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Decarbonising private firms through combined government incentives

A case study on the path to carbon neutrality of the district heating industry in the Netherlands

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Executive summary

The aim of this study was to contribute to the understanding of how government policy through a combination of government incentives could lead firms to decarbonise their activities. Which led to the following research question: **What combination of government incentives will lead private firms to decarbonise their activities?**

The elements behind the research question had individually received in varying degree attention from the scientific community. Studies on individual policy instruments received significant attention on how these impact corporate behaviour for example. How these elements influence each other in achieving this, is however much less understood. Additionally, the knowledge on decarbonising firms through combined government incentives is fragmented and more understanding is needed on for example how mandatory or voluntary these should be. The overall aim of this study was to provide more insights in how these different elements in relation to decarbonisation interact, the research approach was exploratory and largely inductive in nature, resulting in a case study design. The industry of subject in this study was the district heating industry in The Netherlands.

The study focused on the motives of firms to decarbonise, the technological possibility and dependencies that enable firms to decarbonise and government incentives that lead firms to decarbonise. The firms participating in this study all had adopted an environmental strategy that was as or more ambitious on decarbonisation than the policy strategy of the government, the underlying motives for the firms to do so were legitimacy through the eyes of their dominant stakeholders, influencing both the instrumental and relational motives. The effects of legitimacy on corporate motives was found to be relatively high for firms operating in the district heating industry, this is partly caused due to the visibility of the activities and the dependency on institutional investors. In the design of combined government incentives, policymakers could use the susceptibility of the firms towards legitimacy, since sufficient pressure of firms through stakeholders of the firms lead firms to adjust their behaviour while not requiring other complex policy instrument to incentivise firms to do. However, when doing so policymakers do need to be aware to proportionate the pressure over time, since the pressure experienced by dominant stakeholders to decarbonise could result in the divestment of specific activities by these firms that do not sufficiently contribute to the perceived pace of decarbonisation. While the withdrawal of incumbent players might create possibilities for new entrants that could contribute in the decarbonation of an industry it could also result in delays of the government objectives when this does not occur. Government incentives should at the very least ensure equal sharing of risks within the value chain of an industry by providing a level playing field for both incumbent players as well as possible entrants. This can be achieved through the introduction of industry-wide standards as well as clear path that leads to decarbonisation of that industry, in short, providing clarity through government incentives for all stakeholders involved with the decarbonisation of an industry. The need for the government to provide direction and clarity to the industry by introducing a path for the industry that leads to decarbonisation through combined government incentives is what most stand out from this study.

The implementation of technological solutions leading to carbon-neutral heat on a significant scale has not occurred however, while all firms have identified numerous technological solutions of sufficient

maturity. The causes for this were multiple, but the study uncovered that the main underlying causes that inhibit the industry from decarbonising where: 1) current combined government incentives that support the status quo, 2) lack of demand for the carbon neutral alternative, 3) due to the previous causes the technological solutions were largely not affordable for firms to adopt and 4) lack of sufficient public opinion and support for decarbonisation as well as insufficient consensus among stakeholders involved with initiatives to decarbonise. The objective is clear, reach carbon neutrality by 2050, to ensure this objective is met the main obstacle that needs to be overcome through combined government incentives is the lack of demand for the carbon neutral alternative, in the case of this study carbon neutral heat, since decarbonisation it is not a goal that most firms and arguably that most citizens pursue and seems, above all, to require a political response. This study argues that it is not possible to achieve sufficient levels of demand without imposing a mandatory path of decarbonisation on both the industry as well as end-users. In order to facilitate in the mandatory path to decarbonisation it is however necessary to create acceptable levels of affordability and public opinion and support for the technological solutions that lead to decarbonisation through combined government incentives.

In the case of this study affordability can be achieved through simultaneously incentivising both end-user of heat, by the introduction of a solidarity principle to compensate for significant, albeit largely temporary, price difference and the large scale insulation of buildings to make these eligible for carbon neutral heat, and firms that provide for this heat, through revising the current price control mechanism and introduce government support schemes that are customised to the technological solutions needed to decarbonise to ensure eligibility of these solutions for the scheme as well as have a dedicated budget to ensure sufficient funding is available for the industry. The government can create sufficient levels of public opinion and support for decarbonisation of district heating through storytelling by the national government and ensuring the early participation and involvement of relevant stakeholders for specific initiatives that lead to decarbonisation whilst ensuring sufficient consistency between all government communications channels on decarbonisation and the specific technological solutions that are needed to achieve this.

To achieve the desired change in corporate behaviour, policymakers in their design of combined government incentives need ensure stability in government policy, sufficient congruence between policy goals and government incentives, sufficient coherence between government incentives and firm practices, sufficient level of alignment between policy instruments and between policy goals within a policy field as well reduce possible negative impacts on corporate behaviour from other policy fields. Since these design characteristics have an accumulated impact on corporate behaviours these should be in continuous balance with each other. In order for private firms to decarbonise the combination of government incentives needs to adhere to these design characteristics while reaching and maintaining the balance between affordability and public support and ensuring that industries are largely carbon neutral by 2050 through a mandatory path for industries to reduce carbon emissions aligned with the government objectives.

Chapter 1: introduction

In the last decades the political awareness for the need to change the current fossil fuelled economy with all its negative externalities such as greenhouse gases and the impact these have on the global and regional climates and the natural world as a whole to a more sustainable model has dramatically increased. This resulted in several of the United Nations Sustainable Development Goals (Times, T. N. Y., 2015) as well as The Paris Agreement (The Economist, 2015). The European Union (EU) is even more ambitious in her commitment towards tackling climate change, with targets that include a 40% reduction in greenhouse gases compared to 1990 and to have at least 32% share for renewal energy by 2030 (2030 Climate & Energy Framework, 2017), in her long-term strategy the EU aims to have transitioned towards a carbon-neutral economy, with net-zero greenhouse gas emissions by 2050 (2050 Long-Term Strategy, 2017). Governments are also facing increasing demands from society to act, sometimes forced by legal actions which resulted for example in the Dutch nitrogen crisis (The Economist, 2019, October 25).

The international agreements and ever-increasing pressure from a variety of actors in society to address the issue of greenhouse gases led the Dutch Government to adopt an even more ambitious short term climate strategy than the EU. The aim of the Dutch government is to reduce greenhouse gas emissions by 49% compared to 1990 levels in 2030 (Ministry of Economic Affairs and Climate Policy, 2019). This means that the Dutch Government in her turn imposed increasing restrictions on the various industries aimed to drastically reduce greenhouse gas emissions (The Economist, 2019, July 9). The unilateral imposed restriction by the Dutch Governments, which by some actors are characterised as unequal, led to significant unrest within certain industries which resulted in waves of protest from farmers and other special interest groups claiming that they bear the brunt of the climate reforms and that industrial multinationals are largely exempted (BBC News, 2019). Attempts by the Dutch Government to incentivise the 112 largest industrial consumers of energy through a voluntary agreement to implement energy saving measures yielded marginal results (Walle, 2021), instances like these attributing towards the believe that voluntary measures alone will not suffice, and that more persuasive policy is needed. The difficulty in maintaining a stable policy in countries or supranational organisations such as the EU are due to both internal and external pressures (e.g., lobbying), politicians for example struggle with explaining measures that sometimes feel to (and) have major consequences for the public (The Economist, 2021, February 18). Struggling to strike the right balance in her policy on tackling the nitrogen crisis the Dutch Government announced a more balanced approach by incentivising the agriculture industry to innovate in decarbonization through a grant of 172 million euro and a voluntary buy-out scheme of 350 million euro for business that cannot make the transition (Ministry of General Affairs, 2020). While the ongoing COVID-19 pandemic and the resulting economic

downfall might have overshadowed the urgency of climate change policy, intergovernmental organisation such as the OECD urge countries to design polices such as stimulus packages that not only address the economic consequences of the pandemic but also are designed to accelerate the transition towards a carbon-neutral economy (OECD, 2020).

The ambitious climate strategy of the EU and the renewed United States commitment towards combating climate change (Davenport & Friedman, 2021) are likely to boost policy on transitioning towards a carbon-neutral society. Testimony to this is that in the face of the 2021 Dutch General Election climate policy has become mainstream for most political parties (Stellinga & Alonso, 2021). With the increasing commitment of governments to come with solution to halt and even reverse the effects of climate change in the not-too-distant future (e.g., 2030 and 2050), the political and scientific debate is increasingly shifting towards how this should be achieved through policy (Aragòn-Correa, Marcus & Vogel, 2020).

The transition towards a carbon-neutral economy and subsequent changes required to society are unique in its nature in that it requires answers to solutions on problems from a variety of professions in an unprecedented short timespan (Wright & Nyberg, 2017), the goals are largely clear but the solution to the answers that enable society to achieve these goals are far from. The insecurity around the solutions is resulting in a somewhat stalled climate in where initiatives are only very slowly taking form and when they do take form often fail or at best deliver marginal results (The Economist, 2020, October 30). The complexity of the transition towards a carbon-neutral economy in the various industries together with the need to involve a lot of different stakeholders (governments on various levels, NGO's, profit and non-profit organizations) who have different and sometimes conflicting interests and the absents of clear solutions makes the need for government policy that set the right targets, facilitates cooperation between governments, universities and industry, builds trust and creates the right conditions to enable all parties involved to contribute to these goals effectively, apparent (Wijen, 2014; Wright & Nyberg, 2017; Aragòn-Correa et al., 2020).

Private firms (hereafter: firms) play an important role in the transition towards a carbon-neutral economy, since they represent a significant share of the fossil fuel consumers and thus in implementation of government policy concerning the mitigation of climate change (Andrade & Puppim de Oliveira, 2014; Wright & Nyberg, 2017). Firms can also act as a platform for the government to change the behaviour of society, since they influence other actors when acting upon government polices (Wright & Nyberg, 2017). Governments have multiple ways to regulate or incentivise firms in transitioning towards carbon-neutral activities. The most obvious ways include laws and regulation or incentives via subsidies or tax deductions (Aragòn-Correa et al., 2020). Some scholars argue that

environmental regulation can create a win-win in the sense that firms achieve higher profits and produce without less externalities, stimulating innovation and economic growth (Porter & Van Der Linde, 1995a, 1995b; Porter, 1998) as well as increase a firm's competitiveness (Rothfels, 2002). The compliance of firms with regulation can however have unwanted effects on the firms' ability to enter new markets, it can increase the firms operating costs and result in reduced flexibility (Aragòn-Correa et al., 2020). Scholars recognise that the effects policy has on corporate behaviour are context dependent on both the internal and external environment in which the firms operate in as well as specific characteristics to the individual firm (Demirel & Kesidou, 2011; Kemp & Pontoglio, 2011; Wijen, 2014; Tsai & Liao, 2016; Aragón-Correa et al., 2020). Government policymakers struggle to find the right combination of government incentives to effectively implement policy that results in the intended behavioural changes in industries and individual firms due to this complexity (Wijen, 2014; Aragòn-Correa et al., 2020). In a recent report commissioned by the Dutch Ministry of Economic Affairs and Climate Policy on behavioural insights of firms and how this should shape policy, the authors made several recommendations, for example focus on frontrunners in industries and be aware to target the decision-making unit of a firm (PWC, 2018). Very much is still unclear however and more research is needed on the positive and negative effect that certain policy has on corporate behaviour and how different policy rank among themselves in their effectiveness on influencing this behaviour (Kemp & Pontoglio 2011; Wang, 2018; Yigitcanlar et al., 2019; Dale et al., 2019; Aragón-Correa et al., 2020). Scholars also call for more detailed studies on the design and effect of policy (both mandatory and voluntary) in a specific context (e.g., industry) to have a better understanding of corporate behaviour in such a context (Kemp & Pontoglio 2011; Tsai & Liao, 2016; Aragón-Correa et al., 2020). This study answered to the calls of scholars and government policymakers and aimed to study the impact of government policy on corporate behaviour whilst considering the specific characteristics of the environment in which the firm operates. The findings of this study contributed to a better understanding of corporate behaviour when confronted with a certain set of government policies as well as contributed to more insights for future policymaking.

1.1 Towards a research question

As previously discussed, the existing literature on the effect of government policy in changing corporate behaviour through government incentives lacks context and in-depth understanding. There is still much unknow on how the combination of government incentives impacts corporate behaviour within a specific industry and what the optimum between mandatory and voluntary pressure from government policy is within such an industry. The purpose of this study is to provide a more in-depth understanding on the impact that a combination of government incentives has on corporate behaviour in a specific industry and within its context. The focus of this study will be government policy on

incentivising private firms to transition towards carbon-neutral activities. Since the government is committed to making this change within a predetermined time window (e.g., 2030, 2050) and the current pace of change is insufficient (Wright & Nyberg, 2017; United Nations Environment Programme, 2019) this adds an additional complexity, namely a limited time window, into the focus of this study. The above aspects resulted in the following research question: **What combination of government incentives will lead private firms to decarbonise their activities?**

In order to answer the research question systematically and provide structure to this study, the research question was supported by two sub questions, these are:

1. What is the impact of combined government incentives on corporate behaviour?
2. What incentives will lead private firms to transition towards carbon-neutral activities?

Important to note is that this study assumes that corporate behaviour is influences by government policy, testimony to this the vast amount of studies on this topic as discussed in the literature review in the next chapter. The purpose to this study is to provide insights in and to what extent combined government incentives impacts corporate behaviour with the goal of decarbonising firms and what combination of government incentives are likely to be more effective in achieving this goal.

1.2 Position within literature

This study builds on various academic insights and aligns with ongoing academic debates on climate change and sustainably literature that address government policy and instruments in its effect on transitions to decarbonisation (Cirone & Urpelainen, 2013; Rogge & Reichardt, 2016; Fagerberg, 2018; Kern & Rogge, 2018; Dale et al., 2019; Edmondson, Kern & Rogge, 2019), the literature on policy aimed at technological innovation considering both the conditions for firms to innovate and adopt solutions as well as the relevant technological aspects of carbon-neutral solutions (Kemp & Pontoglio, 2011; Demirel & Kesidou, 2011; Horbach, Rammer & Rennings, 2012; Dolfsma & Seo, 2013; Tsai & Liao, 2016), corporate behaviour literature on the intersection with government policy (Davis, Schoorman, & Donaldson, 1997; Bansal & Roth, 2000; Aguilera et al., 2007; Campbell, 2007), the institutional literature (Wijen, 2014; Wright and Nyberg, 2017; Aragón-Correa et al., 2020) and the environmental policy literature (Kemp, Soete, and Weehuizen, 2012; York, Vedula & Lenox, 2018; Hille et al, 2020) as well as the literature specific on government policy with regard to decarbonisation and the possible effects of these (Del Rio & Cerdá, 2017; Grubb, McDowall & Drummond, 2017; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021). How this study fits within the summarised strand of literature and how this study contributes respectively will be discussed in the literature review is included in the second chapter.

1.3 Thesis outline

The structure of this study follows the recommended structure for a thesis namely, to start with the existing relevant knowledge on the subject of the research, the literature review as described in chapter 2. Based on the state of the identified literature it is determined on how this study can methodologically provide an answer to the formulated research question, this is done in chapter 3. The empirical results of the study are elaborated and summarised in chapter 4. The empirical findings together with the literature review will provide fuel for the discussion as well as suggestions for future research in chapter 5, which is followed by limitations to this study and the conclusion in which the contributions of this research are summarised and the research question is answered, the final part of chapter 5 will cover the recommendations for policy and management practices derived from this study.

1.4 Glossary

To improve the readability and reduce the change of misinterpretation of specific terms used while reading this study, table 1.2 includes an overview of commonly used terms and their meaning in the context of this study.

Glossary	
Terms	**Meaning in context of this study**
Carbon neutral(ity)	The balance between emitting carbon and absorbing carbon emissions.
Carbon neutral heat	Heat produced for the heating of buildings without emitting CO_2.
Collective heat solutions	Technological solutions that provide heating for more than 2 buildings.
Combined government incentives	The combination of policy goals and policy instruments in a specific policy field. Also sometimes referred to as the policy mix.
Decarbonisation	The conversion to an economic system that sustainably reduces and compensates the emissions of carbon dioxide (CO_2).
District heating	District heating grids that produce > 0.15 petajoule of heat per year.
District heating industry	All the actors that operate in large scale heat grids.
Government incentive	Individual policy goal and policy instrument in a specific policy field.
Projects / initiatives	Investment proposals, business cases, contracts that include the effort to decarbonise, etcetera.

Table 1.2: Glossary

Chapter 2: Literature review

In this second chapter the state of the current knowns and unknowns with respect to the different dimensions of the research question will be discussed. This structure will follow the chosen terminology of the formulated sub questions and will conclude with how the existing knowledge relates to the research question of this study.

2.1 The impact of combined government incentives on corporate behaviour

In order to understand the impact of combined government incentives it is necessary to identify these, the first paragraph is dedicated to existing knowledge on the identification government incentives and what the prerequisites are for these to have an impact on corporate behaviour. This is followed by the different technological aspects t decarbonisation and the implication this has for combined government incentives. Next, the different corporate motives underpinning corporate behaviour in a generic sense as well as specific towards environmental policy identified in the literature will be elaborated.

2.1.1 Combination of government incentives: identifying and design characteristics

If the decarbonisation of firms through a combination of government incentives is to succeed then the combined effect of these incentives needs to overcome multiple barriers, most notable the current lock-in of the carbon, fossil-fuelled based technologies and infrastructures as well as path dependencies and the resistance to change from incumbent actors (e.g., existing industry players that adapted their business models to the existing socio-technical configurations) (Imbert, Ladu, Morone & Quitzow, 2017; Rogge, Kern & Howlett, 2017; Ashford & Hall, 2018). Strategic policy efforts are needed to overcome cognitive lock-in and vested interest in order to decarbonise firms. Additionally, the design of government policy likely needs to address several markets and system failures. Government policy is not merely comprised of an accumulation of policy that have their independent effect in isolation, policy is embedded in a policy mix that are interrelated (Rogge & Reichardt, 2016; Rissman et al., 2020). Before addressing the aspects of the design of a policy mix with the aim of decarbonising the activities of firms, it is important to recognise that when designing a policy mix, especially in developed countries, a pre-existing policy mix exist and new policy should be embedded or replace these, since new policy most of the time is constrained by previous political choices (Howlett & Rayner, 2013).

The start of designing combined government incentives, in any case, is to have a broad understanding of the existing policy mix. In an attempt to create a more precise definition of a combination of policies that includes the complexity of socio-technical transitions (e.g., decarbonisation), Rogge & Reichardt (2016) defined an extended policy mix based on three building blocks, which are: 1) elements, these include the policy strategy and policy instrument mix, 2) policy processes, both the design and the

implementation of policy and 3) policy characteristics of which policy consistency, coherence, credibility and comprehensiveness have been identified (see figure 2.1). It is likely a combination of existing government incentives with the aim of decarbonising firms can be found in the existing policy mix that exist in several policy fields, on government levels and that is geographically dispersed (regional, national, supernational) which has been created and implemented over time. Rogge & Reichardt (2016) identified these as the dimension that define the delineation of the extended policy mix. The difficulty in empirically analysing the existing policy mix are boundary setting (i.e., delineation), which is comprised of the scope of the policy mix and unit of analysis as well as the operationalisation which is the identification of the instruments (i.e., government incentives) and their design features that make up the extended policy mix (Rogge & Reichardt, 2016). It is important to recognise that government incentives have the desired effect on firms behaviour only if the effect is supported by the policy mix in which these incentives are embedded. Empirically the existing policy mix on specifically defined delineated dimensions could serve as a starting point to ascertain the impact of combined government incentives on corporate behaviour.

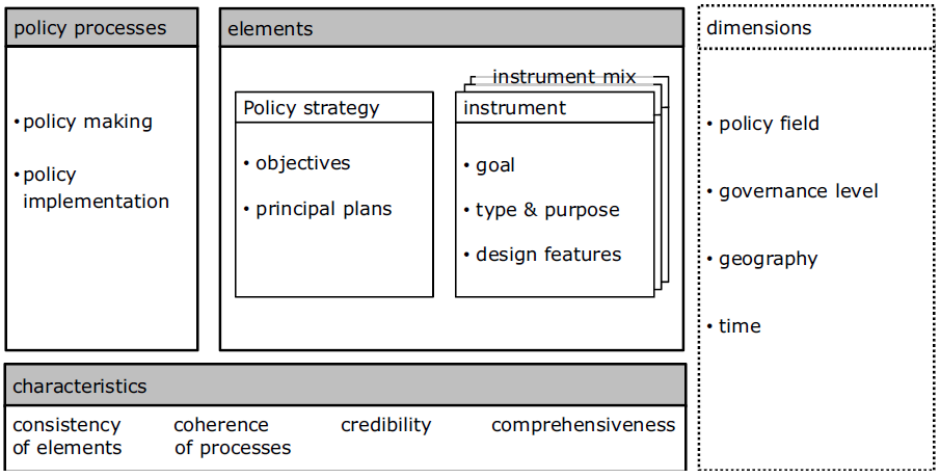

Figure 2.1: Building blocks of the extended policy mix concept (Rogge & Reichardt, 2016)

Furthermore, Kern & Rogge (2018) identified two main shortcomings to earlier research on transition policy. The first is a broader shared critique namely, the limited attention to how policy instruments react to one another and that most studies address (the effect of) one policy instrument rather than a combination of policy instruments (Kern & Rogge,2018; Aragón-Correa et al., 2020). This shortcoming can be overcome by emphasising more on the effects of credible long-term policy supported by ambitious and stable targets, the creation of new green innovations and on parallel the destruction of incumbent systems, the acknowledgement that a policy mix might never be fully coherent nor consistent as well as that policy mix needs constant adjustments and finally understand how policy mixes coevolve with the socio-technical change. Secondly, the limited attention given to linking policy outputs with policy outcomes and how this impacts the aimed transition through policy. Research on

transition policy should try to include the impact that identified policy has and whether this is coherent to the policy goals. Through this additional analysis scholars can reach a better understanding of how a combined government incentives and socio-technical changes interact and what implications this has for future design of combined government incentives (Kern & Rogge, 2018).

It is important to recognise that the design of combined government incentives is significantly influenced by the governments vision on both the topic addressed by the policy (e.g., the urgency and relative importance) as well as the dominating paradigm on how policy in general should affect society (Cirone & Urpelainen, 2013; Wright & Nyberg 2017; Dale et al., 2019; Edmondson et al., 2019). This study recognises that the governments vision can have a profound effect on policy design and how this subsequently affects corporate behaviour. However, considering the political commitment through international agreements, as discussed in the introduction, in addressing the negative externalities related to greenhouse gas emissions (e.g., CO_2) are assumed as well as that policy recommendations within the dominating paradigm are applicable for adoption by the government. Additionally, it is Important to point out that the impact of combined government incentives are contingent on the stability of the government, the literature clearly shows a strong relation between the duration of policy and the effect policy has in reaching her objectives (Cirone & Urpelainen, 2013; Dale et al., 2019; Edmondson et al., 2019). If policy is not protected from shifts in political regimes, the likelihood of long-term success decreases significantly (Dale et al, 2019; Edmondson et al., 2019). Stability in policymaking also influences how the government is being perceived by firms, a political climate that results in significant changes in policy within a relative short timespan will likely result in lower perceived credibility, stability and predictability of the government by firms. This will subsequently result in a lower commitment from firms to this policy due to for example uncertainty about the payback time of investments (Edmondson et al., 2019). Additionally, policymakers need to recognise the importance that the heterogeneity of political systems play in influencing the outcomes of a collective political strategy, outside actors will try to influence policymaking both positively and negatively effecting policy design, implementation and enforcement (Patnaik, 2019).

Before addressing the way policy can be designed and what combination of government incentives embedded in a policy mix likely lead firms to decarbonise their activities, as discussed in paragraph 2.3, it is important to understand that in order to institute behavioural change, first the motives that firms have for adopting environmental policy and specific policy with the aim of decarbonising their activities need to be understood, which will be discussed in paragraph 2.2. However, before addressing the motives of firms there is a specific complexity to the effort of decarbonising firms, namely the specific technologic aspects and challenges in reducing greenhouse gas emissions which also have implications for policy design which will subsequently be addressed.

2.1.2 Combination of government incentives: technological aspects to decarbonisation

Policymakers are typically more concerned with the outcome in certain environmental fields (such as reduction greenhouse gases) rather than the process of innovation and technological development itself (Demirel & Kesidou, 2011; Horbach et al, 2012). The existing literature does provide some insights in the changes needed for firms to decarbonise. The required change is to a large extent driven by innovation and adoption of developed technologies, Demirel & Kesidou (2011) differentiated between three types of innovations that contribute to decarbonisation, these are: end-of-pipeline pollution control technologies, integrated cleaner production technologies and environmental R&D. It is important to have a strict definition of the type of innovation trying to influence through policy. The distinction between incremental and radical innovation has different policy implications, also there is a distinct difference from a technology perspective between innovation new to the world and the push for broader adoption of technologies (Kemp & Pontoglio, 2011). In research on the effects of government policy on innovation Dolfsma & Seo (2013) developed a 2x2 matrix in which they classify technological development on the nature of the technology (discrete, more independent of specific knowledge development in the past and cumulatively, more dependent on past developments and prone to specific knowledge) and the degree of network effect in the market (being low or high based on the (inter)dependence on complementary technologies). Based on this classification the scholars argued for specific innovation policy implications (figure 2.2) that considers the underlining characteristics of technological development (Dolfsma & Seo, 2013).

		Nature of technology	
		Discrete	**Cumulative**
Network effect in market	**Low**	***Romanticism*** 1. Funding and tax credits for R&D. 2. Supporting universities and research centers. 3. Assisting companies to commercialize innovative technology. 4. Innovation vouchers. 5. Stimulate innovative entrepreneurship.	***Standing on the shoulders of giants*** 1. Promote regional clustering. 2. Encouraging technology upgrades through subsidies and tax credits. 3. Procurement policies. 4. Innovation brokerage.
	High	***Schumpeter mark I*** 1. Easy access to intellectual property by third parties. 2. Promoting harmonized standards or requiring compatibility among technologies.	***Schumpeter mark II*** 1. Activating antitrust law to prevent lock-in. 2. Deregulate industries. 3. Liberalize markets. 4. Standard setting/enforcing. 5. Flexible IPR regime.

Figure 2.2: Technology characteristics influencing the design of combined government incentives (Dolfsma & Seo, 2013)

To differentiate between the types of technological solutions that the government intents through policy is important, since the adoption or integration of existing solutions (e.g., technologies and changes in processes, which are more incremental in nature) requires a different emphasise on the design of combined government incentives than the search for new solutions (environmental R&D, which likely are more radical in nature) (Dolfsma & Seo, 2013). At the start of the transition, when the solutions (e.g., technologies) are still uncertain it might however be a sensible policy strategy to have

more diversity in experiments and approaches, when the technology in certain areas matures so should government policy become more coherent with the aim of diffusion and standardisation. This requires the aspect of timing to be an integrated part of policy design and evaluation of policy during the transition (Edler, 2016; Bataille et al., 2018; Rissman et al, 2020). The trade-off that exists is that when governments promote coherence too early in the transition of decarbonisation this risk lock-in of possible unfavourable technologies, when policy does not become coherent it might block the diffusion of technologies and solutions needed for decarbonisation (Edler, 2016; Grubb, McDowall & Drummond, 2017; Rissman et al, 2020). Policy mixes subsequently need to reflect the different technological developments as well as infrastructure changes (Grubb, McDowall & Drummond, 2017). Coherent policy approaches within delimitated industries are needed to ensure the right set of combined government incentives that impacts an industry to make the transition towards decarbonisation (Rogge & Reichardt, 2016; Imbert et al., 2017; Rogge et al., 2017; Bataille et al., 2018; Rissman et al, 2020).

2.2 Corporate motivates: why firms would adopt environmental policy

Firms have a wide range of motives to legitimise their existence and why they behave the way they do. In this study the motivation of firms in relation to their willingness to decarbonise their activities is addressed, for example, by adopting new technologies or changing their production processes but also participating in the creation of new (radical) solutions. By only focussing on certain aspects of firm motivation it is required to make certain assumptions on the basic motives of firms. These are that firms have the intention to stay i.e. they strive for continuity and seek legitimacy for their existence, firms inherently want to comply with the law and firms have economic motives which implicates that firms want (in varying degrees) to be profitable and seek competitive advantages over other firms in doing so, the latter is explained through transactions cost theory by Coase in 1937 which Williamson further elaborated in 1981 that states that firms when making decisions always choose the option that minimises these transaction costs (Child, Hsieh & Tallman, 2019). The main purpose of a firm, or raison d'être, is to survive by establishing and maintaining a competitive advantage and the underlining motives of firms that explain firm behaviour are largely derived from this (Child et al., 2019).

While this study focuses on the specific policy to decarbonise firm, the policy falls in a larger category of environmental or climate change policy (e.g., policy with the aim of reducing negative externalities on the natural environment). In designing environmental policy, it is important for policymakers to understand what motives firms have and how they are likely to respond to new policy. The corporate social responsibility (CSR) strand of literature provides insights in what motives firms have when adjusting their environmental strategy, while CSR is mostly voluntary the identified motives are also likely applicable on the broader field of environmental policy. One of the basic premisses in the

adoption of environmental policy by firms is that there is, while in varying degree, pressure from either inside or outside the organisation to meet the changing expectations that different stakeholders have about the activities of the firm and its impact on the environment (Aguilera et al., 2007). It is also important to recognise that firms do not operate in isolations, firms are embedded in an institutional environment that influence decision-making and enables firm to make strategic decisions (Weaver, Treviño, & Cochran, 1999).

Within the described context scholars identified several distinct motives of firms to adopt environmental policy, these include both economic and non-economic motives (table 2.3). The economic motives are in the core connected to the basic motives, the motive to survive by creating and maintaining a competitive advantage. This Economic logic (Hambrick & Fredrickson, 2005) is a strong component in the strategy of a firms and subsequently also a strong motivator in changing the environmental strategy of the firm by adopting environmental policy. To what degree a firm is successful in creating and maintaining a competitive advantage and how the firms and its main stakeholders perceive its relative place in the economic environment is likely to determine the extent or willingness of firms to adopt environmental policy (Bansal & Roth, 2000; Campbell, 2007). Environmental policy that has a direct or indirect perceived positive effect on the profitability of the firms thus is a strong motivator for firms to adopt environmental policy. In the organisational justice literature this effect is referred to as **instrumental motives** (Aguilera et al., 2007), the firms motivation is driven by self-interest and the need to control. Firms however are not identical and although they all seek continuity through the creation of profits the rationale behind how this profit should be created varies. In the developed world two main models to this rationale can be identified, these are the Anglo-American and Continental models (Aguilera, 2005). For the design environmental policy this matters since firms that are under the sway of the Anglo-American model, chasing shareholder wealth-maximisation by increasing short-term profitability, are less likely to adopt environmental policy that negatively affect the firms short-term profitability (Aguilera, 2005; Campbell, 2007). Whether the firms is more influenced by the Anglo-American model or Continental model (stronger focus on long-term profitability, which is more common in continental Europe and Japan), both are sensitive in the adoption of environmental policy if this is perceived to increase or maintain competitive advantage and ensure the profitability of the firm. For policymakers it is important to know if the target industry is more focussed on the shorter- or longer-term profitability so policy can be designed accordingly (Aguilera et al., 2007). Next to the instrumental motives, several non-economic motives can be identified, these are relational, moral and legal motives and will subsequently be discussed.

The adoption of environmental policies by firms due to **relational motives** can be explained through the Stakeholder theory (Child et al., 2019), of which shareholders are one of the most dominant. In

likeness of the instrumental motive, the relationship motives are also influenced by the focus on short- or long-term profitability through the pressure stakeholders have on the firms strategic decision-making. In the continental model, relationship motives go hand-in-hand with long-term profitability, thus it is likely managers of such firms are more inclined to adopt environmental policy when this results in higher perceived legitimation among the various shareholders (Aguilera et al., 2007). In the pursuit of social legitimation, which relate to the raison d'être, firms will adopt environmental policy if this preserves their legitimacy and ensures the long-term survival and license to operate of the firm regardless of the economic motive of the firm (Bansal & Roth, 2000; Aguilera et al., 2007).

While the firms economic and relational motives are important drivers behind to likeliness to the adoption of environmental policy by firms, the firms employees as well as people that represent the stakeholders of the firms are influences by their own morality, which they bring to the respective organisation by influencing decision-making based on their personal morality, values and cognitive biases (Aguilera et al., 2007). These **moral motives** are mainly recognised on organisation level in the Stewardship theory (Davis, Schoorman, & Donaldson, 1997), which suggest that members of a firm can induce a firm to make decisions beyond their primary economic interest or self-fulfilment. In addition, consumer pressure that comes forth out of moral questioning the activities of the firm can be a powerful influence for firms do adopt environmental policy, especially if they are well organised and can damage the reputation of the firm in eyes of the firm (Smith, 2016).

All of the aforementioned motives directly or indirectly come from inside the firm and the institutional environment in which the firms operates. There is however another motive that the government can address though policy to force firms in adopting environmental policy, this is the **legal motive** (Aguilera et al., 2007; Campbell, 2007). In the introduction of this paragraph, it is mentioned that firms inherently want to comply with the law, for when firms do not, this could result in an immediate risk for their continuity. Government regulations on environmental policy that is well designed and enforced will very likely results in the adoption of these regulations by firms. There are however limitations and trade-offs to be recognised when using regulations, these will be discussed in the paragraphs on the possible environmental policy instruments that incentives firms to decarbonise their activities. The combination of incentives embedded in the environmental policy mix should be designed to target the different motives of firms simultaneously. It is however likely that a hierarchy exist in what motives influence a firm environmental strategy and the subsequent adoption of environmental policy (Aguilera et al., 2007).

