accelerating energy transitions. However, it is important to note that the use of the policy innovation lens does not replace other approaches to studying public policy in energy transitions but complements them. Policy change can be seen as a manifestation of policy innovation, as it involves the adoption of new policies or modifications to existing policies.

Due to the different conceptualization and definitions that can be found in the literature regarding the concept of policy innovation, this research starts by setting the scope and focus in order to give the research a clear framework by answering the first sub-question:

1. *What is policy innovation in the context of the heat transition in the built environment?*

Policy innovation encompasses the introduction of new policies or fresh elements within existing ones at different governmental levels. It involves developing, adopting, and spreading new policy options to address challenges or achieve political goals. It includes creating novel policies, their wide adoption, and assessing their impact. It often involves changes in policy components, leading to new outcomes. This innovation can affect various aspects of a policy and may be positive or negative. It drives policy change and is distinct from mere inventions, emphasizing the importance of considering policy portfolios and the context for change assessment. Overall, it's a multidimensional concept spanning invention, diffusion, and success perspectives, crucial for understanding and accelerating policy evolution particularly in energy and heat transitions.

In the field of policy innovation, there are varied perspectives on what constitutes innovation and how it should be measured. Jordan and Huitema (2014) emphasize three aspects: invention, diffusion, and the effects of policy changes. They focus on the entire lifecycle of a policy, from its creation to its implementation and the resultant impacts. This approach provides a comprehensive understanding of policy development and its broader implications.

Howlett (2014), on the other hand, defines innovation more narrowly as a major policy change. This perspective aligns more closely with the focus of this thesis. It suggests that innovation is not just about creating new policies but also about significant shifts or transformations in existing policies. However, Howlett’s approach typically concentrates on a single policy rather than considering a portfolio of policies. This narrower focus may overlook the complexities and interdependencies within a policy environment where multiple policies interact and influence each other.

In the context of policies, such as the transition vision heat, innovativeness could encompass a broader range of factors, including the number and variety of policy instruments employed. This idea aligns with the views of Knill et al. (2012), who suggest a more inclusive approach to evaluating policy innovation. They propose that innovation can be identified through the diversity and quantity of policy tools and measures within a policy portfolio.

However, there are limitations to Knill et al.’s (2012) approach. It can be challenging to quantify and compare the effectiveness of different policy instruments, especially when they vary widely in nature and scope. Additionally, focusing solely on the number and type of instruments might not adequately capture the true depth and impact of policy changes. Therefore, this research will focus on 1 type of policy: the TVH. This research brings a clear definition of policy innovation to light and tries to support it by examining a specific case: examining the role of policy innovation in heat transition in the built environment in the Netherlands. The theory section will now first further focus on the different concepts of policy change, policy output and policy effectiveness

2.2 Policy Change

Knill, Schulze, and Tosun's (2012) research illuminates a crucial aspect of policy innovation in environmental regulation by exploring the linkage between policy changes and their impacts on environmental quality. Knill et al. (2012) present an innovative perspective on the dynamics of policy changes and their outcomes. In their research, they empirically examine how changes in environmental policy outcomes are related to shifts in environmental impacts. The authors demonstrate the character of the connection between modifications in regulatory policy outputs and their corresponding impacts. Furthermore, the authors conceptualize the policy change in terms of density change and intensity change. Density change pertains to alterations in the level of regulatory penetration and internal differentiation within a policy field, whereas intensity change concerns adjustments in the stringency of policy instruments (Knill, Schulze and Tosun, 2012). Furthermore, an increase in regulatory density indicates expansion, while a decrease suggests dismantling. Similarly, an increase in intensity signifies expansion, and a decrease indicates dismantling. The focus of the article is on empirically testing the relationship between changes in environmental policy outputs and changes in environmental impacts. The authors present a novel approach to measuring events of regulatory output change and explore the extent to which changes in clean air regulations can account for changes in air pollutant emissions.

The findings of their research indicate that regulatory policy outputs have a significant negative effect overall on emission intensities, supporting the idea that higher levels of regulatory density and intensity are associated with lower levels of emission intensities. However, the coefficient for regulatory density does not reach typical levels of statistical significance in the case of CO2 emissions.

The study by Schaffrin, Sewerin & Seubert (2014) establishes the following link between policy output and policy innovation: "The new approach for measuring policy output and assessing policy innovations can serve as a blueprint for further analysis of the politics of policy change and the politics of policy innovation. We follow Walker's (1969, p. 881) definition of policy innovation as a program policy which is new to the states adopting it, no matter how old the program". Furthermore, the authors argue that the outlined approach and method should be applied to other climate-related policy fields. And so, this research from policy innovation within the heat transition contributes to that recommendation.

2.3 Policy Output

Building on the idea of measuring policy change based on policy density and policy intensity, Schaffrin et al. (2014) introduce a structural method to evaluate policy innovation. Their research examines whether innovations in climate change mitigation policies are symbolic or genuinely transformative within existing policy frameworks. They introduced the "Index of Climate Policy Activity " (CPAI) as a measurement tool to assess the impact of these innovations. The CPAI is used to assess the relative importance of policy innovations in complex policy portfolios. Their empirical analysis focuses on energy production policies in Austria, Germany, and the UK from 1998 to 2010. The findings indicate that while the fundamental policy goal remains stable, there are significant changes in policy settings and calibrations, suggesting that policy innovations have brought about substantial changes within these policy portfolios. The framework of Schaffrin et al. (2014) provides a comprehensive viewpoint that emphasizes various policy levels, the entirety of policy measures, and the evolving nature of policies over time. This novel approach for quantifying policy outcomes and evaluating policy advancements provides valuable direction for conducting additional examinations of policy modifications and inventive measures.

Furthermore, Schaffrin et al. (2014) investigated in their research on innovation within national policy portfolios. In their research, they were the first to identify that innovation within policy forms was often viewed by scholars and practitioners from the 'disruptive' lens. In addition, the authors suggest that actual policy innovation can be misled by 'cheap talk', a concept in which statements from politicians are regarded as innovative, while this need not be the case. Failing to assess policy innovations within the context of the wider policy portfolio, encompassing all policies within a specific domain, could potentially lead scholars and practitioners astray by creating an inflated or superficial perception of innovation (Tömmel and Verdun, 2009; Strebe and Widmer, 2012). To provide an objective view of this, Schaffrin et al. (2014) use the Index of Climate Policy Activity as a solid basis for measuring policy output.

Additionally, what has often been overlooked is the application of a comprehensive viewpoint that emphasizes varying policy levels, the entirety of policies in play (policy portfolio), and the evolving dynamics of policies over time (Schaffrin, Sewerin, Seubert, 2014). The accumulation of policy tools plays a pivotal role in policy advancement reinforces the argument in favor of examining policy collections rather than individual (kinds of) policy tools (Hacker, 2004; Pierson, 2004; Huitema and Meijerink, 2009; Tosun, 2013). As stated earlier, the TVH includes multiple policy instruments and programs and are also included in the data analysis, this is clarified in the methodology.

According to the authors, the concept of policy output refers to the actions taken by governments to change or maintain the legislative status quo. In the research from a year later, Schaffrin, Sewerin and Seubert (2015), the authors argue that policy output can be determined by six criteria. The six criteria include integration, scope, targets, budget, implementation, and monitoring. These six criteria are derived from the Index of Climate Policy Activity, which will be explained further later in this theory section. The underlying concept in establishing these six criteria is to assess whether the policy formulation process considers elements from every phase of the policy lifecycle, spanning from agenda-setting to implementation and monitoring (Schaffrin et al., 2015). By utilizing the framework of Schaffrin et al. (2015), light will be shed on the phenomenon of policy output. The framework allows for a comprehensive evaluation of policy portfolios and the impact of policy innovations on the existing policy landscape. The conceptual framework from Schaffrin et al. (2015) can be found in the Appendix (see Appendix 7.1). From that framework, the six criteria are now short explained according to the definition from Schaffrin et al. (2015): Integration pertains the extent to which different policy instruments are coordinated and interconnected to achieve common goals. Scope considers the number of target groups the policy framework addresses. Targets refer to the specific goals or aims that policy instruments aim to address. Budget examines the financial allocation to the policy framework and its expenditures compared to the Value Added Tax from a country. Implementation evaluates the engagement of implementation agencies and the presence of clearly defined rules and procedures. Monitoring assesses whether the policy framework incorporates an automatic monitoring process conducted by an independent institution. This approach from Schaffrin et al. (2015) ensures a comprehensive assessment of the policy framework's effectiveness, encompassing its integration, scope, targets, budget, implementation, and monitoring mechanisms. This framework provides a solid basis for measuring the effectiveness of and contribution to overall climate policy outcomes. In this research, this framework will be adapted for the context of heat transition in the built environment in the Netherlands to support answering the main and sub-research questions

Examining policy outcomes across diverse policies offers the opportunity to evaluate whether the climate policy aligns with the broader environmental policy style of the country or signifies a new approach in terms of instrumental logic (Schaffrin et al., 2014). Utilizing the framework from Schaffrin et al. (2015) as starting point, this research examines how and to what extent the TVH is innovative by measuring policy outcomes.

2.4 Index of Climate Policy Activity

Schaffrin et al. (2015) propose that policy innovativeness can be measured in terms of the Index of Climate Policy Activity (ICPA). This index considers various factors that contribute to a policy's innovativeness, such as the intensity and frequency of policy actions, the scope of the policy measures, and their integration into the broader policy framework. The ICPA provides a more comprehensive tool for assessing policy innovation, especially in complex and multi-faceted policy portfolios.

This approach is particularly suitable for this research. The Index of Climate Policy Activity allows for a detailed analysis of policy innovations, considering not just the presence of new or altered policy instruments, but also the intensity and scope of these changes within the broader policy context. By using the ICPA, this thesis can more accurately assess and compare the innovativeness of the transition vision heat document, taking into account the complexity and interrelated nature of policies associated with the heat transition. This approach provides a comprehensive and nuanced understanding of policy innovation, aligning well with the objectives of this research.

The Index of Climate Policy Activity is a measurement approach used to assess national policy output in the context of climate policy (Schaffrin et al., 2015). The index is used to assess and evaluate the level of activity and effectiveness of policies aimed at addressing climate change. As mentioned earlier, the index is derived from six intensity measures: targets, scope, integration, budget, implementation, and monitoring (see Appendix 7.1). These measures are used to score national policy instruments and calculate the Index of Climate Policy Activity. The index takes into account both the density (number of policy instruments) and intensity (content of policy instruments) of climate policy. To assess intensity, Schaffrin et al. (2015) employed a content-based coding process for each policy framework. Furthermore, the index provides a reliable and valid measurement for comparative analyses of policy output, allowing for the assessment of changes in policy portfolios over time and across different countries. The Index of Climate Policy Activity is applied in empirical studies to evaluate the effectiveness and performance of national climate policies, particularly in the energy production sector. The Index of Climate Policy Activity was empirically validated and found to be a reliable and valid measurement for national policy output (Schaffrin et al., 2015).

The measurement is based on a score by category. The resultant score of the policy, adjusted for weightings, serves as an indicator of the strength or severity of climate mitigation policy. When the scores (weighted values) of all policy instruments are aggregated on a country-by-country basis, it generates the Climate Policy Activity Index. This Index is considered valid and dependable, as tested with alternative measurement methodologies relying on expert assessments (Schaffrin et al., 2014). Furthermore, the index score is empirically validated through an application of the measurement approach to national climate policy instruments in Austria, Germany, and the United Kingdom, demonstrating its validity and reliability for that purpose. While the index score is normally applied to national policy instruments, the framework is adapted to the context of heat transition in existing housing in the Netherlands with the aim of comparing the policy outputs of municipalities in the Netherlands. Policy documents are not compared at the national level, but at the municipal level. This is a scope change of the framework; because the framework focuses on the differences rather than objective scores, this scope change is possible and appropriate for this study.

In this study, the index is also applied to the policy document the TVH. This allows the policy output of the TVH to be compared, and eventually policy innovation is evaluated based on this. Although this index is designed for climate change and the energy transition, the framework and the index will be adapted to the context of heat transition (in the built environment) in this research. The Index of Climate Policy Activity analyzes policy output to measure the effectiveness and intensity of policy measures.

Research will continue on the adaptation and application of the perspective and framework of Schaffrin et al. (2015), and how the Index of Climate Policy Activity is further utilized within this research. Furthermore, the research will continue with the stated definition of policy innovation of this chapter.

3. Methodology

3.1 Methodological Approach

This research constitutes an exploratory study aimed at creating insight in the role of policy innovation and manifestation of policy innovation within the heat transition in the built environment in the Netherlands. Employing a qualitative research approach, the study utilizes a case study methodology to evaluate relevant policies, national programs, and policy instruments associated within the heat transition in the built environment of the Netherlands with a specific focus on the TVH. To gain insights into the application of policy innovation in the heat transition of the built environment and its implications for further advancements, desk research will be conducted.

Within this study, the conceptual framework of Schaffrin et al. (2015) is adjusted for the context of the heat transition and utilized within this context. As described in the theoretical framework, through the lens of 6 categories, policy output can be evaluated. This method section describes how this framework can be applied to the context of heat transition in the built environment in the Netherlands. The unit of analysis in this research is the Transition Vision Heat document. The case study focuses on the municipalities with the highest population in the Netherlands, and a subset of these municipalities are selected. The rationale behind the chosen unit of analysis, the number of documents and selection of the case study is also explained in this methodology.

The entire research approach of this study is represented by a Research Flow Diagram (see Appendix 7.7). This diagram visually depicts the subsequential research steps and the main activities carried out within this research.

To measure policy innovation within policy documents involved in the heat transition in the built environment, a qualitative research method is used. Qualitative research methods are useful, for example, for discovering new topics and (the context of) understanding complex issues (Hennink, Hutter & Bailey, 2020). Furthermore, this research form provides an appropriate opportunity to identify the context, and allows for depth, detail, and nuance to research issues. This allows room to test existing theory against this new environment, and there is room within the context to make any adjustments to the conceptual framework. The research method used in the context of qualitative research is Deductive Content Analysis. A Deductive Content Analysis is a systematic method used to code and analyze textual data for the purpose of describing and interpreting it (Assarroudi et al., 2018). This approach includes Directed Content Analysis (DCA). DCA focuses on refining or extending theoretical frameworks or concepts (Assarroudi et al., 2018) and is further explained in this methodology section.

The findings from this study serve the primary objective of addressing the main research question: 'How innovative are policies, programs, and policy instruments in the domain of the heat transition in the built environment within the Netherlands?' By employing Schaffrin's (2015) existing theory, perspective and framework, potentially expanding categories through an inductive approach, this research seeks to provide comprehensive insights into the innovation of policies within the context of the Transition Vision Heat documents. Through this examination, the study aims to assess the extent of policy innovation embedded within policies, programs, and policy instruments relating to the heat transition, with the TVH as unit of analysis.

The validation and potential extension of Schaffrin's theory not only facilitates a structured analysis but also offers a nuanced understanding of the innovative elements present in the policies governing the heat transition. These insights contribute significantly to assessing the extent of policy innovation in policies and instruments specifically tailored for the built environment's heat transition in the Netherlands, thereby offering valuable perspectives for further advancements in sustainable energy policy.

3.2 Data Collection and Data Characteristics

3.2.1 Case Study

As mentioned in the introduction, the Netherlands has a high dependency on gas usage within the built environment. Furthermore, this nation is actively involved in the transition toward a gas-free built environment, as evidenced by numerous policy documents. Policy innovation is incorporated into policies, programs, and policy instruments in this domain. This study aims to evaluate how policy innovation is reflected in these documents, focusing on a specific policy: the Transition Vision Heat. This research involves exploratory research. In order to investigate the role of policy innovation within the context of the heat transition, a case study was conducted. The case study was focused on ten municipalities within the Netherlands. These municipalities have the similarity of being among the municipalities with the highest number of inhabitants per municipality in the Netherlands. This focus was selected to analyze the policy innovation within the heat transition in the policy documents and to facilitate comparison between municipalities. Choosing to study municipalities with a large population offers a unique lens into the complexities of implementing sustainable heating policies, specifically on the TVH. These municipalities, grappling with complex energy and sustainability challenges due to their dense populations, stand at the forefront of pioneering policy innovation. These municipalities not only have the potential to significantly influence broader environmental outcomes but also possess the necessary resources and infrastructure to test these potential innovative approaches. Moreover, the diversity within these municipalities provides a rich viewpoint for understanding how policies can be adapted to meet the needs of various demographic groups.. Analyzing the TVHs of 10 municipalities in the Netherlands, insight is created into how policy innovation manifests itself in the context of heat transition in the built environment in the Netherlands. The justification for this selection of the specific ten municipalities can be read in the further on.

3.2.2. Unit of Analysis

As delineated in the introduction, each municipality was mandated to finalize its TVH policy document by the end of 2021. According to the Climate Agreement of 2019, municipalities were given the role of directing the heat transition within the domain of the built environment on the local level. Because municipalities were responsible for the heat transition at the local level, this transition was also being worked on at the national level. At the municipal level, the Heat Transition Vision documents served as a guiding framework for municipalities to facilitate the heat transition process. This study focused on the policy document, Transition Vision Heat, as its primary unit of analysis. Through this research, the goal was to uncover the extent of policy innovation embedded within these TVHs, and with that discover the role of policy innovation within these respective municipalities.

The Gas-Free Neighborhoods Program (Gas Free Neighborhoods, n.d.) provided a means for municipalities to learn from each other. This program was part of the broader efforts of the Dutch government to accelerate the transition to sustainable heat and reduce greenhouse gas emissions. It focused on testing and implementing natural gas-free solutions in specific neighborhoods as pilot projects. The knowledge and experience gained from these initiatives were utilized to facilitate a widespread adoption of natural gas-free neighborhoods across the Netherlands. How municipalities were learning from this program was also referenced in the Transition Vision Heat documents. This policy document had a municipality-wide focus. While the Gas-Free Neighborhoods Program may be intriguing, it's worth clarifying that the focus this research is on the extent of policy innovation, thereby uncovering differences between municipalities and assessing the innovativeness of these policies within the context of the heat transition in the built environment.

This research seeks to research the innovative aspects of these policy documents, as well as how innovative strategies are implemented by municipalities. Variations in the approaches adopted by different municipalities offered valuable insights into the progress of the heat transition at the local level, providing a broader perspective on the transition as a whole.

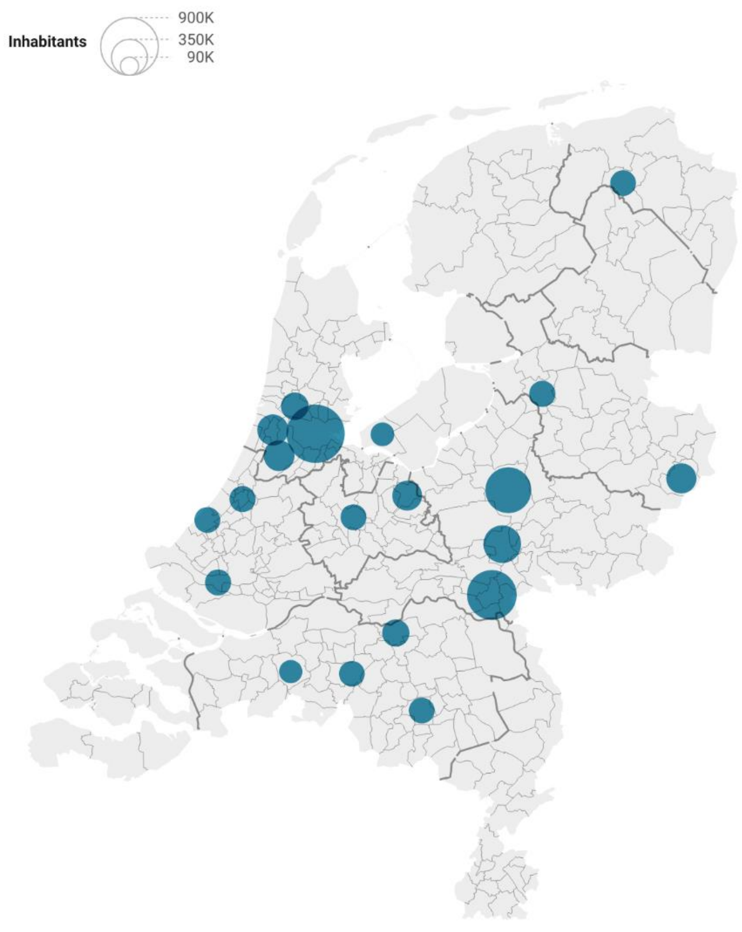
Given that the heat transition policy of each municipality was geared towards achieving gas-free housing, these documents typically shared fundamental components such as targets, costs, and technological solutions. By subjecting the TVHs to systematic analysis and treating them as policies as unit of analysis, the findings could provide valuable insights into the role of policy innovation within the context of the heat transition. The documents are analyzed based solely on the substantive text, without considering attachments and/or appendices. This decision is made to streamline the process and maintain consistency in data analysis. Furthermore, the sizes of attachments vary among municipalities in the sense that this variation did not accurately reflect the essence of the policy documents.

