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The role of problem-solution convergence on ZEV adoption

A comparative case study on the Zero Emission Vehicle policy discourse in the United Kingdom and the Netherlands

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Abstract

The negative effects of fossil-fuel based road transport systems have become more apparent in recent years. Adopting vehicles that do not emit exhaust gases, namely Zero Emission Vehicles (ZEVs), can address these negative effects. Therefore, governments aim to increase ZEV adoption. In implementing the policy needed to do so, actors engage in discourse and framing to influence policy to suit their interests. Thus, policy discourse evolves, and at best, converges around clear problem and solution statements to achieve effective and legitimate policy. This thesis aims to understand policy formation by studying the role and effects of framing in ZEV discourse in the United Kingdom (UK) and the Netherlands. Framing practices are studied as actors use them to make sense of situations and guide collective action. A comparative study of policy developments in both countries from a discourse and framing perspective is insightful because they are culturally and institutionally similar. In addition, the two countries are considered to have different rates of early adoption of ZEVs, with the Netherlands being more successful.

The Problem-Solution Space (PSS) was used to study the degree of convergence on topics over time by assessing how contested, complex, and uncertain problems and solutions were in the discourse. Framing strategies were used to categorize texts from news articles, government reports and private publications into whether they were diagnosing problems, prognosing benefits, or motivating actors to act on these problems and solutions. Interviews were conducted to validate and expand on the findings from the document analysis.

The analysis shows that in the UK early problem discussions revolved around local air pollution and energy dependence. Battery Electric Vehicles (BEVs) were not seen as the best solution until later. Businesses diagnostically framed the issues around BEVs. In the Netherlands, in addition to the UK's problems, global warming and noise pollution were identified as problems. Furthermore, EVs were seen as the best solution from the beginning and framing practices of the different types of actors were mostly aligned. Thus, in the Netherlands the problems and solutions were converged on earlier.

This study shows that convergence can help explain the rate of ZEV adoption in different contexts. Furthermore, using discourse analysis to study framing and convergence allows policymakers to better understand actors' influence on policy discourse. This allows for the identification of situations where focusing policy efforts can help speed up convergence around societal challenges, helping policymakers to address them.

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1. Introduction

Transport-based greenhouse gas emissions have been rising, both in total emissions and share of emissions (IEA, 2021a). Additionally, health risks of emissions like particulate matter have become clearer (Jiang et al., 2017; Slezakova et al., 2013; Woodcock et al., 2009). To keep address global warming and public health issues, action must be taken to reduce emissions, also in the transport sector. Accounting for 25% of global CO_2 emissions, transport is the second largest emitting sector. Road transport accounts for 75% of transport emissions (Our World In Data, 2020). In the United Kingdom (UK), passenger transport energy intensity per passenger-kilometre has decreased by 17% between 2000 and 2018 (IEA, 2020) while in the Netherlands little reduction occurred (IEA, 2021b). Other sectors have shown larger decreases, causing transport to become a larger share of total emissions (IEA, 2020, 2021b). Zero Emission Vehicles (ZEVs) like ones powered by batteries or hydrogen fuel cells have the potential to greatly reduce road transport emissions due to their decreased well-to wheel emissions (Woo et al., 2017). Furthermore, these technologies eliminate harmful exhaust gases, either emitting none (electric) or only water (hydrogen) (Yamada & Mohamad, 2010).

While ZEVs can reduce the environmental impact of road transport compared to traditional vehicles, adoption of ZEVs differs greatly between countries. In Europe, Norway and the Netherlands are frontrunners while Germany and the UK show lower rates of adoption (Diaz et al., 2020). Especially in the countries with low adoption, ZEV usage presents a challenge for policymakers aiming at reducing transport emissions.

To help address these societal challenges of global warming and pollution-related health risks through ZEV adoption, a new way of policy thinking has been proposed. The new societal challenge-oriented policy approaches involve not just fixing but also shaping markets, setting directions for learning and experimenting, and accepting the risks and investments that supporting innovation requires (Mazzucato, 2017). They call for a more active role for governments in goalsetting to define societal challenges and guiding the development of solutions (Mazzucato, 2017; Schot & Steinmueller, 2018). For instance, the Dutch and UK governments embraced the goals of reducing carbon emissions from transport by aiming to ban non-ZEV sales in either 2030 (the Netherlands) (Rijksoverheid, 2019) or 2035 (UK) (Department for Business, Energy & Industrial Strategy, 2020). Next to formulating ambitious goals, governments should support the search for solutions like supporting research into battery technology, hydrogen infrastructure, and tax reductions for consumers buying ZEVs.