Corporate motive	Rationale	Behaviour at corporate level	Source
Instrumental	Economic and instrumental logic, competitiveness and the economic environment	- Sales generation (new markets, price premium) - Cost reduction (eco-efficiency, lower cost of capital, employee motivation) - Risk reduction (less litigation risk)	Bansal & Roth, 2000; Hambrick & Fredrickson, 2005;Aguilera et al., 2007; Campbell, 2007; Child et al., 2019
Relational	Legitimacy, stakeholders	- Good relations with internal and external stakeholders - Maintaining legitimacy ('licence to operate')	Bansal & Roth, 2000; Aguilera et al., 2007; Child et al., 2019
Moral	Moral motives, social responsibility	- Sense of duty (deontology) - Higher-order values	Smith, 1990; Davis, Schoorman, & Donaldson, 1997; Aguilera et al., 2007
Legal	Complying with regulations	- Regulatory compliance - Avoidance of fines or closure - To ensure continutity	Aguilera et al., 2007; Campbell, 2007

Table 2.3: category of generic corporate motives that influence the adoption of environmental policy

2.2.1 Corporate motives: specific motivational aspects to target through environmental policy

It is likely that solutions in becoming carbon neutral are in different stages, ranging from non-existent (i.e., yet to be invented) to ready for adoption by firms. Firms have different motives to adopt existing solution or invest in innovation or R&D, the behavioural motives of firms provided by the innovation as well as the climate and environmental policy strand of literatures will likely provide valuable insights for the design of policy to incentivise firms in decarbonising their activities. These insights relate to the identified generic motives of firms in the previous paragraph, it is however likely that the hierarchy of motives in a specific industry differs or that firms due to various internal or external factors are more or less inclined to adopt policy and subsequently should be taken into consideration when designed policy that targets a specific industry. These insights, presented in table 2.4 are categorised based on the identified generic corporate motive presented in table 2.3., will be discussed in this paragraph.

In a longitude study on five Australian firms, Wright & Nyberg (2017) found several aspects between the conflicting nature of environmental policy and corporate motives. Firms are in general due to technological and financial developments mainly focussed on short term objectives and outcomes. This results in the difficulty of firms in maintaining a stable environmental strategy and the likeliness that firms abandon the strategy to address short-term problems and opportunities (Wright & Nyberg 2017), this is reflected in the instrumental motives firms pursue. The activities that the firm exploit are in most cases the cause of negative externalities such as greenhouse gases, the profitability of firms is thus to a large extent contingent on these activities. Firms thus have an interest in framing climate policy in ways that do not affect their profitability. Short term interest in both political and organisational context need to be diminished by limiting corporate influence on policymaking and by designing policy that encourages long term planning (Wright & Nyberg, 2017). Based on a quantitative

analysis on surveys conducted to study the motives of firms to participate in (eco-)innovation, Demirel & Kesidou (2011) found that efficiency and corporate image are strong motives for firms to pursue incremental innovation or the adoption of existing technology for the prevention of negative externalities such as greenhouse gases.

Cost savings appears to be the most significant motive for firms to invest in R&D (Demirel & Kesidou, 2011), which are more likely to result in radical innovation. Based on a regression analysis Tsay & Lioa (2017) found that high levels of market demand have a positive effect on the likelihood that firms adopt an environmental strategy that led to more investments in innovation. Firms that develop a proactive environmental strategy are likely doing so in response to their perception of society's needs (Wright & Nyberg, 2017), which relates to the relational and moral motives. Based on the close relation between environmental performance and cooperate image it is likely firms adopt voluntary regulations to boost their image, it can also be used to increase the firm's legitimacy (Tsay & Lioa, 2017). The economic (i.e., instrumental) motives of firms need to be considered when designing innovation policy, trying to induce innovation that also enhances productivity will result in a different corporate response compared to mitigation of negative externalities which in most cases increase costs (Horbach et al., 2012). Other internal factors that have been identified by scholars as likely moderators to the firms motivation adhering to government policy are the degree of financial performance of a firm, which has effect on both compliance of regulations (Asch & Seneca, 1976) as well as likelihood of participation in the creation of legislation (Bhuyan, 2000). The visibility of the activities (i.e., practices) of a firm influences the degree of firm response to policy (Okhmatovskiy & David, 2012).

The response of firms on government policy is not only dependent on internal motives, but changes in the external environment are also one of the main reasons (i.e., motives) for firms to adjust their strategy (Porter, 1998). Firms adopted the topic of climate change policy largely in response to external criticism on their business activities (Wright & Nyberg, 2017). Scholars found that the external environment of firms has several implications on how firms respond to policy. The predictability of the environment is an important factor in the adaptation of firms to new government regulations (Raaijmakers et al., 2015), as discussed in the first paragraph of literature review the government can contribute to this directly by setting clear rules and demonstrate her commitment towards policy. In the external environment of firms some actors have more influence on the behavioural response of firms than others, how the firms' competitors (i.e., peers) behave towards government intervention such as financial sanctions or disclosure of information are likely to influence the response of the individual firm towards policy (Bartley & Schneiberg, 2002; Schuler et al., 2002; Okhmatovskiy & David, 2012). In both cases the instrumental motives (costs saving & efficiency) appear to be the leading motive of firms to adjust their behaviour, however firms are sensitive to their corporate image

especially if their activities are highly visible which can be explained as a need for legitimacy and appearing to be socially responsible which refer to the relational and moral motives in the framework. In table 2.4 an overview of the implication for the design of combined government incentives as a result of firms motivations and how this influence the corporate behaviour towards environmental policy is included, which provides further understand on how policy design with the aim of decarbonising firms.

Generic corporate motive	Specific motivational aspects of the firm that influences the firm behaviour towards environmental policy	The resulting behavioural response and effects on the firms environmental strategy	Implication for policy design	Sources
Instrumental	Need for short-term profitability	Difficulty of firms in maintaining a stable environmental strategy and the likeliness that firms abandon this strategy to address short-term problems or opportunities.	Design of policy that encourages long term planning.	Wright & Nyberg (2017)
	Cost saving	Cost savings appears to be the most significant motive for firms to invest in R&D.	Policy that aims to increase the R&D output in a given industry with a higher uncertainty of the future application of the R&D should aim to share the investment risk equally within the industry and as a government bear (some of) the risk.	Demirel & Kesidou (2011)
	Reaching higher levels of efficiency	Firms pursue incremental innovation or the adoption of existing technology for the prevention of negative externalities such as greenhouse gases if this leads to greater efficiency.	Encourage the adoption of existing technologies through information diffusion and push for the adoption of best practices.	Demirel & Kesidou (2011)
	Poor financial performance	It is likely that firms have a stronger internal focus and do not participate the policy-making process.	In designing policy in cooperation with the industry ensure that the actors involved are a sufficient representation of the industry.	Bhuyan, 2000
		Higher chance that firms are less likely to comply with regulations.	Industries with low margins or individual group of firms with poor financial performance likely require higher level of governance.	Asch & Seneca, 1976
	Experience high levels of market demand	Increased likelihood that firms adopt an environmental strategy that lead to more investments in innovation.	If direct targeting of firms in a given industry is proven suboptimal or insufficient the government could target the (end) customer of that industry to incentivize the necessary behavioural change.	Tsay & Lioa (2017)
		Firms that develop a proactive environmental strategy are likely doing so in response to their perception of customer needs.		Wright & Nyberg, 2017
Relational / Moral	Exploiting activities that causes negative externalities (e.g., green house gases)	Firms have an interest in framing climate policy in ways that do not affect their profitability.	limiting corporate influence on policymaking.	Wright & Nyberg (2017)
Relational / Moral	Negate negative effects on the firms image	Pursue incremental innovation or the adoption of existing technology for the prevention of negative externalities such as greenhouse gases.	Stimulate industry adoption of best practices and voluntary standards to reduce greenhouse gas emissions as well as encourage diffusion of existing solutions.	Demirel & Kesidou (2011)
		Based on the close relation between environmental performance and cooperate image it is likely firms adopt voluntary regulations to boost their image.		Tsay & Lioa (2017)
Legal		The symbolic adoption of voluntary regulations if this proves sufficient to reduces or eliminates pressure on the cooperate image.	Ensure sufficient compliance and control mechanism in both design and implementation of (voluntary) regulation.	Aragón-Correa et al. (2020)
Relational	Interpretation or experience of the firms' competitors (i.e., peers) behaviour towards government policy	The behaviour of firms' competitors (i.e., peers) towards government policy are likely to influence the response of the firm towards policy.	The involvement of key stakeholders in policy design and subsequent adoptions can increase the likelihood of widespread adoption in a industry.	Bartley & Schneiberg, 2002; Schuler et al., 2002; Okhmatovskiy & David, 2012
Relational / Moral	Experience high visibility of the firms activities	Firms are more inclined to adopt (voluntary) regulations if their activities have a higher degree of visibility.	The degree of visibility is likely to have a effect on the need of the governance intensity within the targeted industry	Okhmatovskiy & David, 2012
Relational / Moral	Reduce external criticism on their business activities	Increased likelihood of the adoption of climate change policy.	Public awareness campaigns, include the greater public and target (end) consumers.	Wright & Nyberg, 2017
Legal	Experience a higher predictability of the external environment in which the firms operate in.	Firms are more likely to adopts new regulations if the external environment is more predictable.	In industries with higher uncertainty it is likely a higher intensity of governance is needed. In addition, policy should aim to provide more certainty or at the very least not contribute to a greater uncertainty.	Raaijmakers et al., 2015

Table **2.4**: specific motivational aspects of firms influencing the design of a policy mix

2.3 Design of combined government incentives: considerations for design

Scholars found that several design aspects of government policy influence the outcome that policy has on the intended behavioural change of the firm targeted by the combined government incentives. First of all, policymakers need to account for the contextual environment and the effect policy has on the different actors within the targeted environment (Demirel & Kesidou, 2011; Kemp & Pontoglio, 2011;

Wijen, 2014; Tsai & Liao, 2016; Aragón-Correa et al., 2020). Policymakers also need to assist firms in internalising the belief that the necessary measures are an opportunity for sustainable future growth and that unlimited growth without considering the impact on the environment is no longer a viable option as well as that policymakers should help firms in creating a common narrative to bolster against conservative forces both inside and outside the firm (Wright & Nyberg, 2017; Bataille et al., 2018). Other factors that have been identified by scholars to have a positive effect on the effectiveness of government policy are: policy design aimed for long term results (Demirel & Kesidou, 2011; Wright & Nyberg, 2017; Yigitcanlar et al., 2019), policy congruence, coherence and alignment between policy on all government levels (Demirel & Kesidou, 2011; Kemp & Pontoglio, 2011; Tsai & Liao, 2016; Dale et al., 2019; Edmondson et al., 2019; Yigitcanlar et al., 2019), policy to overcome information and knowledge asymmetry (Horbach et al., 2012; Tsai et al., 2017), policy that promote collaboration between industries and universities (Yigitcanlar et al., 2019), policy that tries to incentivise investments in new solutions (e.g., radical innovation) should be designed with the focus of equally sharing risk between all actors involved (Yigitcanlar et al., 2019) and finally, the ability to enforce designed policy (Kemp & Pontoglio, 2011; Aragón-Correa et al., 2020).

Next to the aforementioned elements to the design of combined government incentives that are needed to reduce the mismatch between policy and practises, there is another complexity involved with the design of policy to change corporate behaviour in decarbonising their activities. The goal might be relatively clear, namely a society that is carbon-neutral by 2050 (2050 Long-Term Strategy, 2017), the solutions that enables society to reach these goals are largely unknow and likely dependent on a variety of contextual factors. This means the government needs to design combined government incentives without understanding the full complexity of the possible outcomes that policy has and the effects that these may have on corporate behaviour. In addition, the high contextual complexity and specify per industry and the number of actors and factors involved related to the transition towards carbon-neutral activities makes it difficult for the government to measure all the effects policy has on the targeted industry and actors within such an industry. Wijen (2014) addressed this complexity and theorised that a higher degree of field opacity (causal complexity, practice multiplicity and behavioural invisibility) reduces the ability of institutions (e.g., combined government incentives) to achieve their intended goals by means of these institutions (i.e., means-ends decoupling). The suggested solution for combined government incentives suffering from field opacity are setting detailed and explicit rules with the aim of bringing clarity, by creating strong government incentives to address the motivation problem and to transfer universal best practices to increase the capabilities of actors in opaque fields who might lack the relevant knowledge to implement policy adequately (Wijen, 2014). The solutions of designing more specific and stringent policy does have an expected trade-off however, since it is

likely that these policies are less flexible and thus not equipped to account for the context contingency that environmental issues have (Wijen, 2014). It is therefore advisable for policymaker that design combined government incentives to incentives industries in decarbonising their activities to be aware of the aforementioned trade-off and balance specificity and stringently in policy design with a more flexible implementation, design niche policy for industry specific barriers and timely adjust policy design and implementation when the situation requires this (Wijen, 2014).

2.3.1 Design of combined government incentives: environmental and innovation policy

The combined government incentives for environmental and innovation policy need to incentivise firms to decarbonise their activities can exist of a combination of mandatory regulations (command and control) and a variety of voluntary instruments (e.g., market-based instruments such as environmental taxes or subsidies) (Aragón-Correa et al., 2020). Some scholars argue that stricter environmental regulation have a limited effect since these are being offset by market effects such as economic growth (Hille et al, 2020). Other scholars dubbed regulatory policy as a strong motive for firms to invest in environmental solutions (Kemp & Pontoglio, 2011; Horbach et al., 2012; Horner et al., 2013). Voluntary regulations are more effective in motivating firms to adopt existing solutions rather than innovating (Demirel & Kesidou, 2011), hence voluntary regulations alone might not be effective when governments try to motivate firms to radically innovate. Horbach et al. (2012) found that for the adoption of emission reducing technologies the effects of present and future regulation appear higher than in other areas of environmental regulations, since these measures are in inherently costs increasing for firms. Voluntary adoption of environmental strategies by firms increases the likelihood that firms participate in innovation as well as boost their image and legitimacy (Tsai & Liao, 2016) and the voluntary adoption of standards (e.g., ISO 140001) are found to have positive effects on the adoption and innovation of carbon-neutral technologies, thus can subsequently be an effective supporting mechanism for government policy (Demirel & Kesidou, 2011). In addition, voluntary adoption of reporting requirements helps policy development in two ways, it enables government agencies to monitor current effect of combined government incentives but also can result in better attuning of future policy (Dale et al., 2019). The adoption of voluntary standards by firms is likely not only driven by government policy but influenced to a greater extent by other private actors (e.g., market intermediaries). The adoption of voluntary standards is also influenced by the embedded regional institutional logics in which market logics or community logics can be more dominant (York, Vedula & Lenox, 2018). When the first is dominant, combined government incentives and market-oriented actors prove effective in incentivising firms to adopt voluntary standards, when the latter was dominant in regions the combined government incentives where less effective (York, Vedula & Lenox, 2018). Governments however do need to be aware of symbolic adoption of voluntary instruments

(Aragón-Correa et al., 2020). It is very likely a combination of both mandatory and voluntary policy can overcome challenges such as lack of accountability, free-riding and adverse selection (Aragón-Correa et al., 2020) or insufficient market demand (Mazzucato, 2016; Tsai & Liao, 2016). In the choice of leaning towards a more mandatory or voluntary combination of government incentives, it is advisable to compare the desired policy outcome with the motives of firms that are targeted by the policy, if the outcome are to a higher degree aligned with the (self-)interest of firms in the targeted industry it is likely that a more voluntary combined government incentives is sufficient in reaching the aimed behavioural change since firms will have the incentive to organise the required change themselves or across an industry. In contrasts, when the desired policy outcome is likely is not aligned with the interest of the firms or they are indifferent towards it then it is a more mandatory combined government incentives is required, as a substitution for instrumental or relational motives.

Table 2.5 shows a comprehensive overview from Kemp, Soete, and Weehuizen (2012) of policy instruments on environmental and innovation policy classified by its characteristics, purposes and how it can be applied by the government. The table is complemented with the following characteristics based on the discussed literature: 1) type, being voluntary or mandatory based on Aragón-Correa et al., 2020, 2) categorised on generic corporate motives based on table 2.3 and 3) the proposed design in the policy mix (i.e., the combination of government incentives). The instruments elaborated in the aforementioned table provide direction to the combined government incentives for decarbonisation, since the decarbonisation of firms likely requires a combination of environmental and innovation policies to succeed. There are however policy instruments that specifically addresses decarbonisation, these will be discussed in paragraph 2.3.2. The possibilities of policy instruments may seem endless, the effectiveness of policies however is likely not in the precise policy tools choses by the government but in the alignment between policies and the congruence between the design of policies and the intended behavioural change (Kemp, Soete, and Weehuizen, 2012; Rogge & Reichardt, 2016).

Policy instruments	Type	Characteristics	Application	Purposes	Targeted corporate motivation	Proposed design in policy mix (i.e., combination of government incentives)	Sources
Environmental standards	Mandatory / Voluntary	· Effective in most cases when mandatory (if they are adequately enforced). · Uniform standards give rise to inefficiencies in case of heterogeneous polluters.	· When differences in the marginal costs of pollution abatement are small and economically feasible solutions to environmental problems are available.	· Technological diffusion and incremental innovation	Legal (mandatory) / Relational / moral (voluntary)	**Mandatory:** Clear environmental standards can shape a consistent and stable regulatory environment when implemented for the long-term and is congruent and coherent with other policy instruments. Properly implement it can be a prerequisite to investment decision and R&D spending by firms. **Voluntary:** voluntary instruments in preperation of mandatory standards can incentivize innovation and technology diffusion, especially when combined with taxes, R&D and investments subsidies.	Demirel & Kesidou, 2011; Kemp & Pontoglio, 2011;Kemp, Soete, and Weehuizen, 2012; Horner et al., 2013 Tsai & Liao, 2017; Wright & Nyberg, 2017; Dale et al., 2019;Edmondson et al., 2019; Yigitcanlara et al., 2019; Aragón-Correa et al., 2020
Technology-forcing standards	Mandatory	· Effective (in focusing industry's minds on environmental problems). · Danger of forcing industry to invest in overly expensive and suboptimal technologies. · Problem of credibility.	· When technological opportunities can be developed at low costs; · When there is consensus about the appropriate compliance technology.	· Technological innovation	Legal	In combination with environmental standards and innovation waivers it can be effective in the development and diffusion of technology by creating a level playing field and the ability to give firms time to develop technologies thus reducing the risk for firms.	Kemp & Pontoglio, 2011; Kemp, Soete, and Weehuizen, 2012; Aragón-Correa et al., 2020
Innovation waivers	Voluntary	· Potentially effective and efficient. · Danger of strategic behaviour of industry.	· When technological opportunities are available and when there is uncertainty about the best solution.	· Technological innovation	Instrumental	Reduces the trade-off of environmental and technology-forcing standards by balancing specificity and stringently with the flexibility that innovation waivers provide.	Kemp, Soete, and Weehuizen, 2012; Wijen, 2014; Aragón-Correa et al., 2020
Tradable permits	Voluntary	· Technically effective · Cost-effective (i.e., environmental benefits are achieved at lowest costs).	· Same as taxes; · Costs of monitoring and transaction should not be restrictive.	· Technological innovation and diffusion	Instrumental	- Needs to be combined with voluntary or mandatory environmental standards to be effective; - The combination of tradable permits and R&D / investment subsidies or tax reduction will likely proof a strong incentive for firms to adopt existing technology or best practices or to increase R&D activities.	Demirel & Kesidou, 2011; Horbach et al., 2012; Kemp, Soete, and Weehuizen, 2012; Tsai & Liao, 2017; Aragón-Correa et al., 2020
R&D subsidies	Voluntary	· Danger of funding second-rate projects. · Danger of providing windfall gains to recipients.	· When markets for environmental technology do not yet exist and when there is uncertainty about future policies; · When there are problems of appropriating the benefits from innovation; · When there is a need for knowledge spillovers between policy fields; · In cases of large social benefits and a lack of instrumental motives at firms.	· Technological innovation	Instrumental	- R&D subsidies on their own will likely fail to reach the aimed environmental effects, they should be introduced as a supporting instruments to standards, permits and covenants. - The combination of long-term environmental standards, with e.g. specific pathway to reduce GHG can help guide R&D activities and increases congruence between policy instruments. - Can be used to reduce and equally share risk between firms in the industry and between the industry and the government.	Horbach et al., 2012; Kemp, Soete, and Weehuizen, 2012; Wijen, 2014; Aragón-Correa et al., 2020
Investment subsidies	Voluntary	· In conflict with polluter-pays principle · Danger of windfall gains. · Politically expedient	· When industry faces a competitive disadvantage due to less strict regulations abroad.	· Technological diffusion	Instrumental	Same as R&D subsidies, but even more general in application increasing the risk of not reaching the aimed policy objectives. Should always be combined with other instruments that set the right path and enable congruence with policy objectives.	Horbach et al., 2012; Kemp, Soete, and Weehuizen, 2012; Wijen, 2014; Aragón-Correa et al., 2020
Taxes	Mandatory / Voluntary	· Efficient · Uncertainty about industry response · Danger that they provide a weak and indirect stimulus. · Total environmental costs for industry are likely to be high. · Limited political attractiveness.	· In cases of heterogeneous polluters that respond to price signals; · When there are many different technologies for achieving environmental benefits.	· For recycling, and material and energy saving · Technological diffusion and incremental innovation	Legal (mandatory) Instrumental (voluntary)	**Mandatory:** Likely to be highly effective in combination with voluntary standards to target the biggest polluters and incentives firms to reduce GHG emissions. This combination is also likely to reduce the means-ends trade-off by ensuring both flexibility in technological solutions and stringently due to the fact that the polluter still pays. **Voluntary:** similar to R&D and investment subsidies.	Kemp, Soete, and Weehuizen, 2012; Wijen, 2014; Aragón-Correa et al., 2020
Communication	Voluntary	· Helps to focus attention on environmental problems and available solutions. · Little coercive power · Is only an supporting instrument.	· When there is a lack of environmental consciousness; · When there are information failures.	· Technological diffusion and innovation (in the case of ecolabels)	Relational / Moral	- Adequate communication is relevant in combination with almost all policy instruments in providing a common narrative and internalizing beliefs; - Can be used to overcome information and knowledge asymmetry which increase the effect of both mandatory and voluntary policy instruments.	Horbach et al., 2012; Kemp, Soete, and Weehuizen, 2012; Tsai et al., 2017; Wright & Nyberg, 2017; Bataille et al., 2018; Aragón-Correa et al., 2020
Reporting requirements	Mandatory / Voluntary	· Support the government to increase their understanding of development in certain industries and in monitoring progress; · Provides firms the possibility to bench-mark their performance. · Is only an supporting instrument.	· When there is insufficient knowledge at government agencies or the inability to monitor policy performance adequately; · When current industry or trade associations did not provide in this up to date.	· Technological diffusion	Legal (mandatory) Relational (voluntary)	- It enables government agencies to monitor current policy effects, reducing the risk of symbolic adoption but also can result in better attuning of future policy, hence the introduction of reporting requirements can support all other policy instruments; - Preferably it is voluntary and supported by the respective industry to reduce bureaucracy and governance costs.	York, Vedula & Lenox, 2018; Dale et al., 2019; Aragón-Correa et al., 2020
Covenants and technology contracts	Voluntary	· Uncertainty about whether industry will meet agreements (should be supplemented with penalty for non-compliance). · Low administrative costs	· In cases of many polluters and many technological solutions (field opacity); · When monitoring environmental performance is expensive.	· Technological diffusion	Instrumental	Covenants between the triple-helix in combination with voluntary innovation incentives are likely to result in technology leaps. When properly designed it can also ensure the equal sharing of risks.	Kemp, Soete, and Weehuizen, 2012; Wijen 2014; Yigitcanlara et al., 2019; Aragón-Correa et al., 2020

Table 2.5: Environmental policy instruments a combination of government incentives

2.3.2 Design of combined government incentives: decarbonisation

Government policy with the aim to decarbonise is currently largely shaped under the basic premise that the chosen instruments should have the most limiting effect on the distortion of trade and competition. This is the most cited reason not to pursue a pathway towards decarbonisation, namely the claim that decarbonisation policy has negative effects on socioeconomic outcomes such as competitiveness and affordability (Peñasco, Anadón & Verdolini, 2021). Additionally, the interaction between policy instruments and targets on greenhouse gas emissions and energy consumption are complex and can lead to both negative or positive interactions such as conflicts, complementarities or synergies (Duscha & Del Rio, 2017). The choice of policy instruments and its design features are crucial in delivering the aimed outcome. Based on a systematic review on the effects of decarbonisation policy instruments Peñasco, Anadón & Verdolini (2021) found that in general most policy instruments have positive impact on the environmental outcome, with R&D funding having a limited direct effect compared to carbon taxes and trading schemes which are to be found very effective. They however also concluded that many instruments are, to a varying extent, connected with negative impact on socioeconomic outcomes (Peñasco, Anadón & Verdolini, 2021). Firms that adopt new technologies that result in decarbonisation are likely to incur higher costs in both their supply chain as well as production process, without government intervention it is unlikely firms will be able to and succeed in decarbonising on their own (Bataille et al., 2018). Most primary industries (e.g., electricity, heat, water) not only face the challenge to become more sustainable, in doing so they need to maintain affordable and provide sufficient security of supply (Grubb, McDowall & Drummond, 2017). Since the decarbonisation of the activities of firms will require firms to incur costs in order to change their processes to minimise the negative externalities of CO_2 emission it is more than likely that they will not do this voluntary, hence some scholars argue that strong mandatory component that limits the ability of firms to emit CO_2 needs to be included in a combination of government incentives that leads to the decarbonisation of firms (Aragón-Correa et al., 2020). To reduce the trade-off between the positive environmental and negative socioeconomic outcomes on individual firms, across industries as well as society as a whole, policy instruments targeting specific industries or group of firms should be tailored to provide sufficient financial and fiscal support, especially for new entrants and development of immature technologies or diffusion of relative new solutions (Grubb, McDowall & Drummond, 2017; Bataille et al., 2018; Peñasco, Anadón & Verdolini, 2021).

There are several policy goals that can be embedded in the combination of government incentives with the aim of decarbonising firms activities, these however vary in nature of how they contribute to decarbonisation. Policy can be divided in several economic categories, these include input substitution (e.g., replacement of fossil fuel), process changes (e.g., reduction of energy consumption and capture

and storage of carbon) and demand reduction (e.g., carbon-neutral substitutions and increasing circularity) (Goulder et al., 1999). The success of decarbonisation can be measured in both carbon dioxide (CO_2) reduction or in the increased share or energy generated from renewable energy sources (Staffell, 2017). The decarbonisation of firms can be achieved through multiple policy instruments such as CO_2 mitigation instruments (carbon pricing), promotion of electricity from renewable energy sources, corporate R&D support and introduction of mandatory or voluntary standards. In table 2.6 an overview based on a selective literature review of recent work on decarbonisation policy instruments is included, in the table the aforementioned policy instruments are elaborated on type of policy instrument (e.g., mandatory or voluntary), the likely effect on corporate behaviour, benefits and risks, categorised by targeted corporate motives and proposed design when embedded in a in policy mix with the aim of decarbonisation.

Government policy that aims to decarbonise through economically efficient instruments (e.g., carbon pricing, emission or technology standards) can result in a change in corporate behaviour on investment decisions as a result of increasing prices of carbon emissions, adoption of substitutions or processes changes resulting from industry wide standards or a cap on carbon emissions allowed in a specific industry (Bataille et al., 2018; Rissman, et al., 2020). The combination of CO_2 mitigating instruments and promotion of electricity from renewable energy sources can result in a higher consumer costs for energy and have the opposite effect by not resulting in a reduction in CO_2 emissions due to the growing energy consumption (Del Río & Cerdá, 2017; Bataille et al., 2018). The interaction of CO_2 mitigating instruments and promotion of electricity from renewable energy sources thus might result in negative interactions. These can however be negated when CO_2 mitigation through CO_2 taxes are designed to have a floor price with the aimed effect that newly added renewable energy generation does not reduce carbon prices below a desirable level (Del Río & Cerdá, 2017; Bataille et al., 2018). On the other hand, lower CO_2 prices might result in a lower effectiveness (or willingness) to participate in renewable energy programs. It is however also possible that higher CO_2 prices results in an uncontrollable growth of renewable energy driving the costs of production (Del Río & Cerdá, 2017). The combination of multiple policy instruments appears to be more effective in changing firms behaviour that leads firms to decarbonise their activities, for example the combination of economic instruments and R&D support can reduce the time-to-market of new technology, increase the subsequent diffusion and adoption of new technologies and incorporate these in industry-wide best practices and discourage carbon intensive activities (Bataille et al., 2018; Rissman et al., 2020). It is important that R&D funding and the subsequent projects are part of a technology portfolios and can be linked to R&D development across firms and government entities to ensure both collective risk sharing, cost reductions, learning but also ensure sufficient niche accumulations to enable transitions at the landscape level of the multilevel

perspective (Bataille et al., 2018). Striking the right balance between instruments is crucial in decarbonising firms in a steady but controllable pace (Grubb, McDowall & Drummond, 2017; Del Río & Cerdá, 2017; Bataille et al., 2018; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021). Complementary to this, decarbonisation policy should focus more on the technical changes required and how obstacles that inhibit the change can be overcome through policy (Barbaroux, 2014). Hence, policy should be designed to facilitate transformative change. Technology-specific market formation policy needs to supplement the neutral instruments of which the emphasise of policymakers should shift towards the former (Bergek, 2008). Since the solutions for decarbonisation are not clear it is advisable that a combination of government incentives is shaped based on the innovation system approach, by adopting a multi-dimensional and technology-specific combined government incentives, with the aim of supporting a wide range of immature technologies (Jacobsson, Bergek & Sandén, 2017). This however requires Policymakers to have a clear understanding of specific dynamics in the targeted industry. Policymakers should however accept a greater degree of uncertainty and adopt a policymaking approach of iteration and continuous learning (Jacobsson, Bergek & Sandén, 2017).

Policy category	Policy instruments	Tyoe	Application	Beneifts	Concerns / risks	Targeted corporate motive	Proposed design in policy mix	Sources
Carbon pricing	- Carbon tax (price); - Cap-trade system (quantity); - Hybrid of the above; - Import tariffs (price).	Mandatory / voluntary	- The development of new technologies, adoption and diffusion of best practises with the aim of input substitutions and process changes; - Discourage of carbon intensive activities.	- Technology neutral, since it does not force the adoption of a specific technology; - Requires limited government expertise of specific industry; - The revenue stream resulting from carbon pricing can be used to fund other policy instruments; - High environmental effectiveness (reduction of GHG).	- The use of carbon tax alone does not provide a guarantee of carbon reductions; - The use of cap-trade system alone might not provide sufficient price levels that lead firms to decarbonise; - Possibility of relocation of industry to countries with more favourable regulations; - Can have a negative, albeit short term, impact on competitiveness.	Instrumental	- Use a combination of both a quantity and price mechanism since that reduces the uncertainty of how the policy affects corporate behaviour; - In addition, industries that are subject to trading schemes should be (partly) exempt from carbon taxes to negate the negative impact on competitiveness; - Apply a minimum or floor price on carbon certificates to negate distortions in the policy mix; - The risk of relocation (or leakage) can be significantly reduces when a import tariff is introduced based on industry outputs; **In the mix:** Carbon pricing instruments used in isolation do not lead to diffusion of existing end of pipe solutions nor radical innovation. It is more effective when combined with RES-E and R&D support.	Grubb, McDowall & Drummond, 2017; Del Río & Cerdá, 2017; Bataille et al., 2018; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021
Renewable energy promotion (RES-E)	- Feed-in tariffs and premiums (price); - Tradable green certificates (quantity); - Auctions (quantity).	Voluntary	- The development and adoption of technologies; - Incentivize technological change; - Discourage of carbon intensive activities.	- Technology neutral, since it does not force the adoption of a specific technology; - Allows for the most cost effective technology to be implemented; - Highly effective on technological development and diffusion; - Provide (or substitutes) a demand pull; - Improve competitiveness and provides new entrants with the possibility to compete; - Increases public acceptance of renewable energy.	- Studies has shown that when designed in a certain way RES-E can have a negative effect on carbon pricing mechanisms resulting in adverse effects. - Especially if RES-E does not respond to technological evolution and is not flexible enough to adjust accordingly; - Quantity based instruments can limit (or cap) the growth of renewable energy; - Target setting based on relative targets are less effective since energy consumption is still growing; - Can favour dominant technologies.	Instrumental	- Adopt a end-consumer financing to negate the greater risk of budget financing for RES-E investors; - Combine price and quantity based instruments; - Target setting based on absolute generation caps resulting in easier coordination and higher certainty of the outcome; - Adjust the targets periodically; **In the mix:** RES-E is more effective when combined with corporate R&D support.	Grubb, McDowall & Drummond, 2017; Del Río & Cerdá, 2017; Peñasco, Anadón & Verdolini, 2021
Corporate R&D support	- R&D tax credits; - Grants; - Contracted research.	Voluntary	- Development of new technologies; - Changing or development new processes; '- More suitable to encourage radical innovation.	- Provides a technology push; - Highly effective on technological development; - Reduce development time (time to market) of technologies; - Reduce uncertainty at corporate level by reducing costs and sharing of risk; - Increase likeliness that corporates are willing to invest in R&D with aim of decarbonising.	- Could result in government favouritism of specific technologies; - High bureaucracy can lead to limited adoption; - Government must be willing to accept a degree of uncertainty of the outcome; - Government officials need have greater industry knowledge in order to select more favourable projects; - Individual R&D projects alone might not results in the necessary changes to decarbonise industries.	Instrumental	- R&D funding should not be designed in isolation, it is likely decarbonization requires innovations in the whole value chain; - Strict audit and review processes after the first phase of R&D grants ensure more effective future phases; - Limit bureaucracy as much as possible, higher levels of bureaucracy deter participation in programs; - The use of R&D tax credits should be limited to specific efforts of decarbonization and thus might be difficult to implement; **In the mix:** However a combination of direct R&D support through grants and R&D tax credits is likely to lead to higher corporate R&D spending.	Grubb, McDowall & Drummond, 2017; Bataille et al., 2018; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021
Standards	- Energy reduction (or efficiency) standards; - Emission intensify standards; - Performance standards - Component-level standards	Mandatory / voluntary	- Incentivize technological change; - Encourage adoption of best practises; - More suitable to encourage incremental innovation and diffusion of technologies.	- Industry-wide standards provide a level playing fiend; - Mandatory standards can be enforced; - Provides firms with the possibility to gain a competitive advantage.	- Voluntary standards are less likely to result in the aimed behavioural change; - Only effective when adopted in whole industry and preferably internationally; - Standards that are either to strict or loose can have adverse effects on the policy goal; - Can favour incumbent actors hence reducing competitiveness; - Less effective on providing imitate reduction of GHG and technological development.	Legal (mandatory) Instrumental / Relational (voluntary)	- Efficiency standards should be performance or objective oriented, with less focus on specific technology; - Standards should be updated frequently in pace with technological development; - Mandatory standards are preferred above voluntary standards; **In the mix:** Need to be accompanied with proper governance mechanisms; **In the mix:** Standards should be aligned with other government policy in order to prevent adverse effects.	Bataille et al., 2018; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021

Table 2.6: Policy instruments specific to decarbonisation that could be included in a combination of government incentives

2.4 Conclusion of the literature review

In order to understand the impact that a combination of government incentives have on corporate behaviour within a specific policy field it is necessary to properly identify the government incentives in this field and uncover the objectives and principle plans as well as specific design behind these. Additionally, previous studies indicate that it is necessary delineate the policy field studied to different dimension such as governance level(s), geography and time in order to empirically assess the effects of government policy on corporate behaviour. The outcome of this analysis is a combination of government incentives within a specific policy field that should be sufficiently delineated and understood, government incentives are thus embedded in an existing policy mix (i.e., combination of government incentives) and these impacts corporate behaviour (Rogge & Reichardt, 2016). Unclear is however how the scholar should uncover the impact that combined government incentives have on corporate behaviour, the aim of this study was to formulate an answer to this.