3.2.3 Justification

The Transition Vision Heats of the municipalities examined in this study were selected based on inhabitants per municipality. In addition to the arguments outlined in the case study section, in general, larger municipalities often have more data available, both in terms of policy documents and empirical data on the heat transition. This facilitates comprehensive research and analysis. In addition, the biggest challenge of the heat transition lies with large cities (Minnes, 2022). The diverse housing types and dense construction, among other things, increase the complexity of the transition. This makes for an interesting case within this research. In absolute terms, the 20 municipalities collectively represent approximately 30% of the total population in the Netherlands. Figure 1 visualizes the 20 municipalities with the largest population in the Netherlands.

Figure 1

Overview inhabitants in municipalities



Source: Centraal Bureau voor de Statistiek, 2023.

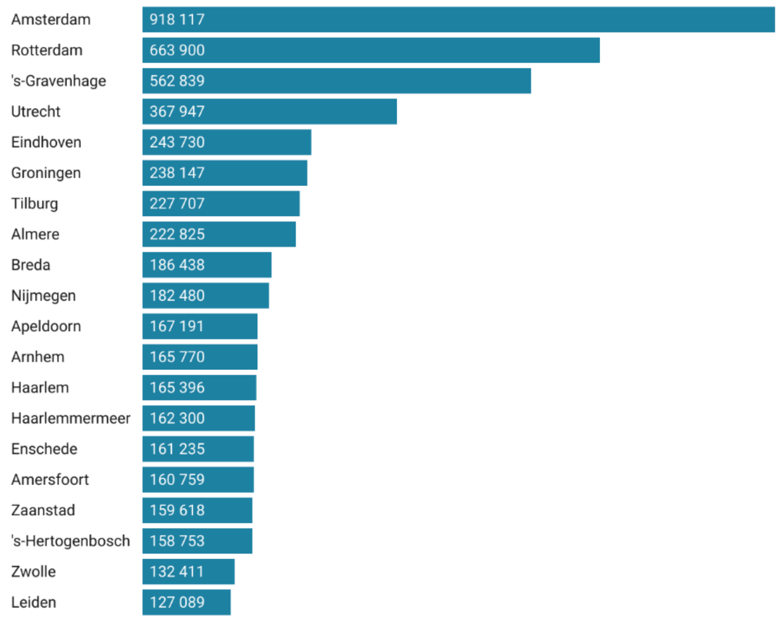
3.3 Inclusion- and Exclusion Criteria

The search for Transition Vision Heat documents was facilitated by a database consisting of all published Transition Vision Heat documents in the Netherlands. The National Local Heat Transition Program (NPLW, 2023) provided this database. The database was created as follows: "The TVH database was developed at the request of the Implementation Table Climate Agreement Built Environment in 2022. Several (professional) stakeholders and interested parties needed a central place with information about TVH's. With this information, they wanted to gain insight into municipal plans in preparation for their role and desirable support in the heat transition. The Expertise Center for Heat, PBL, 11 consulting and engineering firms, and students from Utrecht University collected the data. In 2023, RVO supplemented the TVH's database with newly identified TVH's. The database now contains information on 2,676 planning areas for 346 municipalities in the Netherlands. The database contains information on all available TVH's (until June 2023)."

Thus, the purpose of the database was to map all TVH's. Out of 352 municipalities in the Netherlands, 338 municipalities published a TVH. Through the database, 351 TVH's were accessible (n1 = 351). From this number of documents, a selection was finally made (n2 = 20). This selection was based on the inhabitants per municipality. A purposive sampling strategy is used for this research. Naturally, the 20 municipalities with the most residents are selected to be analyzed. The 20 municipalities with the highest number of inhabitants were initially selected. These municipalities and their respective number of inhabitants are depicted in Figure 2.

Figure 2

Inhabitants per municipality



Source: Centraal Bureau voor de Statistiek, 2023.

3.3.1 Finalized Case Selection and Selecting Sub-set

Within the scope of this research, a deliberate selection was made from among the top 20 most densely populated municipalities in the Netherlands, focusing on a subset of 10 municipalities. This choice was driven by time and resource constraints inherent to the research process. Concentrating on a limited number of municipalities allows for an in-depth analysis within the feasible scope of this project.

The selected municipalities - Amsterdam, Enschede, The Hague, Haarlem, Eindhoven, Tilburg, Breda, Zwolle, Leiden, and Apeldoorn - represent a diverse cross-section of urban environments within the Netherlands. This diversity facilitates the understanding of the broad spectrum of policy innovation strategies deployed in different urban settings.

Focusing on densely populated municipalities enables this research to gain insights into how policy innovation is tailored to meet the specific needs and challenges of high-density areas. The findings from these municipalities provide valuable perspectives on the varying methods and strategies employed to embed policy innovation in the context of the sustainable heating transition. However, it should be noted that while these municipalities are among the most densely populated, it is important to consider whether they form a representative sample. The selected municipalities might vary in regional characteristics, socio-economic status, and urban versus suburban dynamics, which potentially influence policy innovation. Therefore, the generalizability of the findings may be limited to urban environments with high population density and should not be generalized to less densely populated or rural municipalities.

This methodological approach underscores the importance of an in-depth analysis with a limited number of municipalities, as opposed to a broader but less detailed national overview within a limited time frame. Furthermore, this study focuses on the differences and similarities of the municipalities' policy documents. In addition, the (sub-)selection also fulfills the main purpose of this research: to provide insight into the role of policy innovation in the context outlined. This choice is a trade-off made in light of the practical constraints of the research and is intended to provide meaningful and detailed insights into the policy surrounding the heat transition within the available time and resources.

3.4 Directed Content Analysis

To analyze policy documents in a systematic manner, Directed Content Analysis was used. DCA is a methodological approach employed to systematically code and analyze textual data to describe and interpret it (Assarroudi et al., 2018). In this research, DCA is applied from this perspective to the conceptual framework of Schaffrin et al. (2014), in which there is room for further development as described by Assarroudi et al. (2018). Within this research, the 16-step method was also applied, and the step-by-step plan according to theory can be found in Appendix 7.2. Further application for each step is discussed later in the method section.

While inductive reasoning commenced by examining instances to construct a broader theory, deductive reasoning initiated with a widely accepted theory and explored its applicability to specific cases (van Staa & de Vries, 2014). Typically, a general theory might not have perfectly aligned with the data, and the empirical findings might have led to the emergence of more nuanced or refined theoretical concepts. Therefore, utilizing existing theory during the analysis necessitated a blend of both inductive and deductive approaches (van Staa & de Vries, 2014). This research on policy innovation within the heat transition applied Schaffrin et al.'s theoretical framework from 2015 as a starting point. The original theory utilized six categories to measure policy change, and it was expanded to include a total of 8 categories, where two categories are divided into two sub-categories. A combination of inductive and deductive methods was employed in this research.

While in inductive content analysis, theory was frequently only incorporated during the research discussion to aid in interpreting and comparing the results, DCA placed significant importance on theory during the initial establishment of code (rules). This aspect represented the deductive component of DCA, and the predefined code rules underwent further refinement throughout the coding process (van Staa & de Vries, 2014). Within this research, text passages that could not be directly assigned to the pre-defined codes were initially kept separate and later coded in an inductive manner. In this way, the interpretation of the results was strongly influenced by the existing theory: attention was focused on identifying similarities, refining the theory, or possibly rejecting certain aspects of it (Van Staa & de Vries, 2014). The methodological elaboration of this is described in section 3.4.1.

A significant benefit of employing DCA, as opposed to the typical use of inductive thematic analysis, was its explicit aim to advance theory development (Van Staa & de Vries, 2014). The conceptual framework introduced by Schaffrin et al. in 2015 served as the foundation for this study. This research applied the DCA method to further apply and develop the conceptual framework of Schaffrin et al. (2015) to climate policy accordingly. Specifically, the framework was applied to policy documents that aimed to guide the heat transition of the built environment at the municipal level: the heat transition vision. So, using DCA further tested the theory of Schaffrin et al. (2015) for its usefulness and validity. In addition, this framework and its deductive application ensured that policy output within Heat Transition Visions was evaluated. By combining both inductive coding and deductive coding, the data analysis was enhanced by drawing from existing knowledge of a phenomenon and simultaneously generating fresh insights into less familiar aspects. This approach led to a more comprehensive understanding of the data.

3.4.1 Step-by-step Approach

Building on the DCA approach of this methodology, this section will focus on the application of the DCA approach: the 16-step plan of Assarroudi et al. (2018). Through this roadmap, policy documents are analyzed structurally, where there is also room to apply additions to the theory used that underlies this methodology. The complete 16-step plan can be found in Appendix 7.2.

Preparation phase

1. Acquiring the necessary general skills

In this research, the skills needed are in line with Victor Vroom's expectancy theory. The primary categories associated with Victor Vroom's expectancy theory included 'expectancy,' 'instrumentality,' and 'valence.' According to this theory, 'expectancy' was defined as the perceived likelihood that efforts would result in favorable performance, 'instrumentality' represented the perceived likelihood that successful performance would lead to desired consequences, and 'valence' denoted the personal value assigned to these outcomes (Vroom, 1964, 2005). All these categories were taken into account when researching.

2. Selecting the appropriate sampling strategy

This study uses purposive sampling, this form of sampling is substantiated in section 3.3 Inclusion and Exclusion criteria and 3.2.3 Justification.

3. Deciding on the analysis of manifest and/or latent content

This study exclusively utilizes textual information, thus concentrating the data analysis solely on the content, specifically manifest content.

4. Developing and interview guide

Since desk research was utilized, no interviews were held within this study.

5. Conducting and transcribing interviews

Since desk research was utilized, no interviews were held within this study.

6. Specifying the unit of analysis

The unit of analysis is specified in section 3.2.2.

7. Immersion in data

The data analysis process begins with getting acquainted with the type of data and the unit of analysis. Additionally, two pre-testing documents from the Transition Vision Heat (TVH) database, specifically from the municipalities of Valkenburg and Harlingen, were analyzed for this purpose. These documents were selected entirely at random, aimed at familiarizing with the data analysis procedure. The analysis of these TVH's can be found in the attached Atlas.ti file.

Organization phase

8**. Developing a formative categorization matrix**.

From the theory, a formative framework comprising primary categories and their associated subcategories is derived deductively from established theory or prior research (Mayring, 2000, 2014). Furthermore, "The prominent feature of this formative matrix is the derivation of main categories from existing theory or previous research, along with the potential emergence of new main categories through the inductive approach (Elo and Kyngäs, 2008)". Within this research, the formative categorization matrix utilized within this research is mainly derived from the study of Schaffrin et al. (2014).

9. Theoretical definition of the main categories and subcategories.

Based on established theory or prior research, it's essential that the theoretical definitions of categories are precise and impartial (Mayring, 2000, 2014). For this study, definitions and delineations by category are shown in the formative categorization matrix (see Appendix 7.4).

10. Determination of the coding rules for main categories.

The rules for coding, serving as explanations of the characteristics of primary categories, are formulated using the theoretical definitions as a basis (Mayring, 2014). For example, the category 'Integration' can be defined as: Integration is evaluated if the policy is encompassed within a broader policy package and that incorporates framework policies (Schaffrin et al., 2015). These coding rules are labeled as: *Definition of the category for the context of the heat transition* and can be found for each category in Appendix 7.4.

11. The pre-testing of the categorization matrix.

As indicated earlier, the TVH documents of the Valkenburg and Harlingen municipalities were analyzed for the pre-testing phase. The pre-testing phase enhances the trustworthiness of the study.

12. Choosing and specifying the anchor samples for each main category.

An anchor sample refers to a clear and succinct illustration or representative example of a primary category, chosen from meaningful units (Mayring, 2014). An example of this is the anchor example for the Targets category: "In the period up to 2030, our ambition is to make 1,400 existing homes (20% of the total insulation task) natural gas-free”. All anchor samples are displayed within the relevant categories in Appendix 7.4.

13. Performing the main data analysis.

The main data procedure has been completed on the selected policy documents, constituting 10 units of analysis. The outcomes are presented in the results section.

14. The inductive abstraction of main categories from preliminary codes.

Initial codes are organized and classified based on their meanings, resemblances, and distinctions. The outcomes of this classification process are referred to as 'generic categories' (Elo and Kyngäs, 2008). These categories consist of the main categories (see Appendix 7.4).

15. The establishment of links between generic categories and main categories.

Continuously comparing the generic categories with the main categories leads to establishing a conceptual and rational connection between them. This process involves embedding generic categories within the pre-established main categories and forming new main categories (Zhang and Wildemuth, 2009). The constant comparison technique is consistently employed for data analysis throughout this research. As a result, new categories are imbedded in the adjusted framework: ‘Alternative Technologies’, ‘Target Groups’, ‘Targets by 2030’ and ‘Targets by 2030-2050.

Reporting phase

16. Reporting all steps of DCA and findings.

All research steps are represented through this comprehensive roadmap. The results section represents the output of the data analysis. In addition, the attached Excel-file provides a comprehensive view on the data and output and the Atlas.ti raw data file (utilized for coding) is also enclosed. Furthermore, the enclosed Excel-file also provides all results from the data analysis. This Excel file presents all scores of the municipalities, including a comprehensive results per municipality.

ATLAS.TI

Qualitative research is applied within this study, and data analysis is performed using Atlas.ti. ATLAS.ti is a robust software tool for qualitative data analysis that provides functionalities for organizing, coding, and analyzing various forms of data (Atlas.ti, n.d.). Adelowotan (2021) shows the utilization of ATLAS.ti facilitated a more efficient and comprehensive analysis, significantly reducing the time required compared to manual approaches. Moreover, it contributed to the production of more cohesive and consistent outcomes.

Preparations began with importing 12 policy documents (TVHs) into Atlas.ti. Two documents of these are part of the pre-testing. The documents were then analyzed textually, using the 16-step plan described above. In addition, a coding structure was established, which can be found in the formative categorization matrix in Appendix 7.4. This also contains anchor samples, which are examples for a main or sub-category. Additionally, a codebook has been created, which promotes consistency, this codebook can be found in Appendix 7.5. Using the codebook, coding paragraphs was made easier. Through the Text Search in Search & Code, it was faster to identify and code relevant paragraphs. When a paragraph contained a search term, it was analyzed whether the corresponding code was also applicable to this paragraph. Notable though is that not all code has a search term/tag due to the complexity of the code. Search results also displayed "inflected forms" of the search term(s). An example is the code 'Switch to electrical cooking', the search terms for this were Elektrisch AND koken. This brought up 26 search results of paragraphs in which these search terms were identified. After checking, it was assessed whether the paragraph could be related to the code. The code system has been revised regularly to incorporate new insights for the purpose of this study: exploring the role of policy innovation in the heat transition in the built environment in the Netherlands.

3.5 Data Analysis

This section explains how sub-questions two and three will be answered.

2. How innovative is the policy output of Dutch municipalities in the context of the heat transition in the built environment?

The data analysis commenced with the adaptation of the Comparative Measure of Climate Policy Output initially introduced by Schaffrin et al. (2015) to suit the specific context of the heat transition within the built environment in the Netherlands. This process and table are a result of the data analysis performed based on the DCA approach. The modified framework is available in Appendix 7.3, serving as the guiding tool for assessing policy output. This table is instrumental in evaluating the policy documents of the municipalities, and the outcomes are presented in the results section.

The identification of innovative elements was done using the formative categorization matrix (see Appendix 7.4). This matrix was created based on the framework of Schaffrin et al. (2015) and adapted to the context of this research: exploring the role of policy innovation in the heat transition in the built environment in the Netherlands. This matrix was created to perform the data analysis structurally. The matrix contains categories that give an indication about the innovativeness of a policy framework, underpinned by relevant theory. The matrix supports the deductive method of coding.

Based on these categories, the measurement table assesses and evaluates how policy innovation manifests itself in the TVH documents. Using the categories of the Index of Climate Policy Activity (from the framework of Schaffrin et al. 2014), the policy documents are analyzed and quantitatively scored.

The score of the Comparative Measure of CPO results in the understanding of policy output of the policy of the respective municipality. Policy output serves as an indicator of policy innovation, as it reflects the extent to which governments are actively implementing new policies or making changes to existing ones. In addition, policy output also provides an indication of policy effectiveness.

The theory of Index of Climate Policy Activity provides a measure of policy output in the context of climate policy. Within this study, the scoring method is adjusted to the context of the heat transition. Normally, this index is used to compare the policy portfolios of different countries and assess the level of policy innovation in addressing climate change. For this study, the Index is used to compare one kind of policy (TVH) of different municipalities to assess the extent of policy innovation in the specific context of the heat transition in the built environment in the Netherlands. A comparative analysis of policy output helps identifying patterns of policy innovation across different municipalities and TVH's. Although the framework of Schaffrin et al. (2015) was not designed directly for heat transition but for (energy) climate policy, the aspects of integration, targets, implementation, budget and monitoring are fundamental elements of policy analysis that are also relevant to heat transition. Furthermore, the use of an existing framework such as Schaffrin's (2015) facilitates comparison and differences between different policy initiatives. By using the adapted framework as an assessment framework, the heat transition visions of different municipalities can be analyzed and compared in a standardized way. Together with the scores of policy output and the stated definition of policy innovation, each category (and also the score of the 8 categories cumulatively) will be used to answer this sub-question.

3. What are the main differences between policies and Municipalities concerning Policy Innovation in the heat transition in the built environment in the Netherlands?

As indicated above, the differences (and similarities) of municipalities and their policy innovation are revealed. These differences and similarities are a result of the policy innovation assessment through the formative categorization matrix. The results section displays the quantified scores of the categories of the Index of Climate Policy Activity and visualizes the differences and similarities of the contextual factors identified through the analysis. In addition, this sub-question is answered in the results section, where a table provides insight into the main similarities and differences that emerged during the analysis of the TVHs.

3.6 Operationalization of the Research

The operationalization started with defining the clear measurable variables. In this study, these are the deductively drawn up categories based on the theory of Schaffrin et al. (2015). These 6 categories can be found in the Comparative Measure of Climate Policy Output in Appendix 7.3 and in the formative categorization matrix in Appendix 7.4. The categories are part of the theory Index of Climate Policy Activity. The category ‘scope’ is divided into two sub-categories: target groups and alternative technologies. Both are scored based on the maximum score achieved in order to better compare different outcomes. This division has been made because the original definition of scope can be applied to both the alternative technologies for natural gas and the target groups. During the coding process, these categories were drawn up inductively.