To guide policymakers in understanding the dynamics of faced societal challenges, Wanzenböck et al. (2020) proposed the Problem-Solution Space (PSS) framework. The PSS framework builds on the premise that problems and solutions can be analysed to determine how understood and accepted they are by society. They argue that analysing societal challenges based on the degree of convergence of the perceived problem and proposed solutions allows for identifying the state of a challenge. This can guide in the formulation of directional policies and the implementation of specific policy instruments corresponding with the situation. However, the PSS has found little application yet in practical research, and empirical evidence on its applicability in real-life contexts is lacking. Moreover, no empirical studies on the converging of problem-solution constellations to understand their role in guiding collective action have been performed.

This study suggests focussing on the development of the policy discourse around ZEV to understand the dynamics of convergence in addressing emissions originating from road transport. Here, convergence is considered as *"the process of becoming more similar, thus approaching each other"* (Witte, 2008, p. 84). In the context of this study this means that beliefs and topics formulated and

addressed by policy become more homogenous over time as alignment is reached. Moreover, discourse is defined as "*an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena*" (Hajer & Versteeg, 2005, p. 175). 'Policy discourse', then, is the ensemble concerning policy. Such a discourse perspective has been applied in fields like environmental politics (Hajer & Versteeg, 2005), social psychology (Potter & Edwards, 1996), or linguistics (Fairclough, 1992). Recently, it became more prominent in studying sustainable transitions, for instance in the case of water supply (Heiberg et al., 2020) or biofuels (Sengers et al., 2010).

Generally speaking, the aim of policy discourse analyses is to understand how language is used in public debates (Hajer & Versteeg, 2005), how coalitions form (Heiberg et al., 2020), and how solutions are perceived by different actors (Sengers et al., 2010). It is assumed that not only policymakers are active in shaping this discourse; also others may voice opinions, interpret the effects of policy and thus induce policy change (Brown & Klein, 2020). Particularly, actors influence others by framing their beliefs as positive while downplaying others (Battilana et al., 2009; Raven et al., 2016), potentially shifting consensus and causing policy to be drafted differently than without framing (Daviter, 2007; Lee et al., 2008).

So far, a policy discourse perspective has not been applied to study the framing practices and the role of convergence for adopting solutions that combat societal problems, like ZEVs for climate change and pollution-related health risks. This thesis aims to address these issues by answering the following research question:

> *How does the policy discourse on ZEVs between 2007-2018 differ between the UK and the Netherlands, and how did it influence the adoption of ZEVs in both countries?*

Due to the cultural and institutional similarities (Hall & Soskice, 2003; Sluyterman, 2014) and their differing adoption of ZEVs, the UK and the Netherlands are interesting cases to investigate from a comparative perspective. To better understand the emergence and evolution of policy discourse in both countries, the following sub-questions are proposed:

a. *What are the topics covered in the policy discourse and how do they change over time in the UK and the Netherlands?*
b. *What actors are involved in the policy discourse, and which framing practices do they apply in each country?*

By analysing the similarities and differences between policy discourses and actor's framing practices in the UK and the Netherlands, the effects of differences in problem-solution perceptions regarding ZEV adoption become more explicit, providing new insights and potential explanations for the differences in ZEV diffusion in these countries.

Furthermore, the case studies generate evidence on the dynamics of the policy discourse around ZEVs in each country. This will increase the knowledge base for drafting ZEV policy by understanding how convergence occurs over time and what role actors and sectors have in driving convergence. It will also allow policymakers to address global warming and pollution-related health risks better by highlighting what types of interactions or framing help in accelerating convergence, thus addressing societal challenges faster. Additionally, it aids implementation by providing a more detailed view on the discourse, allowing for more specific policy.