To understand the combined government incentives within a specific policy field is however not sufficient in determining the impact that the identified combined government incentives have on corporate behaviour, to enable this it is necessary to understand why firms behave the way they do and what likely motives firms have to adopt environmental policy. Through these identified motives it can be attempted to find an explanation of the interaction between the combined government incentives within a specific policy field and the identified corporate behaviour in that field. Four main motives of why firms adopt environmental policy were identified, which are both economic (instrumental) or non-economic (relational, moral and legal) in nature (Davis, Schoorman, & Donaldson, 1997; Bansal & Roth, 2000; Aguilera et al., 2007; Campbell, 2007; Child et al., 2019). Next to these categories of motives on the adoption of environmental policy there are several underlying motives relevant for firms to decarbonise their activities and policy that aims to incentivise firms to do so. Government policy needs to be attuned to impact the dominant motives of firms in order to incentivise firms in making the correct choices in the path towards decarbonising their activities (Edler, 2016; Grubb, McDowall & Drummond, 2017; Rissman et al, 2020). It is however important to understand that these aforementioned motives affect the behaviour of firms and adoption of environmental policy by firms collectively and that there is a likely hierarchy between motives (Aguilera et al., 2007). How these motives influence the impact of combined government incentives on corporate behaviour is however less understood, this study tried to uncover how combined government incentives relate to its impact on corporate behaviour through influencing the dominant corporate motives of firms and whether a hierarchy of these could be identified.

A significant part of this study is directed at the design of combined government incentives that are more likely to lead firms in decarbonising their activities through incentivising the dominant corporate

motives resulting in the aimed behavioural change. The existing knowledge on how individual policy instrument impacts the behaviour of firms is vast, how a combination of government incentives results in the decarbonisation of firms is far less clear and one of the underlying questions of this study. What the various previous studies indicated is that a wide range of policy instruments and in some instances a specific combination of these instrument might be more likely to influence corporate behaviour and lead firms to decarbonise their activities, these appear however very generic in design and it is unclear how they would impact the corporate behaviour of firms in specific industries. There is however a more fundamental part to the design combined government incentives in the field of environmental policy in general and specific to decarbonising that needs to be underlined. This is the inherent uncertainty of the solutions that are needed to reach the long-term objectives and to a carbon-neutral society, which results in a higher degree of field opacity and reduces the ability of policymakers to design policy with full comprehension of the intended goals (Wijen, 2014). To reduce the uncertainty of the outcome policy has in a specific policy field requires specific and stringent policy design, however the more specific and stringent policy are the more difficult it is to adjust policy to the changing policy field and to account for the uncertainty in what solutions are most effective in reaching the aimed policy goal, substantiating the effects of the aforementioned trade-off and how these influences corporate behaviour was a integrate part of this study.

The decarbonisation of firms appears to be mostly an technological effort, effective government incentives support both the diffusion of existing technological solutions and best practices by reducing the information and knowledge asymmetry as well as incentivise the development of new technologies and solutions through innovation and R&D by equally sharing risk and recognising it is a learning process (Dolfsma & Seo, 2013; Rogge & Reichardt, 2016; Imbert et al., 2017; Rogge et al., 2017; Bataille et al., 2018; Rissman et al, 2020). In order to achieve the first, specificity and stringently in policy design are needed, while the latter requires a more flexible policy approach and thus a trade-off on coherence in development and diffusion of technology and solutions is likely part of the design challenge of combined government incentives with the aim of decarbonising firms and the design is likely a balancing act between the aforementioned identified trade-off.

One of the first questions policymakers face is the choice of designing combined government incentives to have more emphasis on mandatory or voluntary incentives, research has shown that mandatory regulations are e.g., more suitable to ensure the adoption of existing solutions while voluntary policy instruments appear to be more successful in incentivising innovation (Demirel & Kesidou, 2011; Horbach et al., 2012). The choice between mandatory and voluntary is not black and white, there are various degrees in which combined government incentives can be more mandatory or voluntary in nature. In order for policy design to be successful in reaching its intended goals, the

combination of government incentives should be designed to target the hierarchy of motives through a combination of mandatory and voluntary policy instruments (Aguilera et al., 2007; Aragón-Correa et al., 2020). There is lack of understanding of how mandatory decarbonation should be, especially related to the variety of constellations of different industries, to further the understanding on this subject this study aimed to uncover this in relation to the industry of subject in this study.

The goal of becoming carbon neutral is an effort that takes several decades and a trade-off specific to decarbonisation policy exist between environmental vs. socioeconomic outcomes, albeit likely being temporary in nature. In order to overcome the resistance as a result of unfavourable socioeconomic outcomes, previous studies indicate that the combined government incentives should provide sufficient financial support for diffusion of new solutions and balance the effect in policy duration by adjusting the combined government incentives in pace with technological development by reducing time-to-market of existing solutions and gradually reduce demand for fossil energy generation (Bataille et al., 2018; Rissman et al., 2020). The combination of government incentives should include a combination of supply- and demand-side interventions that reduce economic instability as a result of the pace of decarbonisation and the interaction between chosen policy instruments needs to be attuned and adjusted based on technological developments and pace of decarbonisation (Grubb, McDowall & Drummond, 2017). The specific path to carbon neutrality in a specific industry is just that, very specific. This is one of the main complexities of the design of combined government incentives that target specific industries with the aim of decarbonisation firms and subsequently also of this study. The specificity together with context and path dependency makes the design of combined government incentives that targets a specific policy field such as an industry challenging and likely empirically difficult assess (Kern & Rogge,2018; Aragón-Correa et al., 2020). How these industry specific paths to decarbonisation can be translated to a specific combination of government incentives and how the identified trade-offs relate and interact to each other within these distinctive policy fields is empirically still largely unknown and an integrated part of this study.

Chapter 3: Methodology

Following the formulation of the research question and the literature review in the previous chapters, in this chapter the research strategy including the research approach, design of the study, data collection and analysis will be outlined. The last paragraph on the data analysis provides important elements to the structure of the findings in order to interpret these properly in the next chapter.

3.1 Research approach

The complexity of determining the impact that combination of government incentives has on corporate behaviour and the subsequent response of firms required a need for an in-depth understanding of firm motives and behavioural responses (Aragón-Correa et al., 2020). Additionally, this study aims to understand how a combination of government incentives lead firms to decarbonise and in order to gain that understanding the specifics surrounding the firm and how these can contribute to decarbonisation needed to be integrally part of the research approach. This excluded the applicability of quantitative approaches, since they require the ability to measure effects between established or hypostasised relations without contextual interference (e.g., experiments) or do research on a predetermined set of variables (e.g., survey). The current gaps in the understanding of the subjects addressed in this study as well as high specificity and context dependency of decarbonising industries and how a combination of government incentives subsequently influences corporate behaviour in achieving this, also requires scholars to account for these industry and firm specific details, qualitative research approaches and especially case studies were subsequently more applicable on this study (Yin, 2017). The need for context in this study and the exploratory nature due to the current limited understand of the relations between the concepts underlying this study as unveiled in the literature review, resulted in the choice for a case study approach which enabled a broader empirical examination into the aforementioned contextual factors. In addition, by selecting a case study approach this study could rely on multiple data collection methods (e.g., public and internal documents, evidence gathered by previous studies relevant on the subject of this study and interviews the people involved) to conduct the empirical investigation (Yin, 2017). This approach also answered to recent calls of scholars to examine the impact of combined government incentives on the behaviour of firms on environmental issues such as decarbonisation (Aragón-Correa et al., 2020).

3.2 Case selection

In order to enable an in-depth understanding of the impact that combined government incentives have on corporate behaviour and what combination of government incentives are more likely to lead firms in a specific setting to decarbonise their activities, this case study was delineated to a specific industry within a geographical area in which the government environmental policy is comparable. The industry selected for this study is the district heating industry, which is geographically delineated on country

level, in this case The Netherlands. The choice for the district heating industry is motivated due to the clear policy objectives formulated in the 2019 Climate Act on the decarbonisation of the district heating industry by the Dutch government as well as the planned growth of district heating to decarbonise households and industry in the Netherlands (Ministerie van Economische Zaken en Klimaat, 2019).

3.3 Case study design

Since the study examines the corporate behaviour of firms in relation to various theoretical constructs, the unit of analyses are the private firms operating in the district heating industry in the Netherlands operationalised through the corporate behaviour of these firms and this has resulted in a holistic single-case study design (Yin, 2017). As previously discussed, the current theory with regards to the relations of the various theoretical constructs underlying the research question are fragmented, this resulted in a largely inductive research approach in order to create theoretical constructs and relation between them based on the empirical evidence gathered in study, the build the theory from the ground up so to say (Eisenhardt & Graebner, 2007). Through the grounded theory approach, this study aimed to finds patterns in the gathered empirical evidence by sifting through the data, coding and placing these in the context of the literature review in an attempt to find causes for the identified patterns that might lead to new propositions or theoretical insights (Yin, 2017). The risk in building theories from case studies is the possible limitation of inductive research, the lack of construct validity of the from the gathered evidence induced concepts and external validity of the formulated propositions or theoretical insights and if and to what degree this study can argue that these are generalisable (Eisenhardt & Graebner, 2007). The latter is especially the case as a result of the formulated research question, being a “what” questions, implicating the aim to find and understand of what is the cause that leads to an effect. In order to ensure sufficient validity of the findings these were triangulated with secondary data from sources (sufficiently) independent from the primary date source and the uncovered pattern induced from the findings were interpreted by relying on existing knowledge identified in the literature review on the underlying constructs involved (Yin, 2017). This ensured sufficient validity of the gathered empirical evidence and induced constructs, however in order to ensure the data was gathered reliable these were structured as a chain of evidence by properly documenting all gathered data in order to minimise errors and misinterpretation of the data to occur (Yin, 2017).

3.3.1 Data collection

The subject of this study can be placed on the intersection between the government and firms operating in a specific industry, the district heating industry. The data gathered during this study can be split in three phases, first the preparatory desk study in order to gain a better understand of the industry and the combination of government incentives that impacts the industry with regard to

environmental policy on (inter)national levels. This was followed by semi-structured interviews, which will be discussed separately in the next paragraph and finally based on the on preliminary findings of the combination of the desk study and semi-structured interviews when clarification or (additional) triangulation was necessary, material was gathered on specific subjects, such as individual government incentives.

3.3.2 Semi-structured interviews

The semi-structured interviews had two distinct group of respondents, the management of the firms operating in the district heating industry in the Netherlands and policymakers working on behalf of the government. The main constructs of this study revolved on its impact on corporate behaviour as well as corporate behaviour in itself, subsequently the semi-structured interviews had more focus on collecting data through interviewing the management of the firms. The interviews with the two policymakers were more focussed on the rationale of existing government incentives, although due to the semi-structured design valuable additional data was gathered. The choice for semi-structured interviews was a consequence of the exploratory and inductive nature of the research (i.e., you cannot know, that what is hidden), if during the interviews relevant topics were addressed by respondents then there was sufficient flexibility in the structure of the interview to adhere to this.

The role of the interviewer should not be underestimated and is not limited to the content of the interview, the interviewer has an ethical responsibility towards the respondents as well as the data gathered (Fortado, 1990). In order to limit the influence of the interviewer answers to questions, no direct subordinates were interviewed. All interviews were conducted under the agreement of confidentiality and the results were included in the findings of the study in an anonymous form. All respondents agreed to that the data gathered from these interviews could be used in relation to this study. The interviews were fully conducted through Microsoft Teams®, the observation of non-verbal behaviour was subsequently more limited, since non-verbal communication can be essential in recognising information that respondents do or do not want to share (Easterby-Smith, 2018). In table 3.1 an overview of the respondents of the management of the firms as well as policymakers are included. The identity as well as specific positions (or job role) of the respondents will, as discussed, not be revealed, since this was the wish of most of respondents nor is this necessary since this does not, in any identified way, impair the relevance of the data gathered from the interviews.

The questionnaires of the semi-structured interviews where organised based on the dominant constructs derived from the research question and literature review, these are: corporate motives to decarbonise, technological solutions that lead to decarbonisation, dependencies (or obstacles) of decarbonisation and government incentives that lead to decarbonisation. All in relation to the district heating industry. The questionnaires were split between the management of firms (table 3.2) and

policymakers (appendix 6.1), where the emphasis on the first set of questions was more on the corporate motives and the latter on rationale behind the current government incentives. All interviews were conducted in Dutch (appendix 6.2) and recorded in Microsoft Teams®, subsequently the recordings were transcribed via Amberscript® which was followed by a manual review of transcript and in order to ensure the quality as well as proper data analysis the coding happened based on the Dutch transcripts, relevant findings were translated to English. The average length of the interviews was approx. 1:10 hours.

Firm / role	Respondent	Date
Uniper	Respondent #1	22 June 2021
	Respondent #2	23 June 2021
	Respondent #3	24 June 2021
	Respondent #4	16 July 2021
Eneco	Respondent #5	08 July 2021
	Respondent #6	26 July 2021
Vattenfall	Respondent #7	20 July 2021
	Respondent #8	21 July 2021
Haagse aardwarmte	Respondent #9	09 July 2021
Eteck	Respondent #10	04 August 2021
Independend advisor (policymaker)	Respondent #11	30 June 2021
Policymaker	Respondent #12	07 July 2021

Table 3.1: overview of respondents of semi-structured interviews

3.4 Data analysis

The data analysis was conducted thought various methods to recognise patterns and common narratives dependent on the findings from the literature review on a specific construct and indicated relations between constructs, or the absence of these. When the interview where transcribed these were first examined individually to discover relevant aspects in these interviews, this was followed by combining the different information gathered of the interviews per individual question in order to find the common narratives under respondents. These combination of interviews per interview question where subsequently used for pattern identification and coding.

The literature review revealed generic **corporate motives** on why firms adhere to government incentives with regard to environmental policy (table 2.3), these motives and underlying rationale as well as expected behaviour on corporate level were used as coding scheme in order to structure and analyse the data of questions no. #1, #6 and #7 (figure 3.2) of the semi-structured interviews. The question regarding the **technological solutions** to decarbonise (#2, #3 and #4, figure 3.2) were analysed based on the combination of paragraph 2.1.2 from the literature review, the maturity and type of technology derived from Demirel & Kesidou (2011) as well as inductively identified themes on the relation between technological solutions and their applicability to decarbonise. To analyse the questions related to the **dependencies** to decarbonisation as firms (#5, #8 and #9, figure 3.2), the coding scheme of the dominant dependencies was inductively derived based on the identities common narratives among all the respondents of the firm (Boeije & Bleijenbergh, 2019). Finally, the question

with regard to the **government incentives** (#10 to #14, figure 3.2) were analysed via the preliminary findings of the desk study as well as tables 2.5 and 2.6 from the literature review. Since respondents of the firms simply mentioned the relevant government incentive, the identified government incentives themselves formed the mechanism to structure the gathered data and analyse these accordingly.

The data gathered from interviewing policymakers were used to enrich or triangulate the findings from the firms where possible (questionary is included in appendix 6.1). Additionally, secondary data was gathered in order to triangulate the findings from the semi-structured interviews. In table 3.2 an overview is included which summarises all material used in the study in order to provide the necessary triangulations of the semi-structured interviews from government policy and industry perspective, in table 3.3 the information gathered on (statements of) firms to substantiate the findings from the semi-structured interviews are included as well. In the findings distinction is made when referring to respondents from firms (x out of 10) and referring to all respondents (x out of 12), statement from policymakers alone where due to the lack of representation only used for illustrative explanation of the findings. Important to note is that the firms included in this study vary in size, the study included three multinational firms (Eneco, Uniper and Vattenfall), one specific purpose vehicle owned by various companies in size (Haagse Aardwarmte) and one privately owned company (Eteck). Uniper with 4 out of the 10 respondents appears overrepresented in the study, when there was caused to do so the relation between how many respondents from how many firms to specific findings were highlighted (x out of 10 from x firms).

Structure of semi-structured interviews with firms		
No.	**Construct**	**Questions**
#1	Corporate motives	- How would you define the current environmental strategy of your firm and what is the rationale behind these?
#2	Technological solutions	- What changes do you identify that are needed in the district heating industry for it to become carbon neutral?
#3	Technological solutions	- How can the district heating activities in your company become carbon neutral?
#4	Technological solutions	- How would you asses the current technological development in relation to decarbonising the district heating activities in your company?
#5	Dependencies of decarbonisation	- How interdepended is the adoption of these technologies in relation to the district heating industry your company operates within?
#6	Corporate motives	- What steps did you company made in the past that contributes to this? > If so: what drivers behind the described change can you identify and what was most decisive? > If so: Did your company used any government scheme during the process? > If not: what are the reasons for limited to no change?
#7	Corporate motives	- What motives or drivers of decision-making are in your experience decisive with regard to project related to decarbonisation?
#8	Dependencies of decarbonisation	- Can you identify obstacles internally (within your company) that prevents your company from decarbonising?
#9	Dependencies of decarbonisation	- What external (outside your company) obstacles can you identify that prevents your company from decarbonising?
#10	Government incentives	- What existing government policies can you identify that have an effect on the possible willingness of your company to decarbonisation her district heating activities?
#11	Government incentives	- How likely are these government incentives going to contribute to decarbonizing the district heating activities in your company?
#12	Government incentives	- What combination of government incentives do you think are needed that will lead to the decarbonisation of your companies district heating activities (and why)?
#13	Government incentives	- Under what legal (mandatory / voluntary) conditions do you believe these government incentives should be implemented?
#14	Government incentives	- ***Optional***: How do your perceive the new law "Wet collectieve warmtevoorziening" and how do you expect that it will affect the environmental strategy of the company?

Table 3.2: overview of structure and questions semi-structured interviews

Secondary data on (inter)national policy and the district heating industry		
Subject	**Document / report**	**Source**
National policy	Duurzaamheid van warmte- & koudelevering	Harmelink, 2019
National policy	Klimaat- en Energieverkenning 2019	Planbureau voor de Leefomgeving, 2019
National policy	The Netherlands 2020 Energy Policy Review	International Energy Agency, 2020
National policy	Klimaatplan 2021–2030	Ministerie van Economische Zaken en Klimaat, 2020
International policy	Reporting instructions for completing the district heating and district cooling	Eurostat, 2017
International policy	Energy efficiency directive - European Commission.	European Commission, 2019
International policy	Clean energy for all Europeans package - Energy European Commission	Energy European Commission, 2021
Industry	Notitie bij de Workshop Warmtenetten: Een analyse van de Warmtewet.	Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014
Industry	Toekomstbeeld klimaatneutrale warmtenetten in Nederland.	Hoogervorst, 2017
Industry	Inventarisatie duurzaamheid warmtenetten.	Wolf & Loogman, 2020
Industry	Warmtemonitor 2019	Segers, Niessink, van de Oever & Menkveld., 2020

Table 3.2: overview secondary data on (inter)national policy and the district heating industry

Secondary data sources of the firms included in this study	
Firm	**Source**
Eneco	https://www.eneco.nl/over-ons/wat-we-doen/Klimaat/
	https://www.eneco.nl/over-ons/nieuws-en-cijfers/Financien/verslagen/
Vattenfall	https://www.vattenfall.nl/fossielvrij-leven-binnen-een-generatie/
	https://group.vattenfall.com/investors/financial-reports-and-presentations
Uniper	https://www.uniper.energy/benelux/
	https://ir.uniper.energy/websites/uniper/English/3000/reporting.html
	https://cr.uniper.energy/
Eteck	https://www.eteck.nl/nl/samenwerken-met-eteck/wij-zijn-eteck/
	https://www.eteck.nl/nl/samenwerken-met-eteck/duurzame-oplossingen/
Haagse aardwarmte	https://haagseaardwarmte.nl/

Table 3.3: overview secondary data sources of the firms included in this study

Chapter 4: Empirical findings

In this chapter the findings from the case study are presented, which will be divided in 4 parts based on the research design elaborated in the previous chapter. In the first part the scene is set by providing insights in the district heating industry in the Netherlands, the current policy strategy and combined government incentives influencing the decarbonisation of the district heating industry which represents the government's attitude towards the decarbonisation of district heating, which is follow by the environmental strategy adopted by the firms and underlying motivational aspects that make up the firms attitude towards decarbonisation. The chapter continues in part two with the technological aspects to the decarbonisation of the district heating industry and what prerequisite and dependencies to adopting these technological solutions this study identified. In the third part, the attitude of the firm related to adopting these technological solutions as well as perceived obstacles by the firm to adopted solutions will be elaborated. In the final and fourth the perception of respondents on how to overcome the aforementioned prerequisites, dependencies and obstacles through combined government incentives will be presented. This chapter concludes with a summary of the most noteworthy findings.

4.1 Part 1: Setting the scene

In this first part of the chapter in which the results from the case study on how combined government incentives leads firms to decarbonise their district heating activities in the Netherlands will be outlined, the scene is set. First, how to define and interpret carbon neutrally specifically for firms is elaborated. This is followed by a brief explanation of what district heating is as well as the current state of district heating industry in the Netherlands. Subsequently followed by the outlining of the current government strategy and combined government incentives towards the decarbonisation of district heating as well as foreseeable changes in government policy. Finally, the identified adopted environmental strategy towards decarbonisation as well as the rationale behind the adopted environmental strategy of the firms included in this study will be elaborated.

In this part it will be uncovered that the policy strategy of the government to decarbonisation is ambitious, the combined government incentives are however still favouring the status quo (fossil industry). The firms in the district heating industry adopted these ambitious goals in their environmental strategy, due to pressure experience by the firms from their dominant stakeholders to do so, the need for legitimacy by firms appears to be the cause for this through its influence on several generic corporate motives and in order for firms to maintain a competitive advantage.

4.1.1 Setting the scene: what is it for a firm to be carbon neutral?

What is it to decarbonise and to become carbon neutral as a firm? The definition of carbon neutrally appears to vary, does this for example mean that firms cannot emit greenhouse gases (hereafter: GNG) at all? Or is it sufficient to capture and store negative externalities such as GNG for the foreseeable

future and still be carbon neutral? Or can firms still emit GHG and compensate this in other ways? The proper definition of carbon neutrality applicable firms was also not provided in recent found literature, while if governments want to incentivise firms in becoming carbon neutral a common understanding, a common narrative, of what this means for both policymakers as well as firms seems appropriate. How carbon neutrality could and should be interpreted was also a topic in the interviews with most respondents (8 out of 12), to quote a respondent: "*the question is how to define carbon neutrality and whether this always is sustainable*". Hence, as an ongoing part of the case study the search for a suitable definition for carbon neutrality began.

The definition of carbon neutral is provided in the Oxford Learner's Dictionary of Academic English and is: "*in which the amount of carbon dioxide produced has been reduced to nothing or is balanced by actions that protect the environment*" (Oxford University Press, 2021). This is of course a very broad definition, as suits in a dictionary. To operationalise carbon neutrality for policymakers and firms operating within the EU, the EU definition that underlines the EU guidelines for her 2030 (*2030 Climate & Energy Framework, 2017*) and 2050 (*2050 Long-Term Strategy, 2017*) strategies in becoming carbon neutral could provide more guidance, the EU applies following definition to carbon neutrality:

"*Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing carbon oxide from the atmosphere and then storing it is known as carbon sequestration. In order to achieve net zero emissions, all worldwide greenhouse gas (GHG) emissions will have to be counterbalanced by carbon sequestration*". (What Is Carbon Neutrality and How Can It Be Achieved by 2050? | News | European Parliament, 2021)

While this is a more specific definition compared to the broad definition in the dictionary and does provide several leads for a definition useful for firms in becoming carbon neutral such as creating a balance between GHG emissions by either preventing this or capture and storing it, the exact role that different actors play in order to achieve carbon neutrality is still left open and the question whether a firm can compensate while still emitting GHG remains unanswered. In the quest for a more tailormade definition of carbon neutrally that can be applied to firms the search landed on the definition provided by the United Nations Framework Convention on Climate Change for participants of the Climate Neutral Now (hereafter: UNFCCC) initiative aimed to support non-governmental organisation such as firms in becoming carbon, which is:

"*Carbon neutrality describes a state in which the GHG emissions released to the atmosphere by a stakeholder (individual, organization, company, country, etc.) have been reduced or avoided and the remaining ones are compensated with carbon credits. To achieve carbon neutrality, carbon credits from projects that reduce, avoid or temporarily capture GHGs are accepted. Note that carbon neutrality is*

possible at stakeholder level, not at global/planetary level, where use of carbon credits (offseting/compensation) is not possible" (United Nations Framework Convention on Climate Change, 2020)

The UNFCC definition adds the possibility to compensate as firms and still be carbon neutral, albeit under strict conditions. The definition of carbon neutrally that is applicable on firms also the relative relation of the firm to the environment and include the ways a firm can achieve this.

4.1.2 Setting the scene: current state of district heating in the Netherlands

Of the total energy consumption in the Netherlands in 2019 which is more than 3,000 Petajoule (hereafter: PJ) over half (1,858 PJ) is used for the heating of households, the industry and transportation (Segers, Niessink, van de Oever & Menkveld., 2020). While the share of sustainable energy sources to produce heat did increase to 7% in 2019 which mostly is derived from residual heat from industrial processes, the vast majority (over 76%) of heat is derived from natural gas (Segers et al., 2020). The European Commission defined district heating as the supply of hot water in district heating networks and supply of steam in industrial heat grids for two or more customers (Eurostat, 2017). These can be divided in large (greater than 0.15 petajoule per year) and small-scale heat grids. The total of large-scale heat grids provide heat to more than 340,000 households and deliver 20,4 PJ of heat in most of the highly urbanised centres in the Netherlands, this is expected to increase to over 405.000 households and 24.0 PJ in 2023 (Segers et al., 2020). The majority of the large scale heat grids are owned by firms, mainly by energy companies which also own most of the production capactiy to produce heat (International Energy Agency, 2020). This study will focus on the decarbonisation of the large-scale heat grids (hereafter: heat grids), this is due to the heterogeneity of smaller heat grids (below 0.15 PJ) that vary significantly in size and method of heat generation as well as ownership, since most are owned by private citizens, owners associations or housing associations (Segers et al., 2020).

The prices of district heating are regulated by the Dutch Authority for Consumers and Markets (ACM) and is based on the price development of natural gas, this is due to the "niet meer dan ander" principle (paragraph 4.1.4.3), which freely translates to "equal to the other" and ensures that consumers of district heating will pay the same average price compared to consumers that privately own gas boilers to heat their homes (International Energy Agency, 2020; Segers et al., 2020). This principle behind the system of pricing originated from the fact that most heat grids are owned by one firm, which results in an de facto monopoly position and thus the government rationale is that consumers need to be protected from unreasonable prices levels that might occur as a result of this (more on this in paragraph 4.1.4.3).

4.1.3 Setting the scene: the government policy strategy towards the district heating industry

District heating is identified by the government as a key industry and solution to support the climate policy objectives of 2050, the aim is to connect over 1.5 million buildings to collective heat grids, of which the vast majority households, by 2050 (Ministerie van Economische Zaken en Klimaat, 2020a). The current national government strategy related to the decarbonisation can be derived from the 2019 Climate Act, in which a reduction of greenhouse gases is aimed of 49% in 2030 and 95% by 2050, in order to meet both the reduction targets it is necessary to increase the current renewable energy consumption of 9.6% in 2018 to 30-32% in 2030 (International Energy Agency, 2020).

In the 2019 Climate act, which is a covenant between then government and various industries, the goal was set to provide over 1.5 million (non)residential buildings with sustainable heat by 2050. It was agreed upon to connect woningequivalenten (which translated to the average heat consumption of a building expressed as a residential unit, Segers et al., 2020) to collective heat solutions increasing to approximately 80,000 by 2025 and to continue to connect 80,000 woningequivalenten every year up to and including 2030 (Ministerie van Economische Zaken en Klimaat, 2019). Together with the expansion of collective heat solutions the goal is to decarbonise the existing heat grid with 70% compared to a privately owned natural gas boiler (Ministerie van Economische Zaken en Klimaat, 2019). This increase of nearly 0.5 million building of which mostly household means a doubling of buildings connected to collective heating solutions per 2030 compared to 2019. It was not yet agreed upon how this will be organised or who is responsible for the defined targets in the 2019 Climate Act, this was to be determined in the “transitievisie warmte” in 2021 (to be compiled report on the shared vision on growth and decarbonisation of collective heat solutions) (Ministerie van Economische Zaken en Klimaat, 2019).

The current expectation is that in 2050 between the 20-30% of the households will be connected to collective heating solutions such as district heating (Planbureau voor de Leefomgeving, 2019). In a study conducted in by Hoogervorst (2017) it was concluded that it is possible to deliver half of the expected consumption of heat in 2050 through heat grids, which will amount to roughly a quarter of all expected energy consumed in the Netherlands in 2050 (Hoogervorst, 2017).

In order to achieve this and to contribute to the climate policy objective of becoming carbon neutral by 2050 the current district heating industry needs to undergo a rigorous transformation. Currently the district heating relies heavily on natural gas, in 2017 over 68% of the heat was produced with combined heat and power plants (CHP). Other production methods currently used are heat derived from waste incinerators and the use of natural gas-powered boilers ranging from small to industrial scale sizes to produce heat (International Energy Agency, 2020). To decarbonise district heating and ensure the future growth of carbon neutral heat grids it is expected that the current dependency of

the majority of the heat grids on one or two large scale fossil-fuelled heat sources will be replaced by numerous and various non-fossil-fuelled heat generation technologies from varying ranges in capacity (Hoogervorst, 2017). The likely technological solutions that will provide the future carbon neutral heat source are biomass, green electricity, green gas, but also residual heat (if generated in a climate-neutral manner), geothermal heat and other forms of heat extracted from the environment such as through air, water and soil (Hoogervorst, 2017).

4.1.4 Existing combined government incentives impacting the decarbonisation of the Dutch district heating industry

In this paragraph the identified combined government incentives that are likely to affect the decarbonisation of district heating are elaborated, first by addressing the international legalisation (EU) followed by the national legislation and support schemes.

4.1.4.1 Existing combined government incentives: international legislation

In 2009 the European Commission introduced the Renewable energy directive (RED), through this directive member states are obligated to reach a 20% share of energy from renewable sources by 2020 (European Commission, Directive 2009/28). While the RED does not directly target the Dutch district heating industry, it did result in several changes in legislation in the Netherlands that could influence the district heating industry. Next to the RED, the European Union Energy Efficiency Directive (EED) was introduced in 2012 with the aim of reducing energy consumption with 20% compared to 1990 (*Energy Efficiency Directive - European Commission*, 2019). The directive was implemented by the Dutch government in 2015 (Staatscourant, 2015, 20036). The guideline and subsequent directive effects all firms of a certain size under which these firms have to conduct a mandatory energy audit once every four years. The goal of the audit is twofold, first it provides both the government and the firm involved with the energy consumption of the firm and secondly based on the energy consumption and methods identified the audit can advise possibilities do reduce energy consumption or convert to more sustainable sources of energy. The audit can be enforced through a penalty of 1.000€ a week (*Europese Energie-Efficiency Richtlijn - EED | Rijksdienst voor Ondernemend Nederland*, 2020).

4.1.4.2 Existing combined government incentives: national legislation and support schemes

The decarbonisation of district heating is influenced by several national regulations and government schemes, these will now be elaborated.

4.1.4.3 The Dutch heat law

The cornerstone of Dutch regulation on the district heating industry is the Warmtewet (*wetten.nl - Regeling - Warmtewet - BWBR0033729*, 2020), literally: “heat law”, which is applicable on heat delivery (tap water and heating for domestic use) to households and small and medium-sized enterprises up to 100 Kilowatt (kW) that considers heat as a basic human right and is mainly a competition law with the

aim of ensuring fair prices and security of supply to the consumers, the need for such a law was because most suppliers of heat have an de facto monopoly position in a closed heat network resulting in an increased competition risk (Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014). From the heat law a broad definition of a heat network can be derived, namely: the whole network of pipelines which are connected to each other including ancillary installations and auxiliary systems with the purpose of transporting heat (translated from Dutch, from: Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014). This means that the production and transport of heat are separated by law and only the transport and consumption of heat is organised in the heat law. Firms that want to act as a heat supplier are subject to permitting and approval by the Minister of Economic Affairs and are obliged to reliably deliver heat against fair prices and terms under the heat law (*wetten.nl - Regeling - Warmtewet - BWBR0033729*, 2020).