As outlined by the Dutch National Government, by 2050, nearly 7 million homes and 1 million other buildings will need to transition away from using natural gas (Rijksoverheid, 2017). Furthermore, as part of the National Climate Agreement (2019), the objective until 2030 is to make 1.5 million homes and buildings more sustainable (VNG, n.d.). For this reason, the category 'Targets' is divided into two sub-Scategories: Targets by 2030 and Targets by 2030-2050. Also, for these categories, during the coding process, these categories were drawn up inductively. A maximum score of 1 can be achieved in each of the sub-categories. Targets play a crucial role in shaping and guiding policy instruments, as they provide a clear direction and purpose for policy action.

3.6.1. Measurement of Policy Output

To measure policy output, formulas have been drawn up to determine the score. These are based on the framework of Schaffrin et al. (2015). Table 1 below shows the formulas used to determine the score of a category. The table shows the operationalization of the framework from Appendix 7.3. By normalizing the scores in each category to the highest score achieved, the study focuses on relative innovativeness within the selected sample rather than an absolute measure of innovativeness. This approach offers a comparative perspective but does have limitations in terms of providing a definitive measure of overall innovativeness. When categories such as 'scope' are scored based on the maximum score achieved by any municipality in the study, it allows for a direct comparison between municipalities on a relative scale. This means that a municipality's score in each category reflects how it performs in comparison to the best-performing municipality in that specific category. While this method is effective for understanding where each municipality stands in relation to others, it does not provide a pure objective measurement of policy innovation. However, the emphasis of the framework of Schaffrin et al. (2015) is on the differences in policy output, and the framework facilitates the comparison between the policy documents. The resulting scores from the Index of Climate Policy Activity measure the extent and intensity of a municipality's actions towards addressing the heat transition in the built environment. High scores indicate strong policy measures and active engagement in advancing in this transition and promoting sustainability and innovative solutions. Low scores suggest minimal activity or less aggressive policies. This index is utilized to assess and compare the efforts of different municipalities in the heat transition in the built environment. The results section delves further into the meaning of the scores. The input values for the formulas from table 1 are further explained in Appendix 7.3.

Table 1

Scoring (sub)categories

(Sub) Category	Scoring Formula	Range
Integration	Additive aggregation $$= \frac{Score\ of\ category}{Highest\ score\ achieved}$$	0-1
Scope: Target groups	Additive aggregation $$= \frac{Score\ of\ category}{Highest\ score\ achieved}$$	0-1
Scope: Alternative technologies	Additive aggregation $$= \frac{Score\ of\ category}{Highest\ score\ achieved}$$	0-1
Targets: Targets by 2030	$$= \frac{Intended\ CO2\ reduction}{Total\ CO2\ emmissions}$$ Or $$= \frac{Intended\ Heat\ Demand}{Total\ Heat\ Demand}$$ Or $$= \frac{Intended\ Number\ of\ Gas-Free\ Homes/Buildings}{Total\ Number\ of\ Homes/Buildings}$$	0-1
Targets: Targets by 2030-2050	$$= \frac{Intended\ CO2\ reduction}{Total\ CO2\ emmissions}$$ Or $$= \frac{Intended\ Number\ of\ Gas-Free\ Homes/Buildings}{Total\ Number\ of\ Homes/Buildings}$$ Or a statement on a natural gas-free/climate-neutral municipality by 2030-2050.	0-1
Budget	$$= \frac{Program\ expenditure\ of\ municipality\ 2022}{Total\ expenditures\ of\ municipality\ in\ 2022}$$	0-1
Implementation	Additive aggregation	0, 0.25, 0.5, 0.75, 1
Monitoring	Additive aggregation	0, 0.5, 1

Budget

Normally, the 'budget' category in the measurement of policy output is calculated by considering the set expenditures and impositions of the policy instrument, including both the financial resources invested and the financial burdens imposed on societal groups. The intensity of the 'budget' category is determined by the share of public expenditure or imposition for the policy instrument on total public expenditure for energy and fuels or direct public revenue from the revenues of the value-added tax, ranging from 0 to 1.

(Intended) financial expenditures associated with the heat transition in the built environment in the Netherlands cannot be found in the TVHs. According to Schaffrin et al. (2014), the allocation of resources to policy instruments is important for successful implementation, as more resources increase the likelihood of effective policy implementation. Although the (financial) resource allocation is not yet directly included in the current TVHs, the allocation is an important aspect for an effective policy. Decisions on financial investments or impositions contribute to the overall activity and impact of the policy instrument. Within this research, a different way of understanding the budget category was used.

Program expenditures and total expenditures

In order to still make a relevant statement about the scoring of this category, the formula for calculating the score has been modified. The new formula (see Table 1) scores this category based on a program's expenditures divided by the municipality's total expenditures in the year 2022. The numerator consists of the expenditures of a program (program expenditure*)*. By this is meant that the expenditures that are captivated by the heat transition are included in a "program" of the municipalities. ‘Total expenditures‘ refers to the total expenditure that the municipality has outsourced in the year 2022. The municipalities' expenditures are public, and the statements of income and expenses are accessible to everyone. Appendix 7.6 provides an overview that includes source citations.

An example of a ‘program expenditure’ is the program expenditure of the municipality of The Hague. The municipality's total expenditure for the year 2022 is 3,288 million euros. Of this, 130.9 million euros was spent on the program "Sustainability, Environment and Energy Transition (Municipality of The Hague, 2022). In this program, the ambition has been expressed to be a climate-neutral municipality by 2030. Although this ambition is promising, the Municipality of The Hague has set other concrete goals in the heat transition vision which show that this ambition is not (yet) achievable by 2030. "We are aiming for a climate-neutral city in 2030. It is feasible in large parts of the city to connect buildings to sustainable sources for heating or have made the decisions to do so. In other parts of the city, a hybrid heat pump is now a good option. With this, a large CO2 reduction possible by 2030" (Municipality of The Hague, 2022). Later in this policy document, it appears that the municipality does not have a 2030 plan for every neighborhood in The Hague to get rid of gas.

Regardless of this conflicting ambition of the Municipality of The Hague, the following points, among others, are included from the program "Sustainability, Environment and Energy Transition" (Municipality of The Hague, 2023):

- "The Transition Vision Heat has been adjusted in response to motions, information and discussion meetings and views";

- "In 2022, 4,434 transition-ready homes were added. The total number of transition-ready homes in The Hague as of 2023 is 124,362";

- Also in 2022, subsidies (including green roof, cooking and heating on clean energy, and facade insulation and solar panels) in the context of sustainability and energy transition were granted to citizens and businesses."

When statements could be found about the heat transition in a particular spending program, this program was included in the calculation. In no statement of income and expenses were expenses involved in the heat transition found in more than one program.

3.6.2 Validity & Reliability

Directed Content Analysis

According to van Staa & de Vries (2014), too narrow a theoretical focus can arise during the deductive content analysis. This can cause a researcher to be blind to new insights. In order not to keep the theoretical focus too narrow, there is room in the data analysis process for inductive categories. This resulted in the identification of two additional categories. Furthermore, the deductive approach that is employed might impact internal validity by introducing a 'positive bias' (van Staa & de Vries, 2014). This can occur as the emphasis on a specific theoretical framework might incline you to discover elements that confirm the theory rather than those that challenge it. However, the concrete and structured data analysis approach has tried to minimize this possibility. This has also been translated into the minimum score of some deductive categories, the results section describes this further. Hsieh and Shannon (2005) suggest researchers engage in prior critical reflection on the theory's relevance to the analysis. This reflection is embedded in the discussion.

Comparative Measure of Climate Policy Output

Internal validity

Though the comparative measurement framework (see Appendix 7.3) draws from Schaffrin et al.'s theory (2014), it has been tailored to fit the specific context of the heat transition in the Dutch built environment. While the scores are derived using a comprehensive measurement tool, they serve as indicators. These scores offer insights into the policy output of municipalities in the Netherlands across different categories. Subsequently, conclusions are drawn in a narrative fashion based on this analysis.

It was not decided to conduct additional expert interviews for this study. This research has a limited focus with which the aim is to assess how policy innovative the TVHs are within the set context. This was done using an adapted framework from Schaffrin et al. (2014), although the validity can be tested, the research provides a solid basis for further research. In addition, time constraints meant that the choice was made to disregard the interviews.

External validity

This research provides insight into the role of policy innovation in the heat transition in the built environment in the Netherlands. In addition, this research also contributes to the conceptual differentiation regarding the term "policy innovation". Indeed, the theory section has already defined the concept of policy innovation. The analysis was then based on this by means of a case study. Based on the theoretical definition, the main research question was also answered. The main research question creates insight into policy innovation in the context outlined. This gained knowledge can be derived from the case on policy innovation within the heat transition in the built environment, and empirical knowledge can also be derived from the application of the definition of policy innovation in this context. The adapted framework (see Appendix 7.3) can be applied to other policies and policy instruments, provided they are in the same domain (the heat transition) in order to increase external validity when this framework is applied to multiple cases.

Reliability

The degree of reliability was kept as high as possible by applying qualitative analysis in a structural manner. For this purpose, the comprehensive 16-step plan was followed. In addition, the codebook (see Appendix 7.5) ensures a high degree of consistency during the coding phase. As for the scoring process using the Comparative Measure of Climate Policy Output table (see Appendix 7.3), the method of scoring is also explained in detail in the methodology section. Although some categories (such as Implementation and Monitoring) are inherently associated with another researcher's subjectivity, the framework provides a guideline for scoring these categories. While acknowledging the potential influence of researcher subjectivity, efforts were made to mitigate bias through predefined guidelines and a structured scoring system.

Sensitivity

The sensitivity of the research methodology of scoring through the Comparative Measurement of Climate Policy Output (see Appendix 7.3) underscores its resilience to variations and adaptability to diverse contexts. For example, the category "Integration" and subcategories "Target groups" and "Alternative technologies" are adjusted according to the maximum attainable score, allowing the researcher to emphasize the different policy outputs. As a result, the focus is not on a set maximum level of policy output, but rather on similarities and differences.

The comparative measurement methodology is adapted from the energy transition context to the heat transition context. This has increased the degree of its adaptability. And allows researchers to apply the methodology to other domains in climate policy. The extrapolation to broader policy domains maintains reliability and consistency by applying a structured analytical approach, such as establishing a clear measurement table (see Appendix 7.3) and preparing a codebook (see Appendix 7.5) and following the 16-step plan as established in the methodology section (see Appendix 7.2). In addition, the attached Excel file displays the scoring tables of policy outputs by municipality, making the study transparent and increasing repeatability.

4. Results

The results section displays the results of the data analysis. Through these outcomes, sub-questions 2 and 3 are answered. The results of the operationalization of the Comparative Measure of Climate Policy Output by municipality are presented in the attached Excel file.

4.1 Policy Output

The attached Excel file displays the scoring table for each municipality. These tabulations show how each municipality scores on 7 categories. The category 'Budget' is scored based on municipal expenditures, the scoring table of which can be found in Appendix 7.6.

4.1.1 Overall Score

Table 2 presents the results obtained from scoring with the Comparative Measure of Climate Policy Output (see Appendix 7.3). Each Intensity Measure Indicator was computed utilizing the operationalization matrix in Appendix 7.3. The categories 'Scope' and 'Targets' consist of two subcategories, each providing more detailed insights derived from the results.

Table 2

Results of Analysis

Municipality	Integration	Scope: Targetgrou	Scope: Alternative technology	Targets: 2030	Targets: 2030-205	Budget	Implementation	Monitorin
Amsterdam	0.95	0.98	0.975	0.55	1	0.06	0	0.5
's-Gravenhage	0.875	0.42	0.845	0.81	0.68	0.04	0.5	0.5
Apeldoorn	0.525	0.77	0.975	0.28	1.00	0.07	0.25	0.5
Enschede	0.925	0.56	0.845	0.20	1.00	0.25	0	0.5
Haarlem	0.725	0.78	0.78	0.14	1.00	0.07	0	0.5
Zwolle	0.55	0.77	0.65	0.00	1.00	0.20	0.25	0.5
Breda	0.65	0.56	0.845	0.13	1.00	0.07	0	0.5
Tilburg	0.4	0.59	0.455	0.45	1.00	0.12	0	0.5
Eindhoven	0.5	0.14	0.91	0.13	1.00	0.08	0.25	0.5
Leiden	0.375	0.63	0.52	0.00	0.40	0.06	0.25	0.5

The 8 indicators were aggregated, resulting in an overall score representing the policy output. These scores are shown in Table 3. The scores show the policy outputs (based on policy intensity) for the municipalities within this study. The scores show how effective the TVHs are that the municipalities have drafted. These scores are used to compare the policy documents and ultimately assess the policy innovation by answering the main research question and sub-questions. It is evident that the municipality of Amsterdam attained the highest score of 5.01, whereas the municipality of Leiden achieved the lowest score of 2.47, respectively.

Table 3

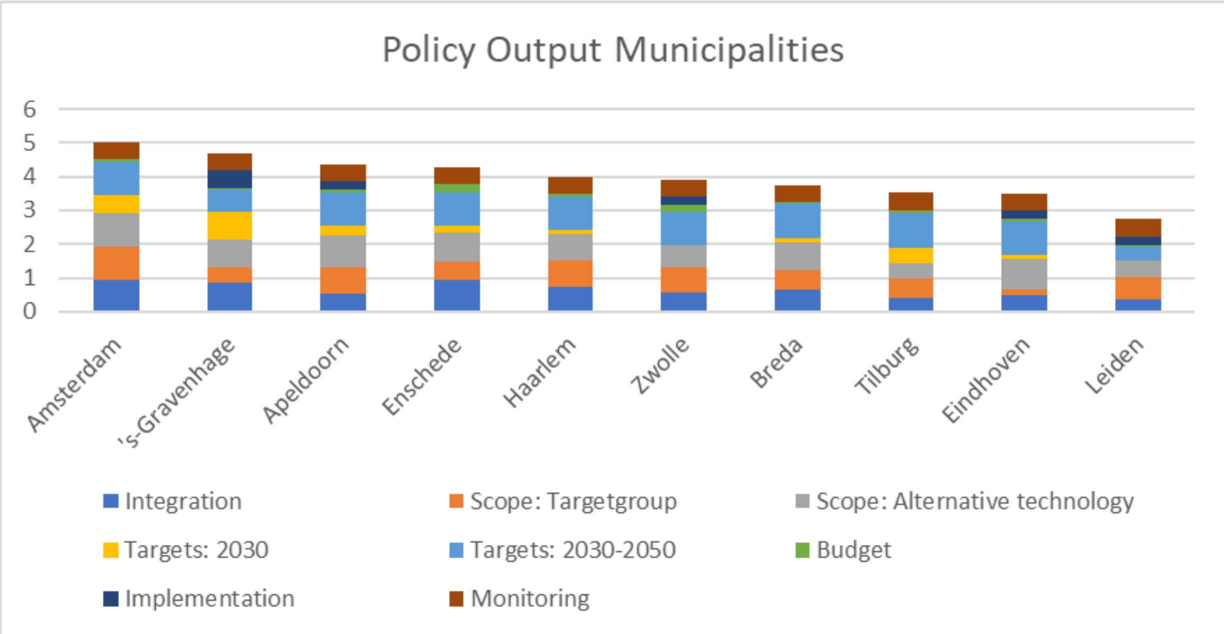
Total policy output of municipalities

Municipality	Total Policy Output
Amsterdam	5.01
's-Gravenhage	4.67
Apeldoorn	4.37
Enschede	4.28
Haarlem	3.99
Zwolle	3.92
Breda	3.75
Tilburg	3.51
Eindhoven	3.50
Leiden	2.74

Figure 3 illustrates, for each municipality, the cumulative scores of the 8 indicators and the resulting overall score representing policy output.

Figure 3

Policy output of municipalities per category



Highest values

The highest score obtained from the categories 'Integration', 'Scope: Target groups' and 'Scope: Alternative technologies' does not reach 1. Table 1 in the methodology suggests that through additive aggregation a maximum score of 1 can be obtained. This score is determined by dividing the score of the (sub) category by the highest score obtained. This is because the score is rounded per measurable unit. An example: the municipality of Amsterdam names and lists 29 different policies/policy instruments. This is the highest number listed within the 10 TVHs. 1 of these is the National Climate Agreement, this is scored at 0.25 points. The remaining 27 together achieve a total of 0.75 points (1 - 0.25). This amounts to a score of 0.02678 (0.75 / 28) for each policy (instrument). The score has been rounded to 0.025 point per policy(instrument) in order to score the other TVHs in a uniform manner and to keep consistency high within the data analysis. In addition, practicality is higher with scoring using a rounded score than a score with multiple decimals.

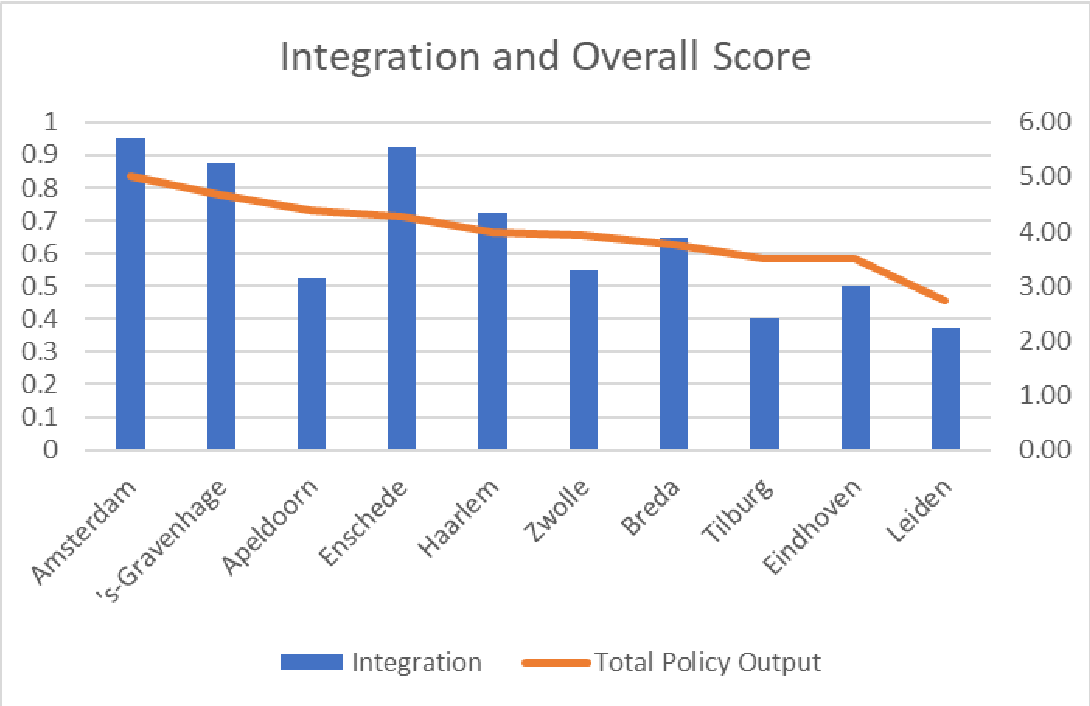
4.1.2 Integration

Policy integration involves the intentional effort to create new designs of policy packages (a collection or set of interrelated policies, measures, or actions designed and implemented to address specific issues or achieve particular objectives) to optimize effectiveness and avoid conflicting actions. It aligns various policy tools within a coherent framework to achieve goals efficiently. In this case, the goals set for 2030 and 2030-2050. These include the common goal of achieving a natural gas-free built environment in the municipality. Integration of policies encourages collaboration and synergy among diverse actors, fostering holistic solutions to complex problems. In addition, integration attracts attention, leading to better evaluation of the policy's outcomes.