This thesis starts with presenting the theoretical bases and framework of the concepts studied. Next, it is elaborated upon how these concepts are studied and how data is gathered. Afterwards, the results

of the analysis are present. Then, conclusions are drawn from the findings of the analysis. Finally, the conclusions, limitations, and further research are discussed.

2. Theory

2.1 Societal Challenges and Innovation Policy

New innovation policy directions have emerged with the focus on complex policy problems like obesity and climate change, which are often referred to as 'societal challenges'. Such societal challenges cover multiple spheres of society, systems, or markets, rendering traditional innovation policy approaches focusing on one technology or market insufficient (Mazzucato, 2017). Instead, entire societal structures need to be transformed as wider change is necessary to address these complex problems.

Two policy directions that emerged to address these complex problems and guide societal transformations are mission-oriented innovation policy (MIP) and transformative innovation policy (TIP). MIP, popularized by Mazzucato (2016), builds upon the idea that policy should be directional, guiding change towards achieving 'missions', or societal goals. Initially, the idea of missions originated from technological and militaristic goals during the 1950s and 1960s, like putting a man on the moon. Modern missions are more encompassing, like addressing climate change. As such, MIP was introduced to encompass these broader challenges, integrating the need for collaboration with many different stakeholders to create policy instead of it emerging from government alone (Haddad et al., 2019; Mazzucato, 2016). Weber and Rohracher (2012) propose that the need to transform parts of society mandates further government action. Like MIP, this would also require the policy drafting process to include more directionality (Schot & Steinmueller, 2018; Weber & Rohracher, 2012). In this study, both MIP and transitions are used to understand the dynamics around the policies to transition to ZEVs.

To accomplish the fundamental changes in the production and consumption of goods, institutions, relationships, and practices must change (Schot & Steinmueller, 2018; Weber & Rohracher, 2012). To guide these changes governments can set goals without drawing specific solution pathways to reach them (Mazzucato, 2017; Schot & Steinmueller, 2018; Weber & Rohracher, 2012). As pathways to the goal are not specified, actors can pursue their own innovations. However, because of this, broad innovation policy is not viable if contestation of the pathway to the goal is high (Wanzenböck et al., 2020). Thus, incentives for actors might be necessary to align their efforts and secure the achievement of goals.

2.2 Policy Change: Beliefs and Framing

Policy studies assume that actors generally aim to influence policy to fit their goals and beliefs**.** Heclo (1974) defines policymaking as "*a form of collective puzzlement on society's behalf*" (pp. 305-306), emphasising the learning by the government that goes into the processes. Moreover, and from a more dynamic perspective, Sabatier (1988) argues that changes in policy through learning reflect shifts in public opinion on problems, discussions on the scope of government authority, and struggles over reformulations amongst others. On this basis, policy change can be seen as a government's response to changing perceptions and circumstances in society, reflected in instruments that attempt to address specific problems (Heclo, 1974; Sabatier, 1988).

To distinguish between types of policy change, Hall (1993) divides policy change – i.e. the shifting of policy over time – into *first*, *second*, and *third* order policy change. *First* order policy change occurs when boundaries and details of policies are adjusted. Examples are changing the level of tax or subsidies for ZEVs. *Secondary* change occurs when policies and settings change but the goal of those policies does not. For example, when subsidies are switched for tax reductions for ZEVs. *Third* order policy change entails a change in the hierarchy of the goals the policies are to achieve. Examples are

the shift from using mobility and transport policy to achieve economic or industrials goals or increased safety to focussing on environmental concerns.

This thesis follows the assumption that actors presenting their beliefs is an important factor for policy change to occur in general (Béland, 2009; Mintrom & Norman, 2009). The next sections will elaborate on what these beliefs are and how actors may present them through framing in discourse.

Actors, beliefs, and belief systems

'Discourse' does not purely concern the linguistics of communication; it also concerns the outcomes of knowledge, memories, and feelings used (Johnstone, 2017). Sabatier (1998) describes this basis as consisting of the actor's pre-existing beliefs. Therefore, clarifying what actors base their views on in a specific discourse is important.