The Dutch heat law: legal parameters that influence the supply chain of heat

In contrast to laws that arrange the production, network operation and supply of electricity and natural gas that have a designated network operator in the heat law there is no distinction made between operator and supplier function of heat and it also implies that within a closed heat network only one supplier for heat exists that is responsible for both operation and supply of heat, practically eliminating the possibility of competition between suppliers of heat within a closed heat network (Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014). Hence, only competition between producers of heat that feed into the heat network is possible.

The rationale of the legislator in not splitting the role of operator and supplier is that a significant part of the heat networks are relatively small in size with on average 40 households that are connected to these heat networks, and that splitting the different roles in small scale heating networks will lead to unreasonable costs for the consumer, while the possibility to abuse the monopoly position by the supplier in such networks is believe to be limited (Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014).

The producer of heat is defined as “a party that is involved with producing heat” (*wetten.nl - Regeling - Warmtewet - BWBR0033729*, 2020), which is a very broad definition and there is no distinction made between the production method used to produce heat (e.g., combined heat and power (CHP) plants that feed large scale network or localised gas fuelled boilers that provides heat to a city block). The heat law does indirectly impose several conditions to producers of heat, which arrange the pricing of heat and security of supply. The current law thus maintains and protects the monopoly positions of heat suppliers and limits the access of producers of heat to these networks.

A noticeable void in the heat law is that the law does not ensure producers of heat the assurance that they can access to heat networks against reasonable prices, nor that heat supplier are compulsory to do so even if this will improve prices for the consumer, this further limit possible competition (International Energy Agency, 2020).

The Dutch heat law: price control mechanism

Under the heat law the maximum price of heat is annually determined and includes all the services that enable the consumption of heat (*wetten.nl - Regeling - Warmtewet - BWBR0033729*, 2020), this effectively regulates that whole district heat industry. The price of heat needs to be fair and consumers under the heat law do not pay more compared to other consumers that own a private gas boiler, this means that the heat supplier needs to operate with predetermined profit margins (Universiteit van Amsterdam, Centrum voor Energievraagstukken, 2014). The method of pricing is subject to critique since it does not account for the differences in heat networks and there is no relation between price and actual costs levels. In addition, some argue that the current method does not protect consumers for unreasonable prices (NOS, 2019). The current regulation does not enable consumers to make a choice based on price nor sustainability standards, furthermore the future development of heat industry is contingent on the heat supplier and its business model. Since the price is based on the consumption of natural gas there is likely limited incentive to change towards production methods that result in decarbonisation.

4.1.4.4 Existing combined government incentives: other government regulations and support schemes

In this paragraph other identified government incentives that impacts the decarbonisation of the district heating industry will be explained.

4.1.4.5 Natural gas: from mandatory to voluntary

Since the discovery of large natural reserves and the subsequent widespread adoption of low calorific gas in the heating of households (in 2018 90% of the household was heated by means of natural gas, International Energy Agency, 2020) it was compulsorily by law to connect all buildings to the natural gas grid. In light of the transition to more sustainable energy sources this obligation has been revoked in 2018 (Staatscourant, 2018, 36136). Also, other laws have been changed to enable the use of for example ground-coupled heat exchangers as well as geo-thermal heat and other sources as a substitute for natural gas (Staatscourant, 2013, 112).

4.1.4.6 BENG norms (NTA8800) for sustainable heat

In 2019 as part of an operationalisation of the 2019 Climate Act the BENG regulations where designed, the regulations came in effect in 2021 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020). These building regulations set requirements for the maximum energy demand, fossil energy use and generation of renewable energy in buildings (Bouwens, 2019). This means that new homes and

buildings must take into account not only good insulation of the building envelope and energy-efficient installations, but also the use of renewable energy (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020). The most important parameters for external heat supply are the temperature of the delivered heat, the efficiency with which fossil energy is used in the generated of heat and the share of renewable energy used to generate heat (Bouwens, 2019). These norms apply on the construction of new buildings but also in the classifying the sustainability existing heat as well how heat through specific technologies is ranked for government support schemes.

4.1.4.7 Energy taxation

Most of the heat generated in heat grids are still generated through the consumption of natural gas which is subject to tax levied by the national government. The rates are determined on the level of consumption and a part of the income generated through taxation is used on support schemes for renewables and emission reductions (International Energy Agency, 2020).

4.1.4.8 European Emission Trading System (EU ETC)

While the EU Emission trading system for carbon certificates is applicable on district heating activities a significant share of the heat produced is exempt through the allocation of free certificate based on the past average emission of carbon (EU Emissions Trading System (EU ETS), 2017).

4.1.4.9 Carbon levy on the industry

Recently the Dutch government introduced a carbon tax (in Dutch: Wet Co2-heffing industrie), however this does not apply the district heating industry (*wetten.nl - Regeling - Wet CO2-heffing industrie - BWBR0044578*, 2021).

4.1.4.10 SDE+ and SDE++ government support schemes

To incentivise sustainable energy production the Dutch government established a support scheme in 2011 called SDE+ which support the adoption and diffusion of wide range of technologies that increase the share of renewable energy (International Energy Agency, 2020). The funds are granted based on a combination of share of renewable energy and cost-effective criteria to which both private firms as well as non-profits and institutions can apply. From 2011 to 2020 over 60 billion euro's for the funding of renewable energy projects were granted (International Energy Agency, 2020). The support scheme was doubled as a result of the Urgenda legal ruling from 2 billion to 4 billion in 2020 (Ministerie van Economische Zaken en Klimaat, 2020b). Since 2021 the CO_2 reduction achieved by the proposed projects was introduced as an additional criterion, for heat this is based on the BENG norms (Stimulering duurzame energieproductie en klimaattransitie (SDE++) | RVO.nl | Rijksdienst, 2020).

4.1.4.11 Setting the scene: foreseeable changes in combined government incentives

Several announced or foreseeable changes in government policy on the district heating industry were identified, since these might provide more insight in the rationale of the government as well impact the behaviour of firms these were examined in more detail.

4.1.5 Announced changes in combined government incentives

Under the 2019 Clean energy for all Europeans package both the EED and the RED where revised (European Commission, Clean energy for all Europeans package, 2021) and the Dutch government introduced targets for the share of renewable energy demand for the years 2020, 2023 and 2030 which are derived from the revised EU Renewable Energy Directive (RED) and required 32% share of renewable energy consumption per 2030 (International Energy Agency, 2020; European Commission, Clean energy for all Europeans package, 2021).

4.1.5.1 Proposal for a revised heat law: The Wet Collectieve Warmtevoorziening

The government, recognising the critique on the current heat law, initiated a review of the law and a new law the 'Wet Collectieve Warmtevoorziening', is currently under debate in the States General (parliament) and under review by the Raad van State (Council of State) (Ministerie van Algemene Zaken, 2021). The law is expected to be in effect per 2022. The proposed changes to the current heat law include the necessary changes to comply with the Paris Agreement and other climate agreements (*Overheid.nl | Consultatie Wet collectieve warmtevoorziening*, 2020).

The major change compare to the current law is the introduction of a collective heat network, which is defined as a system of one or multiple (sustainable) sources of heat that have access to the heat network. The authority of selecting the heat suppliers is transferred to the municipalities which can divide the current heat network in lots and appoint a heat company (warmtebedrijf) to a lot for a duration of up to 30 years, the selected heat company is responsible for the whole heat system in a lot, the heat company can however subcontract specific processes and it also possible for multiple entities to jointly form a heat company. Concerns for competitions and third-party access still exist, however the rationale of the government in assigning one heat company is to ensure affordability, security of supply and the development of sustainable heat sources. These factors are weighted based on the plans of a potential heat company during the tender process of a lot and monitored during the contract period (*Overheid.nl | Consultatie Wet collectieve warmtevoorziening*, 2020).

The current price method will probably be revised from the current natural gas prices benchmark to a price based on the costs to produce and transport the heat plus a reasonable profit margin, hence prices may vary per lot. There are however concerns if this possible under competition law and if this will not result significant price fluctuations per heat network (*Overheid.nl | Consultatie Wet collectieve warmtevoorziening*, 2020). In addition, CO_2 limits will likely be introduced with the aim of reducing

carbon emissions in steps (from 40 kg CO_2 per GJ heat in 2022 to 25kg Co2 per GJ heat in 2030). The combination of a new pricing method and CO_2 limits that will likely be introduced have the aim of mandatory decarbonising district heating and to comply to the numerous international singed climate agreements (*Overheid.nl | Consultatie Wet collectieve warmtevoorziening*, 2020).

4.1.5.2 National growth fund

In 2020 the Dutch government announced the creation of nationaal groei fond (translate to: national growth fund, in which over 4,0 billon euro will be invested in projects related that ensure long term sustainable economic growth (Ministerie van Economische Zaken en Klimaat, 2021a). Part of this government scheme is funding related to collective heat solutions, such as district heating solutions, it is however unclear how much funding is available as well as what projects can apply at the time of this study (Ministerie van Economische Zaken en Klimaat, 2021b).

4.1.5.3 Possible taxation on natural gas

To support the transition from natural gas to low carbon heating the government intends to increase taxation of the use of gas up to 43% by 2026 (International Energy Agency, 2020). It is however likely that district heating will be exempted from this.

4.1.6 Conclusion: decarbonisation of district heating from the governments perspective

The goals of the Dutch government related to the growth and decarbonisation of district heating are ambitious; transition over 0.5 million buildings, of which the majority residential, from heat generated through natural gas to a collective heat solution of which over 70% carbon neutral per 2030, this means a doubling compared to 2019 in the total connections and go from over 70% fossil to less than 30%. The government in the 2019 Climate Act recognised that this requires new combined government incentives in order to make this transition possible and incentive firms to take part in the decarbonisation of district heating. However, until now no real changes in government policy have been implemented and are still subject to ongoing political debate and decision-making, to quote one of the policymakers: "*Yes, we have a climate agreement', but the policy needed to achieve to goals is only partly designed and none of it is has been implemented*".

What stands out is that most of the policy aimed to incentives firms to decarbonise via carbon taxations or energy taxes have a limited effect on the district heating industry since the industry is largely exempted. This is likely due to the restriction imposed on heat prices as a result of the current heat law. The combination that both a connection for natural gas is no longer mandatory in every building as well the introduction of standard for sustainable heat (BENG norms) might provide firms with an incentive and guidance to invest in the carbon neutral growth of their district heat activities, especially if firms are eligible to receive government funding through the SDE++ support scheme. Currently there are no government schemes or specific incentives which directly targets the district heating industry

also the current heat law due to a price control mechanism with a direct benchmark with the gas prices probably inhibits firms to decarbonise if firms incur higher costs as a result of this.

The heat law 2.0 which is currently still subject to political decision-making could provide the necessary incentives though a mandatory path of decarbonisation, it is however likely this will only be possible if other aspects of the heat law, such as the current price control mechanism, are adequately revised to provide for the decarbonisation of district heating.

4.1.7 Setting the scene: adopted environmental strategy by firms

From the interviews with the management of the firms, in total 10, included in this study it can be concluded that all firms have adopted environmental strategies related to the decarbonisation of their activities that are in accordance with or more ambitious than the goals set by the European Union to be carbon neutral per 2050 (2050 Long-Term Strategy, 2017). The respondents of both Eneco and Uniper unanimously recited the respective companies strategy to reach carbon neutrally as per 2035, a responded from Uniper phrased the company strategy as "The g*oal is to be completely carbon neutral as per 2035, this means fully banning carbon emissions or compensating this when there are no immediate solutions available. Ideally we will reach a net position of no Co2 emission while maintaining the same level of activity"* and respondents of Eneco formulated the environmental strategy of Eneco as "*We recently adopted the OnePLanet strategy in which we want to be fully carbon neutral as per 2035*". While based on the answers from the respondents of Vattenfall the company environmental strategy is not set to be carbon neutral as per a specific year for the company as a whole, they refer to be carbon neutral in one generation with specific goals to decarbonisation dependent on the specific country they operate in, for the Netherlands this currently is per 2050 although one respondent indicated that this will be revised "*We are actually going a step further now, this has yet to be published but there is a scientific based target initiative and it actually looks at companies and what is needed to meet the one-and-a-half degree targets of the Paris agreement since our current strategy is based on a maximum of two degree temperature increase and we are going to go one step further. What that will mean for fossil free within a generation, I do not know, but I do know that more needs to be done and, above all, it needs to be done faster*". For Eteck the respondent simply stated that "*But our focus from the beginning has been on sustainable energy, sustainable source, local, sustainable solutions. In fact, we have always said and we continue to say: a local, sustainable energy supply is what we want*", not mentioning a specific date. All the statements made my respondents regarding their firms environmental strategy related to decarbonisation could be triangulated based on several public statements made by the respective firms. The respondents indicated that the changes made to the environmental strategy to include the ambitious targets related to decarbonisation were relative recent, within the last 2 years.

When asking the respondents of the firms what the consequences of the adopted environmental strategy are on the specific district heating activities (hereafter: heating activities) in the Netherlands of their respective firms, the consensus among them was that the implementation of the strategy is going to be a challenge and that is unclear what the effect of the environmental strategy will be on the activities of the respective firms other than that the heat activities need to be fully decarbonised in accordance with the respective strategy. All respondents of the firms recognise that the overall environmental strategy will be fully applicable on their respective heat activities, one of the respondent phrased it as "*set the goal of making the entire production including procurement, or our own production plus purchased energy over the next 14 years, to be almost completely carbon neutral by 2035. Also for district heating, so the strategy covers the entire portfolio*". Of the 10 respondents interviewed, 8 gave answers that resemble the aforementioned statement, in that the firm wide environmental strategy of decarbonisation have to result in the decarbonisation of the entire heating activities nor that there will be any distinction made whether the activities is directly performed by the respective firm or outsourced.

These answers however only reflect the desired outcome of the environmental strategy on the heating activities of the firms, how the strategy will subsequently be implemented, and the decarbonisation of the district heating activities will be achieved resulted in a more mixed response. While some respondents (6 out of 10) made statements such as "*It is still not really clear how this strategy can be implemented for the heat activities in the Netherlands*" or "the s*trategic statement of decarbonisation of all activities as per 2035 is a dot on the horizon*" other respondents (4 out of 10) see a clearer path and state that for example "*so that is really very ambitious, and specifically for heat we assume that we can almost do that, but that a small part of the peak supply cannot yet be made sustainable, so that this can still be compensated*".

4.1.8 Rationale behind the adopted environmental strategy

The overall consensus in the answers of the respondents of the firms is that, if their respective firms are not able to make the transition and decarbonise their activities, this will result in a threat to the long-term survival of the firms in and in order to prevent this that their firms must decarbonise, as one of the respondent states "*It is an existential question to our survival as a firm, if we want to continue to exist, we have too*". Hence, the overwhelming rationale behind the previously discussed environmental strategy adopted by these firms appears to be maintaining legitimacy. Every single respondent mention legitimacy, however, the reasons behind this vary and differ in nature. Legitimacy is perceived to be especially important in eyes of the main stakeholders of the firms and in specific shareholders and customers of the firms, which were both specifically mentioned by 8 out of 10 respondents. 6 out of the 10 respondents addressed the need for access to relative favourable capital

from institutional investors such as pension funds or (semi-)government agencies, as one respondent phrased it as "*I don't think there is any alternative, because if you stick with the same old thing, the investors will walk away, of course*" and another as "*there are some more socially committed shareholders, such as pension funds that consciously choose strategy to shift funding towards more sustainable industries (…) to secure our funding at attractive conditions"*, and in order to keep access to these types of funding the firms needs to decarbonise their activities since this is in accordance with the goals of these institutional investors.

Out of the 10 respondents 8 specifically mention growth, (staying ahead of) competition or competitive advantage as a rationale to the adopted environmental strategy in order to "*keep in the driver seat and maintaining the current market share*", "*ensure future growth*" and in "*expectation of demand*" as well as "*be a frontrunner and stay ahead of other players"* since without the adopted environmental strategy it is perceived that the firms are "*no longer being able to compete economically*".

In addition, a majority respondent (7 out of 10) explicitly establish the relationship between legitimacy and maintaining competitive as an underlying rationale to the adopted environmental strategy by for example mentioning that "*stakeholders are specifically relevant to heat, because we operate locally, of course. Yes, what a municipality or province wants is also very important, and yes, of course we do cooperate where possible to make projects more sustainable*" and "*but in principle, if you do grow in the heat market, the customers will only want to make agreements with you if you can show that you are very sustainable, so there is also a commercial side to it*", which result in a perceived expected lower growth of heat activities if the strategy is not adjusted accordingly as well as by ensuring that the activities of the firm are not subject to litigation that prevent future growth "*we see this happening in society today, with the lawsuits against Shell and the lawsuit that Urgenda had against the Dutch state, and so on*" and "*prove to stakeholders and society that we can take the necessary steps and present the solutions*" (Raval, 2021). From the answers it appears that the aspect of legitimacy is a perceived to be intertwined with both the need for future profitability and growth since it is a prerequisite to this through its influence on the perceived legitimacy by stakeholders such as institutional investors and customers, since the future growth and profitability of the firm in itself is perceived by the respondents to be dependent on the perceived legitimacy of the firm by these stakeholders.

Another rationale behind the adopted environmental strategy as perceived by 8 out of 10 respondents of their firm is existing or the expectation of future more stringent government policy with regard to carbon emissions. This is either the result of government regulation, as a rationale to the adopted environmental strategy, a respondent stated, "*the pressure of current or expected regulatory changes*"

and in the face of the risk of future regulation another respondent cited "*in order to mitigate this risk, we actually need to exit the fossil value stream in time to avoid stranded assets*". Or otherwise, due to more voluntary policy measures for example by "r*equirements from the government either through public tenders or procurement*" and "*we need to publish how sustainable our heat is, this is mandatory through our contracts with municipalities*". Changes in government regulations on decarbonisation that effect customers of the firms also appears to be a motive of firms to change their environmental strategy as 7 out of 10 indicated that they expect demand to increase as a result of government policy, for example one of the responded stated that "*the government deciding to discourage the use of the natural gas, resulted in that existing buildings have become a market for us where there is a demand for our sustainable solutions*". Individual motives of employees or a moral stance of the firms towards decarbonisation that influence the environmental strategy are mentioned by 2 out of 10 respondents.

4.1.9 Conclusion: decarbonisation of district heating from the firms perceptive

All of the firms included in this study have adopted an environmental strategy related to decarbonisation that is either more ambitious or on par with the goals of the EU and the Dutch government. Also, firms do not appear to make exceptions specific for district heating activities in the Netherlands. How the strategy will be implemented and what consequences this will have for the heat activities of the firms, is however less clear for respondents. A parallel can be made between the Dutch government's policy on decarbonisation, the goals are clear but how to reach these goals through policy is far more ambiguous.

The rationale for adopting the ambitious environmental strategy is first and foremost a question of ensuring long-term continuity by maintaining legitimacy in eyes of the firm's important stakeholders such as shareholders, institutional investors and customers. This comes forth out of the instrumental motives of the firms, since the aim is to stay ahead of the competition to generate sales as well as reduce litigation risks while continue to have access to funds (capital) at favourable conditions. Additionally, the perceived pressure by firms due to the introduction of regulations or the expectation that regulation will be more stringent in the future i.e., the legal motive has been underlying to the adopted environmental strategy as well.

A specific finding from the study is that legitimacy appears to be intertwined with the instrumental and relational motives identified in the literature review. First by the perception of firms that legitimacy is needed to maintain a competitive advantage and ensure future growth of which legitimacy is perceived to be prerequisite (instrumental), secondly by ensuring a licence to operate (relational). Additionally, firms adopt their environmental for regulatory compliance which ensures continuity of the firm, since the strategy of the firm and how this influence the activities of the firms in now at risk

of legal actions by NGO's or other special interest groups (legal). This could be the result of the high visibility of the activities of the firm and that the activities of the firm are fulfilling a public function.

4.2 Part 2: How to decarbonise district heating

Now that the scene is set, this study can properly take a deep dive in what it takes to decarbonise the current district heating industry as well as to accommodate the desired growth of district heating from a technological perspective as perceived by the respondents from both the firms as well as policymakers. This is followed by the identification of prerequisites to the decarbonisation of district heating according to these respondents as well as dependencies to decarbonising district heating.

The main findings are that the difficulty in decarbonising the district heating industry is due to the discrepancy between supply and demand, as well as the high temperature of heat. The technological solutions are perceived mature enough to largely provide for the decarbonisation of the district heating industry. For firms to decarbonise sufficient levels of affordability and public opinion for these solutions need to exist (table 4.4), as well as combined government incentive that provide for this. Several dependencies to decarbonisation are uncovered as well, these can be found in table 4.5.

4.2.1 Inherent aspect to district heating

When referring to the different types of technological changes that are needed to decarbonise district heating it is necessary to make a distinction between the generation (or production) of heat, the (temporary) storage and transportation of heat and the consumption of heat by the end-users (or consumers). In addition, the consumption of heat is dependent on weather conditions and various significantly during the year as shown by figure 4.1, the total demand and supply subsequently show a significant discrepancy during the year (Stănişteanu, 2017). Another aspect is the temperature of the heat, the average temperature in the conventional heat grid is approximately 130°C and when the heat reaches the end-users the heat is approx. 90°C with a legal minimum of 70°C when district heating is combined with tap water to prevent the growth of the legionella bacteria (Hoogervorst, 2017).

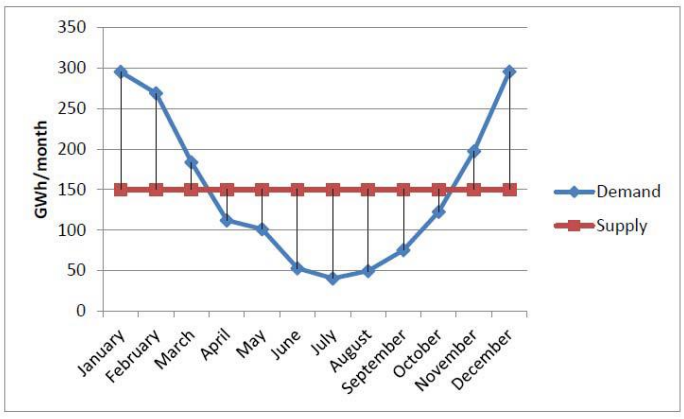

Figure 4.1: Average monthly heat demand and production in the Hague. In one year, the demand equals the production, but discrepancy is significant (Stănişteanu, 2017)

4.2.2 Decarbonisation of district heating: can it be done?

The maturity and applicability of technological solutions that are available to decarbonise a certain industry are an important variable for the design of combined government incentives to consider as indicated in the literature review. Hence, the (perceived) technological maturity as well as possible application of and implementation by firms of technological solutions that enable firms to decarbonise their district heating activities were discussed in detail with the respondents of both the firms as well as policymakers.

The consensus among 11 out of 12 respondents of both the firms as well as policymakers was that the current state of technology is of a sufficient maturity to enable the decarbonisation of the generation of heat as well as the heat grid to a substantial degree and also to facilitate in the further carbon neutral growth of district heating in the Netherlands within the timeframe of 15 to 20 years when considering this in isolation and the sole purpose is to decarbonise district heating and facilitate the carbon neutral growth of district heating under the condition that the identified perquisites are met and current dependencies reduced.

The common narrative among respondents related to the solutions to become carbon neutral are best described by the following combined statements or respondents: "*The technology is available to produce fully carbon neutral and green heat when the only goal is to produce heat in a sustainable and carbon neutral way*" hence it is "*not so much the lack of technology or solutions, these however can be improved to achieve cost reduction so innovations should focus on reducing costs*", "*the question is whether we can decarbonise in an economic way and what are the costs to build a grid to transport the heat (…) the affordability of the solutions is an issue as well*", however "*the availability of sufficient sustainably sources of heat could be a limitation"* as well "*access to renewable electricity*", "*the use of technologies in certain circumstances, in certain neighbourhoods or in certain buildings could be an inhibiting factor*". In order the achieve this it is important to "*start with making the primary sources of heat production sustainable and carbon neutral*" to reach the necessary scale since "*if there is sufficient scale for certain technology it will become affordable in the end*" but *"what is very important to understand is that we cannot be too picky in what type of heat source, in the sense of anything that contributes to better performance we should want to connect*" since most respondents would side with the statement that related to the decarbonisation of district heating "*I am convinced that it can be done*".

The respondents of the firms acknowledged (9 out of 10) that current methods to generate heat are very much dependent on fossil fuel "*Current assets are 100% based on fossil fuel, natural gas*", either directly through the use of natural gas that fuel the CHP and boilers or indirectly through waste

incinerations or residual heat from fossil-fuelled industrial processes, while the latter under current regulations is largely labelled as carbon neutral since it is seen as a by-product (Harmelink, 2019).

The main obstacle related to reach full carbon neutrality as perceived by respondents of the firms is the decarbonisation (8 out of 10) of the peak capacity needed in the few cold weeks in an average year when heat consumption is relatively high, the questions several respondents however raised was the necessity to decarbonise the peak capacity in the short to medium term due to its perceived limited contribution to carbon emissions and likely significant costs in order to achieve a carbon neutral peak capacity. As one of the respondent put it: "*It will be very difficult to be fully carbon neutral in 2035 around 4-6%, the peak capacity, will probably take more time or is very expensive*".

All 12 respondents to varying degree could name several technological solutions as well indicate the level of maturity of these technologies and of these, 11 respondents clearly stated that the relevant technological solutions are available albeit in different stages of maturity, which refers to the scalability and efficiency of the respective technology. In order to make a qualitative assessment of current technological solutions that respondents perceived as most mature and identified other relevant characteristics of these solutions table 4.2 was composed, as indicated this is a qualitative assessment with the sole purpose of translating the answers in an overview that indicates the perceived characteristics of a technology that by respondents is relevant for the decarbonisation of the generation (or production) of heat. The other important characteristics of the implementation of relevant technologies derived from the answers from respondents are the perceived public support by society, affordability as seen from the value chain as a whole and the dependency on both the availability of required resources and changes needed to the excistings infrastructure in order to implement the technology. All characteristics are categorised as being high, medium or low based on the common narrative among respondents, when the combination of technology and characteristics based on the assessment was identified by less than 6 out of 12 respondents these combination were excluded from the findings, these explains the "X" (unknown).

Technological solutions	Identified by respondents*	Perceived characteristics to implementation			
		Maturity	Public support	Affordability	Dependency
Biomass	10	H	L	M	L
Biofuels: green gas	7	M	L	X	M
(green) Hydrogen	11	L	X	X	X
Capture and storage of CO_2	6	M	X	X	X
Residual heat (from waste incineration or industrial	12	H	H	H	M
Geothermal heat	12	M	L	M	M
Power to heat: (industrial) heat pump	12	H	H	L	H
Power to heat: E-boiler	9	H	H	L	H

* out of 12 respondents

Legend
H: High
M: Medium
L: Low
X: Unknown

Table 4.2: overview of identified technological solutions with perceived characteristics

4.2.3 Prerequisites to carbon neutral district heating

From the interviews with both management from firms as well as policymakers several perquisites to the transition to carbon neutral district heating were identified. While varying in perceived importance or dependent on political choices, all of the factors, individually, are a prerequisite to the successful decarbonising district heating.

The adequate heating of residential buildings is recognised as a basic human right in article 25 of United Nations Universal Declaration of Human Rights (UN General Assembly, 1948), while in a develop country such as the Netherlands this might be considered a given, the current reliability is assured due to the access to a steady and available supply of natural gas and the subsequent flexibility and scalability of heat provided through natural gas fuelled production methods, especially during the winter months. Respondents recognised that the decarbonisation of district heating while maintaining the current reliability, or security of supply**,** is a key prerequisite. Hence, new heat sources can only be implemented when the security of supply is sufficiently met for this the discrepancy between demand and supply (figure 4.1) and limited capacity to store significant quantities of heat over longer periods of time (7 out of 12 respondents) need to be considered as well.

Another prerequisites to the effort of decarbonising district heating is **affordability**, this is unanimously identified as an important prerequisite and currently perceived as an obstacle by all respondents of firms as well as policymakers. The affordability does however have different dimensions and is also highly dependent on political choices, the aspect of affordability will separately be addressed in the various contexts during the remainder of this chapter.

In order for firms to adopt technological solutions that reduce carbon emissions an important prerequisite that needs to be met as perceived by respondents of both firms as well as policymakers is a sufficient level of **public support and consensus**. The lack of sufficient support and consensus clearly inhibits firms to invest in new technologies, out of the 10 respondents from the firms, 7 indicated that these firms are highly sensitive for the public opinion regarding these solution. The lack of sufficient support and consensus is perceived by respondents as an important obstacle to implement the relevant technical solutions that enable the district heating industry to decarbonise. How the lack of public support and consensus among stakeholders is perceived as an obstacle by respondents will be elaborated throughout the findings.

While of a different nature, a predictable and stable **government attitude and conduct** regarding decarbonisation is considered as an important prerequisite in order to enable firms to invest in technological solutions that contribute to the decarbonisation of district heating. All respondents of both firms as well as policymakers unanimously identified this as an important prerequisite to decarbonisation as well as a current obstacle that inhibits firms to decarbonise. This starts with a clear and long-term definition and common understanding of what it means to be carbon neutral as a firms and what conditions firms need to meet in order to become carbon neutral.

4.2.4 Dependencies of carbon neutral technological solution and adoption of these by firms

The Initial desk research included a recent study with the subject of a future vision on climate neutral heat grids in the Netherlands by Hoogervorst, 2017 and revealed that the adoption of climate neutral solutions are highly dependent on suitable heat grids and that the current grids are not suitable nor able to facilitate future growth (Hoogervorst, 2017). It was however likely to assume that, due to the nature of district heating technologies and the highly urbanised environment, the decarbonisation of district heating is contingent or dependent on other factors, next to the availability of suitable heat grids. The interviews with employees from firms as well as policymakers revealed a variety of dependencies to the decarbonisation of district heating, these will be elaborated per identified dependency.

4.2.4.1 Dependency: Availability of renewable electricity and capacity of the electricity grid

The transition from the use of natural gas to generate heat towards carbon neutral solutions will result in a shift towards heat generated by electricity, this can either be the primary source via power-to-heat solution such as a heat pump and electric boilers or when converting electricity to hydrogen to fuel heat generation. The power-to-heat solutions are perceived by respondents to be most mature (table 4.2) and are in varying compositions already in use today, in order for these solutions to be carbon neutral these depend entirely on the way in which the electricity is generated as well as access to the electric grid, this dependency on the availability of and access to renewable electricity is

currently perceived be 8 out 10 respondents of the firms as obstacle to implementing carbon neutral heat solutions. In 2020 the total share of renewable energy in the Netherlands was 11,1% (Centraal Bureau voor de Statistiek, 2021), in determining the carbon footprint of heat produced through electricity the product environmental footprint (or PEF) as part of the BENG norm (paragraph 4.1.4.6) is deciding (Harmelink, 2019). Since the average share of renewable electricity is low, so is the amount of carbon emission reduced as a result of heat generated through electricity. In table 4.3 the average CO_2 emission of power-to-heat sources in comparison to the current fossil heat sources is shown, when comparing the natural gas fuelled boiler compared with the electric boiler the CO_2 emission in the year 2020 are higher when heat is produced with the electric boiler. Based on the expected increase in the share of renewable energy production the performance of the electric boiler however positively changes to an expected reduction in CO_2 emission of over 50% by 2030 compared to the gas boiler. Next to the availability of renewable electricity, the ability to gain access to the electricity grid itself is also perceived as an obstacle by 5 out 10 respondents of the firms, the lead time to gain access to the grid as well as the capacity of the electricity grid itself could, in the eyes of the respondents, result in delays and currently inhibits the development of initiatives to decarbonise. In order to decarbonise district heating with technologies that are currently perceived as most mature by respondents it is necessary to increase the share of renewable electricity produced and ensure that the capacity of the electricity grid is on par with the increasing demand of electricity.

Average CO_2 emission per heat source	2020	2025	2030
Combined heat and power (CHP) on natural gas	53 kg/GJth		
Gas fuelled boiler	58,5 kg/GJth		
Aqua thermal (heat pump)	30 kg/GJth	21 kg/GJth	15 kg/GJth
Electric boiler	85,03 kg/GJth	59,52 kg/GJth	25,51 kg/GJth

kg/GJth: carbon dioxide in kilograms per gigajoule heat produced

Table 4.3: average expected CO_2 emission of GJ heat produced per heat source (figures derived from Wolf & Loogman, 2020)

4.2.4.2 Dependency: Temperature of the heat grid

The current heat grids are designed to transport heat with a temperature above 90°C to residential buildings and offices, the higher temperature is a result of the time in which the grids where installed and the level of insulation and technological capabilities at that time as well as a, during that time, vast supply of relative cheap natural gas. In order to decarbonise district heating it is most efficient to reduce temperature required to heat buildings simultaneously with the introduction of new carbon neutral heat sources. The dependency of carbon neutral heat sources on lowering the temperature in the heat gird is perceived by all respondents as an important dependency to first all add residual heat from lower temperature industrial processes (e.g., water treatment, data centres etc.) and secondly

increase the deployability and efficiency of renewable heat sources. The lower temperature heat production is however, as perceived by 8 out of 12 respondents, contingent on separation of the water used for tapping and heating.

The most efficient way to achieve this, as perceived by all of the respondents, is to improve the insulation of buildings, especially residential buildings and offices. The insulation in itself already reduces carbon emission by reducing demand and secondly enables for a lower temperature heat generation, transportation and delivery. Recent studies on the climate neutral heat grids also recognise the insulation of residential buildings and offices as an important element to the transition (Hoogervorst, 2017), especially since this can be done largely independently of other aspects of the transition towards carbon neutrality.