In the context of a Heat Transition Vision, the degree of integration among various policies, policy instruments, and programs can potentially play a significant role in policy innovation. Mentioning and coordinating these different aspects may contribute to a more cohesive and potentially more effective policy framework. While the direct link between integration and the overall effectiveness of policy output is complex and dependent on many factors, it is assumed that well-integrated policy may increase the likelihood of successful implementation and realization of policy objectives. Municipalities often support stakeholders through policy tools like subsidies, contributing to a higher effectiveness score in achieving the objectives of the Heat Transition Vision. Figure 4 shows the score on integration and the overall score of the municipalities, respectively.

Figure 4

Integration and overall score



Framework Policy in the TVH

The National Climate Agreement (2019) could be regarded as a comprehensive and overarching framework policy within the context of the heat transition. The Agreement establishes the broad goals, principles, and guidelines that shape the direction of climate policy at the national level. This policy serves as a foundational document, outlining the country's commitments, targets, and strategies to address climate change. Framework policies like the National Climate Agreement set the stage for the development and implementation of more specific policies and measures. They provide the overall framework that guides the creation of detailed strategies and actions necessary to achieve the outlined goals. Each of the 10 municipalities mentions the National Climate Agreement, and also indicates that the Transition Vision was drafted from the guiding principles within this Agreement.

"You have before you the Heat Transition Vision. In this vision we indicate how we want to meet the agreement in the Climate Accord to make Enschede natural gas-free by 2050. A task that, if we approach it smartly, is not wishful thinking, but certainly achievable" (Municipality of Enschede, 2021).

As can be seen from the quote above, the municipality of Enschede states here that the goals from the Climate Agreement are guiding the preparation of the Heat Transition Vision. It is characteristic that each municipality relies on the fact that the Heat Transition Vision is an elaboration of the goals set within the Dutch Climate Agreement.

The implementation plan described in the various TVHs does not count toward this category's score. Although an implementation plan is closely related to policy, it serves as a detailed action plan to achieve the goals of the policy.

4.1.3 Scope

Policy documents map target groups and target technologies. It indicates which policy areas or domains a policy instrument targets and whether it takes a comprehensive or limited approach to a particular issue. The targeted actors and technologies are a determinant of the overall score, as is shown in figure X5.

Within the Index of Climate Policy Activity, the scope is calculated as 1 digit (0-1), in this study this category is specifically divided into two sub-categories: Target Groups and Alternative Technologies. Although the two-subcategory scores do not exceed the maximum score of 1, the two are analyzed separately.

A broader scope can facilitate policy innovation by considering multiple dimensions and stakeholders, allowing for a more comprehensive and holistic approach to addressing complex problems. It also enables policymakers to take into account the diverse needs and interests of different sectors and actors, leading to more inclusive and effective policy outcomes. According to Schaffrin et al. (2015), the scope of a policy instrument also determines the allocation of resources or economic burdens and can lead to intense political activity, bargaining and lobbying among the actors involved. Further, a policy instrument with an ambitious scope can significantly influence the behavior of actors.

Target Groups

The following target groups have been identified and scored within the Heat Transition Vision:

Table 4

Scoring list target groups

Residents	Grid operator	Commerical heating company	Local government	Energy cooporation	(Social) Housing Associations	Social Enterprise/ Non-profit	Businesses	Knowledge institutions	VVE
Tenants/individuals, resident initiatives, neighborhood associations, entrepreneures (associations), building owners, resident initiatives.	The grid operator in the region. Grid operators in the Netherlands: Liander, Enexis, Stedin, Rendo, Coteq, GasUnie.	Commercial heat companies in the Netherlands: Eneco, Ennatuurlijk, Vattenfall,	Local public agencies. An example of local public bodies: local city council,	An example of energy corporations are: Energy Together, Neighborhood Power and Here Generated	Examples of social housing corporations are: Mitros, Vestia and Ymere.	Social entrepreneurs can also be included as a target group. These include drinking water companies or Rental Interest Organizations, for example.	Business areas	University's/ College's	

A score is awarded for each target group mentioned, which also means that points are awarded for each specific mentioning is of a (Social) Housing Associations. The resulting score is shown visually in Figure 5.

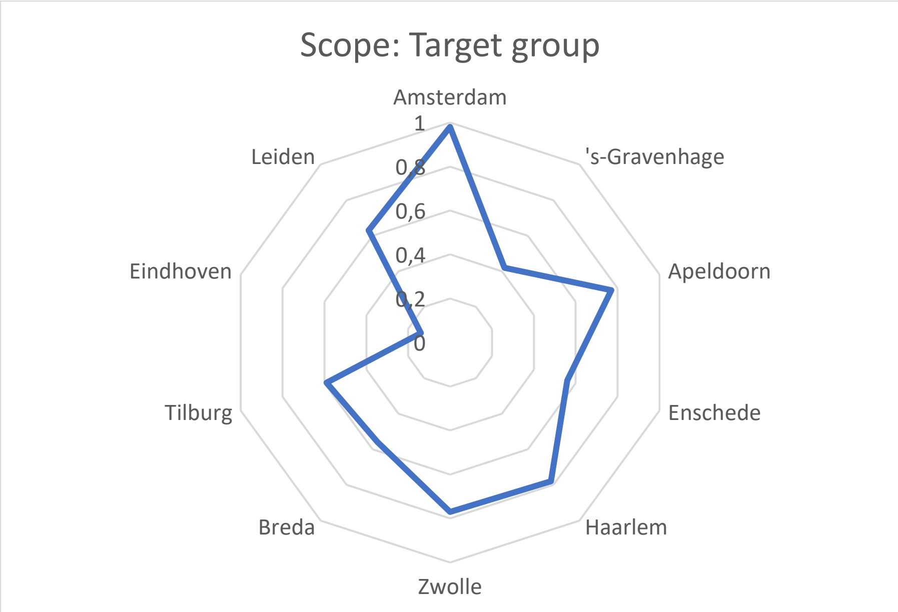
Table 4 shows the different types of target groups. The score is bordering on the designation per actor. This means that multiple points are awarded when multiple (social) housing associations are mentioned. The reasoning behind this is that the identification of multiple actors leads to a broadening of the scope 'Target Groups'. For instance, the municipality of Zwolle (2020) focuses the policy regarding heat transition within the built environment on three actors within the (social) housing associations: deltaWonen, Openbaar Belang and SWZ. As a result, the municipality scores 0.21 points (3 x 0.07) for the focus on these three actors within the (social) housing associations. Although the size of the municipality may affect the number of actors in a subgroup, this study focuses on the designation of the specific actor. The delineation was made here because the direct naming of a specific actor provides more clarity and a higher degree of reliability than if only a type of target group is named. In addition, a more specific naming can show that the municipality has a good view on the actors involved who thus become involved in the TVH.

Through the TVH the Amsterdam municipality focuses on all equal stakeholders (see table 4), for this the municipality gets the highest score achievable of 1. The municipality involves all stakeholders within the scope of this research. The high score also implies a larger scope than a lower score. A larger scope encourages collaboration between different sectors, organizations and stakeholders. This broader focus then focuses on the essential collaborations between (social) housing associations, grid operators, resident initiatives, commercial heating companies and local governments, among others. This increases the option for knowledge sharing which can lead to the further advancement of the heat transition in the built environment.

In addition, a broader scope helps to adopt a holistic approach to complex problems. This results in policymakers being able to consider different aspects of an issue, enabling innovative and comprehensive solutions. A broader scope reflects itself by scoring higher on the "Target Groups" and "Alternative Technologies" categories.

Figure 5

Points on category 'Target group'



Although the government is an important actor in the heat transition in existing housing in the Netherlands, this actor has been omitted as a target group in the Scope category. This is because the heat transition does not specifically address this actor. In addition, the policy document is a direct result of the National Climate Agreement (2019), which was released on behalf of the Dutch government itself. The transition is driven by the government, and according to the National Climate Agreement (2019), the municipality should take the lead in it. However, support from the government is essential to bring about the transition; municipalities still face too many structural uncertainties. For example:

"Switching to another form of heat will only be a success if it is feasible and affordable for residents to make their homes more sustainable. Furthermore, municipalities must be enabled to carry out the extra tasks that are coming their way. For this they need sufficient resources, extra capacity and the right powers. The government will have to accommodate municipalities in this respect" (Municipality of Leiden, 2022).

Alternative Technologies

When a municipality lists potential alternatives for heating with natural gas, the scope of the policy document is expanded. Table 5 provides all possible alternative technologies; the maximum number of technologies is based on the identification of the alternatives offered during the encoding process. A score of 1 means that a municipality names all the alternatives offered in the TVH. In this case, this score was assigned to the municipality of Amsterdam and the municipality of Apeldoorn. Providing more alternative solutions prompts policymakers to broaden the scope of policy instruments to cover a wider range of sectors and activities. This expansion can lead to the development of innovative policies that address previously overlooked areas of emissions. For instance, the municipality of The Hague scores relatively high on this subcategory, thus providing a high number of potential alternatives for heating with natural gas in the built environment:

"Heat pumps are a good choice in neighborhoods where the insulation and heating system can relatively easily be made suitable for a heat pump for one or more buildings. This is especially true in "blue" neighborhoods. See the map on page 3 for this.

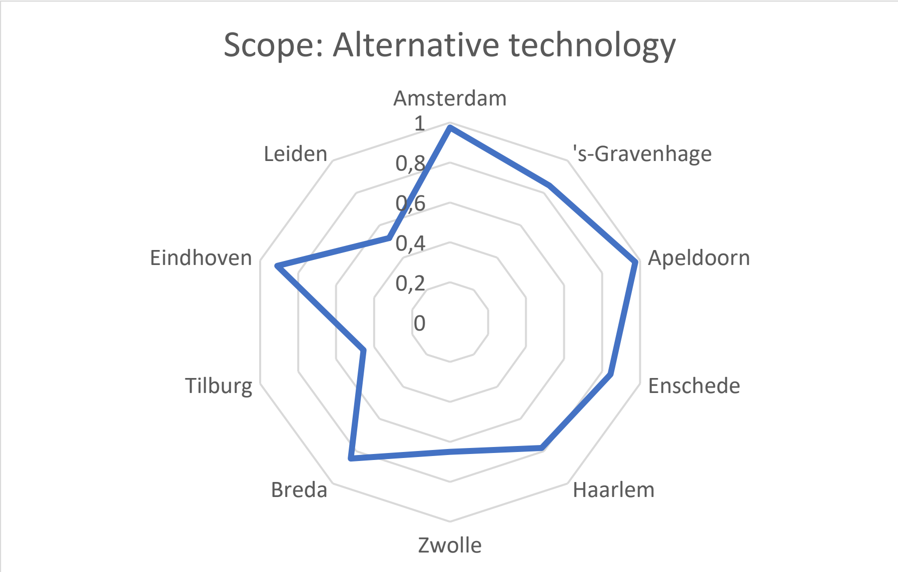
Heat networks are a good choice in neighborhoods where we can use local sustainable sources or where there is already a heat network. Sources for The Hague are heat from the deep underground (geothermal energy), heat and cold storage (WKO) in the shallow subsurface, heat from the immediate surroundings such as water (aquathermy), air and sun or residual heat from the region. This applies particularly to the "green" neighborhood" (Municipality of The Hague, 2022).

Table 5

Heat network	*All-electric*	*Bronnet*	*Surface water*	*Ground energy*
Hydrogen	*Residual heat*	*Heat pump (not specified)*	*Infrared panels*	*Geothermal energy*
Biomass	*Sewer heating*	*Hybrid*	*Sustainable gas*	*Solar thermal*
Aquathermy				

Figure 6

Points on category: 'Alternative technology'

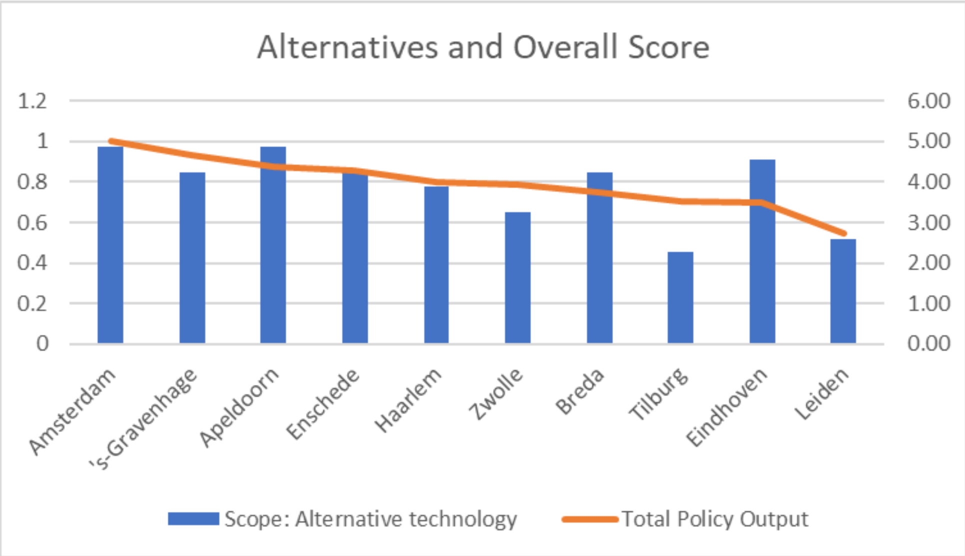


On the other hand, the municipality of Tilburg scores the lowest number of points on this sub-category. This municipality names 8 potential alternatives, while the municipality of Amsterdam with the highest score names 16 potential alternatives, respectively. Although the quantity of alternatives need not directly influence the final score of policy output, the number is a good indicator of the overall score. The visual representation of this is shown in Figure 7 below.

Besides having a low score on this sub-category, the municipality of Tilburg divides the built environment into 4 district parts. Unlike the municipality of The Hague, which divides the built environment into 105 districts. For reference, the land area of the municipality of Tilburg is 11,915 hectares, versus the 9,813 hectares of the municipality of The Hague (CBS, 2023a). In contrast, the municipality of The Hague has more than 2.4 times as many inhabitants as the municipality of Tilburg (CBS, 2023b). The Hague municipality provided potential solutions for each neighborhood of the 105, while the Tilburg municipality provided solutions for 4 zones. Providing more specific solution increases the policy effectiveness of the TVH, thus increasing the policy output. Exploring multiple solutions increased the likelihood of diverse ideas and approaches. This can lead to a broader view of the problem and more innovative solutions. It allows policymakers to consider different perspectives and explore possibilities that would otherwise be overlooked. In addition, a diversity of solutions encourages experimentation. By trying different approaches, policymakers learn what does and does not work in different contexts. This leads to a more adaptive approach and promotes a learning mindset within the policymaking process.

Figure 7

Alternative technologies and overall score

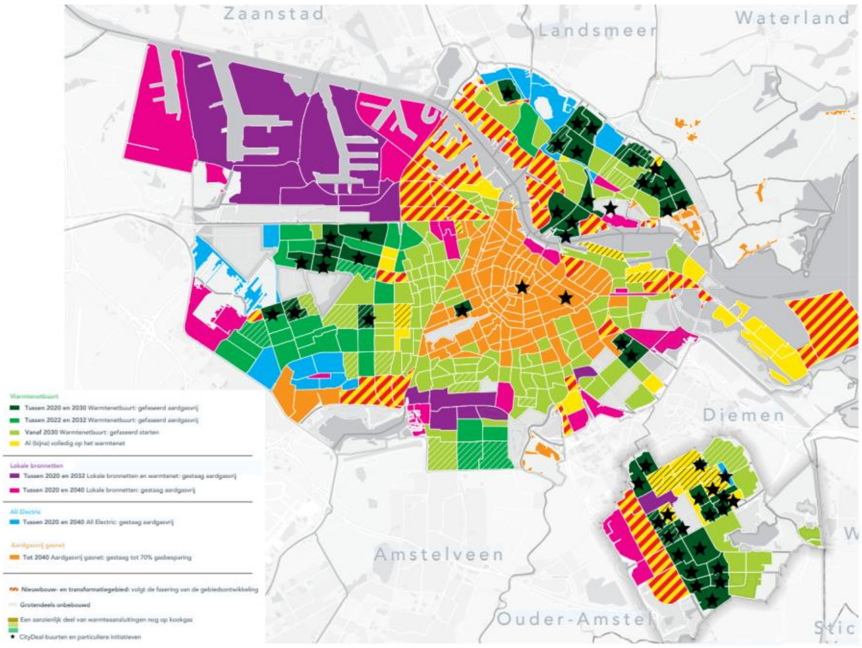


When a municipality scores higher on this category, it also results in a higher score on the overall policy output (see Figure 7).

One possible explanation for the different scores is the extent to which municipalities present concrete solutions as solutions for heating the built environment without natural gas. As an example, the municipality of Amsterdam achieved the highest score. This municipality already selects in advance different solutions for many different neighborhoods within the region (see Figure 8). On the other hand, the municipality of Tilburg scored lowest in this category. This municipality only divides its region into 4 zones (see Figure 9), and also offers focuses on solutions per region. The municipality of Tilburg lists 8 alternatives, while the municipality of Amsterdam lists 16 alternatives, respectively. The identified alternatives and associated scores within the TVH for each municipality can be found in the attached Excel sheet.

Figure 8

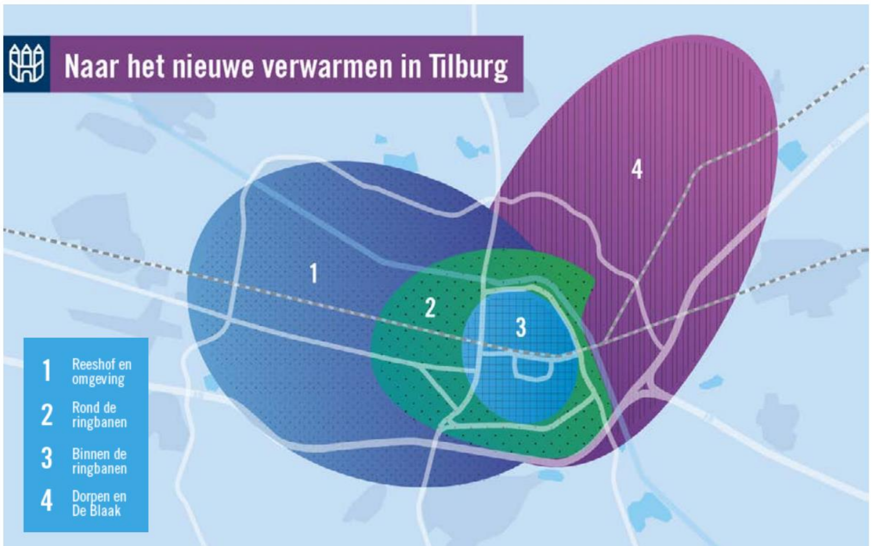
Possible alternatives for the municipality Amsterdam



Source: Municipality of Amsterdam, 2022

Figure 9

Possible alternatives for the municipality Tilburg



Source: Municipality of Tilburg, 2021

4.1.4 Targets

What is striking about the goals set by municipalities is that they are notably derived from the national framework from the government. The municipalities of Zwolle and Leiden were both assigned a score of 0 due to the lack of concrete and specified goals. As stated in the National Climate Agreement (2019), the target until 2030 is to make 1.5 million homes and other buildings more sustainable. Additionally, the agreement states that by 2050, nearly 7 million homes and 1 million other buildings should be transitioned to natural gas free homes and buildings. Specifically, realizing a gas free built environment within the Netherlands by 2050.

Targets 2030

Figure 10 shows the scores achieved by the TVHs on a scale of 0-1. The score is related to the policy document that named a specific goal for the year 2030. The score was calculated according to the formula shown in Table 1. The score means that a TVH scores on this category when a TVH names a goal (in 2030) that describes in a way how the TVH focuses on CO2 reduction/reduction of heat demand [TJ]/the number of homes that are targeted to be transformed to natural gas-free housing. The calculations of each score on this category by municipality can be seen in the attached Excel sheet.