Before studying actors' beliefs, some clarification about the notion of actors is necessary. The reason is that many scholars studying policy change perceive the actor as an individual person to guide their analysis (Battilana et al., 2009; Benford & Snow, 2000; Peffley & Hurwitz, 1985; Sabatier, 1998; Schlager, 1995; Schlager & Blomquist, 1996). Freudenburg and Gramling (2002) instead conceptualise a 'policy actor': an actor that is involved in the discourse around policy or policymaking itself. Here, it does not need to concern an individual but can also group multiple individuals acting from the same perspective, for example representatives of an organisation, or co-workers in a firm. This does not mean that these actors form an advocacy coalition necessarily as they can be acting semi-anonymously under the same banner (e.g., their organisation). Thus, since individuals are not always traceable in policy discourses, this thesis defines an actor as an individual or a group of individuals that acts in accordance with the body they are instructed by.

Then, beliefs, defined as: "*Something believed or accepted as true, especially a particular tenet or a body of tenets*" (American Heritage, 2020), are the ideas an actor perceives as truthful or correct. As the definition implies, beliefs can be aggregated. The widely accepted view on an actor's aggregate of beliefs is that of the 'belief system', defined as: "*a configuration of ideas and attitudes in which the elements are bound together by some form of constraint or functional interdependence*" (Converse, 1964, p. 3). Converse (1964) thus links the emergence of beliefs to 'constraint' which he describes as the binding idea between different concrete beliefs but also between concrete and abstract beliefs. Examples provided are a person's opinion on social justice and social chance.

While Converse (1964) focuses explicitly on the beliefs of individual actors to study dynamics on the micro level of belief systems, Inglehart (1985) argues that when belief systems are aggregated, more stable patterns emerge. This allows for concrete analysis of the belief systems of multiple actors and their discourse. Peffley and Hurwitz propose the notion of constraints by Converse (1964) in their model of attitude constraints, arguing that "*an individual's concrete policy attitudes are, in fact, constrained by their abstract beliefs*" (p. 1). In this way, they pave the way for policy analyses based on beliefs.

The construct of these concepts in this study is visualised in Figure 1: the individual belief systems make up the *landscape of belief systems*. The landscape, therefore, does not encompass all possible beliefs: participating in discourse requires some degree of overlap. Thus, the landscape has boundaries: belief systems outside the accepted landscape do not add information that is considered useful. This allows for the analysis of an actor's beliefs as well as the analysis on an aggregate level by analysing the beliefs of the different actors.
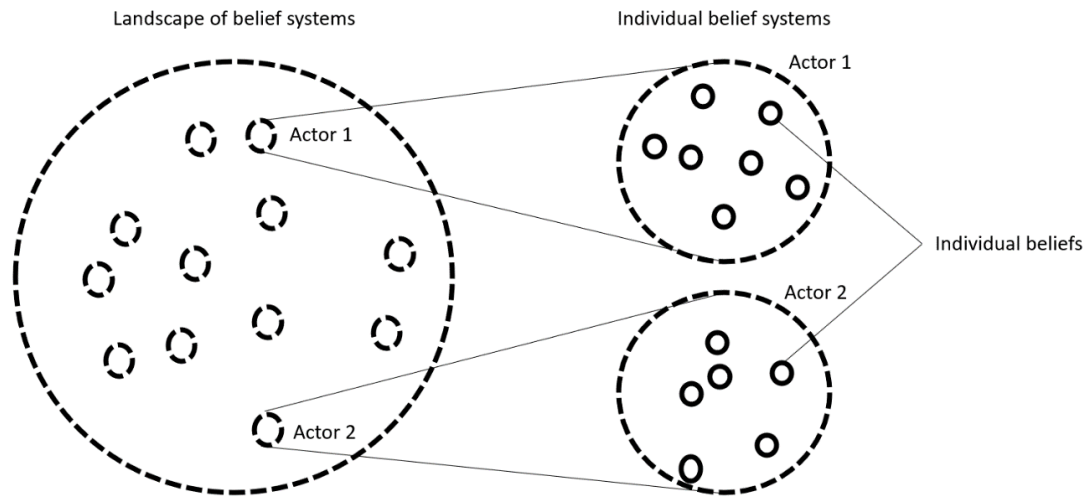
Figure 1: Individual belief systems and the landscape of belief systems

In the context of ZEV policies, such beliefs could materialise through business or ideological interests. An example may be car manufacturers pushing for research and development investment into hydrogen vehicles as this technology suits their current knowledge base well. A policymaker may believe that government should instead focus on market creation and not picking a single technology and provide subsidies to all ZEVs instead of working with industry to finance research and development. The two beliefs can both be present in the landscape of belief systems. However, because they differ, they can cause discussion among the actors, both hoping to convince the other of their belief, to bring the landscape more in line with their own beliefs.