As one respondent put it: "*Decarbonisation should be the goal. Yes, and there are several to reach that goal and in my opinion I do see an important role for collective heat grids (…), but please start by adapting the residential buildings and invest in insulation in a massive scale*". However, it is important to add a nuance to this, which several of the respondents made (4 out of 12), since there is a perceived trade-off between the level of insulation and the costs to reach this level. To quote one of the respondents: *"What we are saying, in fact, what I am saying everywhere, is to think about functional insulation. So what is functional? When I can look outside from under a roof of a house, then it is functional. If you have uninsulated glazing, do something about it, if you have double glazing and its old well, then maybe you can do something in the long run if you do have to replace window frames. Think about a good window frame, but don't, hey, strip the house right away and replace it. Because then it will indeed add up in costs (…) resulting in a gas-free transitions that becomes unaffordable. Think also about a natural moments, when am I going to do? And everyone's turn comes at some point, between now and say 15 years, so be efficient and use common sense."*.

4.2.4.3 Dependency: Local infrastructure and available heat sources

One of the important characteristics of heat is that it is, unlike for example power or gas, a very local resource since it is expensive to transport heat, as a respondent stated: "*I made several calculations (…) in other words heat transport is per megawatt in the order of 100 to 200 times as expensive as gas and 10 to 20 times more expensive as electricity, especially the exchange from the grid to individual buildings"*. The relative high costs to transport heat has as a consequence that heat must be generated (or produced) locally and transported over relative short distances. This means the possible sources to produce heat are regionally oriented which are in fact the separate grids of district heating that exist per (greater) city area. The regional orientation of district heating has several consequences for the decarbonisation of district heating, firstly 7 out of 12 respondents refer to a path dependency of technological choices made in the past which could inhibit the use of new technologies in that specific

heat grid or require significant costs to adjust the existing infrastructure thus "*options of technological solutions are constrained by local infrastructure and existing commitments to technologies*". Secondly, the proximity of carbon neutral heat sources near a specific grid is recognised by 9 out of 12 respondents to be a dependency for options to decarbonise heat grids, the comparison between Rotterdam and other cities was made several times by respondents: "*Rotterdam is of course very spoilt, with its residual heat and with the harbour. There, I think, the goals are achievable. In other areas without significant residual heat from industries it is really very difficult to find a collective solution for district heating*", "f*or The Hague or Leiden is this more difficult and it might need to rely more on local sources of heat such an aqua or geothermal heat sources to decarbonise*". The third effect of the localised application of specific technologies or solutions is the efficiency and scalability, *"scale, yes, it is really needed to achieve this for district heating we need at least a few thousand homes preferably within close proximity of each other for example stacked, so that the housing intensity is high*".

The consequences of the characteristic of heat, as being a local recourse and the dependency on the local infrastructure that provides the heat has an indirect consequences for public support and consensus to the decarbonisation of district heating, as indicated by 9 out of 12 respondents for new technological solutions to be implemented in certain neighbourhoods the local public support and consensus among municipalities, housing associations but most notably the residents of the neighbourhood cannot be underestimated. Since the new solutions are sometimes literarily in the 'backyard' of residents and the construction of heat grids as well as changes to the heat grid results in a lot of local disturbance, albeit temporary. The consequences of this will be addressed further in paragraph 4.3.2.

4.2.4.4 Dependency: Regulations and government incentives

In the answers of all the respondent of firms, government incentives has also been recognised as an important dependency to the decarbonisation of district heating. The district heating industry is strongly regulated as discussed in paragraph 4.1, most of the regulation finds their origin in safety requirements related to the infrastructure, housing and urban environment as a whole. Regulation has an effect on all dimensions of carbon neutrally in the district heating industry such as the technical applicability (i.e., is it possible to use technology within the framework of regulations), affordability of the solution due to the price regulation of carbon, natural gas or heat but also the applicability of government schemes and subsidies to enable investments in decarbonisation by firms (discussed in paragraph 4.3) and also current and future restriction on carbon emissions or on how specific technologies are classified as contributing to carbon neutrality. Next to regulation that specifically target the district heating industry, policy in another field influences the decarbonisation of district heating as well. Examples of these are the requirements for newly build as well as existing buildings

("*the requirements for new buildings are very decisive for the propositions we can deliver in terms of collective heat. But that number of propositions is limited by for example legal sustainability standards*"), regulation and restriction on fossil industry but also restriction on safety and environment for construction work in urban environments. These are all examples mention by several respondents but are likely not limited to these, as one respondent put it: "*the decarbonisation is very much dependent on government policies, so we are in our projects equally dependent on these and we run in the bumps during every new project"*. In the upcoming paragraphs the effect of government regulations or incentives, as perceived by the respondents, on the identified relevant topics will be described.

4.2.5 Conclusion: decarbonising district heating from a technological perspective

When designing government incentives to decarbonise district heating two inherent aspects to district heating (or broader collective heat solutions) are important to understand, first heat demand various greatly during the year (with a factor of up to 6 times in an average year) and secondly currently relative high temperatures of water are required to ensure safe heat delivery in the current heat infrastructure, both have consequences for the security of supply and affordability when introducing technological solutions that lead to decarbonisation. In order to achieve carbon neutral district heating as well as for firms to decarbonise their heating activities several prerequisites that need to be met as well as dependencies that need to be reduced were identified, these are summarised in table 4.4 and 4.5.

The current state of technological developed as perceived by respondents from both firms as well as policymakers as mature enough to facilitate the decarbonisation district heating activities, albeit that prerequisites need to be met and dependencies to be reduced, from technological perspective especially by lowering the temperature of the heat grid as well as the increase of renewable electricity while ensuring security of supply. For the design of government incentives with the aim to decarbonise district heating this has important implications. While some innovations mainly to increase efficiency are required, the technology is available and subsequently government policy should emphasise more on incentivising diffusion and subsequent adoption of these technologies by firms. Additionally, the technological solutions to become carbon neutral are not so radically different compared to the current situations since the heat source is replaced by other heat sources and the change is often in the energy from which heat is generated (biomass, electricity, green gas or hydrogen instead of natural gas), the adoption of the technology depends however heavily on the development and adoption of other technologies in both the infrastructure of heat grids as well as for example the adoption of renewable electricity.

Identified prerequisites to decarbonising district heating	
Prerequisites	**Effect on decarbonisation**
Affordability	The solutions that enable carbon neutral heat generation and delivery need to be (made) affordable, both for firms in order to adopt the relevant technologies as well as for end consumer to create the necessary demand.
Public support and consensus	In order to implement solutions a sufficient level of public support and consensus among relevant stakeholders need to exist before firms are able to implement these solutions.
Security of supply	The introduction of technologies that enable carbon neutral production can only be adopted when sufficient guarantees can be made that ensure security of supply. The inherent disceptation between supply and demand further complicates this.
Stable government attitude	Provide a clear and long-term definition and common understanding of what it means to be carbon neutral as a firms and what conditions firms need to meet in order to become carbon neutral.

Table 4.4: prerequisites to carbon neutral district heating

Dependencies to overcome in order to achieve carbon neutral district heating	
Dependencies	**Effect on decarbonisation**
Availability of renewable electricity	The solutions that enable the carbon neutral generation of heat are either directly or indirectly dependent on power-to-heat solutions. This solutions can only produce carbon neutral heat when the electricity used in this process is itself carbon neutral.
Sufficient access and capacity of electricity grid	The demand for electricity will increase, in order to provide this the capacity of the electricity grid needs to be expanded. This needs to be on par with the efforts to decarbonise district heating to ensure timely access to electricity.
Lower the temperature of the heat grid	Most of the carbon neutral heat sources are not capable to produce heat at the required temperatures, for this the temperature needs to be increased by secondary solutions (mostly power-to-heat or even natural gas). If the heat grid is able to handle lower temperatures more sources are eligible to provide carbon neutral heat and the affordability of carbon neutral heat will increase.
Available carbon neutral heat sources	Heat sources are due to the costs and efficiency losses when transport heat very localised. This means that there need to be sufficient local sources available to implement carbon neutral district heating.
Local heat infrastructure	The local heat infrastructure need to be adapted and expanded to ensure the capacity for carbon neutral heat as well as provide for the future growth.
Government policies	Government regulations in different policy fields need to include and provide for the relevant technologies before the adoption of carbon neutral heat solution can implement by firms.

Table 4.5: dependencies to carbon neutral district heating

4.3 Part 3: Firms decarbonising their district heating activities

What drives firms to decide to invest in decarbonisation in the district heating industry and did firms already start with the decarbonisation of their activities, this will be explained based on the interviews with respondents from the firms. Additionally, perceived obstacles where identified that inhibit firms currently from decarbonising their activities.

The findings elaborated in this part show that firms have operationalised their environmental strategy in their decision-making process, and favour projects that lead to decarbonisation compared to those

that do not. Firms are however, mostly due to lack for demand of carbon neutral heat, unaffordability of the technological solutions that provide carbon neutral heat and lack of public opinion and subsequent public support for these technological solutions, unable to decarbonise. The lack of solutions that enable the firms to decarbonise could result in the divestment of these activities by the firms. The identified obstacles that inhibit firms to decarbonise can be found in table 4.6

4.3.1 Dominant factors that drive decision-making towards decarbonisation

All of the respondents of the firms were, by virtue of their position, in a decision-making or advisory capacity with regard to investment proposals or business cases of decarbonisation projects within their respective firm. During the interviews initiatives (e.g., investment proposals, business cases, contracts that include decarbonisation) with the aim of tangible decarbonisation of their district heating activities were discussed in order to gain a better understanding of the dominant factors that drive the decision-making process of the firms related to decarbonisation.

Of the respondents of the firms that were interviewed during this study, all identified the financial contribution of the initiatives being return on investment (hereafter: ROI), i.e., reach a predetermined minimum profitability within a maximum payback time, as well as the decarbonisation factor, contribute to defined GHG emissions reduction, as the most important hurdles to overcome to reach a favourable decision on the respective initiatives. The ROI factor is composed of several elements such as the perceived (future) demand of heat generated by the specific technology and the perceived predictability of the industry i.e., whether the specific technology and produced heat are likely to meet the required conditions over a longer period of time, which both related to the possible payback time on investments as being a key elements to the ROI factor. The firms included in this study all had recently (0-2 years) adopted an environmental strategy that was operationalised to quantitative decarbonisation targets and applied a grading system onto projects for the level that these projects contribute to the decarbonisation of the firm. The multinationals included in this study all adopted the recently approved EU taxonomy classification (EU Taxonomy for Sustainable Activities, 2020), in order to evaluate the contribution of the assets to the decarbonisation of the firm.

What respondents identified as a requirement in order to determine the ROI and decarbonisation factor is the assurance that the heat produced by the technology has the label of, for example, green heat over a predetermined time. Or in other words, firms want the certainty that the heat they aim to produce with a specific technology will be classified as heat that is eligible for minimum period of time so that demand for their heat is guaranteed, this in turn will ensure the needed payback time of the investment as well as the likelihood that the technology will contribute to the decarbonisation targets of the firm. The respondents identified the government on various levels as the body to provide this assurance, which in turn relates to the identified prerequisites of stable government policies.

When explaining the current decision-making process, the following hierarchy could be identified in 4 firms of which all the multinationals included in this study, namely: the level of strategic fit of the project as a more qualitative measure, followed by meeting quantitative decarbonisation reduction criteria and lastly meeting quantitative ROI requirements. This is next to the compliance of the project to health, safety and environment standards from a regulatory perspective, which is more seen as a prerequisite to any initiative.

Several of the respondents perceived this as a recent shift in company policy with regard to hierarchy of decisions-making (8 out of 10), in the past (varying between 1-3 years) the dominant factor was the ROI. Based on answers from respondents the decarbonisation factor, which is an operationalisation derived from the defined environmental strategy of the respective firm, is taking precedent before the ROI factor. Additionally, all three multinational firms have introduced incentives to achieve their respective decarbonisation goals by applying lower ROI requirement for green (i.e., projects that contribute to their respective decarbonisation goals) compared to grey (i.e., fossil) projects.

4.3.2 Steps taking by firms to decarbonise their activities

In order the understand the current state of the decarbonisation of the district heating industry all respondents of the firms were asked what steps their firm currently had taken in decarbonising their district heating activities. The most common step (8 out of 10) was the adoption of end-of-pipeline pollution control technologies to reduce GHG emissions or improve efficiency (i.e., produce more with equal fuel consumption). Additionally, when it was (financially) opportune to do so and when perceiving pressure from municipalities or provinces by the firms steps were taken to introduce residual heat from waste incineration or highly industrial processes such as the petrochemical industry (7 out of 10). The available technologies that respondents identified with regard to decarbonising district heating such as biomass, large scale heat pumps, geothermal heat or electric boiler where are cited by respondents as ongoing initiatives, but when inquiring about the status of these most initiatives where either still on the drawing board or in preparation due to a variety of causes and some of the projects were shelved for the short-term.

The causes for the limited implementation of projects that lead to decarbonisation vary, but three underlying causes stand out and are cited by one or more respondents of every firm included in this study. Firms perceive a **lack of affordability** (9 out of 10), from the viewpoint of the firm projects lack an acceptable return on investments this, together with issues or uncertainties related to changing and inconsistent **government attitude and conduct** towards of the solutions as a result of the previously elaborated dependencies (8 out of 10) in combination with the absence of sustainability requirements or standards and **insufficient public support and consensus** among key stakeholders (8 out of 10). To summarise: the return on investments are too low in light of the perceived risks that

relate to the technical application of the solutions and lack of public support and consensus for the solutions. Hence the projects for firms are perceived to be "*too risky*" resulting in a "*unacceptable business case*" or projects that "*cannot compete with other projects*".

The lack of feasible projects in conjunction with the pressure that firms experience to decarbonise their activities could lead firms to divest fossil activities that no longer fit the firms' environmental strategy without the necessity to replace these activities with production methods that do fit the respective strategy, which was cited by all of the respondents from multinationals (8 out of 10) included in the study. Based on answers from the respondent it is a likely that due to the current pressure perceived by firms to decarbonise their activities (as discussed in paragraph 4.1.6) and the lack of feasible projects, firms withdraw strategically from certain industries in which the decarbonisation is not on par with their own environmental strategy especially if the current profitability of those activities are perceived as relativity low by the firm. This appears be especially the case for multinationals who do not depend solely on a specific activity in a specific country.

4.3.3 Obstacles to firms decarbonisation their district heating activities

From the interview with employees of firms and policymakers it was possible to unravel the obstacles to the attempts by firms to decarbonise their district heating activities as well as to the future growth of carbon neutral district heating as a goal set by the government in the 2019 Climate Act (Ministerie van Economische Zaken en Klimaat, 2019), these will be elaborated per perceived obstacle. The obstacles will be categories based on the affordability, public support and consensus and government attitude and conduct as experienced by firms related to the decarbonisation of district heating by firms.

4.3.3.1 Affordability: it pays to be fossil

The relative low costs for that are involved with the use of natural gas to produce heat both directly as a commodity (9 out of 12), but also the technology on which heat through natural gas is generated is perceived as mature and efficient (8 out of 12). In addition, while the EU Emission trading system for carbon certificates is applicable on district heating activities a significant share of the heat produced is exempt through the allocation of free certificate (*EU Emissions Trading System (EU ETS)*, 2017) and the introduced carbon tax (in Dutch: Wet Co2-heffing industrie) by the Dutch government does also not apply on district heating (*wetten.nl - Regeling - Wet CO2-heffing industrie - BWBR0044578*, 2021). The combination of the aforementioned results in a status quo that is difficult to change, since the primary stimuli that encourage firms to change their process or business model are absent.

4.3.3.2 Affordability: restriction due to the current price control mechanism on heat

The current price control mechanism in place for district heating is subject to the price development of natural gas (discussed in paragraph 4.1.4.3), this inhibits firms to adjust prices as a result of

increasing investments and costs when they want to implement technology to decarbonise their activities. Most respondents specifically mentioned the restrictions imposed by the current price control mechanism as an important obstacle to decarbonisation (11 out of 12). In the proposed new heat law, the price control mechanisms is revised to give firms more options to change prices when decarbonising, this however met with controversy in parliament and beyond and led to the current caretaker cabinet to declare the revised heat law controversial and subject to a new coalition agreement (van Santen, 2021).

4.3.3.3 Affordability: lack of appropriate government support schemes

Respondents from the firms find the absence of proper government support mechanism for decarbonisation business cases that can negate the aforementioned perceived low rewards as an additional obstacle to the affordability of technologies (8 out of 10). The most important policy instrument in place to support firms decarbonising is SDE++ scheme (paragraph 4.1.4.10), as explained this is an instrument which applies to a wide variety of industries with the aim of incentivising renewable energy production as well as decarbonisation (Stimulering duurzame energieproductie en klimaattransitie (SDE++) | RVO.nl | Rijksdienst, 2020). The experience of most respondents from the firms is however that the solutions needed to decarbonise district heating are highly customised and do not fit the general parameters of the scheme, in an attempt repair this policymakers added an increasing number of categories (combination of technologies and applicability in a specific set of conditions) to the scheme. This however appears not to be adequate since even when new categories where added it did not provide the necessary customisation for most initiatives to be eligible (7 out of 10) and when initiatives have found to be eligible there have been examples provide by respondents (5 out of 10, from 4 firms) that the specific set of conditions related to a specific category where still incomplete resulting in uncertainty about the amount of subsidy that will be received for the project.

Another aspect of the SDE++ subsidy scheme that inhibits the diffusion of technologies that could contribute to decarbonisation in the long run is the recent introduction of a grading system of projects based on reduction of carbon under current conditions (7 out of 10 respondents). For this the agency responsible for the grading of projects applies the current average share of renewable energy in the electricity grid for heat that is produced through electricity to determine the reduction in carbon emission. This means that most power-to-heat solutions (heat pump, electric boiler) but also geothermal heat are less likely to be eligible to receive funding from the SDE++ scheme, due to the current low share of renewable electricity in the Netherland (paragraph 4.2.4.1).

4.3.3.4 Affordability: uncertainty of demand (lack of demand commitment)

Respondents from the firms recognised the uncertainty in heat demand due to a lack of commitment from stakeholders as an important obstacle for the future growth of the heat grid and the ability to

reach the scalability necessary to ensure a level of efficiency needed for certain solutions to be profitable (8 out of 10, from 3 firms). The lack of commitment as perceived by firms can be broken down to several aspects. Firstly, for firms it is still unclear how the heat they produce through a specific technology is classified and whether or not this will ensure a place in the merit order for the heat they produced both in existing as well as future heat grids and is due to the absence of clear regulation as well as the inability of government agencies as well as municipalities to make a decision on this (7 out of 10, from 3 firms). Secondly, when evaluation business cases for the expansion of existing or the construction of new heat grids firms experience a lack of commitment from municipalities but also housing associations and homeowners. Several of the respondents (8 out of 10) recognised that currently both housing associations as well as homeowners do not have a financial incentive to switch from natural gas to solutions that are based on carbon neutral technologies. While respondents do indicate that both municipalities as well as housing associations are cooperative and have a positive attitude towards decarbonisation of district heating and the future growth of carbon neutral district heating as well as want to commit to this, due to the complexities and dependencies revolving district heating in urban environments they often back down, which appears to be the result of a lack of consensus and support among residents. The combination of the aforementioned perceived lack of demand has a third effect on the diffusion of carbon neutral technologies in district heating, namely that firms currently judge it as too risky to invest in certain technologies in the Netherlands entirely (7 out of 10, from three firms).

4.3.3.5 Public support and consensus: inherent complexity in decarbonising district heating

The inherent complexity experienced by firms surrounding to decarbonise their excising activities and expanding or construction new district heating solutions is high and identified as one of the main obstacles that prevent the decarbonisation and growth of carbon neutral district heating by all respondents from the firms, "*you just have a whole range of stakeholders who all have to work together to make the transition possible, and I see that as one of the greatest threats to sustainable heat*". This is due to the fact that district heating is part of the urban infrastructure and both the generation and transport of heat is close to urban environments. Changes in the generation, transport and delivery of heat are subject to significant regulations and in the implementation of these changes the firms are dependent on a variety of stakeholders such as municipality, utility companies, water boards, housing associations and private homeowners. All of these stakeholders have their own goals and interests that do not necessary align with the goals and interests of the firms.

4.3.3.6 Public support and consensus: absence of broad consensus and support for decarbonisation

One of the primary reasons that initiatives with the aim of decarbonising district heating currently fail to go beyond the drawing board is the perceived lack of sufficient levels of support and consensus by

firms among the relevant stakeholders that are involved in these initiatives. In all interviews with respondents from firms as well as policymakers this was recurring topic, next to the affordability, the main reason why projects fail to materialise. The firms perceive risk on possible reputation damage as well as for stranded assets to be too high.

Biomass is a technological solutions that has been particularly affected by the volatility in support among important stakeholders, the general public opinion and attitude of the government, especially politicians, towards the technology. The use of biomass to decarbonise various industries is an important pillar in the national Climate Act of 2019 (Ministerie van Economische Zaken en Klimaat, 2019). The word "biomassa" (which is the Dutch equivalent) is mentioned 114 times in the official document and it has even received its own dedicated chapter on how to best make use of this technology across industries and applications and how to devise an intergrade approach. Strengthened by the commitment made by leading actors in the Climate Act led several firms included in this study to start, or continue, with developing initiatives to generate heat through the use of biomass. These initiatives were supported through specific subsidy schemes and several government agencies provided assistance to firms during the developing phase in permits or in infrastructural changes, however shortly after the conclusion of the Climate Act the opinion of key stakeholders changed (Konings, 2019), which resulted in the delays in development and implementation of these initiatives and might lead of the abandonment of these initiatives by the firms in the near future. The main rationale behind the current delay of the initiatives by firms is the risk that resistance by different stakeholders towards permitting (now and in the future) and operating the technology will result in reputational damage as well as early termination of the initiatives and will result in stranded assets and the subsequent losses for the firms involved.

The current political debate led to the temporary suspension of all subsidy schemes applicable on biomass (Ministerie van Economische Zaken en Klimaat, 2021c). An important side-effect of this, beyond the delay or abandonment of individual initiatives, is the degree of credibility firms perceive with regard to government incentives, which currently is perceived as low by all respondents of the firms and this critique is recognised by the two policymakers included in this study, in the words of a respondent of a firm working closely on a biomass project:

"*The frustration that we have, is that two years ago we concluded a climate agreement with over 100 companies in the Netherlands in which the biomass solutions were explicitly agreed upon, and now almost on all of these solutions we see relevant authorities and stakeholders recanting and making objections and not supporting the commitments made. Well we can't develop projects and we can't make decisions with these conditions*" continuing with "f*urthermore, you do notice that, particularly*

as I mentioned earlier, while the climate agreement has been concluded and we have been developing things in response to it, especially biomass, we experience enormous opposition on these developments and that from the government, no one, wants to publicly help us, everyone dives in but behind closed doors say: please continue, because without biomass we won't make it, our decarbonisation objectives as the Netherlands, then I think, you sometimes have the of, what are we fighting against and doesn't motivate you very much."

The example of biomass is not an isolated to one specific technologic solutions, with the development of geothermal heat firms face similar obstacles (5 out of 10 from 4 firms) and some respondents made parallels with the ongoing public debate that the expansion of renewable energy through wind turbines and solar farms on land face (NOS, 2021).

The worry among respondents from the firms as well as policymakers is that the social debate, together with the lack of successful projects will have negative impact on the success of future projects and especially impacts the support among residents and results in mistrust towards both the firms as well as the (local) government and housing associations (8 out of 12). Likely further reducing the willingness of residents to participate in local district heating initiatives, increasing the risk not achieving the needed scale of certain technological solutions due to absence of sufficient demand.

4.3.3.7 Government attitude and conduct: perceived instability of the political climate and government policy

Intertwined with both the perceived affordability and public support and consensus among the stakeholders experienced by firms is the stability of the political climate and the policies that result from this, as briefly touched upon in the previous paragraph. All respondents came to the same conclusion, the current political climate is unstable which results in a lack of adequate policies and also limited coherences between policy fields and lack of coordination between government bodies tasked with implementing policy contributing to an unfavourable investment climate.

Firms experience in general a lack of continuity of government policy in the Netherlands and inadequate compensation when changes in policy negative affects firms (9 out of 10), while assets in district heating have an average lifespan of 20-40 years. This results in firms seeing the volatility in Dutch policy as a threat (8 out of 10), "*you must not create an atmosphere in a country that the government, without taking responsibility, adjusts policies and passes the consequences onto private firms. It is understandable that insights change over the years, but this should be a shared responsibility*."

Specifically, in relation to heat law firms are "*currently held hostage due to pollical developments and indecisiveness, since these decisions determine to a great extent what role our current activities will*

have in the future heat grids", this refers to the new heat law which is still in review and the uncertainties this creates for firms which in turn delays decision related to decarbonisation initiatives (9 out of 10). The critique is however not limited to the review of the heat law, government incentives related to the transition away from the use of natural gas are currently still lacking according to these respondents "*the government committed to a natural gas-free society, but they haven't designed any real instruments for this yet and without incentives or enforcement through regulation a transition is difficult, of course.*"

The consistency between policies between different policy fields is also identified by respondents as an obstacle (8 out of 10) "*the consistency between different policies is not quite right, and that may be partly because it is between ministries and they have other goals with the policy. But, there is not enough harmony and this also major obstacles."*. A clear example of this is that there are subsidy schemes in place from the Ministry of Economic affairs and the Environment that incentivises the diffusion of specific technologies, however the heat produced by these technologies does not qualify as sustainable heat based on the standards issued by the Ministry of the interior, resulting in unfeasible business cases for firms since the ability to sell the heat is uncertain.

All the above effects contribute to a unfavourable investment climate and postponement of projects due to a wait-and-see attitude of firms towards decarbonisation of district heating, "*in the current situations firms that want to invest in district heating do not have sufficient guarantees about the future conditions in the industry in which they need to pay back that investment*" This could have serious consequents to reach the goals set in by the 2019 Climate Act related to the decarbonisation and growth of carbon neutral district heating. Especially since the lead times of typical projects in the district heating industry are considerable due to the complexities involved and are on average longer than 4 years from (feasibility) study to being operational and it is likely that the expansion of heat grids will take considerably longer.

The topic of entrepreneurial risk with regard to changing government policy was also addressed frequently by respondents from the firms, the common understanding was that a change in policy in relative sort notice after the policy was introduced cannot be seen as an entrepreneurial risk (8 out of 10). The topic of decarbonisation and that policy over time will become more stricter towards the consumption of fossil fuel is however seen as an entrepreneurial risk and part of the ever-changing environment in which firms operate (7 out of 10).

In this study three international operating multinationals are included, the respondents of these firms all see the perceived instability and lack of policy continuity and commitment as a threat in obtaining funds to invest in the local activities, to quote one of the respondent: "*For international companies the*

comparison between countries plays an important role, if local policy is disadvantageous for projects or technologies compared to other countries than this will affect the change of local projects approval."

4.3.3.8 Government attitude and conduct: absence of knowledge at key government agencies

An important indicator of the gap that appears to be existing between firms and government on how to go about the decarbonisation of district heating is the perceived absence of expertise and knowledge on key positions at government agencies (6 out of 10, from all firms included in this study). The worry among several respondents is that the specific complexities are not well enough understood, with the expected shift of authority towards municipalities this knowledge gap between firms and government is expected to increase even further, since 4 out of 10 respondents perceive the knowledge gap to be the most significant at municipalities. The effect of the knowledge gap according to the respondents is that policy is not attuned towards the need of firms and either does not contribute or presents itself as an obstacle to decarbonisation, to quote several respondents:

"*Currently the local government do not have the means or knowledge to really make a difference in determining the best solutions for heat grids*", "*we do see a cooperating government, but a government that also wants to do things carefully, but we clearly experience lack of knowledge on the part of the government, which is sometimes even a bit shocking*" which is perceived by most respondents as "(…) logical since it is very specific" it is however seen as a necessity that *"(…) the relevant knowledge should be available to local authorities so that they understand it too and can make informed decisions*".

4.3.4 Conclusion: Decarbonisation of district heating from industry perspective

The adoption of carbon neutral solutions are subject to internal decision-making by the firms. Relevant factors that drive the decision-making are the strategic fit of the initiative, the amount in which the initiative contributes to decarbonisation of the firm and the financial contribution of the initiative. In order to determine the contribution to decarbonisation all multinationals included in this study adopted the recently introduced EU taxonomy classification for sustainable activities. Respondents perceived a shift in the relative importance in the decision-making factors, namely that as a results and operationalisation of the environmental strategy the contribution to decarbonisation of the firm takes precedent over the financial contribution of the project, since required financial performance for projects that result in decarbonisation is lower compared to projects that do not contribute decarbonisation.

At the time of this study, the firms included in this study have made limited steps beyond the introduction of end-of-pipeline pollution control technologies to reduce emission as a result of consumption of natural gas and the use of residual heat from waste incineration or industrial processes when financially opportune to do so. For firms to reach a favourable discission related to decarbonisation initiatives an acceptable balance need to exist between the perceived risks and

expected rewards of an individual initiative. For the decarbonisation of district heating this appears not to be the case and the cause of this, as perceived by firms, can be attributed to the **lack of affordability**, issues or uncertainties related to the **government attitude and conduct** and insufficient **public support and consensus** experienced by firms among their stakeholders. In table 4.6 a summary of the identified perceived obstacles by firms categorised according to the aforementioned subjects is included.

Firms indicate that the lack of feasible projects to decarbonise their district heating activities results in tension between the adopted environmental strategy of the firms, which requires a certain pace of decarbonisation, and the inability to do so for district heating activities. For firms, and in specific multinationals, it was indicated by respondents that this could result in a strategic withdraw by the firm for activities that are lagging behind the environmental strategy of the firm when the firm is experience significant pressure to decarbonise in a certain pace.

Identified obstacles that inhibit firms from decarbonising their activities		
Category	**Perceived obstacles**	**Effects on decarbonisation**
Affordability	Natural gas is a relative cheap commodity.	Limited incentive to replace heat generation through natural gas as dominant technology.
	The costs for firms as a result of carbon emission are limited.	Absence of strong incentive for firms to decarbonise their activities.
	Current price control mechanism has a bench mark with natural gas.	Firms are unable to include price increases in the heat price as a result of adopting technologies that lead to decarbonisation due to current price restrictions.
	Current technologies are most of the time not eligible for government support through existing schemes.	Firms postpone or currently refrain from investing in carbon neutral heat solutions as a result of expected initial losses during project implementation as well as first years of operating.
	Lack of incentives for demand of carbon neutral heat at end-customers of heat.	Perceived lack of demand to justify investments in the expansion or construction of new heat grids as well as increase capacity of carbon neutral heat generation.
	Uncertainty of what technologies are classified as carbon neutral for the foreseeable future.	Uncertainty about what technological solution to invest in by firms to ensure long-tern qualification of carbon neutral heat i.e., have sufficient demand for heat produced by specific technology.
public support and consensus	Discrepancy between goals and interests among various stakeholders involved in the decarbonisation of district heating.	Lead time of projects related decarbonisation are long or it inhibit firms from decarbonising due to inability to receive the necessary cooperation.
	Public support for decarbonisation of district heating is perceived as too low by firms.	Firms postpone or currently refrain from investing in carbon neutral heat solutions due to fear for bad publicity and effects on public image.
Government attitude and conduct	Uncertainty about future changes in government policy on district heating.	Firms postpone or currently refrain from investing in carbon neutral heat solutions due to uncertainty about future conditions in the industry.
	Perceived low commitment by firms of government related to towards policy (credibility and continuity of policy).	A unfavourable investment climate and postponement of projects due to a wait-and-see attitude of firms towards decarbonisation of district heating.
	Lack of consistency between policies field affecting the decarbonisation of district heating.	Policy is not attuned to needs of industry resulting in firms postponing or currently refraining from investing in carbon neutral heat solutions.
	Absence of knowledge at key government agencies.	

Table 4.6: Identified obstacles that inhibit firms from decarbonising their activities

4.4 Part 4: Combined government incentives: the perceived need for an integrated approach towards district heating

How government policy can create the prerequisites, reduce the dependencies and overcome the identified obstacles that lead firms to decarbonise is the central theme of this study and the final part of the study was aimed at identifying ways on how government incentives could collectively contribute

to the conditions that enable firm to decarbonise their district heating activities and contribute to the further growth of collective heat solutions. In this paragraph the insights gathered from both the management of the firms as well as policymakers have been combined to provide an overview with the leading policy recommendation that enable firms to decarbonise their activities. The policy recommendations described in this paragraph are derived based on the identified common narratives among the respondents of this study and should be interpreted as such.

The findings in this part show that firms require combined government incentives to ensure a level playing field that provides firms with the necessary guarantees in order for firms to invest in carbon neutral solutions. The district heating industry is not a functioning market, hence policy cannot be devised under the assumption that such a market for carbon natural heat exist. The market and thereby the demand for carbon neutral heat are based on political choices and this underpins the need for an integrated policy approach. In order to achieve this, the government needs to provide for a mandatory path to decarbonisation since this ensures demand for carbon neutral heat supported by government incentives that improve the affordability and public opinion. The stakeholders of the industry together with the government need to be organised in structured dialog as part of the integrated industry approach that facilitates the decarbonisation of the industry.

4.4.1 Elements underpinning an integrated approach

Based on the interviews with both respondents from firms as well as policymakers the need for an integrated approach towards district heating from national to local (municipality) policy perspective and vice versa as well as from generation of heat to delivery of heat and the grid which connects both was apparent, this was cited by all respondents in this study. All policy regarding district heating should, according to the respondents, be devised based on the main assumption that the value chain of heat is an integrated system, since different parts of the value chain react to one another and the resulting effects are not just isolated to that part of the value chain. As one respondent put it: "*move away from haphazard instruments instead look what is needed "on the ground" and devise an integrated approach*". This in order to create the investment climate needed for firms to invest in carbon neutral district heating. Prerequisite to an integrated approach, as perceived by all respondents, is the cohesion of government policy both between policy fields as well as the different levels of government.