An example of a calculation is as follows: "There are approximately 93,600 housing equivalents (weq) in Haarlem. We expect that with the plans as currently designed, about 12,700 housing equivalents can be disconnected from the natural gas grid in the period up to 2030" (Municipality of Haarlem, 2021). The formula (according to Table 1) is then as follows: (12,700/93,600) = 0.13568. The Haarlem municipality's score is rounded to 0.14.

Only the municipalities of Amsterdam (0.81) and The Hague score above average (0.55). The rest of the municipalities underperform in setting concrete goals for 2030. The effect may be that the lack of clear goals leads to little in the way of effective policy action. Although municipalities cite a multitude of uncertainty, it is noteworthy that 8 of the 10 municipalities surveyed have not set concrete goals for 2030.

The municipalities of Zwolle and Leiden were both assigned a score of 0 due to the lack of concrete and specified goals. However, both municipalities do mention the ambitions from the national framework.

"In the National Climate Agreement, companies, organizations and governments have indicated how they want to reduce their emissions by 49 percent by 2030 compared to the base year 1990. In this Climate Accord it was agreed that municipalities take the lead in the heat transition of the built environment. To this end, each municipality will draw up a Heat Transition Vision. In it they report to the State which neighborhoods and homes are promising to make them natural gas-free before 2030, or to prepare for this" (Municipality of Leiden, 2022).

"The national task is that 1.5 million homes (approximately 20 percent of the number of homes in the Netherlands) must be freed from natural gas by 2030 in order to achieve a completely natural gas-free built environment by 2050" (Municipality of Zwolle, 2020).

Both statements indicate little initiative from the municipalities themselves, a phenom that is occurring throughout the heat transition visions. Perhaps this is also logical, since municipalities have been given the directing role by the government to realize the heat transition in the built environment. Municipalities have not had a say in this, since this governing role and its approach and goals are set out in the National Climate Agreement (2019). Although the municipalities of Zwolle and Leiden do name national climate goals, the lack of a specific goal for 2030 leads to the lowest possible score for this municipality.

Figure 10

Score on category 'Targets: 2030'

Targets 2030-2050

Whereas municipalities score poorly on the 2030 targets, 8 out of 10 municipalities score the maximum score of 1 on the 2030-2050 targets (see figure 12). These municipalities' targets consist of the goal of at least no longer using natural gas within the built environment. Remarkably, these targets correspond 1:1 with the central government's overarching goal: the Netherlands will be a climate-neutral society by 2050. While this seems logical, it is all the more striking that two municipalities have different plans from the outlined overarching national climate goals.

Furthermore, ambitious mitigation targets can create a need for new and innovative approaches to achieve those targets. Despite the fact that the targets by 2030-2050 directly is derived from the National ambition to dismantle natural gas use, ambitious targets can drive policymakers to experiment with different policy instruments and strategies, potential leading to increased policy innovation.

The municipality of The Hague (2022) achieves a score of 0.68 points on this subcategory. This municipality's transition road map lists the various options for each neighborhood in an easy-to-read map (see Figure 11). The Hague municipality 36 out of 114 neighborhoods has not yet specified a concrete alternative. In addition, no statement can be found on the target related to the transition to a natural gas-free built environment.

Figure 11

Possible alternatives for the municipality The Hague

Source: Municipality of The Hague, 2022

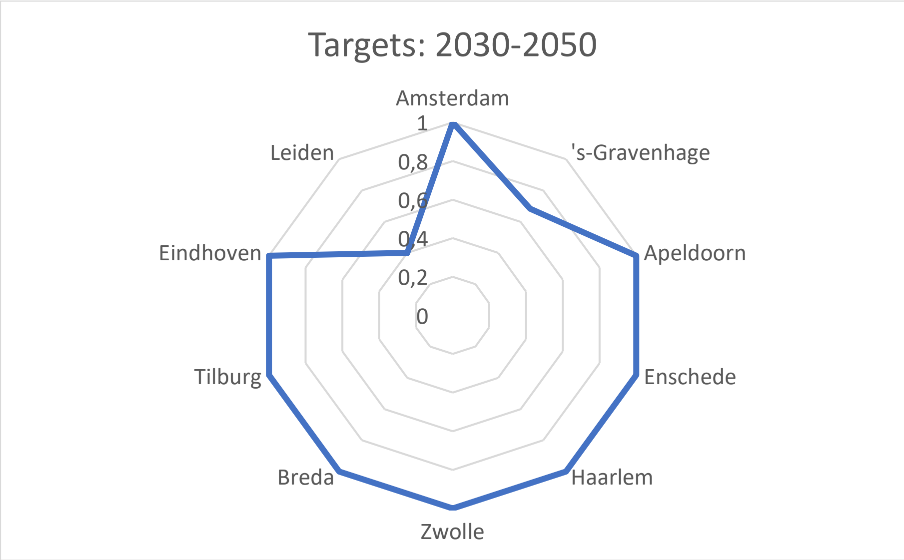
The municipality of Leiden, alongside the municipality of The Hague, also does not score the maximum. Although the Leiden municipality brings in TVH a statement of the ambitious goal of a climate neutral municipality in 2050, the same document also contains a contradiction:

"The expectation from the said Roadmap is that Leiden will achieve a 40% CO2 reduction through 2050. This reduction will therefore not go to zero. This stems from the expected growth of the municipality of Leiden with thousands more homes and the lack of sufficient space for large-scale locally generated electricity" (Municipality of Leiden, 2022).

This statement resulted in a score on this subcategory of 0.4 points.

Figure 12

Points on the category 'Targets: 2030-2050'



4.1.5 Budget

The TVH's do not refer to the financial resources allocated to the policy instrument. However, another way to determine the score of this category is by looking at the allocation of financial resources to programs compared to the total expenses of the municipality. Namely, a higher allocation to innovative projects may indicate a greater emphasis on innovation. According to Schaffrin et al. (2015), it is recognized that more resources increase the likelihood of successful policy implementation. However, not all policy instruments have a substantial budget. The authors mention that decisions on financial investments or impositions can increase policy activity.

As described, the standard calculation does not rely on the values of intensity calculated as the share of government spending or tax for the policy instrument out of total government expenditures on energy and fuels or direct government revenues from value-added tax revenues. Instead, a score is assigned using the formula described in the methodology section. The municipalities' budget scores are shown in Table 5.

Table 5

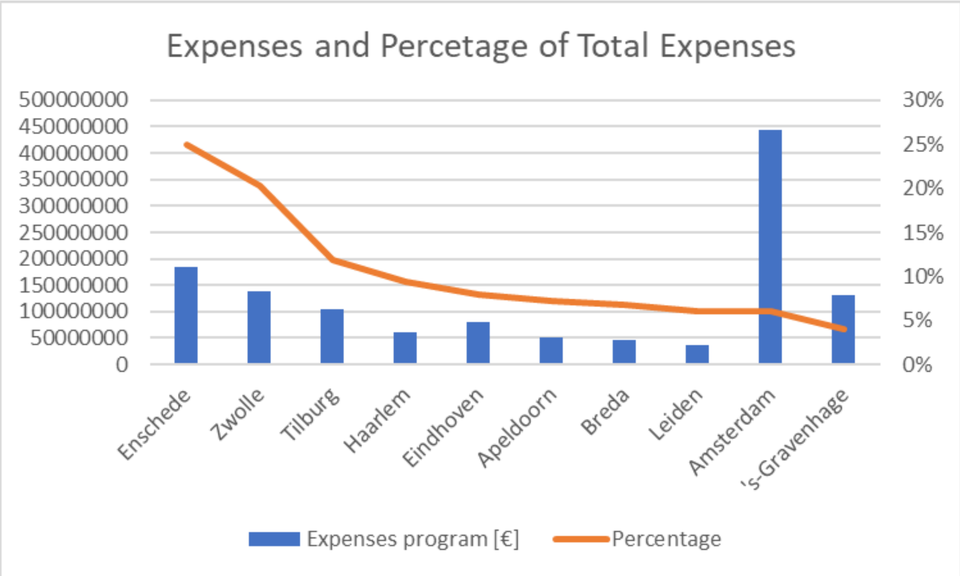
Points (in percentage) on the category 'Budget'

Municipality	Program	Expenses program [€	Total expenses [€]	Percentage
Enschede	Duurzaam wonen, leven en werken	183481000	734926000	25%
Zwolle	Toekomstgerichte stad	138480270	680724224	20%
Tilburg	Duurzame stad Tilburg	105000000	884100000	12%
Haarlem	Duurzame Stedelijke Vernieuwing	60280000	641675000	9%
Eindhoven	Volkshuisvesting, ruimtelijke ordening en stedelijke vernieuwing	80505000	1022848000	8%
Apeldoorn	Stedelijke en ruimtelijke ontwikkeling	51000000	709498000	7%
Breda	Duurzaam wonen in Breda	45904000	673038000	7%
Leiden	Stedelijke ontwikkeling	35490000	568202000	6%
Amsterdam	Duurzaamheid en ruimtelijke ordening	443900000	7404800000	6%
's-Gravenhage	Duurzaamheid, milieu en energietransitie	130900000	3288000000	4%

Appendix 7.6 displays the complete table including references of the scoring of the 'Budget' category.

Figure 13

Expenses and percentage of total expenses



In absolute terms, the municipalities of Amsterdam, The Hague and Enschede spend most on a program that includes the costs of heat transition. The municipalities of Zwolle and Enschede have relatively high costs for such a program, but also have fewer programs overall.

4.1.6 Implementation

Implementation refers to the process of putting policy decisions into action. It involves the actual execution and enforcement of policy instruments. According to Schaffrin et al.'s (2015) framework, this category is divided into the number of actors, and the type of implementation procedure. Implementation is an important aspect of policy output because it determines the extent to which policies are effectively implemented and achieve their intended outcomes. The coordination of actors is also essential, as this further emphasizes narrowing potential conflicts of interest between actors.

A score of 0 was given when no indication or description of implementation procedures was discovered. Within this study, the highest score achieved for a TVH is 0.5. This means that the implementation procedure is assigned to actors and is followed by established rules. In addition, 1 specific actor has also been appointed to coordinate this implementation process. A score of 0.75 was not achieved, this study did not show that an implementation has been determined so strictly that it is not susceptible to changes and/or modifications in the process. In addition, the maximum possible score of 1 has not been awarded because there are no strict sanctions for not following the implementation process. Appendix 7.3 shows the full scoring indicators for this category.

The results of this category are shown in figure 14. The maximum attainable score was 1. Only the municipality of 's-Gravenhage achieved 0.5 points here, four municipalities achieved 0.25 points and the remaining five achieved 0 points.

Each municipality wants to achieve the implementation of the TVH through Implementation Plans. No municipality has established strict rules and/or standards, and there are no sanctions yet for non-compliance. This is partly due to the uncertainties surrounding the heat transition. However,

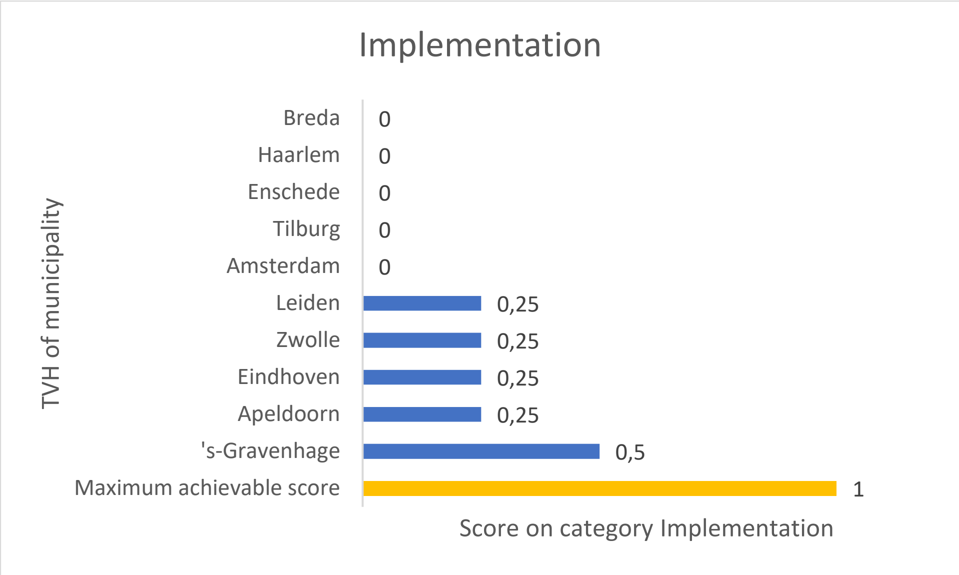
"The heat transition is a mega task for everyone. The municipality has a directing role to play, but it is heavily dependent on the initiatives and willingness to invest of higher authorities, housing corporations, residents and companies. Together we must work towards a sustainable and affordable future!" (TVH, Municipality of Tilburg).

"Other cases require more substantive and policy elaboration before concrete implementation is possible" (TVH, Municipality of Tilburg).

The Transition Vision, unlike the National Climate Agreement, is not binding (yet). Agreements are not finalized, and specific implementation procedures have not been determined. Because of this legitimate freedom, municipalities are not required to draw up concrete implementation procedures, let alone attach sanctions to them. Municipalities lack a directing role of government. Although this need not be a barrier to drawing up more concrete procedures themselves and establishing specific actors and rules.

Figure 14

Points on the category 'Implementation'



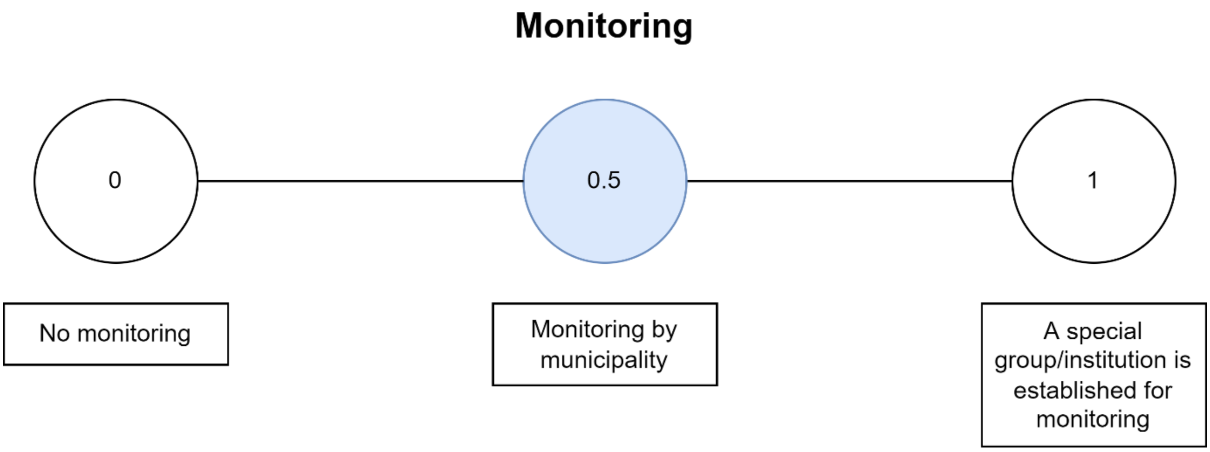
4.1.7 Monitoring

Monitoring refers to the process of observing and assessing the implementation and effectiveness of policy instruments. The category involves the collection of data and information to evaluate whether the intended outcomes of the policy are being achieved. From the data analysis, each municipality scores 0.5 points on the monitoring category. This means that each municipality monitors its own progress on policy implementation. All municipalities scored 0.5 on the three-point scale from 0 to 1 (see figure 15). Appendix 7.3 shows the values associated with the coding question. From this it can be seen that the municipalities achieve the 0.5 score when they themselves monitor the progression of the TVH. No municipality engaged a separate institution or special group to keep track of the monitoring process, hence no municipality scored 1 in this category. The municipality's monitoring process consists of updating the TVH every 5 years. They do this themselves, and no other body is mentioned to carry out this process.

"We will incorporate the experience gained and lessons learned in the updating of the Heat Transition Vision, the heat strategy to be drawn up and use them to scale up the approach. In the coming years we will also start in other districts where possible" (TVH, Municipality of Zwolle).

Figure 15

3-point scale on the category 'Monitoring'



Updating TVH and National Climate Agreement

In the quote below, the municipality of Tilburg emphasizes the fact that updating the TVH is an agreement stated in the National Climate Agreement. Remarkably, every municipality mentions that the TVH will be updated within, or in 5 years. More concrete than naming this enrichment is not found in the TVHs of the ten municipalities.

"The Heat Transition Vision is an adaptive document. After all, the heat transition is in full development, many preconditions have not yet been met, new innovations are coming onto the market and there is not yet a feasible and affordable final solution for every building in Tilburg. Therefore, we regularly renew the Transition Vision Heat based on the latest insights. As agreed in the Climate Agreement, we do that at least every five years. Given the rapidly changing developments, a first revision will probably be made earlier. This will allow us to monitor progress, incorporate innovations, appoint new heat implementation plans and adjust the determined course in time." (TVH p9, Municipality of Tilburg).

Each municipality scores the same, so this does not lead to an understanding of the differences between municipalities. Although, this category does influence the total policy output. A maximum score of 1 is assigned when the policy instrument is subject to regular observation and evaluation to assess its implementation and effectiveness. None of the municipalities apply monitoring of the TVH to that extent.

4.2Policy Output and Policy Innovation

2. How innovative is the policy output of Dutch municipalities in the context of the heat transition in the built environment?

In addressing the sub-question of the innovativeness of Dutch municipalities' policy output in the heat transition, this research undertook a comprehensive analysis of the TVH documents from 10 highly populated municipalities. Using Atlas.ti and a modified framework from Schaffrin et al. (2015) (see Appendix 7.3), the Transition Vision Heat (TVH) documents of these municipalities were thoroughly analyzed and evaluated on their policy output in the section above.

The assessment focused on eight distinct categories designed to measure the policy output, providing an in-depth understanding of the effectiveness and intensity of the TVH's of the ten municipalities. The results of this analysis revealed a varied landscape of policy innovation embedded within these municipalities. While some municipalities demonstrated prominent levels of innovation, particularly in integrating new technologies and engaging in collaborations, others showed a more traditional approach, focusing on incremental improvements. For instance, the municipality of Amsterdam scored the highest on the policy output with outstanding scores on the categories: 'Integration,' 'Target groups' and 'Alternative technologies'.

The policy output of Dutch municipalities in the context of the heat transition in the built environment displays a varied degree of innovation. The municipalities are actively exploring and implementing various innovative strategies and instruments. However, the extent and depth of innovation vary, reflecting the challenges and opportunities each municipality faces in its transition to a natural gas free built environment.

Based on the results (see Table 3) of the analysis, it can be seen that the there are great differences between the municipalities and their approach towards the heat transition to a natural gas free built environment. Although the degree of innovativeness is not scored overall absolutely, the results show which municipalities have a less innovative approach than others. Overall, the implementation policies of municipalities can be improved, although the transition paints an uncertain picture for the future. With the arrival of the new Heat Act, this could provide more certainty for municipalities.