Framing

To study how actors use their beliefs to influence policy and policy discourse the concept of *framing* is used. Framing is defined as "*an act of sense making that renders events or objects meaningful and guides collective action*" (Heiberg et al., 2020, p. 8). Framing as a concept is often used in the study of sustainable transitions. For example, Geels (2014) and Lee and Hess (2019) analyse the framing strategies used by incumbents that face competition by low-carbon alternatives, finding they tend to protect their own interests through framing, reducing the impacts of low carbon alternatives. Rosenbloom (2018) studies the use of framing in discourse to understand how negotiation on competing interests shape carbon reduction pathways, showing that government intervention can accelerate pathway formation in situations where the market faces political struggle. In addition, Benford and Snow (2000) use frames to guide their research on the development of social movements, which are often influential in changing their prevailing discourse

Framing is therefore not just a way to make sense of ideas but is explicitly used to influence others through empowering or downplaying specific beliefs (Battilana et al., 2009; Raven et al., 2016). Snow and Benford (1988) identified three core tasks in framing: *diagnostic, prognostic,* and *motivational* framing. In *diagnostic framing* a problem is identified (Snow & Benford, 1988). In addition, reason or blame can be given. However, when consensus on a topic exists, identifying it as problematic will either not add to the discussion (if it is already considered a problem), or not be taken seriously (when the topic is not considered problematic). In his study on framing in the UK energy sector, Geels (2014) points out that in 2003 the main problem being diagnosed by policymakers was the sector's impact on climate change for example. Later, this diagnostic framing shifted to encompass the rising energy prices caused by a dependence on fossil fuels. An example for ZEV discourse would be that diagnosing global warming as a threat will not add much as prevailing consensus largely agrees on the issue, while

the environmental impact of battery production for EVs is still widely debated. Thus, diagnostic framing in the latter topic might be given more attention by others (Snow & Benford, 1988).

Prognostic framing concerns the proposal of solutions and strategies to reach them (Snow & Benford, 1988). An example of this is the study by Voytenko Palgan et al. (2017) who illustrate that accommodation sharing organisations frame their services as a more sustainable alternative to hotels in terms of resource use, highlighting the importance of prognostic framing in pushing an actor's discourse (Voytenko Palgan et al., 2017). In the context of ZEVs, prognostic framing might concern the introduction of hydrogen vehicles and fuelling infrastructure. In the context of this study, when a technology or policy is mentioned as having benefits or positive attributes this is seen as prognostic framing too. This is done to account for cases where the specific goal the framing contributes to is vaguer. Like diagnostic framing, solutions that are framed in more contested spaces are more likely to receive attention.

Motivational framing concerns the call to action as more than consensus is needed for change. Snow and Benford exemplify nuclear weapons: when consensus on the negative effects of them is too strong, it has a numbing effect on actors (Snow & Benford, 1988). Therefore, framing the topic as something actors can work towards can help push them towards the framer's interests. Motivational frames are also used to call specific actors to action. An example of this is that of citizen concerns on climate change falling in the UK because of the 2008 financial crisis, illustrated by Geels (2014). This change in motivational framing was followed by a shift to more cost awareness by government (Geels, 2014). Together, these processes influence the belief systems of actors, reaching consensus on problems, solutions, and actionable plans if a frame becomes dominant enough over others.

Van Hulst and Yanow (2016) further embrace the dynamic nature of frames by viewing 'frames' not as static but rather as a dynamic process of 'framing'. Thus, the concept of framing can be used to guide analysis of policy discourse. In this study, the process of 'framing' will be used to analyse how actors influence the policy discourse through presenting their own frames of beliefs.