Part of this integrated approach is to ensure that both rewards and risk are equally divided between the different parts and players of the value chain, what is clear from the various statements made by the different respondents from the firms is that no firm is willingly to take upon risks that are beyond their immediate control, especially if these are not quantifiable. A way to cope with these risks is try and reducing these risks (or de-risking) through government incentives, this can for example be achieved by properly managing the whole environmental situation through permitting or conducting

the preliminary studies and making clear agreements with all stakeholders through a framework or covenants. The approach used by the government related to the construction and exploitation of wind parks in the North Sea was presented by a respondent as an example of such an approach.

Several of the respondents of the firms (7 out of 10) indicated that it is likely that certain activities of the value chain are no longer profitable, albeit temporary, but are important to ensure security of supply and thus it is in the public interest to ensure continuity of these activities and that it should be a shared responsibility to find solutions how to organise these activities in the value chain, it is important as perceived by respondents to assess the heat production as well as supply as capacity market (Crampton, Ockenfels & Stoft, 2013).

An important aspect of the integrated approach is for the government to facilitate in a structured dialog between all relevant stakeholders, which not just includes the directly concerned such as the different government bodies and agencies as well as the firms but also housing associations, home owners (associations) but also entities that have an important role in the infrastructure and urban environment, an important prerequisite to this as perceived by several respondents is the accessibly to such a dialog by a relevant stakeholders as well that stakeholders are consulted in early stages of development of projects. The common narrative is that most problems can be overcome when properly addressed early in the process. Some respondents refer to a government role as being a matchmaker, that when the need arises brings the relevant stakeholder together, while others would also prefer a more direct(ing) role of the government by stimulating different stakeholders to work on specific topics of interest for the decarbonisation of district heating.

The respondents of the firms as well as policymakers also identified the need for a strong governance role (9 out of 12), especially since there is currently limited competition, and it is believed that this is not likely to change in the foreseeable future which reduces the incentives of different industry players to change. The shared understanding is that the government is the only suitable party that can take on such a role by setting targets for all parts of the value chain and ensuring alignment between them as well as suitable policy mechanism to enforce these targets of being met.

The following elements to a government policy mix on the decarbonisation of district heating should all be seen as part of the integrated approached to the decarbonisation of the value chain of heat.

4.4.2 Provide a clear path to decarbonisation for the industry

While the goal for respondents towards decarbonisation is clear, to be largely carbon neutral by 2050 or sooner, the path that will lead to this goal and what the role of district heating plays in achieving this goal is perceived as fragmented by respondents of the firms. The shared experience among firms in this study is that "*the government is currently far for clear on the solutions that lead to*

decarbonisation, the goal is clear the solutions not and this absence makes it difficult for firms to invest in new solutions" since it is "*the government that should make a clear choice of specific technologies and determine the path for decarbonising district heating based on the local situation*" which is above all seen as by firms "*the solution in a specific area of city is first of all a political choice*" and "*this will result in a government intervention, the choice needs to be made carefully and substantiated and needs to consider the effect in the market*". The path of decarbonisation should for example include what neighbourhoods or city blocks are eligible for collective heat solutions and also in what timeframe the transition should take place. The firms do see a role for themselves to provide perspective and assist in creating a shared understanding of the path towards decarbonisation of the industry, the ultimate choice of which path to take is however ultimately seen as a political one. Part of providing a clear path, as perceived by several respondents (8 out of 12), is the introduction of uniform standards across industries related to (carbon neutral) heat.

4.4.3 Reinvent the current price control mechanism

Before the above incentive can be implemented the current price control mechanism needs to be adjusted according to all respondents participating in this study. The current benchmark of the heat price with natural gas should be replaced by a different model based on the actual costs to produce the heat including the effort to decarbonise the current heat generation and the heat grids. Most respondents did see a challenge or complexity with regard to a new price control system that included the prices for decarbonisation, this is due to the likelihood that decarbonising of heat grids will be heavily dependent on the local situation and available carbon neutral heat sources, in some areas this is perceived to be relatively more easily due to the close proximate of industry or electricity generation, like the greater Rotterdam area, for other parts of the country it is perceived to be more difficult to implement affordably heat solutions that lead to decarbonisation due to the absents of relative affordable sources of carbon neutral heat. Several of the respondents (7 out of 12) specifically indicated that a solidarity principle should be included in the price control mechanism in order to prevent significant price deviation for end consumers of collective heat and in specific district heating solutions throughout the country, "*(…) , a likely scenario is that in Rotterdam it will probably remain affordable, because there is a surplus of heat. But in other heating areas, where things are less obvious and possibilities are more limited, you would have to pass on a huge heat price to your customers in order to make that move towards sustainability (…) so when they want to make heat more sustainable, you have to come up with a certain mechanism, so that it becomes affordable for all citizens*".

4.4.4 Devise incentives that lead firms to decarbonise

In order to create the necessary incentives for firms to pursue decarbonisation of their activities and justify business cases and investment decision to that end, all respondents from the firms believe the

current price levels on consumption for natural gas as well as the taxes or costs on the emission of CO_2 should be adjusted. The costs for the production of heat by means of fossil fuel should gradually be increased based on the defined path towards decarbonisation. Since current price levels on natural gas and taxation on CO_2 are perceived to be too low to justify a business case to decarbonise, several of respondents from the firms believe they would have made other decisions in the recent past when the price conditions where different (6 of 10), to quote one: "*the current levels of carbon prices are not sufficient that decarbonisation as such is rewarded. If prices were higher in the past it is likely we would have taken different decision regarding our activities*.". However, several of the responds warn that a "t*o high carbon price could also result in discontinuation of activities*". Another policy approach brought up by respondents is to reward firms that produce sustainable electricity or heat with discounts on corporate or energy taxes.

Next to the incentives that directly affect firms, most of the respondents of the firms as well as policymakers (9 out of 12) believe that specific incentives for private homeowners, homeowner association and housing associations could indirectly assist firms to decarbonise the existing district heating as well as expand carbon neutral district heating solutions. These incentives should have very specific goal namely reduce the energy consumption as well as make building eligible to receive carbon neutral heat and the perceived best way to achieve this is to improve the insulation of residential buildings and offices. These incentives should be in place to overcome the dependency of lower temperatures as well as creating sufficient demand (paragraph 4.3.3.4), currently there are some incentive schemes available, but respondents believe these are currently not sufficient to adequately reach the scale and level of insulation required in urban centres.

The timing of the aforementioned incentives should be attuned to the identified path of decarbonisation according the respondents (8 out of 12), as part of the integrated approach to the decarbonisation of existing and expansion of carbon neutral district heating. It is believed by respondents that a wide range of sufficient incentive should be in place that influence the specific parts of the value chain of heat in the appropriate order if the decarbonisation is to really pick up the pace.

4.4.5 Customisation and flexibility in government support mechanism

Due to the likelihood that the solution that result in carbon neutral heat generation and delivery will vary as a result of the identified dependencies and local conditions in urban centres, the perception among both firms as well as policymakers is that there will likely be a need for customisation in how and where to apply the different technological solutions in varying combinations. According to the respondents in this study this should result in government incentives that is designed to cope with the need for flexibility while still supporting and enabling firms to invest in carbon neutral heat solutions (11 of 12). In order to achieve the required customisation, as perceived by respondents from the firms

in this study (9 out of 10), it is necessary to incorporate new technologies and solutions that provide sustainable heat in existing policy schemes and support the development and diffusion early on. Within these scheme it is believed to be necessary to create the flexibility that firms need to create and implement tailor made solutions based on the specific local conditions while being eligible for government support.

In order to reach the flexibility, the current SDE++ scheme should, according to respondent from the firms (8 out of 10), either be adjusted or replaced by a new scheme for collective heat solutions that contribute to carbon neutrality. One of the important characteristics of the new scheme is that it should have a dedicated budget for the decarbonisation of district heating rather than that projects for district heating should compete with renewable energy and decarbonisation initiatives from a wide range of industries, as is currently the case with the SDE++. A possible way to, partly, fund the scheme as indicated by several respondents (4 out of 12) is to adjust the current ODE tax: *"(…)use the ODE (…) e.g., the national basic tariff and its capacity component, to subsidise district heating. A trick could be to have this happen via the fixed right or the ODE on electricity and gas as well, than you let the income from the ODE tax flow back into subsidising district heating*".

Additionally, many of the respondents from the firms (8 out of 10) believe the current direct relation between carbon neutral heating solutions and the availability of renewable electricity in government schemes is counterproductive and inhibits to reach a necessary scale of decarbonisation of the district heating grids in the future.

4.4.6 Expand the ways for firms to temporarily compensate for carbon emissions

For firms to become carbon neutral, while still emitting carbon as a result of the absence of technologies mature and affordable enough, it is believed by respondents that the ways to compensate for carbon emissions should be expanded (6 out of 12). Firms believe that it might be in the best interest of society to momentarily pause with the decarbonisation of specific activities, if the prerequisites are currently not met (7 out of 10). Tools that might help firms to compensate are green gas certificates (4 out of 12) or supporting projects that capture and store carbon emission from the natural environment (7 out of 12).

4.4.7 Turn around the public opinion

The effect that public opinion and perception has on the efforts of firms to decarbonise is a recurring topic during in this study. This is a policy element that respondents perceive as overlooked and that is currently missing in in government policy toolbox. All of the respondents believe that it is a prerequisite to improve the public support and consensus for decarbonisation of district heating to really take root. The way to go about this can be broken down into several specific, albeit interrelated, policy

instruments such as storytelling, information campaigns as well as organising local participation and involvement.

The government and the various government agencies tasked with implementation of policy should, as perceived by both the respondents from the firms as well as policymakers, pay more attention to storytelling and in trying to create a common narrative among the general public that decarbonisation is not just necessary but that it will come with lifestyle changes, temporary inconveniences and that it will likely costs the taxpayer in the short run. The rationale behind decision and effort to decarbonise can subsequently be the based for the storytelling by the government, which will require more sharing of information and alignment between the various stakeholders. The storytelling is perceived by respondents to be a task more suited to the national government in order to pave the way for local initiatives to take shape. This is where municipalities and government agencies involved with individual initiatives should step in, by not only communication about the initiatives but also ensure early participation and involvement of residence in the neighbourhoods effected by these ensure, this in support of both firms as well as housing associations and other relevant stakeholders. All respondents indicate that the aforementioned is only effective in convincing the public in a significant way if the government speaks with a unified voice on all levels, which was identified as an important prerequisite to the decarbonisation of district heating (paragraph 4.2.3).

4.4.8 Safety net that accounts for policy changes

The stability and coherency of government policy is perceived to influence the investing climate and thus the affordability of carbon neutral district heating solutions as well as the public opinion. Respondents recognise however that the underlying assumptions to policy can change over time and new insights arise that might result in changes in policy, especially since there are a lot of uncertainties related to decarbonisation. This uncertainty however is currently perceived as an obstacle and prevents firms from investing in solutions that contribute to decarbonisation (paragraph 4.3.3.7), a way to overcome this risk according to the respondents from the firms is devising a failsafe mechanism or government guarantee that provides a reasonable compensation when specific activities have to be discontinued as a result of policy changes (8 out of 10), especially, so is the consensus among these respondents (7 out of 10), for specific assets that are currently needed to ensure the security of supply but are difficult to decarbonise in the future "*for assets that are really stranded and cannot be converted in a sustainable way there should be a possibility to opt-out under reasonable terms (…) give the assurance that long term investments are not stranded in a few years, or create a safety net for when this happens to provide some security towards investors*". This safety net can, in the eyes of respondents, also contribute to a level playing field for all different actors in the industry, both for existing players as well as new entrants. An example of such as safety net or government guarantee,

provided by several respondents, was a law in place during the privatisation of the electricity generation industry which ensured a compensation for the costs made by the affected entities as a result of the privatisation (*wetten.nl - Regeling - Overgangswet elektriciteitsproductiesector - BWBR0012088*, 2003).

4.4.9 An integrated approach: the matter of voluntariness regarding decarbonisation

In the literature review the matter of voluntariness in relation to government policy is extensively discussed, this matter was also a recurring topic in several of the interviews with both the management of the firms as well as policymakers. The shared narrative among respondents, which is reflected in all interviews with respondents from both firms as well as policymakers, is that the current policy with the aim of incentivising firms to decarbonising their activities is too voluntary. The current regulations on climate change as well as the mechanism to enforce these are seen by respondents as "*a toothless tiger*" and result in "*decarbonisation is now too non-committal"* and the believe that "*policy must be stricter*" since "*CO_2 reduction is of course a wish but not necessarily one of the industry, so you are not going to achieve that by sitting on your hands and waiting for the industry to solve the problems, they don't have the incentive too*" it is also believed by respondents that stricter regulation can create a level playing field since "*legislation can create the conditions and long term guarantees for the industry*" since "*legal frameworks go both ways. So, on the one hand, it can create obligations for things that would otherwise be voluntary, but it can also be used to create clarity, which I think is an important role of legislation*", some form of coercion is believe the be necessary since "*I am convinced that nobody is going to do this voluntarily*".

The majority of respondents believe that the new heat law could provide the necessary coercion through regulation (9 out of 12), by providing a compulsory yearly reduction of carbon emissions if the heat law is part of an integrated approach and recognise the aspects discussed in the previous paragraphs on customisations as well as is complemented with adequate government supporting schemes.

The matter of voluntariness regarding decarbonisation policy in interviews with respondents reached beyond government policy directly affecting the firms. The common understanding is that, if you really want to make the transition to carbon neutral heating, this cannot be achieved without the necessary coercion towards homeowners and housing associations in order to create sufficient demand and reach the necessary scale to operate a heat grid. While some respondents would opt for a legal obligation to cooperate when collective heat solutions are constructed in neighbourhoods or city blocks others believe that it should be possible for homeowners or housing associations to have an option not to cooperate but under the conditions that they ensure an individual carbon neutral heating solution and sufficiently prove the feasibility of this solution. This could be achieved, as cited by 7 out

of the 12 respondents, by introducing specific sustainability standards not only for new to build but also excistings buildings.

4.4.10 Conclusion: An integrated approach

The rationale behind the policy recommendation devised by the respondents from the firms as elaborated in this paragraph is to ensure a level playing field that provides firms with the necessary guarantees in order for firms to invest in carbon neutral district heating solutions. Also, respondents from the firms do not consider district heating as a functioning market, hence policy cannot be devised under the assumption that such a market for carbon natural heat exist. The market and thereby the demand for carbon neutral heat is based on political choices and this underpins the need for an integrated approach. In order to achieve this clarity, the government needs to provide for a path to decarbonisation in which the government provide for the demand for carbon neutral heat solutions according to the respondents. Important aspects to this integrated approach as perceived by respondents is eliminating or reducing risks that, in the eyes of the firms, can be taken away by proving clarity through policy and the equal sharing of risks in the value chain of heat related to risk that remain or are inherent to the decarbonisation of both the existing industry as well as the through expansion of district heating solutions. All policy introduced by the government should be aligned and interact with the path to decarbonisation, this aspect of timing the right incentives at the right time is perceived as important for the effectiveness of policy.

All of the respondents refer to the introduction of a new heat law (in Dutch: Wet Collectieve Warmtevoorziening) as the opportunity to provide for a regulatory framework that enables and incentives firms to decarbonise. Important elements in the new heat law, as recommended by respondents, are 1) include a mandatory path for decarbonisation for firms related to the existing district heating activities, 2) revise the price control mechanism to include for the decarbonisation and replace the current benchmark with natural gas to a cost price plus model that accounts for decarbonisation while ensuring affordability of the heat for end-users through the introduction of a solidarity principle, 3) define uniform standards across industries related to (carbon neutral) heat and 4) introduce a legal framework that can assist the expansion of collective heat solutions by making participation to these solutions largely mandatory.

The respondents also believe that the government should take on a more directing role in the growth of carbon neutral collective heating solutions, such as district heating. This directing role has several dimensions; firstly, the government, on various levels, should be a facilitator by working with firms and other stakeholders in a structured dialog to overcome the complexities as well as act as a mediator. Secondly, ensure the governance role at different governance levels in order to enforce the commitments made by the various stakeholders and ensure the pace according to the defined path

towards decarbonisation. The other recommendations made by respondents for specific policy instruments are summarised in table 4.7.

The overall conclusion from the findings is that the government, together with the main stakeholders involved with district heating, needs to develop an integrated approach to the transition of carbon neutral district heating and shape policy accordingly to support this approach in order to overcome the identified prerequisites, dependencies and obstacles. The different policy instruments should be consistent and introduced at the appropriate time to support this approach and a governance structure needs to be implemented that can enforce this approach. Above all it requires cooperation between the government and all the stakeholders in the value chain of heat and commitment by all stakeholders to the formulated goals.

Policy instrument	Recommendation by respondents
Government support scheme	- Reduce the time it takes to include new solutions in government; - Increase eligibility of solutions by allowing tailor made solutions; - Assign a dedicated budget to carbon natural collective heat solutions; - In determining the contribution of collective heat solutions use the expected increase in the share of renewable electricity instead of the current share; - Increase stimulation for owners to insulate their buildings.
Carbon pricing	- Increase taxes on consumption of natural gas and CO_2 emissions based on identified path towards decarbonisation; - Reward firms that produce sustainable electricity or heat with discounts on energy taxes; - Create temporary possibilities for firms to be carbon neutrality while still emitting carbon through an compensation mechanism.
Communication	- Storytelling as part of national campaign to promote and create awareness for decarbonisation through collective heat solutions in order to pave the way for local initiatives to take shape; - Part of the introduction of local new collective heat solutions ensure the early participation and involvement of the stakeholders and above all residents of the affected neighbourhoods.
Safety net for security of supply and stranded assets	- Legally ensure security of supply and provide for an framework how to compensate if this results in temporary unprofitable situations; - Develop a safety net that compensates firms that incur disproportionate losses as a result of policy changes (especially when policy is changed in relative short term).

Table 4.7: Policy recommendations to support decarbonisation

Chapter 5: Discussion and conclusion

The current knowledge on the various aspect addressed in this study as well as the findings from the empirical study have been elaborated and summarised, what now remains is how the empirical findings from this study relate to the existing knowledge on the research question of this study and how these should be interpreted in the context in this study and of the existing knowledge. This chapter will provide this and follows the structure of the research questions and sub question formulated. In doing so the limitations of this study as well as possible avenues of future research will be formulated. This chapter will conclude by answering the research questions and by providing recommendation for policymakers and management of firms derived from this study.

5.1 Discussion

The purpose of this paragraph is providing context to the findings by placing these in light of what is known and identify how the findings contribute to the future academic debate and government policymaking.

5.1.1 Corporate behaviour and underlying motives for firms to decarbonise

In this study the motives of firms to adhere to combined government incentives related to the decarbonisation of their activities were tried to uncover multiple times, first by ascertaining the rationale (i.e., motives) behind the environmental strategy in relation to decarbonisation adopted by firms and secondly, in relation to dominant factors that drive decision-making (i.e., operationalisation of motives) with regard to initiatives to decarbonise and if there was alignment between the environmental strategy and dominant decision-making factors of the firms.

All of the firms included in this study adopted an environmental strategy related to decarbonisation of their activities that is more ambitious than the policy strategy of both the European Union as well as the Dutch government and all firms did undergo these changes in environmental strategy related to decarbonisation relatively recently (< 2 years), both the statements from respondents as well as information derived from secondary data such as publicly accessible corporate statements and reports confirmed this. The adopted environmental strategy resulted in operationalised goals and incentives in all of the firms, by prioritising investments that contribute to the decarbonisation of the firms through implementing targets on activities and project and their contribution to the decarbonisation of the firms as well as accepting lower return on investments for these projects. The employees of the firms included in this study all perceived this as a relative recent shift in the decision-making of the firms. This suggest that the environmental strategy is not just symbolic, but that firms do want to make steps to decarbonise their activities and that they even would accept a lower financial performance of individual projects in order to achieve this, albeit that an acceptable return on investments remains a prerequisite to the approval of projects that contribute to decarbonisation.

The findings suggest that the dominant motive behind the adopted environmental strategy of the firms is legitimacy through both its influence on the instrumental and relational motives of the firms, legitimacy in the eyes of all relevant stakeholders but specifically the shareholders, institutional investors (which can also be shareholder) and customers of the firms as well as NGO's that pressure firms to decarbonise. In doing so the firms try to maintain a licence to operate (relational motive) in the eyes of their stakeholders (Aguilera et al., 2007; Child et al., 2019). The pressure on firms by its stakeholders to decarbonise in this study is likely relatively high due to visibility of activities and since firms are fulfilling a public service, providing energy in the form of electricity and/or heat, as well being at the core of EU's and the Dutch government's efforts to decarbonise. This confirms previous findings that the visibility of the firms activities increases the likelihood that firms response to policy (Okhmatovskiy & David, 2012). Among the customers of the firms operating in the district heating industry are municipalities and housing associations, the legitimacy of the firms as perceived in the eyes of these specific stakeholders is seen by the firms as a prerequisite for future growth and maintaining a competitive advantage. In order to fund the growth of the district heating activities, firms are dependent on institutional investors that provide capital at relative low costs, these institutional investors are only willing to do so if the firms contribute sufficiently to the goals of these institutional investors, of which decarbonisation appears to be one of relative and likely recent importance, the adoption of the environmental strategy is perceived by the firms as a prerequisite to secure these funds that enable future growth. The need for legitimacy seems largely one of self-interest and control, in order to chape the conditions to maintain a competitive advantage and that enable future growth and therefore secure long-term continuity, thus the adopted environmental strategy appears to be mainly driven by instrumental motives, which also appears to be the dominant motive in the hierarchy of motives of these firms. This seems to confirm the findings of Aguilera et al. (2007) that there likely is a hierarchy between the motives that influences corporate behaviour dependent on the how firms perceive its relative place in the environment the firms operates in. Additionally, the combination of the expectation of increasing stringent regulation to decarbonisation as well as the legal steps taken by NGO's in order to force firms to adhere to their commitments to decarbonisation in recent years, such as the Urgenda lawsuit against the Dutch state and Shell (Raval, 2021), is likely a third underlying (legal) motive to the recent changes in the environmental strategy of the firms as findings indicate. This appears to confirm previous findings of Wright & Nyberg, 2017 that firms adopt environmental policies in response or prevention of external criticism on their activities and indicates that firms are likely susceptive to the anticipation of more stringent regulations and adopt a stricter environmental strategy as a result of this.

In summary, the recent adoption of the environmental strategy related to decarbonisation thus appears to be mainly driven to secure a licence to operate (relational motive) in the short-term and in the long-term to secure future growth and profitability (instrumental motive). A possible theoretical implication of this is that the findings suggest that firms operating in the district heating industry are relatively more susceptive to the effects of legitimacy on their motives than firms in other industries due to its relative high influence on several generic corporate motives, a likely generalisation is that this is also applicable for firms operating in other utility services or industries that depend highly on government agencies and institutional investors for their current and future profitability as well as experience high visibility of their activities. This has policy implications as well, since policymakers can for example design government incentives that influence the environmental strategy of stakeholders of these firms if firms themselves will not adhere to the government policy strategy and it is likely that these stakeholders, such as institutional investors, are inherently more susceptive to government incentives.

5.1.1.1 Corporate behaviour: possible divestment of activities due to external pressure to decarbonise

A finding that has both theoretical and policy implications is that there is likely a tipping point between 1) the amount of pressure experienced by the firms from its stakeholders to achieve a level of decarbonisation with a timeframe and 2) the availability of solutions to decarbonise specific activities in order to 3) achieve the environmental strategy that was formulated as a result of the pressure experienced from these stakeholders to satisfy these by firms in time on 4) the decision of firms to divest specific activities that do not sufficiently contribute to the environmental strategy. The rationale behind this is that the negative consequences on the corporate image as perceived by firm and the effect on the legitimacy as perceived by important stakeholders of the firm in conjunction with the perceived pressure to decarbonise from these stakeholders by the firm within a certain timeframe takes precedent above the continuation of specific activities when the availability of solutions to relieve this pressure is perceived as too uncertain by the firm for these activities especially if these activities have 5) a relative low profitability, such as district heating activities appear to have. The possible theoretical implication is that firms might choose to divest activities in order to become carbon neutral rather than invest in or wait for solutions that will lead to the decarbonisation of specific activities of the firm. The policy implication is that policymakers in the design of combined government incentives should use the susceptibility of the firms towards legitimacy to their advantage, since sufficient pressure of firms through stakeholders could lead firms to decarbonising while not requiring other complex policy instrument to incentives firms to do. This also aligns with previous studies that policy is more effective in impacting corporate behaviour when designed to influence the dominant motives of firms (Kern & Rogge,2018; York, Vedula & Lenox, 2018). However, policymakers do need to

be aware to proportionate the pressure over time, since the pressure experienced by dominant stakeholders to decarbonise could result in the divestment of specific activities by these firms. While the withdrawal of incumbent players might create possibilities for new entrants that could contribute in the decarbonation of an industry, policymakers should only act upon this effect when they have an indication this is the case, otherwise this could have adverse effect on the decarbonisation of industries and only results in delays to the government objectives. The findings require future research on decision-making of specific activities of the firms as a result of perceived pressure to decarbonise as well as to the various underlying motives for firms to do so in order to test these propositions. It is also likely this will not be applicable on all activities of a firm, but likely on activities that are outside the core business of in the case of multinationals in countries with less importance for these firms.

5.1.2 Assessing the impact of combined government incentives on the accumulation of corporate behaviours

To have an indication of an answer to the question of what combined government incentives will lead firms to decarbonise their activities, it is necessary to understand what the impact of combined government incentives are on the corporate behaviour of these firms, since without assessing this the policy outcomes of the designed combined government incentives on corporate behaviour remain obscured. The findings suggest that the impact of combined government incentives on corporate behaviour are dependent on 1) the design of an individual policy instrument in a specific policy field and how this impacts corporate behaviour in a specific moment in time, 2) the design of combined government incentives and how this impacts the accumulation of corporate behaviours both in relation to the specific policy field in a specific moment in time as well as 3) (combined) government incentives outside this specific policy field and how these interact with the specific policy field in a specific moment in time and finally 4) how the government as an institutional agent is being perceived by the firms at that time. The construct of time is related to construct of impact, since the identification of impact as a result of combined government incentives on corporate behaviour by scholars is a moment frozen in time. How these aforementioned constructs help to assess the impact of combined government incentives on corporate behaviour will now be discussed per construct. It is important to recognise that this does not include the possible discrepancy between policy design and implementation of government incentives and how this subsequently impacts corporate behaviour, however one might argue that the implementation of policy is to a large extent dependent on how these are designed.

5.1.2.1 Individual government incentives in a policy field

The design and implementation of individual policy instruments is dependent on the congruence between the goal or objective and the design of the individual instruments as well as the coherence between the individual policy instrument and its effect in the real world , in other words how well the

individual policy instrument matches with the practice of the firm by changing the behaviour of the firm in accordance with the objective of the individual policy instrument at the aimed moment in time, this confirms with various recent studies on this topic from (Dale et al., 2019; Edmondson et al., 2019; Yigitcanlar et al., 2019). This can be examined as a one-to-one relationship which makes it less ambiguous to determine the impact of an individual policy instrument on corporate behaviour (Kern & Rogge,2018; Aragón-Correa et al., 2020).

5.1.2.2 Combined government incentives in a policy field

When trying the asses what the impact combined government incentives is on the accumulation of corporate behaviours, this becomes exponentially more ambiguous and several studies identified the limited attention given by scholars on the impact of combined government incentives on corporate behaviour as a shortcoming in the current knowledge on combined government incentives, past studies suggest this can only be examined by properly delineating a policy field (Rogge & Reichardt, 2016). However, this study as shown that policy designed and implemented in other policy field can have an effect on respective policy field studied, this can be overlooked when scholars only focus on the effect of policy within a policy field. Other recommendation done by scholars to understand the impact of combined government incentives on corporate behaviour are to assess how different policy react to one another and how policy outputs relate to policy outcomes (Kern & Rogge, 2018; Aragón-Correa et al., 2020), this study has tried to do just that.

What has been confirmed in this study is that all combined government incentives in a specific policy field should be designed based on the desired outcomes of the accumulation of corporate behaviours in that policy field and that policymakers should have a clear understanding of these desired outcomes, if this is not clear then policymakers risk designing combined government incentives that has contradictory effects on the accumulation of corporate behaviours. This can be achieved by properly aligning the different policy instruments in a policy field to one another to ensure coherency between the combined government incentives and its impact on the accumulation of corporate behaviours, i.e., between policy and practices. The impact of combined government incentives on the accumulation of corporate behaviours is therefore dependent on the congruence between the policy goals within a policy field and the design of policy instruments in a specific policy field, the alignment between the individual policy goals in a policy field as well as the alignment between the different policy instruments in a policy field while ensuring the proper design elements of all individual policy instrument as discussed in the previous paragraph. The conclusions from earlier studies that combined government incentives are never fully coherent nor consistent can be further substantiated through this study, the developments in a policy field during the time and the fact that the government has multiple policy objectives regarding a specific policy field or industry make this likely a practical impossibility (Kern &

Rogge, 2018). The question is, do combined government incentives need to be fully coherent? Probably not, as this study argues, combined government incentives need to be sufficiently coherent in order to minimise the discrepancy between the combined government incentives and the degree in which these impact corporate behaviour that that lead to the desired change.

5.1.2.3 Combined government incentives across policy fields

Limiting the study only to the policy field of subject is however not sufficient in order determine the impact that a combined government incentives has on corporate behaviour. To determine this, the impact of combined government incentives outside the studied policy field on the accumulation of corporate behaviours in studied policy field must be assesses as well. This study has shown that policy devised to contribute to goals in a different policy field can have an effect and even adverse effects on policy in the studied policy field. Hence, the impact of combined government incentives on the accumulation of corporate behaviour is also dependent on the how policy outside the studied policy field effects the policy field studied thus a degree of alignment between policy fields is needed to prevent adverse effects of one policy field onto another. This however leads to both theoretical and practical complications during the design of studies on the impact of combined government incentives on accumulated corporate behaviours, since the different policy fields are abundant, and it is unfeasible and likely unnecessary to account for all this different policy fields and how they might relate to corporate behaviour in the design of the study. To this end it can be argued that it is sufficient that scholars are aware of this during their field studies and that when encountering corporate behaviour as result of policy that is likely not the result of the combined government incentives of policy field studied the scholars trace the origin of the behaviour to the policy instrument that causes the identified behaviour and to the subsequent policy field and assess how this relate to the studied policy field in order to understand the alignment between policy fields and how this impacts corporate behaviour. It is however unclear what level of alignment is needed between different policy field in order to prevent adverse effects on the decarbonisation of specific industries, this is likely very specific and dependent on the policy field and subject to causal complexities, for policymakers it is however relevant to have an indication what factors might contribute towards the (mis)alignment between policy fields related to decarbonisation and how to prevent adverse effects, this could subsequently be a subject for future research.

5.1.2.4 Corporate perception towards the government

Finally, how the government as an institutional agent is being perceived by the firms at the time when new policy is introduced will to some extent determine the degree of adherence to this policy by firms, especially for voluntary policy instruments where there is no legal motive to comply as argued by previous studies (Aragón-Correa et al., 2020). How the perception of firms of the government can have

an adverse effect on the adoption of policy was shown multiple time in this study. The rationale behind this could be found in the perceived lack of commitment of the government to their own goals as a result of the indecisiveness to implement policy by firms and also the lack of credibility experienced by firms due to frequent changes in policy in the past and lack of congruence between policy instruments in a field and across policy fields. This study showed that the perception of the government influences corporate behaviour in adhering to the desired outcome of combined government incentives and this corresponds with recent studies (Dale et al, 2019; Edmondson et al., 2019), also for firms operating in industries that are more prone to public opinion for specific technological solutions this effect is likely greater. Results however indicate that the perception of the firms towards the government is a results of an accumulation of these elements and it is also like that this is attributable to the different employees in a firms and between employees this likely varies. How and to what degree these constructs specifically contribute to the perception of the government by the firm, what role of employees play in this perception and how this subsequently impacts corporate behaviour towards new policy on decarbonisation of specific industries has not been examined in this study, this could be an avenue for future research.

5.1.2.5 Conceptual model: assessing the impact of combined government incentives on the accumulated corporate behaviours

The findings previously discussed led a conceptual model (figure 5.1) on how to assess the impact of combined government incentives and this is based on the following propositions to assess the impact of combination government incentives on corporate behaviour:

1.1 The impact of individual government incentives on corporate behaviour is a result of the congruence between the individual policy goal and the individual policy instrument in a specific moment in time;

1.2 The impact of individual government incentives on corporate behaviour is a result of the coherence between the policy instrument and the practice of the firm in a specific moment in time;

2.1 The impact of combined government incentives on the accumulation of corporate behaviours is a result of the alignment between policy goals within the studied policy field in a specific moment in time;

2.2 The impact of combined government incentives on the accumulation of corporate behaviours is a result of the alignment between policy instruments within the studied policy field in a specific moment in time;

3 The impact of combined government incentives on the accumulation of corporate behaviours within a policy field can be moderated by the degree alignment between different policy fields in a specific moment in time;

4 The impact of combined government incentives the accumulation of corporate behaviours is moderated by the corporate perception of the government at that specific moment in time.