Now that the definition of policy innovation has been stated in the theory section, we can also reflect on the outcome of policy output and policy innovation. Starting with the integration category. Noteworthy is the varying degree of inclusion of other relevant policy instruments and programs in the TVHs. Some municipalities immediately identify the relevant policy instruments that help various actors with progress in the heat transition in the built environment within the local context. For example, municipalities provide relevant subsidies and sustainability programs in their approach. These often new policy instruments and programs promote the adoption and advancement of the heat transition. The policy instruments and programs mentioned are mapped out per municipality in the attached Excel. With regard to the target groups, municipalities are largely positive about the inclusion and involvement of relevant actors (except for the municipality of Eindhoven). The municipalities focus specifically on the relevant actors and involve the interests of the actors in the further advancement of the heat transition. In addition to the target groups, the extent of the alternative technologies mentioned differs between the municipalities. The municipalities that score high in this category can be said to have new technologies and see specific opportunities in the use of technology. For a complete overview of all listed technologies, see the attached Excel file. Further on the goals for 2030: challenging and major goals are missing for this year. No municipality (except the municipality of The Hague) has been able to set a convincing statement and goal for this year. The municipalities tend to focus on the small steps, but the speed and focus for that year are not sufficient for the complex heat transition. All statements can be found in the attached Excel file. On the other hand, the municipalities do score high on the score of targets by 2030-2050. Eight out of ten municipalities have the ultimate goal of realizing a natural gas-free built environment. How realistic this will be remains to be seen. The goals for this year indicate that future policy (including when updating the TVHs) must focus on this challenging objective, even though the overarching objective comes from the National Climate Agreement (2019). For the budget category, efficiently distributing resources across policy instruments plays a crucial role in their successful execution. This is because enhanced resource allocation significantly boosts the chances of implementing policies effectively. Although the formula for determining this score differs slightly from the original calculation, this category does provide a cautious insight into the prioritization that municipalities give to budget allocation. A large relative expenditure on the program (including costs of the heat transition) may indicate a greater interest in the heat transition and/or insight into the complex challenge facing municipalities. In the field of implementation, the municipality of The Hague scores lower or equal to a score of 0.25, which means that there is no implementation policy or that there is an implementation policy, but it is linked to several actors. The practical steps that municipalities have to take are often missing or are explained in such a way that it is not clear where responsibilities lie for an implementation policy. Finally, the monitoring category, each municipality monitors its own policy, and this policy is updated at least every 5 years. Monitoring plays a crucial role in tracking progress towards the stated goals, identifying policy gaps, and informing decision-making processes. Although every municipality has approximately the same statement, municipalities do not take the lead in a refreshing or new insight (for an overview per municipality, see the attached Excel file).

In summary, municipalities each have their own approach (with some similarities, highlighted in the next section), in which the focus is in any case on pursuing the overarching goal of the National Climate Agreement (2019): realizing a natural gas-free built environment in the Netherlands. This is expressed by, for example, directly adopting the goals for 2050 without specifying the goals in the local context. In addition, each municipality updates the TVH every 5 years, an agreement that also comes directly from the climate agreement. Although some municipalities are trying to draw up an innovative approach, the general gist is that municipalities take a leading role, while they should take the directing role in making the heat transition successful locally and nationally.

4.3 Differences and Similarities

3. What are the main differences between municipalities concerning the heat transition in the built environment in the Netherlands?

The differences of policy output of the municipalities are conveniently displayed by category in the results section. This also highlights some more specific examples. This sub-research question is answered by presenting the major differences and similarities that emerged from the results.

The involvement of other stakeholders affects the total policy output of municipalities, this phenomenon manifested itself slightly in the target groups category, where the higher degree of listed actors within this study led to a higher degree of policy output. Although a direct cause still requires further research, this still brings to light interesting findings.

Municipalities listed many different potential alternatives to natural gas. Although each municipality listed many solutions, this research shows that the more specific solutions can lead to a higher degree of total policy output. A broader and situation-specific view of the various solutions may lead to a higher degree of innovativeness than a more shortsighted and generic view of the solutions.

The 2030 goals are mostly specified in the TVHs. Setting specific targets is not directly derived from the National Climate Agreement, but rather allows municipalities to devise them themselves and expose them to their own situations. In contrast, the 2030-2050 targets are mostly taken from the National Climate Agreement. Where municipalities usually follow the national ambitions directly. Whether these are achievable remains to be seen, but these 10 TVHs do not go far into that.

In terms of budget, the municipalities also differ in expenditures of the program related to heat transition. The analysis focused on relative spending. From that, at least, it was found that higher relative expenditures do not directly result in a higher degree of total policy output, although further and more extensive research can be entirely conclusive on this.

Although the heat transition is an uncertain and complex issue, differences among municipalities can also be found in the "Implementation" category. However uncertain the situation, some municipalities dare to define a more concrete approach with regard to this category.

In the end, there is no difference among the municipalities within the 'Monitoring' category. Each municipality revises its Heat Transition Vision every 5 years, with the municipality itself taking charge of this direction (although as described, this stems from the National Climate Agreement).

Table 6 shows the main differences and similarities in their approach towards the heat transition in the built environment.

Table 6 Differences and similarities

Main Differences	**Main Similarities**
Municipalities use a different approach towards the involvement of relevant stakeholders.	Each municipality specifies that the TVH is updated every 5 years.
Municipalities use various policy instruments and programs for the further development of the heat transition in the built environment	Eight out of ten municipalities aim to achieve a natural gas-free built environment by 2050.
Municipalities offer various alternatives as a solution for the use of natural gas in the built environment.	No municipality strictly enforces the TVH implementation process.
Municipalities have different expenditures regarding the heat transition.	

5. Conclusion

This study examined how innovative policies, policy instruments and programs are in the domain of heat transition in the built environment in the Netherlands. To answer this main research question, three sub-questions were formulated. The answers to these three sub-questions are prepared below. This study concludes by answering the main research question.

This data analysis showed the innovativeness of Dutch municipalities in heat transition policies, analyzing TVH documents from 10 populous municipalities. The analysis, using Atlas.ti and Schaffrin et al.'s framework, revealed varied innovation levels. Some municipalities showed high innovation, particularly in technology and collaboration, while others followed traditional approaches. The results, including Amsterdam's high scores in some key categories, indicated innovative approaches. Overall, the research suggests potential for policy improvement in the transition to a natural gas-free built environment. Measuring policy output of the eight categories provided a comprehensive understanding of innovativeness within the TVH's.

The main differences between Dutch municipalities in heat transition policies primarily relate to policy integration, stakeholder involvement (target groups), specificity of alternative solutions, goals setting, budget allocation, monitoring, and implementation approaches. Municipalities scoring high in the integration category also exhibit greater overall policy output, indicating that collaboration with various policies and stakeholders significantly impacts innovativeness. Specificity in alternative solutions to natural gas and setting localized targets, as opposed to just following national guidelines, also contribute to higher policy output. While budget allocations vary, their direct impact on policy effectiveness requires further research. All municipalities consistently revise their Heat Transition Vision every five years, showing uniformity in monitoring despite diverse approaches in other areas.

Before the main research question is answered, a summary of the answers to the three sub-questions follows.

1. *What is policy innovation in the context of the heat transition in the built environment?*

In summary, this sub-research question can be answered as follows: Policy innovation is the process of introducing new or updated policies at various government levels to solve problems or achieve goals. It includes the creation, adoption, and evaluation of innovative policies, leading to novel outcomes. This multidimensional concept is key for policy evolution, especially in areas like energy and heat transitions, emphasizing the need for comprehensive policy analysis and contextual understanding.

2. *How innovative is the policy output of Dutch municipalities in the context of the heat transition in the built environment?*

While some municipalities attempt innovative approaches, the overall strategy emphasizes their leadership role, suggesting a shift towards more directive actions is needed for successful local and national heat transition. In general, the municipalities follow the overarching agreements from the National Climate Agreement (2019), and there are no new and specific approaches to lead the heat transition.

3. *What are the main differences between municipalities concerning the heat transition in the built environment in the Netherlands?*

The main differences are that municipalities display a variety of approaches in engaging stakeholders, utilizing policy instruments, and proposing alternatives to natural gas use in the heat transition. Additionally, their financial commitments to these initiatives differ significantly. Regarding the similarities, all municipalities plan to update their Transitional Vision Heat (TVH) every five years, the majority aim for a gas-free built environment by 2050, and none enforces the TVH implementation process stringently.

Based on the three sub-research questions, an answer is given to the main research question:

"How innovative are policies, programs and policy instruments in the field of heat transition in the built environment within the Netherlands?"

Exploring the heat transition policies across various Dutch municipalities reveals a diverse landscape of approaches and innovations. From analyzing documents from ten densely populated areas, it's clear that while all aim to meet the national climate objectives, their paths diverge. Some municipalities stand out with solutions in the selection of alternative technologies and engaging stakeholders, showing an adaptation to their unique urban contexts. This mix of strategies, from the more innovative to the more traditional, highlights a broader narrative of how Dutch municipalities are navigating the complexities of the heat transition. Their shared commitment to transition to a natural-gas free built environment by 2050 and updating the TVH every 5 years are the result of the agreements established in the National Climate Agreement (2019). The current state of policy innovation is substandard, and the analysis (in the form of statements and scores) clearly shows that municipalities are taking a more subsequent role than the leading role intended for them. The complex challenge: heat transition for the built environment in the Netherlands requires more than a holistic and standard approach. The TVHs often follow standard approaches, which do not always match the complex assignment designated to them. Policy innovation must manifest itself better within policies, programs and policy instruments by offering solutions that are better suited to the specific context in which the policy is applicable. For TVH, the local context includes the municipal region. The TVH should better apply itself to the needs and problems that persist locally, instead of stating too general a solution. There is a growing need for more appropriate and innovative solutions that are focused on the context that the policy focuses on, this will further promote the advancement of the heat transition in the built environment in the Netherlands.

5.1 Discussion

This section consists of an extensive discussion focused on different topics.

Scientific added value

This research used the framework of Schaffrin et al. (2015) as a starting point, which was built upon and adapted to the context of the heat transition in the built environment in the Netherlands. Although the framework is designed for policy portfolios for countries, it has been shown that it can also be suitable for analyzing policy documents for policy output through a comparative analysis. On this basis, the policy innovation was tested, where the concept is defined in the theory. This research reflects the role of policy innovation within the heat transition, which has provided interesting insights. The role of policy innovation is not remarkably present but is mainly evident in the field of innovative alternative technological solutions, involving relevant actors and integrating (new) policies that support the heat transition in the built environment. Although the emphasis within the framework of collaboration is not included as standard in the viewpoint from Schaffrin et al. (2015), collaboration is an important aspect in innovation, and essential in the advancement of the heat transition.

The essential characteristics of collaboration are also underlined by Head (2022). According to Head, the primary emphasis of innovation design endeavors lies in collective processes, discussions among stakeholders, and decentralized approaches to solving problems on a smaller scale. Furthermore, the author suggests that ultimately, the majority of discussions related to 'design' occur beyond the primary operations of government departments. These conversations frequently involve consultants, think tanks, and research centers collaborating directly with citizens and various stakeholder groups. Although collaboration and the development of innovation were not the central focus of this research, their importance has certainly become apparent. This underscores the essential role that collaborative efforts play in driving innovation.

Another problem is the scale in which policy innovation should be designed. Much is still unclear about how to address problems, problems can be addressed on a small scale, and rolled out larger. In addition, the trade-off is whether to focus on different levels (local, regional, provincial, national), or to solve on the overall system. This issue holds significance within the literature on 'sustainability transitions,' advocating for innovative thoughts across all systemic levels. It emphasizes the imperative of linking local innovative initiatives to broader strategic institutional changes (Sengers et al., 2019; Voß et al., 2009). The flexibility in scale, from local to national levels, underlines the need for cross-system innovation, as discussed by Sengers and Voß. This underlines the importance of connecting local initiatives with broader institutional changes, a key aspect in achieving sustainability transitions. And so, the findings of local initiative and its impact on policy innovativeness should be further explored in future research.

Limitations

In this study on policy innovation in the Dutch heat transition, several limitations must be considered, with implications for future research and policy development. The subjective nature of defining and measuring policy innovation necessitates more standardized definitions and metrics for clearer policymaking guidelines. The representativeness of selected municipalities limits the generalizability of findings, suggesting that future research should include a more diverse sample and policymakers should consider regional specifics in policy implementation. The study's scope offers only a snapshot of evolving policies, indicating the need for ongoing research to track long-term trends and continuous policy adaptation. Complexities in assessing policy integration and effectiveness highlight the importance of developing methods for comprehensive analysis and coherent policy frameworks. Methodological constraints regarding data quality and availability underscore the need for robust data sources and methodologies in future studies and improved data collection for policy analysis. Additionally, regional and cultural differences within the Netherlands should be considered in future holistic studies and in tailoring policy initiatives. Finally, focusing on policy output rather than outcomes suggests future research should link these aspects to better understand policy effectiveness, urging policymakers to focus on tangible impacts and outcomes of policy innovations.

Dynamics over time

According to Schaffrin et al. (2015) the richness of information gathered with the Index of Climate Policy Activity over time allows for analyzing further phenomena such as the innovativeness of policy portfolios and changing patterns of instrument use. In line with this, it is interesting to examine the updated TVHs for adjustments to this policy instrument. After all, through agreements from the National Climate Agreement, municipalities are obliged to revise the TVH every 5 years. This review and/or renewal will reveal any adjustments over time. This reveals relevant insights into the policy innovation. Thus, technological developments can be incorporated into more concrete solution-oriented goals. In addition, policymakers can learn from lessons learned and experiences from previous TVHs. Additionally, evaluating any shortcomings and successes can lead to more innovative adjustments and solutions

Sample size

Although this study focuses on ten municipalities, it provides interesting insights into the variations and similarities of policy outputs and policy innovations of the largest municipalities in the Netherlands. Examining all 342 municipalities provides a much broader and more representative view of the policy landscape in the Netherlands. This approach ensures a comprehensive understanding not only of the largest municipalities but also sheds light on the diversity and variations among smaller municipalities. As stated earlier, variations in the TVH adopted by different municipalities offered valuable insights into the progress of the heat transition. Furthermore, investigating all municipalities leads to a more comprehensive analysis. It allows for the identification of trends, patterns, and variations that might not be apparent when focusing solely on ten municipalities. Although ten of the 342 municipalities were analyzed, they represent about 16% of the population in the Netherlands. One suggestion, therefore, is to conduct follow-up research to get a more complete picture of how policy innovation manifests itself in municipalities' transition heat visions.

Expert Validation

To verify the framework's credibility, seeking input from experts in the fields of policy innovation and heat transition within the Dutch built environment is strongly recommended for further research. Expert validation is crucial in ensuring the framework's strength and reliability. Although this research was built on the methodologically validated framework of Schaffrin et al. (2015), it is relevant for follow-up research to validate the context in which the framework is placed with practitioners and experts. Within this study, no interviews were conducted with experts and practitioners within the timeframe and scope. Nevertheless, this research provides insight into the role of policy innovation within TVHs and municipalities by scoring policy documents based on 8 categories, after all, these categories were applied from the already validated framework of Schaffrin et al. (2015). The adjusted framework (see Appendix 7.3) is constructed based on the Index of Climate Policy Activity methodology, specifically tailored to suit the context of heat transition in the Dutch built environment. External validation not only enhances trust among relevant stakeholders and researchers but also encourages broader acceptance of the framework within the field.

Innovation in Context

Collaboration is widely recognized as a catalyst for successful innovation in the academic realm. Working together often brings diverse perspectives, expertise, and ideas to the table, fostering an environment where innovation can prosper. The Social Science Research Council advocated for new types of cooperation among researchers, institutions, policymakers, and private entities to enhance the advancement of social knowledge and its capacity to benefit the collective welfare (Social Science Research Council (2018). Thus, in addition to examining policy outputs, it is also relevant to examine the context in which policy innovation is created. This context includes the collaborations formed in the creation of the TVH. In this the municipalities vary quite a bit, municipalities work during the realization with grid operators, local governments, (social) housing corporations, energy cooperatives and knowledge institutions, among others.

Establishing trust among stakeholders and the public in institutions poses challenges. The OECD (2017, p. 24) identifies five elements that aid in fostering public trust in governmental bodies: responsiveness, dependability, honesty, transparency, and equity. These dimensions correlate with governmental obligations such as delivering public services, ensuring citizen safety, and ethically utilizing resources.

The pursuit of policy innovation demands the cultivation of fresh skills and capacities, such as expertise in data analytics, forward-looking analysis, scenario planning, and experimental frameworks. Simultaneously, it advocates for facilitation techniques that stimulate novel ideas and inventive thinking through inclusive processes involving multiple stakeholders. Ansell and Gash (2018) posit that establishing 'platforms' for continual collaborative dialogue, design, and supervision can uncover practical and adaptable methods to address intricate requirements amidst evolving circumstances. Platforms can leverage a diverse array of stakeholder insights, contributing to broadened dedication toward common objectives and collective aspirations. For municipalities, the use of platforms is also essential in the innovativeness of the TVH, as the partnerships manifest themselves in the categories 'Integration' and 'Target groups'. Although further research requires further elucidation of the specific role of this form of collaboration and its impact on innovation.

Measuring Absolute Innovativeness

To address this issue and provide a more comprehensive understanding of the absolute innovativeness of Dutch municipalities, it would be beneficial to include benchmarking against predefined standards or goals, such as those set by national or international bodies. This would enable the study to not only compare municipalities against each other but also against a set standard of innovativeness, offering a more rounded view of their performance. While the current approach effectively highlights the relative differences in innovativeness among the selected municipalities, it is less effective in assessing their absolute level of innovativeness. Incorporating additional benchmarks could enhance the study's ability to provide a more complete picture of policy innovation across Dutch municipalities in the heat transition in the built environment.

Local Initiative

A finding that was not identified through the framework but does have an impact on policy output and policy innovation, is the extent to which municipalities are open to local initiative. Every municipality considers the opinions of residents and the utilization of local solutions to be important in drawing up the heat transition vision and its implementation. The implementation of the heat transition also often requires intervention indoors: such as replacing the central heating boiler with a heat pump/hybrid solution, modifying the heating system and having solar or infrared panels installed. In addition, the construction of new heat infrastructure is drastic for the accessibility of homes and buildings. Often it is the local interest that is incorporated into the principles of a heat transition vision. Such is the case in the TVH of the Municipality of Zwolle: Principle 2. "What we can do locally, we do locally" (Municipality of Zwolle, 2020).

Although not directly named, the importance of local initiative and cooperation has been emphasized in the National Climate Agreement (2019):

"But especially when we realize that the biggest challenge of this transformation is not a technical, financial or managerial task, but a social task. This is about people. That is why we are shaping this together, with residents, tenants, owners, corporations, builders, installers, etc.

One way we do this is with a neighborhood-oriented approach. Heat networks or conversions are organized at the district level. Practical examples so far show that this is more successful, the more neighbors cooperate with each other and with the (local) government. Making the right considerations together, jointly organizing the possible interventions in the neighborhood and in the houses - for convenience and cost - and perhaps even jointly owning the new (natural) heat source or solar panel plant. The sustainable transformation of the built environment is radical but also offers new opportunities."

That the agreements of the national climate agreement form the basis for the principles in the heat transition visions is also clarified by the following text found in the TVH of the Municipality of Eindhoven (2021):

"It is also a social challenge. Heat is a basic need. I am committed to ensuring that everyone can participate in the energy transition. We will have to convince and entice people in Eindhoven's residential neighborhoods that it really makes sense and is ultimately more economical to get rid of natural gas".

To include the interests of residents in the drafting of the TVH, and its subsequent implementation, some municipalities have conducted surveys on the subject.

"The heat transition is going to affect all of Enschede. Therefore, it is very important to know what is important to Enschede residents in this large-scale transition to natural gas-free heating. Residents from the municipality of Enschede gave their views on the heat transition through a survey in September 2020. This survey was completed by a 1,314 people (representative sample).10 With the survey we asked residents for their concerns and ideas about the heat transition in Enschede" (Municipality of Enschede, 2021, p.20).

While conducting a survey is certainly not the only way to include the interests of residents in the heat transition vision and its implementation plans, Table 7 shows the overall score of the municipalities and whether they conducted a resident survey.