2.3 Convergence in the Problem-Solution Space

This thesis draws on the Problem-Solution Space (PSS) framework by Wanzenböck et al. (2020) to link framing to convergence of problems and solutions. Here, analysing different framing practices is useful to uncover how, why and when in the policy process problem-solution convergence emerges. The PSS is based around the idea that for innovation policy to achieve its goals, policy should be made to support converging the problem and the solution setting. The assumption is when actors' views on either are diverging, no consensus about a policy direction is achievable as actors are unaligned. Instead, a clear best solution or problem statement is present when actors' perceptions are aligned to address the societal challenge. By driving convergence, it is assumed that a stable frame of reference can emerge which is more suitable for traditional innovation policy like diffusing and scaling innovations. Therefore, identifying where a societal challenge currently stands in policy discourse can provide policymakers with better insights into what policies are needed to move the challenge towards alignment.

The combination of divergence, convergence, problems, and solutions is visualised in Figure 2. Three pathways for driving alignment are identified by Wanzenböck et al. (2020): the problem-led, solution-led, and hybrid policy pathways. These pathways describe the trajectories through which problem-solution convergence can emerge, all three potentially requiring instruments to move the process forward.
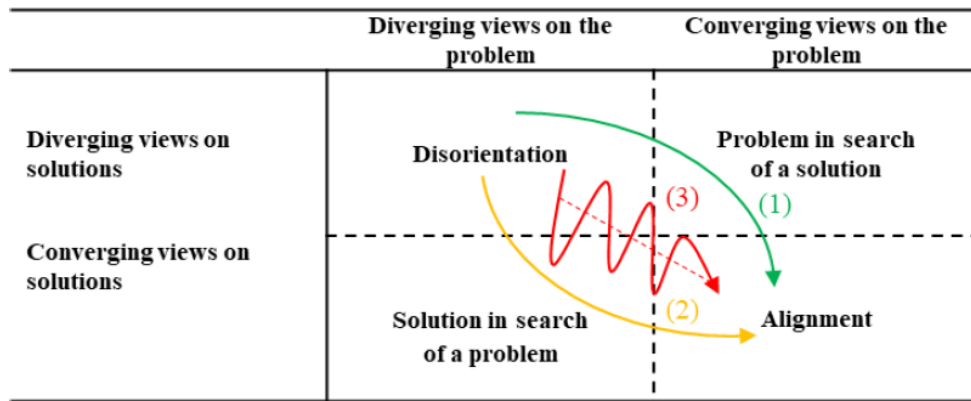
Figure 2: The problem-solution space and policy pathways within it, by Wanzenböck et al. (2020)

Wanzenböck et al. (2020) decompose the degree of wickedness of problems and solutions into three categories: complexity, contestation, and uncertainty. Decomposing problem-solution constellations into these three categories allows for a more detailed and structured analysis of the convergence process. For problems, complexity refers to the understanding on who should take responsibility for addressing them, and how many actors and domains need to be involved in addressing the problem (Wanzenböck et al., 2020). Contestation entails how 'accepted' or normative the problem is by different actors in society, resulting from actors' different values, framings, and interests. Uncertainty regards the understanding of the problem, its causes, consequences, and effects, and whether there is evidence of this or not. If complexity, contestation, and uncertainty are high for a problem, divergence is present on the problem side (Wanzenböck et al., 2020).

For solutions, complexity entails the need for a solution to fit with a broader socio-technical system, whether combining multiple systems or aligning existing ones, and the difficulties that emerge from this (Wanzenböck et al., 2020). Solution contestation can exist on whether an option is feasible, and on the opportunities and threats it brings to businesses, broader society, and individual users. Uncertainty around solutions emerges when there is a lack of knowledge on a solution's feasibility, or if potential (side-)effects of an innovation are unknown. In addition, if multiple options exist to address a problem but there is no single clear best one within a reasonable timeframe uncertainty arises too. If complexity, contestation, and uncertainty are high for solutions, divergence is present on the solution side (Wanzenböck et al., 2020).

To understand how views on a societal challenge change, this study will analyse convergence through the abovementioned categories. The categories will be connected to the framing practices of policy actors in policy discourse in terms of problems and solutions. For example, an actor might discuss a solution's feasibility (*solution contestation*) both through stating that problems persist (diagnostic framing) or proposing improvements to increase feasibility (prognostic framing). This way, both what *kind* of discussion is taking place in discourse (in terms of complexity, contestation, and uncertainty), and what *direction* actors are trying to move towards can be studied.