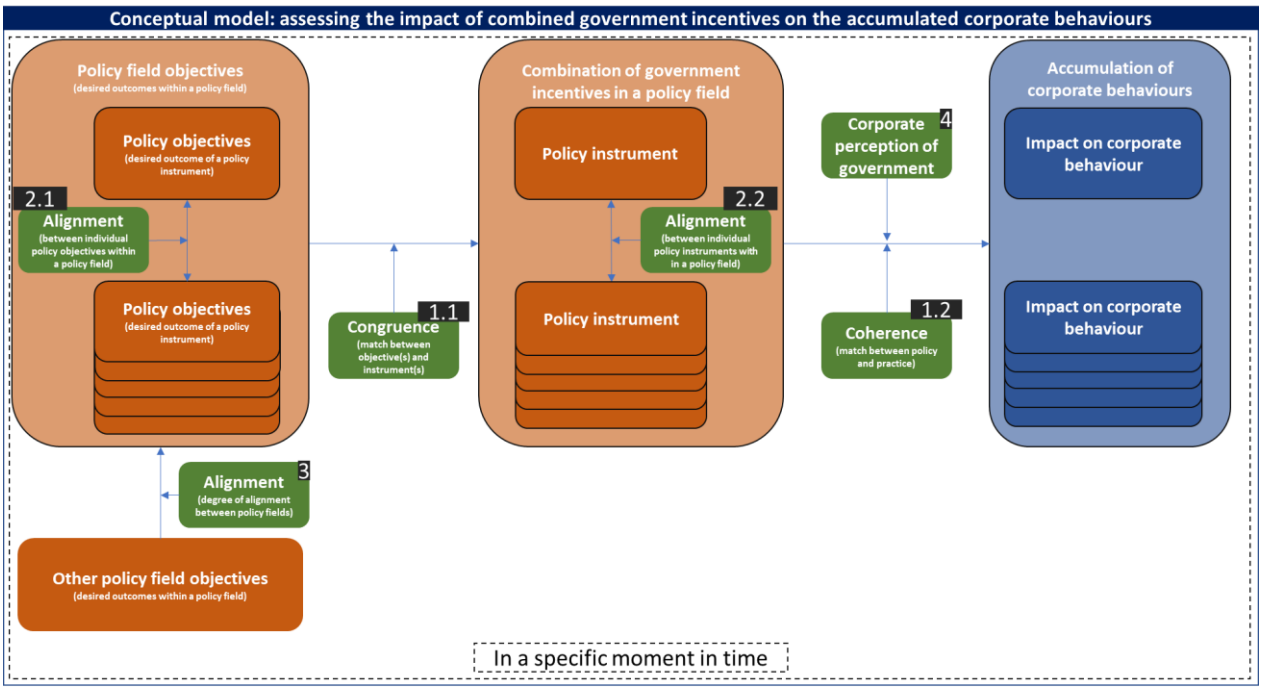

Figure 5.1: conceptual model – assessing the impact of combined government incentives on the accumulation of corporate behaviours.

5.1.2.6 Assessing the impact of combined government incentives on the accumulated corporate behaviour in this study

The impact that the combined government incentives had on corporate behaviour in this study were to a degree identified, it was however difficult to determine the effect of policy on the whole firm due to the international presence of many of the firms and that strategic decision-making happened in various degrees beyond the local management, therefore the results of this study are mostly applicable on the local heat activities of these firms in the Netherlands. The policy related to decarbonisation of district heating was also fragmented and one of the main reason why firms were relucted to decarbonise was as a direct result of government policy. In previous studies scholars had similar difficulties in empirically determining the causal relationship between combined government incentives and corporate behaviour due to the various contextual factors that (Rogge & Reichardt, 2016; Kern & Rogge,2018; Aragón-Correa et al., 2020). Both policymakers and scholars studying the impact of combined government incentives on specific industries as well as policymakers in designing these suffer from field opacity due the high contextual complexity of the corporate behaviour in that industry (Wijen, 2014).

The effect of the combined government incentives on accumulated corporate behaviours in this specific study can be divided in the adoption of goals and a common narrative for the need decarbonisation by the firms and the implementation of these goals by actually decarbonising as firms. All the firms in this study had adopted an environmental strategy on decarbonisation which is either similar or more ambitious than the EU and Dutch government, results indicated this was in order to

maintain legitimacy, especially in eyes of important stakeholders, which influences both the instrumental and relational motive of the firms as discussed (paragraph 5.1.1). It is likely that government policy, albeit international policy, has contributed to the adopted environmental strategy by the firms and that this was likely achieved by the introduction of a uniform strategy, goals, norms and reporting requirements for decarbonising that stakeholders of the firm, specifically institutional investors, adopted. This indicates that the international policy on decarbonisation has been effective in changing the behaviour of firms in this study with regard to decarbonisation, especially since these firms operationalised their environmental strategy in their decision-making. This seems to confirm outcomes of earlier studies, that when peers and other important stakeholders of the firm adopt government standards these are more likely to become industry-wide standards and subsequently the firms adhere to these (Okhmatovskiy & David, 2012). It is however unclear to what extent the international policy on decarbonisation contributed to the adopted environmental strategy.

The impact of combined government incentives that should lead the district heating industry in the Netherlands to decarbonise can best be described as supporting the status quo and in some instances even obstructing. This can be concluded from the results of this study, which found that current combined government incentives were insufficiently aligned between policy fields and within the policy field on both the goals as well as between policy instruments that should lead to decarbonisation as well the gap that exists between policy and practice, which was the case for most government support schemes with the aim of decarbonising. The current combined government incentives do not appear to be attuned to facilitate the decarbonisation of the district heating industry in the Netherlands. Findings indicate that especially the current heat law inhibits firms from decarbonising, the delays to introduce a new heat law adds to this effect due to the increased uncertainty on the future industry as perceived by firms. Since the current decarbonisation also does not appear to be in the self-interest of the firm current combined government incentives seems to aggregate this effect. These aforementioned findings on how combined government incentives impact corporate behaviour are not new, earlier studies showed the that when policy is not attuned to the practices of the firms (Wijen, 2014), is not sufficiently coherent between the technological development in an industry and policy instruments (Bataille et al., 2018; Rissman et al, 2020) and firms experience uncertainty about the future regulatory climate (Edmondson et al., 2019) than this will reduce the impact of combined government incentives significantly.

If the government intends to achieve the decarbonisation of the district heating industry and incentivise future growth of collective heat solutions in order to contribute to decarbonisation the chances of reaching these goals through the current combined government incentives appear to be slim. It is likely that this is was to a degree caused be the fact that policy related to the government

goals of the 2019 Climate Act was not yet implemented which aligns with the assessment made by the IEA (International Energy Agency, 2020). The delay in the development of new policy together with the identified misalignment of policy had an adverse effect on the corporate perception of the government in this study as well at the desired outcomes of the policy goals, it likely that this will have a similar effect on firms and the effectiveness of policy in other industries facing these conditions as well.

5.1.3 Government incentives that lead to decarbonisation

The findings on how government incentives interacts with corporate behaviour to decarbonise were plentiful and will be discussed per relevant policy instrument and how these impacts and interacts with corporate behaviour as well as other policy instruments in the district heating industry. However, this study identified two prerequisites to the decarbonisation of the district heating industry as well as the future growth of collective heating solutions to facilitate in the carbon neutral heat, these are the affordability and public support and consensus, and these will first be discussed.

5.1.3.1 Prerequisite: affordable decarbonisation

The transition to decarbonise will cost society as a whole, at least when not putting a price tag on the adverse effect on the environment due to carbon emissions. When this is projected the subject of affordability on the decarbonisation of the district heating industry it is valuable to briefly summarise the status quo of why district heating is currently relatively affordable. The causes of this are: firstly, the relative low costs incurred on firms and end-users for the consumption of fossil fuels which in this case is predominantly natural gas, secondly the current maturity of the technology that provides heat through fossil fuel as well the abundant experience of firms in operating these, thirdly, the existing infrastructure that transports the fossil generated heat is already in place and largely requires maintenance and is relatively straightforward due to the flexibly that the fossil generated heat provides and lastly the demand for district heating was limited due the extensive natural gas network that is available in the Netherlands which made a privately owned gas boiler both a cheap and convenient alternative. When this is projected to the likely situation during the transition to a carbon neutral district heating industry based on the findings of this study the following will likely occur, albeit most of it temporary: heat will be generated through a variety of technological solutions and as long as affordable renewable electricity is not abundantly available the costs to produce this heat will be higher. These technological solution to produce carbon neutral heat will vary in technological maturity and firms have at first limited experience in operating these, reducing the efficiency of the generation of heat compared to the status quo. Additionally, the multitude of technological solutions to produce carbon neutral heat as well as the characteristics of heat produced through these solutions such as a lower base temperature and reduced flexibility in operation (you can’t just flip a switch) will impose higher technological demands on the infrastructure to transport the heat as well as the buildings that

use the heat. During the transition it is also important to ensure the security of supply since heat is essential for the economical and sustainable functionality of households and industries, this likely requires that the current fossil-fuelled production capacity needs to be maintained to some extent in case the newer technological solutions cannot temporarily provide for the heat demand due a variety of possible known and unknown causes. The aforementioned elaborated transition period was derived from the findings of this study, but the described effects are likely not limited to this and other scholars found similar effects in other industries whereby especially the need for affordability and security of supply conflicted with each other (Grubb, McDowall & Drummond, 2017), what is however clear that it is unreasonable to expect that the costs to provide for carbon neutral heat will not increase compared to the status quo. The costs will increase, at least temporary during the transition period and some of these costs might be recurring and other non-recurring in nature, it is however unclear how long this transition will take and what the situation will be the end of the transition as well as how the costs to provide for carbon neutral heat will vary during this transition. This findings indicate that the affordability of the solutions that lead to carbon neutral heat is a prerequisite to the decarbonisation of the district heating industry as well to provide for the growth of collective heat solutions that provide for carbon neutral heat for both firms as well as end-users.

5.1.3.2 Prerequisite: Public support and consensus towards decarbonisation

In order to transition to carbon neutral district heating as well as grow in collective heat solutions that will provide carbon neutral heat to reach the government goals as set out in the 2019 Climate Act, sufficient levels of public support as well as consensus among all relevant stakeholders is required, since the transition is dependent on this for multiple reasons as the findings indicate. First of all, to create sufficient levels demand for carbon neutral heat enough buildings need to be made eligible to receive this heat as well as that the demand for carbon neutral heat in itself needs to reach a specific level and to achieve this a level of public acceptance and commitment is needed which in turn is likely dependent on the general public opinion and the subsequent public support for carbon neutral heat. When initiatives are announced by firms, these firms currently experience, in various degree, opposition to the implementation of these especially by residents of the neighbourhoods and local politicians resulting in for example permitting issues and lack of cooperation as perceived by these firms. More generally, when firm perceive a lack of public support and a public opinion that appears to be against certain technologies, such as was perceived to be the case with biomass as the findings show, than firms are very hesitant to publicly commit to these technologies and adopt these. If the decision was reached to prepare the implementation of initiatives the firms found it hard to secure sufficient levels of cooperation from government agencies and other stakeholders such a utility companies in order to create the necessary conditions for these initiatives, which led to delays,

postponement or dismissal of these initiatives. The results of this study indicate that this was to some extent due to the discrepancy between the goals and interests among various stakeholders involved in these initiatives. The effects that public opinion has on decarbonisation of industries in studies on government incentives seems to be neglected and a greater understand of this effect is necessary. To what degree public opinion is needed and what an acceptable level of public support is for firms to initiate or implement an initiative that lead to decarbonisation likely differs per individual initiative and various other circumstances, this could be a subject for future research. The degree of consensus among relevant stakeholders should at the very least result in the facilitation of firms during the transition that leads to carbon neural heat in the set timeframe.

5.1.3.3 Interaction between affordability and public support on decarbonisation by firms

The results of this study indicate that on different dimensions an interaction exist between affordability and public opinion and subsequent support in its combined effect on the decarbonisation by firms and these can likely have a reinforcing or weakening effect on one another. First there is the element of demand, since sufficient levels of demand lead to scale and likely in more affordable carbon neutral heat. One of the elements to reach these sufficient levels of demand is a sufficient level of public support, however one of the likely elements in creating sufficient public support is affordable carbon neutral heat. Additionally, the findings from this study also lead to the proposition that successful implementation of projects that lead to decarbonisation result in the increase of public support for carbon neutral heat, however one of many likely criteria that determine the success in the eyes of the public is the affordability of these projects. This leads to the likelihood that affordability increases public support and vice versa as well as that lack of affordability decreases public support and vice versa. This is further complicated in the case of district heating by the fact that the current price of heat through fossil consumption, especially for residents that own a privately owned gas boiler, is relatively affordable and that there is no clear perceived benefit for carbon neutral heat, and this results in the base assumption for these propositions, that there is limited demand for carbon neutral heat. This study has shown that both affordability and public support are themselves prerequisites to the decarbonisation of district heating and that the interaction between these can likely either be reinforcing or weaking to each individual prerequisite. Additionally, the findings indicate that there is a likely interaction between affordability and public support and where these interaction could, but not limited to this, occur and how these can either be reinforcing or weakening, in order to further understand this interaction further research is needed to understand how these elements relate to one another in specific circumstances and how this effects decarbonisation by firms to validate the described effects. It is likely this effect is generalisable for industries that face lack of demand for the carbon neutral alternative. The implication for the design of combined government

incentives is that the these are likely more effective in decarbonising the district heating industry and the growth of collective heat solutions as well as lead firms to adopt technological solutions when stimulating affordability and public support simultaneously. However, one can argue that supporting public support early on in the transition likely leads to more demand and thus affordable solutions in the future. These aforementioned effect are summarised and shown in the conceptual model in figure 5.2 and the proposition underlying the model are as follows:

1. Sufficient levels of demand for the carbon neutral alternative lead firms to adopt the technological solutions that provide for this carbon neutral alternative and this contributes to the industry being largely carbon neutral in the formulated timeframe;

2. The degree of affordability of the technological solutions moderates the sufficient levels of demand for the carbon neutral alternative and the subsequent adoption of the technological solutions that provide for the carbon neutral alternative by firms;

3. The affordability of technological solutions that provide for the carbon neutral alternative is influenced by sufficient levels of demand for these technological solutions, since these ensure scale.

3.1 Sufficient levels of demand for the carbon neutral alternative that increases the affordability of the technological solution that provide for the carbon neutral alternative is moderated by the degree of public support for these technological solution;

4. The degree of public support for the technological solutions that provide for the carbon neutral alternative moderates the sufficient levels of demand for the carbon neutral alternative and the subsequent adoption of the technological solutions that provide for the carbon neutral alternative by firms;

4.1 The degree of public support for the technological solutions is moderated by the affordability of the technological solution that provide for the carbon neutral alternative.

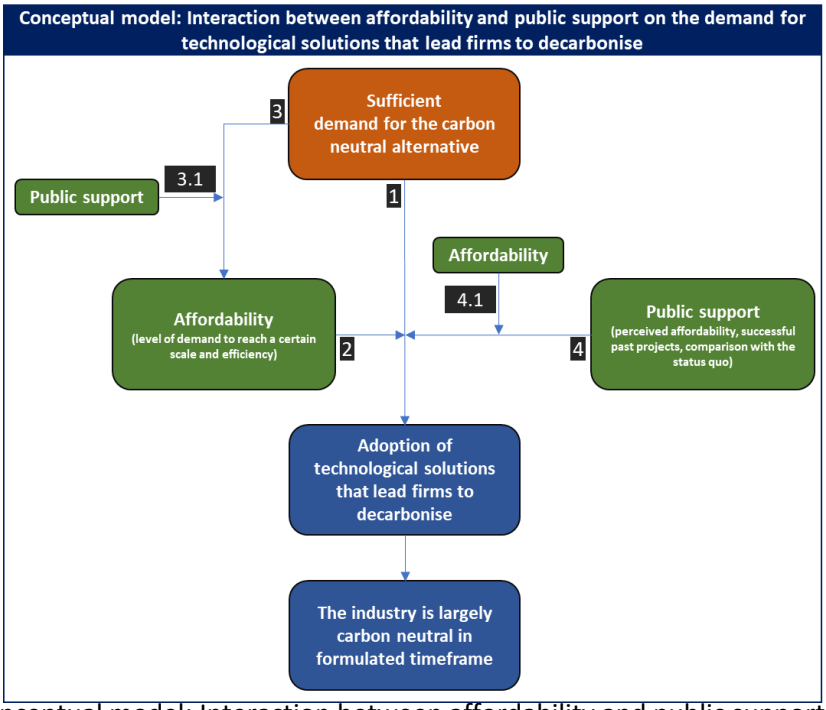

Figure 5.2: Conceptual model: Interaction between affordability and public support on the demand for technological solutions that lead firms to decarbonise

5.1.3.4 Other prerequisites to the effectiveness of combined government incentives

This study adds to the already existing literature that the effectiveness of combined government incentives are contingent on the stability and duration of government policy and that frequent changes in the policy lead to perceived lower credibility of the government by firms and that this subsequently result in a lower commitment of firms towards the government policy objectives (Cirone & Urpelainen, 2013; Dale et al., 2019; Edmondson et al., 2019). Additionally, a clear finding of this study, which is consistent with previous studies, is that in order for policy instruments to be effective in contributing to the policy goals these should be sufficiently congruent with the policy goals, coherent between the various policy instruments and aligned across policy fields (Rogge & Reichardt, 2016). When these prerequisites are absent than policy could have limited or even adverse effects on corporate behaviour as the findings from this study substantiate. The results from this study indicate that with regard to policy fields that are more prone to public opinion, as the decarbonisation of district heating likely is, that the adverse effects of unstable and frequently changing policy on the effectiveness of government policy in changing corporate behaviour is likely greater.

5.1.3.5 Combined government incentives: create public support and facilitate consensus among stakeholders

As previously discussed, the results indicate that a degree of public support is a prerequisite for firms to decarbonise in the district heating industry, with a likely generalisation on similar industries that face similar complexities. The suggestion that resulted from the findings of this study is that policy that positively influence public support likely indirectly lead firms to decarbonise and this has two policy different implication of government incentives, the first on shaping the conditions and the latter on capitalising on these conditions.

The first elements is in creating a common narrative through government incentives on the need for decarbonisation of the heating of households, offices and other buildings in the Netherlands of which collective heating solutions and in specific district heating is a part of. This suggestion from the respondents is that this could be achieved through storytelling and that the national government is best suited for such as role, an important aspect of storytelling would be consistency in the message through all different governmental communication channels. The idea is that this can pave the way for local initiatives that actually lead to the decarbonisation of heating, of which a large share through collective heating solutions. One can see the benefits that a broad communication plan of the government with the aim of increasing awareness for the need of decarbonisation and how this will influence aspects of the daily life such as heating would have in creating more support for the solutions that lead to decarbonisation, the findings suggest that the communication of the government with regard to the decarbonisation of heating through collective heat solutions has not led to sufficient

support for these solutions. It is however unclear to what degree the indicated gap in government communication has an effect on public support and how this relate to the willingness of adopting solutions that lead to decarbonisation, this could be subject for future research.

The second element is in assisting firms and other stakeholders involved in individual initiatives, or more likely a combination of multiple initiatives during a relative short time span, to decarbonise district heating with creating local support and consensus for these solutions by ensuring the early participation and involvement of residence and other stakeholders in the neighbourhoods affected by these initiatives. This is perceived to be more a task of municipalities and government agencies involved with the implementation of these initiatives; however, it would be advisable in order to create the necessary consistency between all government communications that the contents and formats of these instruments are aligned nationally.

Both broader public support for decarbonisation as well as local support and consensus for initiatives will likely assist firms in decarbonisation of district heating and when this is support is perceived to be sufficient by firms this will also likely lead firms to decarbonise their activities. The perceived need among respondents in this study to include policy instruments that lead to increase in public support for decarbonisation was unanimous.

5.1.3.6 Mandatory decarbonisation

The findings from this study adhere to previous studies in the sense that decarbonisation is not necessarily a goal that firms or industries for that matter pursue (Aragón-Correa et al., 2020), you can also argue that for most citizens decarbonisation is elusive and far from a priority in the events of daily life. In this study several of the respondents considered the ability to personally invest in decarbonisation a luxury that most people cannot afford. Previous studies also found that it is important the achieve a sufficient level of decarbonisation to prevent the subsequent reduction in carbon emission being overshadowed by economic growth (Hille et al, 2020). When this is projected onto the industry of subject in this study this has two dimensions, namely the firms and the end-users of heat. The firms in this study appear to adhere to the need to decarbonise, within the confinements that individual projects need to contribute sufficiently to decarbonisation and to the financial performance of the firms, albeit that firms appear to accept a lower level of profitability when the projects sufficiently contribute to decarbonisation. The results from this study also indicate that when firms experience a certain degree of pressure to decarbonise, they could divest specific activities, especially if this withdraw or divestment has limited effects on their profitability. From the perspective of the end-users these can be divided in four categories, the municipalities that contract firms to provide the service of district heating, housing associations that directly contract firms on behalf of their residents, homeowners sometimes organised in homeowner associations and other firms that

that both directly contract the heat. A recurring topic with regard to the decarbonisation of district heating and growth of collective heat solutions that provide for carbon neutral heating is the need for sufficient demand for carbon neutral heat, this demand is currently due to a variety of casus as previously explain, largely absent. Combined government incentives should therefore be aimed in providing for this demand, and since it is likely that this to a significant extent is not going to voluntary by end-users this likely requires a mandatory incentives in the shape of regulations in order to enforce demand. The ability to create demand through policy targeting the end-users should be support by a mandatory path for decarbonisation of firms for both existing district heating activities and a minimum share of decarbonisation for new collective heat solutions implemented by firms. The obvious instrument to achieve this through amendments to the current heat law. To ensure a certain of freedom of choice for the end-users however, it could be possible to introduce the principle of 'mandatory unless', unless refers to measures that can be taken individually and that at least reach the same underlying goals to decarbonise. Another aspect in order to organise demand is for policymakers to define uniform standards across industries related to (carbon neutral) heat. The results from this study are generalisable for other industries where the demand for carbon neutrally is likely lacking, especially for commodities such as but not limited to electricity, water, waste and water treatment where there is a limited direct benefit for end-users to decarbonise.

5.1.3.7 Incentives that contribute to affordable decarbonisation

When making consumption of carbon heat largely mandatory directly leads to the required answer on the question of how to make this affordable for the firms generating and transport the carbon neutral heat as well as for the end-users that consume the carbon neutral heat. The answers to this question is political and ultimately only the government can make this decisions, however during the course of this study certain government incentives that might assist in achieving affordability were revealed. The aspect of affordability is woven with the specific technological solutions in relation to the scale of adoption and to what extent the current infrastructure is adapted to these technologies as discussed in paragraph 5.3.1. The findings that indicate that government incentives should provide sufficient support to a mandatory path to decarbonisation from this study seem to support the findings from recent studies (Grubb, McDowall & Drummond, 2017; Bataille et al., 2018; Peñasco, Anadón & Verdolini, 2021).

Government incentives: reducing demand and its effect on the affordability of heat through the insulation of buildings

The financial barrier for owners of existing buildings to insulate currently appears to be inhibiting the large-scale insulation of buildings and the government schemes do not appear to be adequate as findings from this study indicated. The effect of proper insulated buildings has an immediate effect on the goals of the government by permanently reducing carbon emissions by reducing demand for heat

as well as making these building eligible for collective heat solutions. The reduction of demand subsequently also contributes to the affordability, since the reduced consumption of heat could to some degree compensate the higher costs of carbon neutral heat for end-users. When the intensity of proper insulated buildings that are eligible for collective heating solutions increases in urban centres the implementation of collective heating solutions are more affordable due to the resulting scale which will also increases the applicability of various technological solutions and when demand for solutions increase so does the likelihood that firms invest in these solutions. This means that a likely relative simply policy instruments, since the effect can directly be measured, has a substantial effect on the whole value chain as well as both directly and indirectly contributing to decarbonisation. Important is that this incentive need come with mandatory standards for insulation that are based on the future adoption of collective heat solutions. During the transitions it will likely pay to invest in insulation early on, these future gains could be used in determining an adequate subsidy for homeowner which could be a subject for future research. Possible constraints are the availability of the workforce to insulate buildings as well as materials, specifically carbon neutral materials. The reduction of demand in its one-dimensional effect on reducing carbon emissions is recognised by scholars as an important goal underlying policy instruments design that lead to decarbonisation (Bataille et al., 2018; Rissman et al., 2020) however the subsequent effects on the value chain of district heating in relation to decarbonisation might have parallels with other industries and these are worthwhile to investigate.

Government incentives: solidarity principle to decarbonisation of heat

When measures to reduce demand for carbon neural heat and increasing the eligibility of building for collective heat solutions begin to have its effect, results from this study indicate that it is likely that the costs of carbon neutral heat provided by collective heating solutions such as district heating will differ per urban centre as result of the availability of eligible heat sources and that this will result in varying heat prices per urban centre. It is however likely that it is politically unacceptable for prices of heat to vary greatly between households, for this is one of the main principle behind the current heat law and this will also likely have adverse effect on the public support for collective heat solutions. Findings of this study indicated that the effects can be mitigated by introducing a solidarity principle in the new heat law by for example determining an average yearly cost price for the different elements to produce and transport heat, including a risk premium for firms, and use these average prices as a benchmark to determine an average yearly price for heat. This will mean that revenue of firms will need to be redistributed based on the actual costs plus risk premium of individual firms. A method like this would likely be complication and will have to comply with competition laws as well as enforce the cooperation of firms to determine the actuals costs which would likely involve independent auditors, this might seem costly, but this is largely already in place under the current heat law. Future studies could try in

assisting to develop a method that would be suitable to implement such a solidarity principle. It is also likely that these findings are to some degree applicable on the decarbonisation of other industries that provide services or product for the general welfare of society.

5.1.3.8 Government incentives that directly interact with firms that might lead to decarbonisation

The government can directly incentives industries to decarbonise their activities or to contribute in new ways to decarbonise in various ways. The findings have shown several elements to how current government incentives impacts firms in their efforts to decarbonise, this aspect will firstly be discussed in this paragraph. This is followed by the discussion of various instruments based on identified gaps between government incentives and firms practices on decarbonisation and how government incentives directly affecting the industry might close this gap.

Government incentives: support schemes and its effectiveness in decarbonising of a specific industry.

The finding from this study indicate that government schemes, such as the SDE++, are unsuccessful in the diffusion and adoption of technological solutions by firms that lead to decarbonisation in the district heating industry. The suggested causes as derived from the findings of this study are: 1) the way projects are ranked based on their short-term contribution towards decarbonisation 2) discrepancy between the level of customisation required and ability of policy instrument to cope with this and 3) absence of dedicated budgets per industry. Some of these are clear examples of the mismatch between policy and practices and these will be discussed per identified cause. Future studies on the effectiveness of government support schemes on the decarbonisation of specific industries, and likely other government goals through support schemes, should consider including these elements that can reduce the effectiveness of these schemes on reaching the goals in specific industries as indicated by the findings from this study.

Ranking the contribution of projects to decarbonisation: share of renewable electricity

The eligibility of individual projects are partly determined by the contribution to decarbonisation based on the existing share of renewable energy. From the perspective of the government this can be understood since policymakers want to have a level certainty that public funds contribute to the goals of society and prevent misuse of these funds, also when projects immediately contribute to the decarbonisation goals of the government this is more effective in achieving the overall goals in the short-term. The transition of decarbonisation is however one of the long haul and the question is whether society can afford to delay initiatives until sufficient levels of renewable electricity are available, the findings indicate that the lead time of projects that will lead to the decarbonisation of the existing district heating industry might take up to 4 years and the development of new collective heat solutions will likely have even longer lead times. It would therefore be arguable that when evaluating individual projects to consider these in light of the expected growth of the share of

renewable electricity based on the governments goals and plans underlying the aimed growth of renewable electricity, the goals are part of the 2019 Climate Act and subsequently known, alignment should therefore be likely achievable for policymakers. An additional argument to consider such an approach is that the technological solutions currently affected by this method of ranking are perceived to be most mature by firms and the certainty that these could contribute to the decarbonisation goals of the government are therefore likely be greater.

Customisation and inclusion of new technologies

Another finding from this study is the specificity of solutions that could lead to the production of carbon neutral heat, these are dependent on a variety of factors such as the existing constellation of the heat grid and assets as well as the availability of specific heat sources and how a combination of these solutions can result in the most effective way to contribute to decarbonisation. Currently the government schemes do not appear to be designed to cope with this level specificity of solutions in the district heating industry, the answers to this by policymakers was to include new combinations of technologies in relation to a specific set of conditions, however the speed in which new solutions present themselves and the likely uniqueness of solutions will likely mean that these new categories are inadequate or have limited relevance. The findings also identified instances where projects were found eligible for funding by the SDE++ scheme, but due the fact that new categories where insufficiently described and implemented the specific amount of funding remained uncertain which resulted in delays in the internal decision-making of firms for these respective projects and subsequently also delayed or postponed the implementations of these projects. One could argue that the cause of this is lies likely not with the policymakers in implementing the scheme nor with the employees of firms that try to apply for government funding through the scheme, nor the communication between these two since several respondents of both firms and policymakers indicated that both where cooperative, the problem likely lies with the unsuitability of the instrument itself. The scheme is developed to promote the adoption of technologies in order to increase the share renewable energy and decarbonisation in a variety of industries, it is near impossible for policymakers to account for all the individual complexities of these industries, let alone customisation per individual technological solutions under a specific set of conditions. In order to reach the level of customisation and inclusion of new technologies that are required to effectively support the adoption and diffusion of these technological solutions that lead to the decarbonisation of specific industries trough public funds a dedicated scheme as part of combined government incentives based on an industry specific policy approach is likely required. This would not only increase the likely effectiveness of the funding though government policy but also the governance on how these funds are spend by firms and how this adheres to the overall government goals for the decarbonisation of a specific industry.

Dedicated budget to decarbonisation of an industry

The last finding related to the effectiveness of a government schemes in this study relates to the amount of budget available and how this subsequently is divided among industries. The results from this study indicate the due to the distribution of funding to projects of all industries on a first come first serve method some projects will never due to their ranking be eligible for public funding, this in itself might not even result in less effectiveness of government policy in a specific industry, however industries differ in scale and this leads that individual projects by themselves do not contribute as much as projects from other industries to the overall goal of decarbonisation or increase in the share of renewable energy. Hence, it is very likely that some industries are overrepresented and other industries underrepresented in this scheme. It could therefore theoretically be possible that the projects of an industry collectively contribute more to decarbonisation but since the evaluation is based on individual projects the total funding received by this industry is lower compared to other industries. This led to the policy recommendation that it is likely advisable to create dedicated budgets per industry, however it is arguable that it might not always be opportune to invest a specific amount in a specific year in a specific industry and to the question what would subsequently be enough public funding for a specific industry and how does this relate to other industries. A part of the funding could be reserved as part of an integrated policy approach as discussed in the previous paragraph. Another solution could be to allocate funding in different stages and divide the remaining budget of industries among other industries after the first allocation of funding. What the best method is to ensure dedicated funding to specific industries is not in the scope of this study nor able to formulate based on the findings of this study. The need for a dedicated budget per industry when trying to reach carbon neutrally in the set timeframe is however very likely.

Government incentives: price mechanism that lead to decarbonisation

Most of the dominant theories on government policy related to decarbonisation suggest that price mechanism that would put penalties on the use of fossil fuels or carbon emissions contribute to the decarbonisation of the industry (Grubb, McDowall & Drummond, 2017; Del Río & Cerdá, 2017; Bataille et al., 2018; Rissman et al., 2020; Peñasco, Anadón & Verdolini, 2021), the findings of this study also result in policy recommendations based on the views from respondents with suggestion to implement such penalties. The question is however if this is going to result in the desired behavioural changes of both firms in the district heating industry as well as end-users of the heat and if other policy instruments are not more effective in achieving decarbonisation. When introducing penalties on the consumption of natural gas or carbon emissions on the district heating activities of firms these will increase the cost price of heat and subsequently will increase the costs for the end-users. The rationale behind this policy approach would be to make carbon neutral heat more affordable compared to the fossil alternative, this however implicates the ability to choose and just that ability is not available for

end-users of district heating. If anything, this would promote individual solutions and would likely negatively affect the public opinion towards collective heat solutions that provide carbon neutral heat. Combined government incentives with a mandatory reduction of carbon emissions for both existing and future (collective) heat solutions together with effective government schemes that support the diffusion and adoption of the technological solutions that contribute to decarbonisation are likely more effective and would not require to impose such penalties. The main contributor to current share of renewable heat is residual heat from waste incineration and industrial process, in order to prevent the lock-in from future heat production from these, current fossil, industries price mechanism that would lead these industries to decarbonise could be implemented, however this is dependent on how this would interact with the corporate behaviour of firms in these industry and the combined government incentives to decarbonise these industries.

Government incentives: a safety net?

The matter of a government safety net that could protect industries from sudden changes in policy was brought up by most of the respondents from the firms. According to the respondents from the firms this policy mechanism should compensate firms that, as a result of government changes, incur unreasonable losses and especially if these losses are the result of recent shifts in policy. The complexities involved with the introduction of such a policy instrument are not a subject of this study, but it is likely that these will affect the level playing field in an industry should adhere to competition law as well as the matter of how to determine unreasonable losses and how to calculate the resulting compensation. However, the suggestion by respondents is not without merit with regard to the decarbonising of the district heating industry, which relate to one vary specific aspect of the industry and one likely more generalisable aspect namely the uncertainties regarding the decarbonisation of an industry. The industry specific element that might be eligible for such a safety net mechanism is related to the security of supply with regard to heat as being a vital resource that supports the economical and sustainable functionality of households and industries. As previously discussed, it is likely that in order to guarantee security of supply it is necessary to maintain a certain amount of fossil-fuelled production assets in reserve, strategic reserve if you will, to produce heat if the new assets that produce carbon neutral heat cannot provide sufficient heat due to possible known and unknown, likely temporary, limitations of these technologies. For firms it is however likely not profitable to maintain these assets, since these will eventually become obsolete and to avoid the possibility of stranded assets with subsequent losses that the firm will incur it is likely in the self-interest of firms to divest these. A solution for this would be to nationalise these specific activities, however this comes with its own complexities and it can be argued that this would not be a viable option since the situation that these assets are needed is likely only temporary thus it arguable that firms should receive

compensation if these firms to keep the assets, that are soon to be obsolete, in operation. This can be organised directly between the government and specific firms, however this aspect could likely best be included in an integrated industry approach from the government and all key stakeholders of an industry in order to identify these and agree upon how to organise this. For this policymakers likely need to consider the district heating industry as a capacity market which is more common for the electricity market (Crampton, Ockenfels & Stoft, 2013). While this is very specific for the district heating industry, one might assume that this could also be applicable to other industries that are of vital importance to the functioning of society and this algins with findings from Grubb, McDowall & Drummond (2017), scholars could include the element of security of supply in relation to decarbonisation of these industries in their study and try to identify whether this issue is likely to occur in the respective industry of subject to their study.