Table 7

Surveys and energy cooperations per municipality

Municipality	Total Policy Output	Resident survey	Energy cooperation
Amsterdam	5.01	Yes	Yes
's-Gravenhage	4.67	Yes	Yes
Apeldoorn	4.37	Yes	Yes
Enschede	4.28	Yes	Yes
Haarlem	3.99	Yes	Yes
Zwolle	3.92	Yes	Yes
Breda	3.75	No	Yes
Tilburg	3.51	No	Yes
Eindhoven	3.50	No	No
Leiden	2.74	Yes	Yes

Local initiatives can focus on the development of new technologies or the application of existing technologies to address local issues, such as sustainability and community needs (Pesch, Spekking & Quist, 2019). In addition, the authors argue that local initiatives often involve citizens and public interest groups working together to solve local problems and create more sustainable communities, leading to innovative solutions and a greater sense of community ownership.

Municipalities also offer the possibility of participation by local energy cooperations and communities. According to Arentsen & Bellekom (2014), local energy initiatives can serve as seedbeds of innovation in the energy sector. These initiatives can be autonomous in coordination and community-oriented in performance, leading to more sustainable and innovative energy solutions. The promotion of local interest through energy cooperatives also manifests itself in the heat transition vision. For example, every municipality (except the municipality of Eindhoven) focuses on this target group (see Table 7).

Policy Advice

The aim of this research is to investigate the role of policy innovation in the context of the heat transition in the built environment in the Netherlands. The policy innovation of the TVHs was assessed using the adapted framework of Schaffrin et al. (2015). This chapter started with extensive advice on scientific follow-up research. In addition to the relevance of the scientific addition, this research also provides insights into the policy developments of municipalities that must take charge to ensure the success of the heat transition in the built environment in the Netherlands. As mentioned earlier, the TVH results from the policy agreements laid down in the National Climate Agreement (2019). Municipalities show many different similarities through the TVH (shown in chapter 4.4). Also show that municipalities differ in their approach, municipalities can also learn from each other when they update the TVH. The results of this research show that a more concrete, more extensive solution and the solution offered (for example in the categories: target groups, scope, and alternative technologies) leads to a higher effectiveness of the TVH. In this way, municipalities could consider a more extensive policy in further policy development, and more guidance can be provided on the basis of the 8 categories in this study. Although municipalities must consider the local context in which the policy must be effective, municipalities can learn from each other how to take control of the heat transition in the built environment in the Netherlands, and thus make the transition successful together.

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7. Appendix

7.1 Policy settings and calibrations

Table A1

Policy settings and calibrations

Policy settings and calibrations	Description and coding range
Integration	Is policy integrated in a larger package and supplemented by an overarching policy process? (Coding: 0, 0.5, 1)
Scope	How many target groups and energy sources does the policy instrument address as a proportion of all possible target groups (households and companies/demand and supply) and energy sources (coal, gas, nuclear, wind, solar, geothermal, biomass, water, including energy efficiency and combined heat and power)? (Coding: 0–1)
Targets	How much does the policy instrument contribute to reach the benchmark target of 80% greenhouse gas reductions or 100% electricity and heat production from renewable sources by 2050 (base year 1990)? (Coding: 0–1)
Budget	How much is spent on the policy instrument as a proportion of the public expenditure on energy and fossil fuels in the country? How much is the revenue from the policy instrument as a proportion of public revenue from Value Added Tax in the country? (Coding: 0–1)

Implementation	Is not more than one implementing agency involved and are rules and procedures defined and strict? (Coding: 0, 0.25, 0.5, 1)
Monitoring	Do policy instruments include an automatic monitoring process and is monitoring implemented by an independent institution? (Coding: 0, 0.5, 1)

Source: Schaffrin et al. 2015

7.2 16-step approach for Directed Qualitative Content Analysis

Table A2

16-step approach for Directed Qualitative Content Analysis

Steps	**References**
Preparation phase	
1. Acquiring the necessary general skills	Elo et al. (2014), Thomas and Magilvy (2011)
2. Selecting the appropriate sampling strategy	Inferred by the authors of the present paper from Elo et al. (2014)
3. Deciding on the analysis of manifest and/or latent content	Elo and Kyngäs (2008)
4. Developing an interview guide	Inferred by the authors of the present paper from Hsieh and Shannon (2005)
5. Conducting and transcribing interviews	Elo and Kyngäs (2008), Graneheim and Lundman (2004)
6. Specifying the unit of analysis	Graneheim and Lundman (2004)
7. Being immersed in data	Elo and Kyngäs (2008)
Organisation phase	
8. Developing a formative categorisation matrix	Inferred by the authors of the present paper from Elo and Kyngäs (2008)
9. Theoretically defining the main categories and subcategories	Mayring (2000, 2014)
10. Determining coding rules for main categories	Mayring (2014)
11. Pre-testing the categorisation matrix	Inferred by the authors of the present paper from Elo et al. (2014)
12. Choosing and specifying the anchor samples for each main category	Mayring (2014)
13. Performing the main data analysis	Graneheim and Lundman (2004), Mayring (2000, 2014)
14. Inductive abstraction of main categories from preliminary codes	Elo and Kyngäs (2008)
15. Establishment of links between generic categories and main categories	Suggested by the authors of the present paper

Reporting phase	
16. Reporting all steps of directed content analysis and findings	Elo and Kyngäs (2008), Elo et al. (2014)

Source: (Assarroudi et al., 2018).

7.3 Comparative Measure of Climate Policy Output

Table A3

Comparative Measure of Climate Policy Output

Category	*Coding Question*	*Coding Values*		*Specific Aggregation to Final Value*	*Range*
Integration	Is the policy part of a larger package or does it reference policy (instruments) or programs?	0	No	Additive aggregation	0-1
	Does the policy incorporate a framework policy (National Climate Agreement)?	0.02 5	For each reference to policy (instruments) or programs.		
		0.25	Yes, including framework policy (National Climate Agreement)		
Scope	Is every target group addressed in the policy?	0	Only one target group included	Additive aggregration	0-1
		0.07	For each target group businesses/ energy companies/ entrepreneurs/ other		
	Are all mitigation actions targeted within the policy?	0	Only one technological solution suggested		0-1

		0.065	For each technological solution suggested (all-electric, aquathermy, biogas, biomass, geothermal, ground energy, heat network, heat pump (air/ground sourced), hybrid, hydrogen, infrared, solar thermal, residual, sustainable gas, solar panels etc).		
Targets	What is the policy's objective concerning its performance?		No specific target given. Objective for asbolute CO2 emission reduction/ Objective for decreace in heat demand/ Objective in the absolute number of homes transitioned to natural gas-free.	This value is calculated: by the intended CO2 reduction as part of the total CO2 emissions in the municipality / intended heat reduction as part of the total heat demand [TJ] / intended number of homes that are transformed into natural gas-free homes compared to the total number of homes.	0-1
Budget	What are the specified expenditures or obligations associated with the policy?		There are no fixed costs or impositions mentioned, implying a lack of specific, set expenses associated with the policy	This value is calculated as the percentage share of municipal expenditure on the heat transition (expenditure program) over to the total expenditures of the year 2022.	0-1

Implementation	Does the policy outline implementation procedures, assigning specific actors and rules?	0	No indication or description of implementation procedures discovered.	Additive aggregration	0, 0.25, 0.5, 0.75, 1
		0.25	Implementation is distinctly assigned to actors and governed by specific rules.		
		0.25	One specific actor coordinated implementation		
	How is this implementation planned, and are there provisions for sanctions?	0.25	The implementation process strictly adheres to set standards or rules without allowing any variation or alteration.		
		0.25	Actors who do not comply with the implementation process face sanctions.		
Monitoring	Is there a dedicated monitoring process for the policy, and who is responsible for conducting it?	0	No monitoring	Additive aggregration	0, 0.5, 1
		0.5	Monitoring by the municipality		
		1	A special group/institution is established for monitoring		

7.4 Formative Categorization Matrix

Table A4

Formative Categorization Matrix

Category	*1. Integration*	*2. Scope*		*3. Targets*		*4. Budget*	*5. Implementation*	*6. Monitoring*
Sub-category		*2.1 Target groups*	*2.2 Technologies*	*3.1 Targets by 2030*	*3.2 Targets by 2050*			
Defintion of the category for the context of the heat transition	Integration is evaluated if the policy is encompassed within a broader policy package and that incorporates framework policies.	The policy's scope is evaluated according to target groups (residents/ businesses/ energy companies/ grid operator)	The policy's scope is evaluated according to technologies (all-electric, aquathermy, biogas, biomass, geothermal, ground energy, heat network, heat pump (air/ground sourced), hybrid, hydrogen, infrared, solar thermal, residual, sustainable gas).	The policy's goals are evaluated based on the performance of the policy. The target by 2030 can translate into a focus on: CO2 reduction, heat demand reduction and/or the number of homes that are intended to be transformed into natural gas-free homes.	The policy's goals are evaluated based on the performance of the policy. The target by 2050 can translate into a focus on: CO2 reduction, heat demand reduction and/or the number of homes that are intended to be transformed into natural gas-free homes.	This value is calculated as the percentage share of municipal expenditure on the heat transition (expenditure program) over to the total expenditures of the year 2022.	This category is assessed when an implementation process is described that involves one or more actors.	This category is assessed when an monitoring process is described that involves one or more actors.

Operational definition	Information that reveals that the policy document is part of another policy and/or program.	Information suggesting that one or more target groups are targeted.	Infomrmation that reveals one or more technologies that are mentioned as possible technology.	Information that reveals/suggests a specific target by 2030 and how that target might be reached.	Information that reveals/suggests a specific target by 2050 and how that target might be reached.	Information that reveals associated costs to the respective policy document	Information that suggests that one or more multiple implementation entities are involved. Writing that reveals that strict rules are set.	Information that suggests that one or more multiple monitoring entities are involved.
Anchor sample (NL)	"Leiden heeft in 2021 de Omgevingsvisie 2040 vastgesteld en daarin een hoofdstuk opgenomen met de opgaven voor de inrichting van de ruimte, zowel boven als onder de grond. De Transitievisie Warmte is een verdere uitwerking van de in de Omgevingsvisie Leiden 2040 benoemde ambities en biedt handvatten voor de uitvoering van de warmtetransitie."	Zorg per doelgroep (scholen, maatschappelijke organisaties, bedrijven etc.) voor een aanspreekpunt in de wijk. Dit is iemand met kennis van de verduurzaming van dit type gebouwen en die weet welke (financiële) ondersteuning er is en hoe die te verkrijgen. Dit kan een wijkambassadeur zijn, zoals die er nu zijn voor particuliere	In de onderstaande tabel is aangegeven welke warmtealternatieven in Valkenburg aan de Geul beschikbaar zijn. Daarbij is gekeken wat er nu al kan en welke technieken de komende 10 jaar ingezet kunnen worden. Daarbij is gebruikgemaakt van de Startanalyse en Leidraad Warmte van het Planbureau voor de Leefomgeving. De leidraad gaat	"In de periode tot 2030 hebben we de ambitie om 1.400 bestaande woningen (20% van de totale isolatieopgave) aardgasvrij-gereed te maken".	"In 2050 moeten alle woningen en gebouwen in Valkenburg aan de Geul en alle andere gemeenten in Nederland voldoende geïsoleerd én van het aardgas af zijn".		Nadat het uitvoeringsplan is opgesteld, moeten de overeengekomen maatregelen in de daarop volgende periode (vanaf 2024) worden uitgevoerd. De grootste taken liggen bij de ondernemers in de toeristische sector op het moment dat zij daadwerkelijk hun pand gaan verduurzamen. De gemeente ondersteunt de ondernemers waar mogelijk en zet zich, samen met de brancheorganisaties, in voor uitvoering van de	8.5 Monitoring: In het uitvoeringsplan ontwikkelen we een methode waarmee we kunnen monitoren of de warmtetransitie op schema ligt, hoeveel woningen al voldoende geïsoleerd en aardgasvrij zijn gemaakt.

		woningeigenaren en huurders maar het kan ook iemand zijn van een bewonersinitiatief of een energie coöperatie, met een link naar de gemeente. Dit draagt bij aan de opbouw van een (laagdrempelig) kennisnetwerk en biedt goede ondersteuning per doelgroep.	uit van de volgende strategieen: [1. ..., 2. ...,]				communicatie- en participatieactiviteiten.	

Translated anchor sample (EN)	Leiden adopted the Ambient Vision 2040 in 2021 and included a chapter with the tasks for the design of space, both above and below ground. The Transition Vision on Heat is a further elaboration of the ambitions stated in the Leiden 2040 Environmental Vision and provides guidance for the implementation of the heat transition.	For each target group (schools, social organizations, businesses, etc.), provide a point of contact in the district. This is someone with knowledge of making these types of buildings sustainable and who knows what (financial) support is available and how to obtain it. This can be a neighborhood ambassador, as there are now for private homeowners and tenants, but it can also be someone from a residents' initiative or an	The table below shows which heat alternatives are available in Valkenburg aan de Geul. It looks at what is already possible now and which techniques can be deployed in the next 10 years. Use was made of the Start Analysis and Guideline Heat of the Netherlands Environmental Assessment Agency. The guide assumes the following strategies: [1. ..., 2. ...,]	"In the period up to 2030, our ambition is to make 1,400 existing homes (20% of the total insulation task) natural gas-free ready".	By 2050, all homes and buildings in Valkenburg aan de Geul and all other municipalities in the Netherlands must be adequately insulated and off natural gas".		After the implementation plan is drawn up, the agreed measures must be implemented in the following period (from 2024). The biggest tasks lie with the entrepreneurs in the tourism sector at the time they actually start making their premises sustainable. The municipality supports the entrepreneurs where possible and, together with the industry associations, is committed to implementing communication and participation activities.	"8.5 Monitoring: In the implementation plan, we develop a method by which we can monitor whether the heat transition is on track, how many homes have already been adequately insulated and made natural gas-free".

		energy cooperative, with a link to the municipality. This helps build an (accessible) knowledge network and provides good support for each target group.						
Source for anchor sample	TVW Leiden 2021-2026	TVW Leiden 2021-2026	Transition Vision Heat, Municipality of Valkenburg (2022)	Transition Vision Heat, Municipality of Valkenburg (2022)	Transition Vision Heat, Municipality of Valkenburg (2022)		Transition Vision Heat, Municipality of Valkenburg (2022)	Transition Vision Heat, Municipality of Valkenburg (2022)

7.5 Codebook

Table A5

Codebook

Code	Sub-code	Code Groups	Word label(s)	Synonm
Alternative technologies	● Solar Thermal	Technological Solutions	Zonnethermie	
○ Housing costs neutrality (Woonlastneutraliteit)		Financing and Costs	Woonlastenneutraliteit	
○ Living comfort			Wooncomfort	
○ District Implementation Plan		Implementation	Wijkuitvoeringsplan	
Policy form	● Wet Collectieve Warmtevoorziening	Integration Policy Development	Wet Collectieve Warmtevoorziening	
○ Employment			Werkgelegenheid	
Alternative technologies	● Hydrogen as alternative	Technological Solutions	Waterstof	
○ Heat law (Warmtewet)			Warmtewet	
Alternative technologies	● Heat pump as alternative	Technological Solutions	Warmtepomp	
○ Heat storage option		Technological Solutions	Warmteopslag	
Alternative technologies	● Heat network as alternative	Technological Solutions	Warmtenet	
○ Warmtelinq+			Warmtelinq	
○ Heat chain			Warmteketen	
○ Heat infrastructure		Technological Solutions	Warmte infrastructuur	
○ Butterfly effect			Vlinder AND effect	
○ Strengthening electricity grid			Verzwaren	Verzwaring, netverzwaring
○ Acceleration of transition			Versnelling AND transitie	
○ Decrease of CO2		Sustainable Energy Sources	Verlagen AND CO2	Reduceren, minimaliseren, verminderen
○ Vereniging van Nederlandse Gemeenten (VNG)			Vereniging van Nederlandse Gemeenten	VNG
○ Ventilation of the building		Technological Solutions	Ventilatie	

○ Utility buildings			Utiliteitsgebouwen	
Implementation Plan			Uitvoeringsplan	
○ Payout from government (uitkering)		Financing and Costs	Uitkering	
○ Transparency			Transparantie	
○ Transition pathways			Transitiepad	
● Tilburg University		Collaboration and Stakeholder Engagement	Tilburg University	Universiteit AND Tilburg
○ Timeline			Tijdlijn	
○ Temporary solution			Tijdelijk AND oplossing	
Pace/Speed of transition			Tempo	
○ Technological developments			Technische ontwikkelingen	Technische AND ontwikkelingen
○ Tariffs			Tarief	
○ Subsidy		Policy Development Financing and Costs	Subsidie	
○ Need for subsidy			Subisidie AND nodig	
○ Support needed from government		Financing and Costs	Steun AND overheid	Rijksoverheid, het rijk
Stedin			Stedin	
○ Urban area			Stedelijk gebied	
○ Step-by-step approach		Learning Process	Stap voor stap	
○ Smart grids		Technological Solutions	Smart grid	
○ Bad insulation			Slecht AND isolatie	
○ Seasonal storage			Seizoen AND opslag	
○ Scarce			Schaars	
○ Participation of residents		Collaboration and Stakeholder Engagement	Samen met bewoners	
Alternative technologies	● Residual heat	Technological Solutions	Restwarmte	Rest warmte
Policy form	● RES	Integration Policy Development	Regionale Energie Strategie	RES

○ Direction from the municipality (regie)		Legal and Regulatory Aspects	Regierol OR regie	
○ Regulations		Legal and Regulatory Aspects	Regelgeving	
Policy form	● Regeerakkoord 2017	Integration Policy Development	Regeerakkoord	
○ Preconditions		Legal and Regulatory Aspects	Randvoorwaarde	
○ Public space			Publieke ruimte	
○ Public good			Publiek goed	
Policy form	● Programma Aardgasvrije Wijken	Integration Policy Development	Programma Aardgasvrije Wijken OR PAW	
○ Testing ground (proeftuin)			Proeftuin	
○ Principles city			Principe AND stad	
○ Principles TVH		Integration Targets Governance	Principe	
○ Peak load			Piekbelasting	
Policy form	● Paris Aggreement	Integration Policy Development	Parijs	
○ Over Morgen			Over Morgen	
○ Opt-out			Opt-out	
○ Surface water			Oppervlaktewater	
○ Uncertainties in heat transition		Learning Process Governance	Onzekerheid AND transitie	
○ Entrepreneurs			Ondernemer	
○ Environment Act (Omgevingswet)			Omgevingswet	
○ Environmental Vision (omgevingsvisie)			Omgevingsvisie	
Omgevingsprogramma			Omgevingsprogramma	
○ Environmental Plan (Omgevingsplan)		Integration Policy Development	Omgevingsplan	

○ Nuon Warmte			Nuon	
○ No regret measure			No-regret	Spijtvrij
● Nibud		Collaboration and Stakeholder Engagement	Nibud	
○ Grid operator			Netbeheerder	
○ Natural moments (Natuurlijke momenten)		Governance	Natuurlijke momenten	
○ Monitoring		Monitoring	Monitor	Toezicht, observeren, controleren, evalueren
○ More independence			Meer AND onafhankelijkheid	
○ Custom-made solution (maatwerk)		Governance	Maatwerk	
○ Social costs		Financing and Costs	Maatschappelijke kosten	
○ Local initiative		Collaboration and Stakeholder Engagement Governance	Lokaal AND initiatief	Plaatselijk
○ Local ownership		Legal and Regulatory Aspects Governance	Lokaal AND eigenaarschap	
○ Liander			Liander	
○ Supply security			Leveringszekerheid	
○ Leefbaarheid			Leefbaarheid	
○ Lower costs		Financing and Costs	Lagere kosten	
○ Cooling demand			Koude vraag	
○ Short-term			Korte AND termijn	
○ Pairing oppertunities (koppelkansen)		Collaboration and Stakeholder Engagement Learning Process	Koppelkansen	
○ Climate change			Klimaatverandering	
○ Ambition climate neutral city			Klimaatneutraal AND ambitie	