The aggregate of this framing will then be used to map the policy discourse around ZEV in the PSS framework. This is further elaborated on in the next section.

2.4 Proposed conceptual framework

To study the changing content due to framing in the ZEV discourse, the landscape of belief systems is integrated in the PSS. An example is visualised on the left in Figure 3 where the arrows indicate pathways the landscape of belief systems can take through the PSS as the content in discourse

changes. By analysing framing taking place in the landscape of belief systems the prevailing discourses can be identified. This in turn allows for the mapping of the policy discourse in the PSS framework.
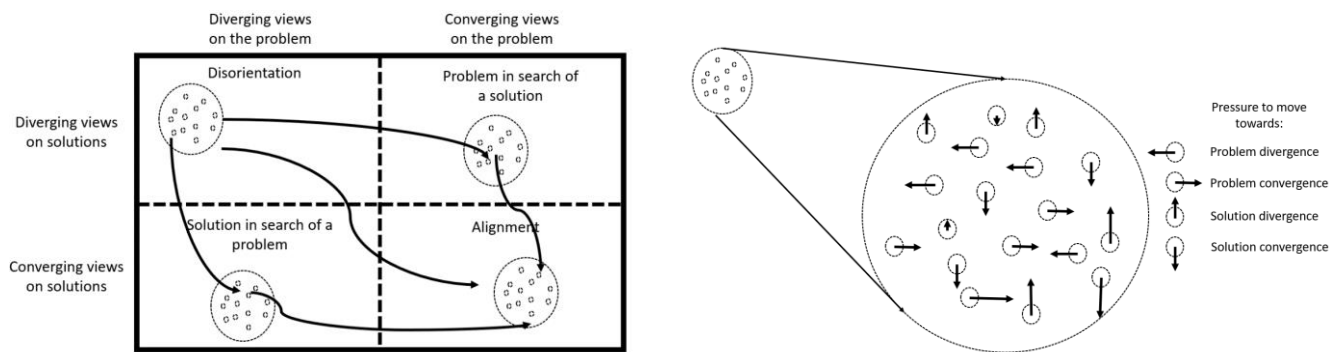

Figure 3: Framing processes in the problem-solution space framework

The framing processes in the landscape of belief systems are conceptualised on the right in Figure 3. The arrows indicate the direction the actors try to push the landscape of belief systems in compared to the previous period. Here, the actor can use different framing techniques to influence the discourse according to their interests and beliefs, that is diagnostic, prognostic, or motivational framing. Aggregated, these movements account for the shift in the landscape. For example, when pro-EV discourse is dominant, and pro-EV discourse was dominant in the previous period too, this means that the actors pushing pro-EV discourse are moving for solution convergence. When a different discourse is more dominant compared to the previous period, divergence is pressured. In total these forces will drive the policy discourse in one of the four PSS directions over time, allowing for a historical analysis of the policy discourse. These forces can be studied in form of a discourse analysis, as discussed in the next section.

3. Methods

3.1 Research Design

As this study did not aim to make broad generalisations or test specific theories or hypotheses, an abductive approach was followed. Described by Peirce as "*the process of forming an explanatory hypothesis*" (1974, p. 106), abduction aims to offer suggestions to explain phenomena. Where deduction can be used to prove something with certainty and induction can highlight inner workings of processes (Peirce, 1974), abduction reasons from the available evidence to provide the most likely explanation (Aliseda, 2006). Following the structure of abductive research as described by Kovács and Spens (2005), this study started by looking at the policy situation in the UK and NL. Next, the PSS, beliefs, framing, and policy change were combined into a framework. Linking the (sub)categories of convergence from the PSS (*complexity*, *contestation*, *uncertainty*) (Wanzenböck et al., 2020) and framing strategies by Snow and Benford (*diagnostic*, *prognostic*, and *motivational* framing) (1988), allowed for the categorisation of beliefs expressions into them. In addition, this made analysing pushes for policy change easier to analyse in a structured way as elements of texts were labelled by the framing they used and whether they added to complexity, contestation, and uncertainty. Because of this, types of organisations were better linked to how they influenced framing and degree of convergence. Based on this, the documents and interviews were analysed to improve upon the theory by testing the applicability of the proposed categories of complexity, contestation and uncertainty to study convergence.