The aspect that is far more generalisable is the uncertainty related to the specific trajectory or path a specific industry might take in order to become carbon neutral and the uncertainties that policymakers face when designing government policy in how to best direct and facility the industry in her transition through policy and that these insights might change, even within a relative short timespan such as the example identified in this study regarding biomass indicates. If and how this should result in a safety net mechanism that lead to compensation for firms is likely a political question that requires a political answer, how such an instrument subsequently can be devised is not part of study nor do the findings indicate how this could be done and wat the implications are on a level playing field of an industry as well as on competition law. If the government indeed decides to implement such a policy instrument this should likely be part of an integrated policy approach of the decarbonisation of a specific industry. It is however interesting to theorise what the characteristics of such a policy instrument should be in relation to decarbonisation and this could be a subject for future research.

5.1.4 Complexity in designing combined government incentives that lead firm to decarbonise in specific industries

What the findings of this study above all have shown is the complexity to decarbonise an industry that is inherently woven with the larger infrastructure that support the economical and sustainable functionality of households and industries. This results a multitude of stakeholders that are involved and affected by changes in the infrastructure as a result of decarbonisation, which all have specific and likely different attitudes and interests towards decarbonisation. Next to these, all these stakeholders are influenced by a layers of excistings combination of government incentives on a variety of policy fields and governance levels (national, provincial and municipal). Introducing new policy with the aim of decarbonising onto the existing policy is very complex since it is difficult to assess the impact that the introduced policy instruments has on these different stakeholders and the behavioural changes of

these stakeholders, this is not new, previous studies found that in order for new government incentives to be introduced these should be evaluated in light of the existing combination of government incentive (Howlett & Rayner, 2013).

Institutional scholars have argued that in order to achieve sufficient impact from policy that policy must be designed to reduce the mismatch between policy and practises by overcoming various obstacles that might inhibit firms from changing their behaviour (Wijen, 2014; Wright & Nyberg, 2017; Aragón-Correa et al., 2020), the findings of this study seem to confirm this view as was discussed in paragraph 5.2. This was followed by studies that unveiled another complexity to the effectiveness of policy in changing behaviour of firms when policymakers experiencing field opacity due to high complexity and specifics in the industry of subject, namely that policymakers do not understanding the full complexity of the possible outcomes that policy has on corporate behaviour (Wijen, 2014). The likelihood that policymakers when devising combined government incentives with the aim of decarbonising the district heating industry and subsequently lead firms operating in this industry to decarbonise their activities suffer from field opacity is high, this study has indicated this abundantly and the delay to devise and implement policy as a result of the 2019 Climate Act could be a testimony to this. To subsequently overcome this field opacity and the industry specific complexities, policy should be designed to be more specific and stringent and account for these industry specific complexities (Wijen, 2014). In turn, this lead to a likely trade-off as result of the stringent and specific policy, namely that policies are less flexible and thus not equipped to account for the context contingency that environmental issues such as decarbonisation inherently have and to account for this trade-off policy design should balance specificity and stringently with a more flexible implementation, design niche policy for industry specific barriers and timely adjust policy design and implementation when the situation requires this (Wijen, 2014).

The findings from this study support the need for policy on decarbonisation to account for these industry specific complexities as multitude of examples in the case study as discussed in paragraphs 5.2 and 5.3 has shown, and these are likely generalisable to other industries with similar complexity. Additionally, it is as discussed highly likely that policymakers are experiencing a high degree of field opacity in relation to the design of policy with the aim of decarbonising the district heating industry and in influencing the behaviour firms in this industry through combined government incentives accordingly, findings from this study on the impact of the current combined government incentives on the decarbonisation of the district heating industry certainly suggest this. The questions that now remains that if, policymakers would design policy to account for this specificity and in doing so consider the aforementioned trade-off by balancing specificity and stringently with a more flexible implementation, design niche policy for industry specific barriers and timely adjust policy design and

implementation, this would result in achieving the policy objectives, in the case of this study the decarbonisation of district heating industry. The findings of this study indicate that this might not be the case, since the complexity and high specificity of decarbonising the district heating industry likely surpasses what can be reasonably achieved through conventional combined government incentives and supersedes that what can be asked from policymakers since it requires intimidate knowledge and direct involvement on various complexities in the industry by the government, a likely seat at the table in the boardroom as you will?

5.2 Limitations

Next to the limitations included in the discussion as well as the inherent limitations of the chosen research approach, which provides significant details as well as uncovers the various relations and effects within a specific subject, a case if you will, but requires scrutiny in relation to the generalisation of the uncovered relations and effects, several specific limitations on the results of this study are elaborated in more detail to inform and assist the readers of this study to interpreted and place the presented results of the study in the proper context.

Technical applicability of solutions to decarbonise: a limitation in this study is that technical applicability of the solutions and the assumption that these are on a sufficient enough level for policy design to focus more on diffusion and adoption of these technical solutions by firms, albeit with the dependencies identified, are based on the perception of the respondents from this study and this could therefore not be a full reflection of reality, although no indication of this has been encountered during the course of this study.

Government rationale on policy: in this study the government rationale behind the policy field of subject to this study is based on secondary data and could not be sufficiently triangulated with interviews with multiple policymakers since only two policymakers have been included in this study, to compensates for this, additional material from other studies were included in this study this could however lead to gaps in the understanding of the rationale behind certain elements of policy design.

Multinational vs. local management: From the five firms included in this study four were multinational or subsidiaries of these, these interviews were conducted with the local management of these firms and while findings were triangulated based on the broader information available of these firms such as corporate statements and reports. The findings of this study are therefore applicable on the heat activities of these firms in the Netherlands and do not necessarily reflect the corporate behaviour of these firms in general or on other activities.

Specificity of the district heating industry in the Netherlands: The district heating industry in the Netherlands has very specific characteristics, such as but not limited to the level or regulation of the

industry on prices and other aspect of the industry as well as the de facto monopoly of several firms in specific heat grids. These specifics could impair the possible generalisation of the findings.

Finally, the impact that combined government incentives have on corporate behaviour and how these might or might not lead firms to decarbonise are abundant and likely not limited to the effects identified in this study. This does not limit the relevance of the findings of this study, it is however important to point out that the impact of combined government incentives are not limited to these findings alone.

5.3 Future research

During the course of the chapter several suggestion for future research were made on the specific topics discussed in paragraph 5.1. There is however one matter with regard to the decarbonisation of industries which has been indirectly discussed, this the matter of state aid and competition law. There is a likely tension between the political desire to aid industries to decarbonise as a result of the pressure the government wants to impose on the industry to decarbonise and the effects that state aid has on the level playing field within the industry, across industries and across countries. While one might argue that this is similar to the broader topic of state aid of the government to advance their industries and investment climate, there is a great need to decarbonise within a limited timeframe to reduce or even reverse the effects on the environment. The underlying question is how far a government can legally go in supporting its industries to decarbonise as well if the current legal framework on for example competition law is sufficiently suited for the aspect of decarbonisation. This topic of importance warrants future research on the different dimensions it entails.

5.4 Conclusion

This brings this study to the research question that has guided this study and subsequently in how this study was able to formulate an answer to this question based on the identified existing knowledge, findings from the empirical study and how these relate to one another and to the research question. The answer to the research question has a general and a content-related aspect to it, since combined government incentives, no matter their specific objectives, need to sufficiently impact corporate behaviour to achieve the desired behavioural change of the firms. The decarbonisation of firms is the specific content aspect of the question, since the research question searches for an answers to what combined government incentives lead firms to decarbonise. The research question will be answered systematically by addressing the general aspects to combined government incentives in having an impact on corporate behaviour followed by what government incentives lead firms to decarbonise, together these lead to an integrated answer to the research question.

Design combined government incentives to having an impact

In order for any combination of government incentives to be successful in their aimed behavioural change of firms, these combined government incentives need to have sufficient impact on the corporate behaviour of these firms. The degree in which combined government are effective in having an impact is contingent on the stability and duration of government policy. Next to this, the design characteristics of these combined government incentive need to ensure sufficient congruence between policy goals and government incentives, sufficient coherence between government incentives and firm practices, sufficient level of alignment between policy instruments and between policy goals within a policy field. To ensure sufficient impact on corporate behaviour, policymakers should also be aware of how combined government incentives of other policy fields might influence corporate behaviour, subsequently there should be sufficient alignment between the objectives of the various policy fields as well. Since combined government incentives have a continues impact on the accumulation of corporate behaviours a level discrepancy will always exist, the design of combined government incentives need to reach and maintain a sufficient balance between all these aforementioned design characteristics to reduce this discrepancy and when new government incentives are introduced this might require a readjustment of the other government incentives in order to maintain this balance. When combined government incentives lack these design characteristics and fail to reach or maintain this balance, this not only reduces its impacts on corporate behaviour it also leads to a lower perceived credibility of the government as perceived by firms, which further reduced the impact of combined government incentives on corporate behaviour.

Design combined government incentives by influencing dominant motives of firms

Next to the proper design of combined government incentives, the individual government incentives collectively need to influence the corporate behaviour of firms in an industry to elicitate the desired behavioural response, this can be achieved by either influencing the dominant motives of these firms directly or indirectly through stakeholders of the firms. Firms are in their assessment of their external environment particularly susceptive to the how important stakeholders perceive the firm, this perception of legitimacy as perceived by firms influences multiple motives of the firms due to its effect on the licence to operate in the short-term as well as the future growth of firms thus in creating and maintaining a competitive advantage by the firms. Policymakers in the design of combined government incentives should use the susceptibility of the firms towards legitimacy to their advantage, since sufficient pressure on the firm through stakeholders of the firm could lead the firm to adjust their behaviour while not requiring other complex government incentives to incentivise firms in that industry to do so. Achieving this effect is possible through combined government incentives when these introduce a uniform strategy, goals, standards such as uniform reporting requirements that are adopted by dominant stakeholders of the firm, and this is likely only effective on all firms in an industry

when this is achieved at supernational level. However, policymakers do need to be aware to proportionate the pressure on firms over time in relation to the decarbonisation of industries, since the pressure experienced to decarbonise from its dominant stakeholders by the firm could result in the decision of the firm to divest specific activities that do not sufficiently contribute to the perceived pace of decarbonisation due to the lack of available solutions to decarbonise these specific activities, this effect is less likely to occur when these activities are highly profitable. While the withdrawal of incumbent players might create possibilities for new entrants that could contribute in the decarbonation of an industry, policymakers should only act upon this effect when they have an indication this is expected to occur, otherwise this could have adverse effect on the decarbonisation of industries and results in delays to the government objectives.

Decarbonisation, mandatory.

When designing combined government incentives with the aim to decarbonise a specific aspect to decarbonisation need to be understood that influences corporate behaviour and their willingness to decarbonise. Where firms normally would adjust their strategy based on their perception of (changes) in the nature of demand in their respective industries. The argument this study makes is that a clear demand for the carbon neutral alternative is largely absent, which appears especially the case for commodities, since there is a limited direct benefit perceived by end-users for the carbon neutral alternative and the subsequent technological solutions that provide for this carbon neutral alternative. Subsequently firms are unable to make the choice to decarbonise since the usual prerequisites to making this choice, a clear demand for the carbon neutral alternative, is largely absent. If, in what pace and to what extent the carbon neutral alternatives are to be introduced is above all a political choice since decarbonisation it is not necessarily a goal that firms and arguably that most citizens pursue. The other aspect that is intertwined with decarbonisation of industries is the aspect of time, namely the time in which decarbonisation need to be achieved in order to limit and even reverse the effects of carbon emissions on the environment. Therefore, combined government incentives need to provide for the demand of the carbon neutral alternative while simultaneously ensure that industries decarbonise at the required pace. The conclusion of this study related to achieving the government goals on the decarbonisation of the industries within the set timeframe is that it is not possible without sufficient coercion and imposing, mandatory demand on end-users, mandatory reduction of carbon emission in the industry as well as mandatory levels of carbon reduction that need to be achieved when industries expand through the adoption new technological solutions, through combined government incentives.

Prerequisites to the decarbonisation of industries

The element of mandatory decarbonisation alone is however not sufficient in leading firms to decarbonise. What this study has shown is that the decarbonisation of industries is as specific and complex as the industry itself, subsequently combined government incentives should adhere to this complexity. However, this study argues that there is no single or set of combined government incentives that generically results in the decarbonisation of industries, the inherent differences between individual industries to varying degrees prevent this. It is how these combined government incentives are able to formulate an answer the dominant questions behind the effort to decarbonise a specific industry. The questions that combined government incentives need to formulate an answers to in order to make a collective effort and lead firms to decarbonise are: 1) how the transition to decarbonise can be made affordable? While simultaneously answering the other question: 2) how to create sufficient levels of public opinion for the decarbonisation and public support and consensus among all relevant stakeholders for the technological solutions during this transition? The government is the only institutional agent that can answer these questions, since these at the core, are political questions. All combined government incentives that are subsequently devised should adhere to the formulated answers to these questions and should be created under the assumption that decarbonisation is the goal and combined government incentives a means into an end.

Bridging the affordability and public opinion gap through government incentives

In order to overcome the current affordability gap, combined government incentives should both directly and indirectly address specific aspects that support the mandatory imposed demand for the carbon neutral alternative. The aspects of making the carbon neutral alternatives affordable are ensuring sufficient levels of demand for this alternative as well as the adoption of technological solutions that provide for the carbon neutral alternative by firms, while this differs per individual product and service across industries, some elements are generalisable to all industries. Government incentives should at the very least ensure equal sharing of risks within the value chain of an industry by providing a level playing field for both incumbent players as well as possible entrants. This can be achieved through the introduction of industry-wide standards as well as clear path that leads to decarbonisation of that industry, in short, providing clarity through combined government incentives for all stakeholders involved with the decarbonisation of an industry. Since the decarbonisation of industries is largely a technological effort, the government incentives with the aim of developing or diffusing the technological solutions that lead to decarbonisation, such as government support schemes, should adhere to the industry specific elements and ensure a level of customisation necessary for firms be eligible for these schemes as well as dedicated public funding allocated these industries to ensure the required pace of decarbonisation can be met for the specific industry.

The impact that decarbonisation has on various activities of industries varies, at the very least this will result in the gradual transition in production methods and procedures based on fossil to carbon neutral variants. This could however hinder the security of supply of certain products or services that are vital for the economical and sustainable functionality of society, if this is the expectation in an industry the government through government incentives should aim to ensure sufficient compensation for firms that are disproportionately disadvantaged when these firms need to keep these in operation to ensure that security of supply. In order to incentivise demand by end-users for these carbon neutral alternatives that indirectly lead firms to decarbonise, especially for commodities where there is limited direct benefit perceived by end-users for the carbon neutral alternative, a solidarity principle needs to be introduced to negate the negative, albeit likely temporary, effects as a result of variation in recurring and non-recurring costs at different moments in time for specific groups of end-users during the transition. The latter is also a prerequisite to ensure sufficient public support for the decarbonisation of industries.

Furthermore, the government, through combined government incentives, can indirectly lead firms to decarbonise by stimulating the public opinion by assisting in creating a common narrative for the need to decarbonise. This can be achieved through storytelling by the government and ensuring the early participation and involvement of relevant stakeholders for specific initiatives that lead to decarbonisation by for example municipalities and government agencies involved with the implementation of these and to be sufficient consistent between all government communications channels on decarbonisation and on the specific technological solutions that are needed to achieve this. The implementation of technological solutions that lead to decarbonisation vary in complexity, in industries where the complexity surpasses the sphere of influence of this industry the government should take a more directing role by ensuring that a structured dialog exist between all relevant stakeholders so that possible obstacles are identified early in the transition of decarbonisation and together with these stakeholders, both in and outside the industry, devise measures, that sometimes lead to government incentives, to overcome these.

What combination of government incentives will lead private firms to decarbonise their activities?

To conclude, leading firms to decarbonise through combined government incentives requires policymakers to have intimate knowledge of the specific industry that is targeted through these government incentives and the devised combined government incentives should provide a sufficient enough answer to the dominant questions behind the steps needed to decarbonise a specific industry. As concluded, there is no single or set of combined government incentives that generically lead firms to decarbonise, the inherent differences between individual industries to varying degrees prevent this. There are however parallels on the dominant questions between industries, which are the affordability

of decarbonisation for all parts of the value chain in that industry and the public opinion for and support to decarbonise the industry, which both determine to the degree of adoption of technological solutions that lead to the decarbonisation of industries and subsequent by the firms. Policymakers cannot formulate these answers alone, the dominant stakeholders in an industry need to be intensively involved to provide these answers. Hence, policymakers need to formulate answers together with the dominant stakeholders in an industry to these questions and subsequently adjust the combined government incentives to decarbonise the specific industry accordingly, while ensuring that there is a sufficient balance in the design of the combined government incentives to ensure their impact on corporate behaviour.

The objective is clear, reach carbon neutrally by 2050, to ensure this objective is met, so argues this study, sufficient coercion is needed since decarbonisation is, especially at the start of the transition, not going to happen voluntarily. The combined government incentives should, as this study argues, adhere to this assumption by including a mandatory path for industries to reduce carbon emissions aligned with the government objectives. Reaching and maintaining the balance between affordability and public support, whilst ensuring that industries are largely carbon neutral by 2050, through combined government incentives that are designed to sufficiently reduce the discrepancy between its design and subsequent impact on corporate behaviour, is the challenge that policymakers and for that matter society face but are, as this study concludes, what a combination of government incentives lead firms to decarbonise.

5.5 Recommendations

In this final paragraph the recommendations for both policy as well for management practices derived from this study are summarised to improve the readability for all whom find themselves reading this study. While the recommendation are derived from the study, the contents does not necessarily adhere to the same standards and should therefore be interpretated as such.

5.5.1 Recommendations for policy practices

If this study has made one thing clear it is that decarbonising industries will likely be as specific as the industries themselves, however, there lacks one important component to the decarbonisation of industries that played an instrumental role in the creation of these industries, namely the demand or expectation that there will be a demand for the products or services produced by these industries. The lack of demand for the carbon neutral alternative is the result of limited perceived benefits for the carbon neutral alternative and this study concludes that public opinion and support for these alternative is therefore currently insufficient, the fact that the carbon neutral alternative is current less affordable, this is at least the case for carbon neutral heating, but it is likely this is applicable on other utility services as well, does not contribute to this. Additionally, in the district heating industry it is

important to recognise that the industry is not a functioning market of supply and demand, hence policy cannot be devised under the assumption that such a market for carbon neutral heat exist. The absence of demand for carbon neutral alternatives and the lack of a function marked requires the government to make those choices that the industry cannot make. The inability for the government to do so currently inhibits the decarbonisation of the district heating industry and it is more than likely that this is in varying degrees applicable on other industries as well. How the government through a combination of government incentive can overcome these obstacles by providing answers to these question based on the findings from this study will now be elaborated, where to find the consideration when designing these instruments discussed during this study is indicated via the reference to a specific paragraph.

Devise an integrated policy approach to the decarbonisation of industries

That the government needs to adopt a more directing role with regard to the decarbonisation of industries does not exempt the various players in these industries and other stakeholders involved with the decarbonisation of these industries from their responsibilities. In order to reach the destination that lies at the end of the path towards decarbonisation efficiently the government together with these stakeholders in the various industry need to devise an integrated approach to the decarbonisation of that industry. In the example of district heating all government policy regarding the industry should be devised based on the main assumption that the value chain of heat is an integrated system, since different parts of the value chain react to one another and the resulting effects are not just isolated to that part of the value chain, this is however applicable on other industries as well dependent on the complexities in that industry. Part of this integrated approach is to ensure that both rewards and risk are equally divided between the different parts of the value chain. The combined government incentives that support the industry in this endeavour to decarbonise are a part of this integrated approach, but commitments made by industries to adhere to these objectives are equally important. The different individual policy instruments should be consistent and introduced at the appropriate time to support this integrated approach and a governance structure needs to be implemented that can enforce the commitment made by all stakeholders. This will require structured dialog between the various government agencies and stakeholders in an industry on various governance levels, from national to municipal. The various consultative bodies on various governance levels could identify possible obstacles as well as lack of commitment to the formulated goas as part of the integrated approach that interfere with the path to decarbonisation of the industry early on and take appropriate measure to overcome these accordingly (4.4.10 and 5.1.3).

Provide a clarity and mandatory path to decarbonisation

What this study above all has shown is the need for clarity provided by the government on the desired path to decarbonisation of an industry, in the case of this study the district heating industry. This clarity is not only needed to ensure that the objectives of a largely carbon neutral society in 2050 are met, but also a requirement in order to provide a level playing field in the industry for both incumbent players as well as possible entrants. This can be achieved through the introduction of industry-wide standards as well as clear and largely mandatory path that leads to decarbonisation of that industry, in short, providing clarity through government incentives for all stakeholders involved with the decarbonisation of that industry. When this is projected on the district heating industry, the obvious policy instrument to achieve this is by revising the current Warmtewet (heat law). Based on the findings from the study the following amendments to the heat law could be made:

- Include a mandatory path for decarbonisation for the district heating industry by 1) imposing mandatory reduction of carbon emission for the existing activities of the industry as well as ensure 2) mandatory levels of carbon reduction that need to achieved when expanding the industry through new technological solutions (5.1.3.6);
- Define uniform standards across industries related to (carbon neutral) heat (5.1.3.6);
- Introduce a legal framework that can assist the expansion of collective heat solutions by making participation to these solutions largely mandatory for end-users (5.1.3.7);
- Revise the price control mechanism to include for the decarbonisation and replace the current benchmark with natural gas to a cost price plus model that accounts for decarbonisation while ensuring affordability of the heat for end-users through the introduction of a solidarity principle (4.4.3 and 5.1.3.7).

It is important to note that policy design with elements that lead to a mandatory path of decarbonisation are introduced with sufficient support instruments in place to maintain a level of affordability. This especially relevant in light of the effect derived from this study that firms when experience relative high pressure from their dominant stakeholders to decarbonise but lack the possibilities to do so, these firm can decide to divest that specific activity, while this might result in an opportunity for new entrants in the industry that do contribute to the decarbonisation it could also delay efforts to decarbonise an industry. Next to the affordability, government policy should facilitate the creation of sufficient levels of public opinion and subsequent support for decarbonisation. The specific government incentives derived from this study that lead to sufficient levels of affordability and public support will now be discussed.

Invest in the large-scale insulation of buildings early in the transition

While very specific to the decarbonisation of district heating, this study recommends increasing the stimulation of owners to insulate their buildings, homes but also offices and other commercial buildings. Proper insulation is expected to be a catalysator early in the transition by reducing demand and thus carbon emission directly, ensuring the eligibility of these buildings for future growth of collective heat solutions and the reduction in demand also, to an extent, compensates the higher costs for carbon neutral heat. It is important that specific standards for insulation are introduced together with this incentive. The expected reduction of carbon emissions on the environmental as a result of proper insulated buildings could be used to determine a more incentivising compensation for owners (5.1.3.7).

Government support schemes to incentivise the adoption of technological solutions by firms

The design of policy instruments with the aim to support firms in the adoption of technological solution that lead to decarbonisation though public funding, such as the current SDE++, require a more industry specific approach, at least if these policy instruments adhere to the goals formulated in the 2019 Climate Act. A recommendation derived from this study is that government supporting schemes will be more effective in incentivising specific industries when these are designed to cope with various industry specific technological solutions, assign budgets to specific industries and have sufficient alignment with goals between industries (in the example of heat generated through electricity, consider the expected increase in share of renewable energy when ranking such projects, since lead times of projects are significant) (5.1.3.8).

Government safety net to ensure security of supply

In order to guarantee security of supply, in the case of this study, for heating it is likely necessary to maintain a certain amount of fossil-fuelled production assets in reserve to produce heat if the new assets that produce carbon neutral heat cannot provide sufficient heat due to possible known and unknown, likely temporary, limitations of these technologies. This example is derived from the district industry, but it is arguable applicable on other industries as well. For firms it is however likely not profitable to maintain these assets, since these will eventually become obsolete and to avoid the possibility of stranded assets with subsequent losses that the firm will incur it is likely in the self-interest of firms to divest these. This however is not in the best interest for society and in order to compensate firms for keeping these assets in operation these should be compensated. This can be organised directly between the government and specific firms operating in the industry, however this aspect could likely best be included in an integrated industry approach from the government and all key stakeholders of an industry in order to identify these and agree upon how to organise this.

Policy instrument to influence the public opinion

When proper instruments are in place that lead to (more) affordable solutions for the carbon neutral alternative, this leaves the matter of public opinion. Based on various findings the recommendation is that the government, through storytelling, can assist in shaping a common narrative for the need to decarbonise and assisting firms to bolster against critique form both inside and outside these firms. When initiatives are beginning to take shape, municipalities and governance agencies involved with the implementation of these should ensure the early participation and involvement all stakeholders with these initiatives, in the case of district heating above all the residents of neighbourhoods affected. Important to note that with regard to decarbonisation, government communication through all channels is more effective when consistent, speak with one voice so to say (5.1.3.5).

Some final consideration to policy designed to decarbonise industries

In order for policymakers to understand the specifics of the decarbonisation of the various industry it is necessary to attract and retain knowledge within various government agencies on these specific industries, this to ensure both coherence between policy and practice and also ensure proper governance. Additionally, when introducing policy instruments that aim to impact the behaviour of firms and to lead these to decarbonise, it is important to evaluate these in the context of existing government policy on the industry, since existing policy instruments can have an adverse effect and act as a barrier to introduced policy. The last recommendation that needs to be highlighted from this study and was derived from all respondents participating in this study is that it is essential to ensure the continuity of policy and commitment of the government to the goals set by for example the 2019 Climate Act. Frequent changes in government policy or government attitude will not only resulting in a lower perceived credibility of the government by firms but also likely results in lower public support for decarbonisation (5.1.2).

5.5.2 Recommendations for management practices

While the focus of this study was on what combination of government incentives lead firms to decarbonise their activities, in doing so this study uncovered various corporate behaviours and underlying motives that indicate why firms behave the way they do. This results in various recommendations for management of firms with regard to the effort to decarbonise, which all firms will ultimately to a greater or lesser extent face.

Accept a different pace of decarbonisation between various activities

Since firms from a certain size likely exploit multiple activities it is important to understand and accept that decarbonisation moves at different paces for individual activities in the firm, dependent on the nature of activities and the maturity and applicability of the technological solutions that lead to decarbonisation in specific countries. This can result in a discrepancy between the adopted

environmental strategy of the firm in becoming carbon neutral and the ability of individual activities of the firm to adhere to this. It can even be argued that it could be the wiser course of actions to wait with decarbonising specific activities since the demand for these carbon neutral alternative is insufficient or the costs to creating these alternatives are simply too high, while doing so firms could instead compensating for the carbon still emitted in the environmental, this is a temporary solutions to bridge the gap between lack of affordability and public opinion for the carbon neutral alternative and the subsequent adoption of these by the firm when conditions are met. The implication of this is that when including decarbonisation in the decision-making process, which is likely necessary in providing sufficient incentives for the firm to decarbonise, it is more effective to introduce specific decarbonisation goals and incentives for specific activities in order to ensure the possible pace of decarbonisation is met for that specific activity.

Proactive approach to formulate an answer to the decarboniseren of your industry

It is advisable for firms to adopt a proactive approach with regard to decarbonisation of their respective industry in order to try to formulate an industry wide answer on the question of decarbonisation for that industry and what prerequisite, dependencies and obstacles these firms face in becoming carbon neutral. Such an industry wide approach could significantly influence policymakers in designing government incentive that support the devised industry approach to decarbonisation and reduces the likelihood that mandatory imposed government incentives combined with less adequate support instruments result in higher costs incurred by the industry to become carbon neutral.

Be aware of Impact that resistance to decarbonise has on employees

Firms do need to be aware of the effects of how government policy is being perceived by different employees in the firm, lack of credibility by the government as perceived by employees could possibly result in indifference of the employees with regard to decarbonisation and undermine effort of the firms to become carbon neutral. In the instance of this study various employees where intrinsically motivated to contribute to decarbonisation, these intrinsic motivated employees are of great value to firms since these are the internal flag-bearers and promotors and likely invaluable in creating a common narrative of the need to become carbon neutral as a firm, however the resistance experienced by these employees from the government and the public during specific initiatives resulted in frustration and could eventually lead to indifference to the effort to decarbonise and this could likely have consequents for the pace in which the firms decarbonises. How to cope with this as a firm is not in the scope of this study, but sufficient attention should be given to the possible adverse effects of this. This likely also varies between countries dependent on the regulatory and political climate on decarbonisation in that country.

Shop around

Especially for international operating firms it is possible to 'shop' for the best combination of conditions that provide opportunities to experiment and gain knowledge on how decarbonise specific activities and develop best practices and to become less dependent on specific national policies that might inhibit these from occurring. Therefore, it is advisable to develop best practices to decarbonise specific activities in countries that have the best alignment between policy and public support and those practices and subsequently capitalise on these experiences in countries that lack these government incentives.

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5.7 Some final, slightly philosophical, remarks from the author

The road that leads to carbon neutrality will undoubtably be a steep and winding road with slippery paths, holes and sometimes even a dead-end, it should be clear by now that no one can go down this road alone, only when working together between governments, businesses, NGO's and individual citizens across countries, one might say the global society as a whole, is it possible to reach the destination of a carbon neutral society, this above all requires leadership and willpower from politicians and business leaders as well as the equal sharing of the burdens when going down that road to reach the destination of carbon neutrality.

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Chapter 6: Appendixes

6.1 Structure and questions semi-structured interview with policymakers

Structure of semi-structured interviews with policymakers		
No.	**Topic**	**Questions**
#1	Technological solutions	- What changes do you identify that are needed in the district heating industry for it to become carbon neutral?
#2	Technological solutions	- How would you asses the current technological development in relation to decarbonising the district heating activities in your company?
#3	Dependencies of decarbonisation	- How interdepended is the adoption of these technologies in relation to the district heating industry your company operates within?
#4	Corporate motives (perceived)	- What motives or drivers of decision-making are in your experience decisive with regard to project related to decarbonisation at private firms?
#5	Dependencies of decarbonisation	- Can you identify obstacles prevents private firms from decarbonising?
#6	Government incentives	What is the are the rationale behind the current policy of decarbonising district heating?
#7	Government incentives	- What existing government policies can you identify that have an effect on the decarbonisation district heating industry?
#8	Government incentives	- How likely are these government incentives going to contribute to decarbonising the district heating activities?
#9	Government incentives	- What combination of government incentives do you think are needed that will lead to the decarbonisation of the district heating activities (and why)?
#10	Government incentives	- Under what legal (mandatory / voluntary) conditions do you believe these government incentives should be implemented?
#11	Government incentives	- ***Optional*** : How do your perceive the new law "Wet collectieve warmtevoorziening" and how do you expect that this will contribute to the decarbonisation of the district heating industry?

6.2 Format of semi-structured interviews in Dutch

Interviewverslag- master thesis: decarboniseren **van private bedrijven**

Interview met: ……..

Functie: ……..

Organisatie: ……..

Datum: ……..

Taal in interview: ……

Toestemming via audio: Ja / Nee

Interview vragen:

1. Hoe zou u de huidige strategie van uw onderneming beschrijving m.b.t. tot het decarboniseren van uw bedrijfsactiviteiten en wat is de rationale hierachter?
2. Welke veranderingen zijn volgens u nodig in de stadsverwarmingssector om deze te decarboniseren?
3. Hoe kunnen de stadsverwarmingsactiviteiten in uw bedrijf worden gedecarboniseerd?
4. Hoe beoordeelt u de huidige technologische ontwikkeling met betrekking tot de mogelijkheden om de stadsverwarmingsactiviteiten in uw bedrijf te decarboniseren?
5. Hoe verweven is de toepassing van deze technologieën met de stadsverwarmingssector waarin uw bedrijf actief is?
6. Welke stappen heeft uw bedrijf in het verleden ondernomen die bijdragen aan het decarboniseren van de stadsverwarmingsactiviteiten?
    a. Zo ja: welke drijvers / motivatie / rationale achter de geïdentificeerde stappen kunt u aanwijzen en wat was het meest doorslaggevend?
    b. Zo ja: Heeft uw bedrijf tijdens het proces gebruik gemaakt van een overheidsregelingen en kunt u beschrijven welke en waarom?

    c. Zo nee: wat zijn de redenen voor beperkte tot geen verandering?
7. Welke motieven of drijfveren voor besluitvorming zijn in uw ervaring doorslaggevend voor projecten gericht op decarbonisatie?
8. Kunt u interne (binnen uw bedrijf) obstakels aanwijzen die uw bedrijf ervan weerhoudt haar stadsverwarmingsactiviteiten te decarboniseren?
9. Kunt u externe obstakels (buiten uw bedrijf) aanwijzen die uw bedrijf ervan weerhoudt haar stadsverwarmingsactiviteiten te decarboniseren?
10. Welk bestaand overheidsbeleid kunt u aanwijzen dat een effect heeft op de mogelijke bereidheid van uw bedrijf om haar stadsverwarmingsactiviteiten te decarboniseren?
11. Hoe waarschijnlijk is het dat deze overheidsstimulansen zullen bijdragen tot het decarboniseren van de stadsverwarmingsactiviteiten in uw bedrijf?
12. Welke combinatie van overheidsstimulansen zijn volgens u nodig om de stadsverwarmingsactiviteiten binnen uw bedrijf te decarboniseren?
    a. Technische veranderingen ondersteunen / vergemakkelijken?
    b. Standaarden en normen (technologie / prestaties / reductie)
    c. R&D-steun / investeringssubsidies
    d. Bevordering van duurzaam opgewekte energie (RES-E)
    e. Carbon pricing (hoeveelheid / prijs)
13. Onder welke wettelijke (verplichte / vrijwillige) voorwaarden moeten deze overheidsstimulansen volgens u worden toegepast?
14. Hoe beoordeelt u de nieuwe wet "Wet collectieve warmtevoorziening" en hoe verwacht u dat deze de decarbonisatie van de stadsverwarmingsactiviteiten in uw bedrijf zal beïnvloeden?