○ Klimaatdeals		Policy Development	Klimaatdeal	
Policy form	● National Climate Aggreement 2019	Integration Policy Development	Klimaatakkoord	
○ Freedom of choice		Governance	Keuzevrijheid	Zelf AND kiezen
○ Knowledge sessions		Collaboration and Stakeholder Engagement Learning Process	Kennissessie	
○ Insulating homes and buildings		Technological Solutions	Isoleren	Isolatie
○ Start with insulation		Technological Solutions	Isolatie AND begin	Start
○ Need for investment		Financing and Costs	Investeringen AND nodig	
○ Innovation environment			Innovatie AND omgeving	
○ Innovation		Technological Solutions	Innovatie	Innovation, vernieuwing
○ Iniatives from municipality			Initiatief AND gemeente	
Alternative technologies	● Infrared panels	Technological Solutions	Infrarood	IR, infrafroodpanelen
○ Individual solution		Technological Solutions	Individueel	
○ Implementation strategy		Implementation	Implementatie AND strategie	Uitvoering
○ Implementation policy		Implementation	Implementatie AND beleid	Uitvoering
○ Implementation of TVH		Implementation	Implementatie	
Alternative technologies	● Hybrid Solution	Technological Solutions	Hybride	
○ Increasing costs		Financing and Costs	Hogere kosten	Stijgende
○ heat stress			Hitte stress	
○ Feasibility heat transition		Learning Process	Haalbaarheid AND transitie	Warmtetransitie, haalbaar
○ Not financially feasible		Financing and Costs	Haalbaarheid AND financieel	
○ Feasibility Residents			Haalbaarheid AND bewoners	inwoners
○ Big challenge			Grote opgave	
○ Green hydrogen		Technological Solutions	Groene waterstof	
○ Green deal		Policy Development	Green deal	
○ Cheap solution		Financing and Costs	Goedkope AND oplossing	

Alternative technologies	● Geothermal energy	Technological Solutions	Geothermie	
○ Building density			Gebouw AND dichtheid	Bebouwingsdichtheid
○ Extra costs		Financing and Costs	Extra kosten	
○ EU			EU OR Europese Unie	
○ Gain experience with transition		Learning Process	Ervaring AND opdoen	
Enexis			Enexis	
○ Energy transition		Sustainable Energy Sources	Energietransitie	
○ Energy storage		Technological Solutions	Energieopslag	
○ Energy label		Policy Development	Energielabel	
○ Energy costs		Financing and Costs	Energiekosten	
○ Energy coorporation			Energiecoöperatie	
○ Energy savings			Energiebesparing	
○ Energy poverty (Energie armoede)		Financing and Costs	Energiearmoede	
○ Energy infrastructure		Technological Solutions	Energie AND infrastructuur	
○ Electricity grid			Eletriciteitsnetwerk	
○ Switch to electrical cooking		Technological Solutions	Elektrisch AND koken	
○ Ecofys			Ecofys	
○ Availability of sustainable sources		Sustainable Energy Sources	Duurzame AND bron AND beschikbaar	
○ Sustainable source		Sustainable Energy Sources	Duurzame AND bron	
○ Duurzaamheidspact			Duurzaamheidspact	
Alternative technologies	● Sustainable gas	Technological Solutions	Duurzaam gas	Groen gas
○ Support for stakeholders (draagvlak)		Collaboration and Stakeholder Engagement	draagvlak AND stakeholders	
○ Support for residents (draagvlak)		Collaboration and Stakeholder Engagement	draagvlak AND bewoners	
○ Target group		Targets	Doelgroep	
○ Goals			Doel	
○ Disinvestments			Desinvestering	

○ Data usage			Datagebruik	
○ Complex challenge		Governance	Complexe opgave	Probleem
○ Competition			Competitie	
○ Comfortability heat transition			Comfortibaliteit AND transitie	
○ Collective heat solution		Technological Solutions Collaboration and Stakeholder Engagement	Collectieve AND oplossing	
○ CO2 emissions			CO2 AND uitstoot	emissie
○ CO2 neutral			CO2 AND neutraal	
● CE-Delft			CE-Delft	CE Delft
● Centraal Bureau voor de Statistiek (CBS)			CBS	
○ Bronnet			Bronnet	
Alternative technologies	● Ground energy (WKO)	Technological Solutions	Bodemenergie OR WKO	
Alternative technologies	● Ground energy (WKO) 5th generation	Technological Solutions	Bodemenergie AND 5 OR WKO AND 5	
Alternative technologies	● Biomass		Biomassa	
Alternative technologies	● Biogas as alternative	Technological Solutions	Biogas	
Affordability	○ Affordability heat network	Financing and Costs	Betaalbaarheid AND warmtenet	
Affordability	○ Affordability heat transition	Financing and Costs	Betaalbaarheid AND transitie	Betaalbaar
Affordability	○ Affordability residents	Financing and Costs	Betaalbaarheid AND bewoners	
Affordability general		Budget Financing and Costs	Betaalbaarheid	
○ Decision-making			Besluitvorming	
○ Financing the transition		Budget Financing and Costs	Bekostigen AND transitie	Warmtetransitie Visie
○ Basic insulation		Technological Solutions	Basisniveau AND isolatie	
○ Barrier			Barrière	Obstakel, hindernis

Autoriteit Consument en Markt (ACM)			Autoriteit Consument en Markt	ACM
○ Aquathermal energy from drinking water			Aquathermie AND drinkwater	
Alternative technologies	● Aquathermy	Technological Solutions	Aquathermie	
● Alliander			Alliander	
Alternative technologies	● All electric solution	Technological Solutions	All-electric	
○ Waste water		Technological Solutions	Afvalwater	
○ Updating TVH (Actualiseren)		Learning Process	Actualiseren	Herijken, herijkt, herziening
● Targets by 2050		Targets	2050	
○ Targets by 2045		Targets	2045	
○ Targets by 2040		Targets	2040	
● Targets by 2030		Targets	2030	
○ Target by 2022			2022	

7.6 Program expenditures of municipalities

Table A6

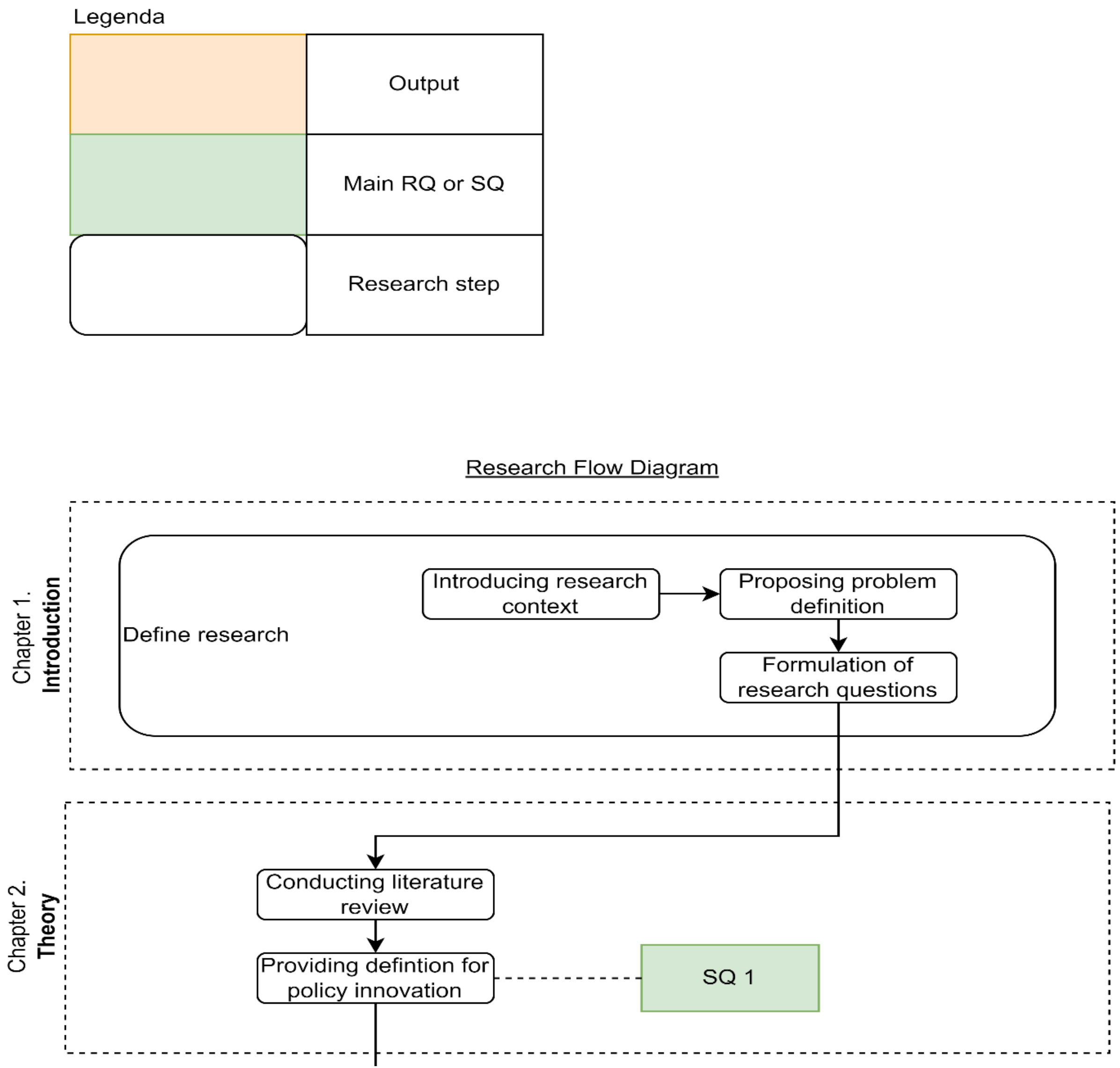
Program expenditures of municipalities

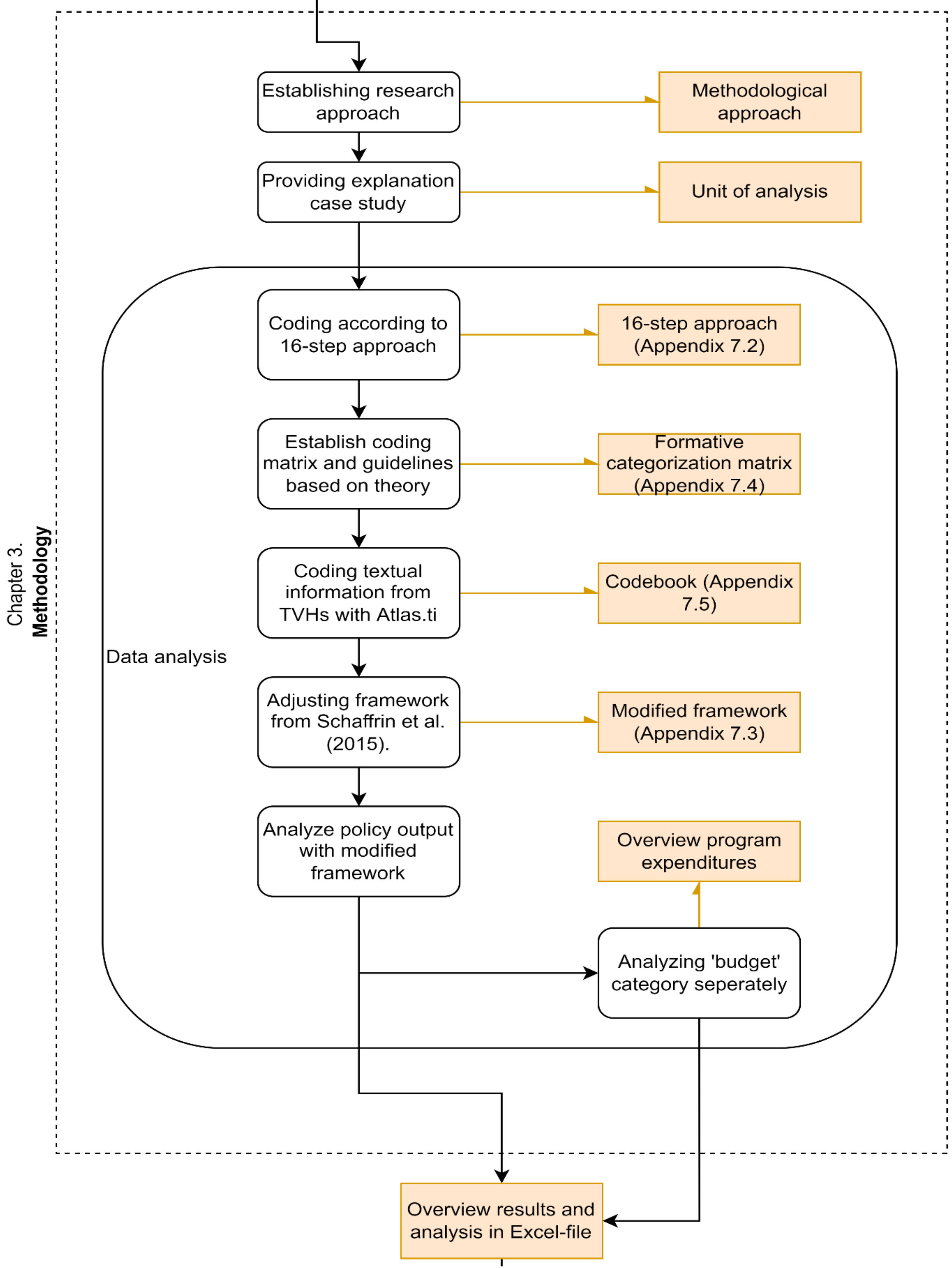
Municipality	Program	Expenses program [€]	Total expenses [€]	Percentage	Source
Enschede	Duurzaam wonen, leven en werken	183481000	734926000	25%	(Municipality of Enschede, 2023)
Zwolle	Toekomstgerichte stad	138480270	680724224	20%	(Municipality of Zwolle, 2023)
Tilburg	Duurzame stad Tilburg	105000000	884100000	12%	(Municipality of Tilburg, 2023, p.219)
Haarlem	Duurzame Stedelijke Vernieuwing	60280000	641675000	9%	(Municipality of Haarlem, 2023, p.263)
Eindhoven	Volkshuisvesting, ruimtelijke ordening en stedelijke vernieuwing	80505000	1022848000	8%	(Municipality of Eindhoven, 2023)
Apeldoorn	Stedelijke en ruimtelijke ontwikkeling	51000000	709498000	7%	(Municipality of Apeldoorn, 2023)
Breda	Duurzaam wonen in Breda	45904000	673038000	7%	(Municipality of Breda, 2023)
Leiden	Stedelijke ontwikkeling	35490000	568202000	6%	(Municipality of Leiden, 2023, p.13)
Amsterdam	Duurzaamheid en ruimtelijke ordening	443900000	7404800000	6%	(Municipality of Amsterdam, 2023, p.5)
's-Gravenhage	Duurzaamheid, milieu en energietransitie	130900000	3288000000	4%	(Municipality of 's-Gravenhage, 2023)

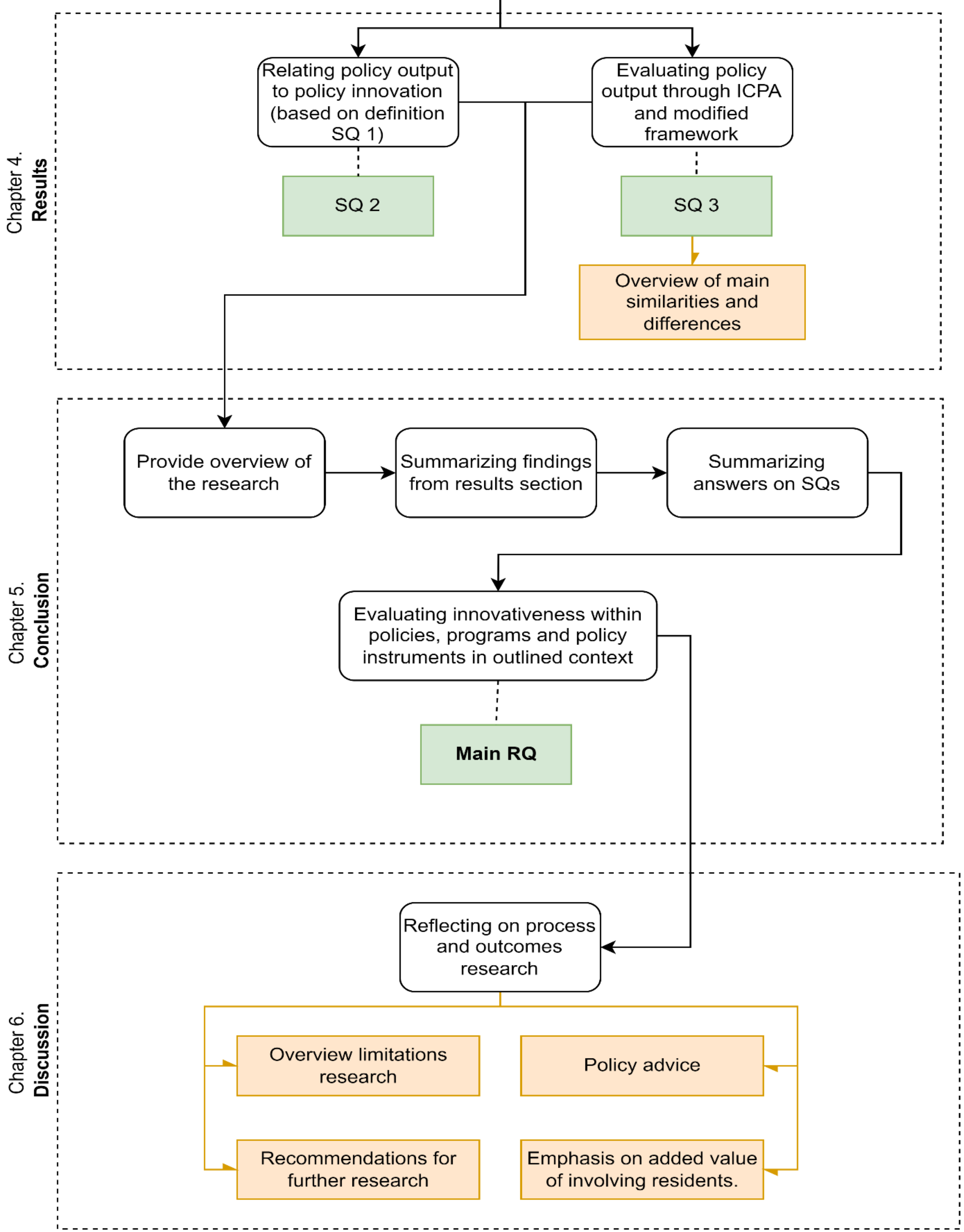
7.7 Research Flow Diagram

Figure B1

Research Flow Diagram




Chapter 3.
Methodology
Establishing research approach
Methodological approach
Providing explanation case study
Unit of analysis
Data analysis
Coding according to 16-step approach
16-step approach (Appendix 7.2)
Establish coding matrix and guidelines based on theory
Formative categorization matrix (Appendix 7.4)
Coding textual information from TVHs with Atlas.ti
Codebook (Appendix 7.5)
Adjusting framework from Schaffrin et al. (2015).
Modified framework (Appendix 7.3)
Analyze policy output with modified framework
Overview program expenditures
Analyzing 'budget' category seperately
Overview results and analysis in Excel-file


Chapter 4.
Results
Relating policy output to policy innovation (based on definition SQ 1)
Evaluating policy output through ICPA and modified framework
SQ 2
SQ 3
Overview of main similarities and differences
Chapter 5.
Conclusion
Provide overview of the research
Summarizing findings from results section
Summarizing answers on SQs
Evaluating innovativeness within policies, programs and policy instruments in outlined context
Main RQ
Chapter 6.
Discussion
Reflecting on process and outcomes research
Overview limitations research
Policy advice
Recommendations for further research
Emphasis on added value of involving residents.