This study aimed to answer a 'how' question, no control over behavioural events existed, and the focus of the study was on relatively recent events. As argued by Yin (2018), for such situations, case studies are more appropriate than other types of social science research. A case study "*investigates a contemporary phenomenon (the "case") in its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident*" (Yin, 2018, p. 32). For ZEVs this is the case because the discourse around ZEVs is deeply embedded in wider contexts like climate change, politics, and economic opportunities and threats (Pinkse et al., 2014). Furthermore, this study concerned two countries: the UK and the Netherlands. Both countries were analysed and compared to each other in-depth. While research designs that study more than one subject do not always lead to the same types of outcomes as when a single subject is analysed, the evidence is usually more compelling and robust (Yin, 2018).

The UK and the Netherlands were selected for this multiple-case study for several reasons. Within Europe, large differences in ZEV adoption exist. The Netherlands and Norway are frontrunners in EV adoption, with respectively 13,9 and 42,4% of passenger cars sold in 2019 being BEVs or FCEVs driven (Diaz et al., 2020). Germany and the UK are growth markets but BEV and FCV only accounted for 1,8% and 1,6% of sales (Diaz et al., 2020; McKinsey & Company, 2014). Moreover, the UK and the Netherlands are relatively similar countries in terms of socio-cultural and economic institutions. Even though the Netherlands is often considered a Coordinated Market Economy (CME), similar to Germany, it also shows similarities with Anglo-Saxon economies such as the United Kingdom (Bruff, 2011; Hall & Soskice, 2003; Knell & Srholec, 2005; Menz, 2005; Sluyterman, 2014). Thus, in terms of institutional context the Netherlands is often considered to be positioned between the UK and Germany (see for example: Koopmans, 2004; Schils, 2008). Due to their similarities, and the accessibility of data for the researcher, the UK and the Netherlands were selected for the comparative case study on differences in the ZEV policy discourse and adoption patterns.

3.2 Data Collection

This research uses both documents related to policy discussion on the topic of ZEVs and semi-structured interviews. The former were used to analyse and map crucial events and the trajectory the policy has taken in the UK and the Netherlands while the latter were used to both validate the findings of the former and obtain additional insights.

Documents

To study the ZEV policy discourse, documents were analysed. Documents provide an unobtrusive archive of events through which a reconstruction can be made of the events that occurred (Yin, 2018). To limit the scope of the study, three types of documents were used: officially published documents derived from governments, officially published documents derived from private sources, and mass-media outputs from newspapers. These three sources were chosen to ensure a balance between representation of different actors in public discourse as well as high quality of data derived from the documents.

The documents were gathered via online databases such as the sites of the Dutch and British governments for official state documents, and the newspaper database NexisUni for mass-media publications. The newspapers searched were limited to ones generally classified as 'quality newspapers' to ensure the data was of reasonable and comparable quality. In the Netherlands, the newspapers searched were Trouw, De Volkskrant, NRC Handelsblad, Het Parool, and Het Financieele Dagblad. For the UK, the newspapers were The Times, The Guardian, The Observer, the Financial Times, and The Telegraph. For private documents no single database was available. Therefore, these documents were gathered through online search engines like Google, or on websites of organisations

such as large consulting firms that were likely to have relevant reports. It was aimed to collect documents that were both reasonably representative, to ensure generalisability, and of high quality, ensuring that enough information could be obtained from them. The queries used to search for these documents shared terms like 'Zero Emission Vehicle', 'Electric Car', 'Hydrogen Car', 'Road Vehicle Policy', and 'Road Emissions'. For official private documents also terms like 'sector report', 'trade association, or 'research' were added to further specify the type of documents. An overview of the specification per document category can be found in Table 1.

Table 1: Data collection of documents

	Official State Documents		Official Private Documents		Mass-media outputs	
Country	NL	UK	NL	UK	NL	UK
Sources	Rijksoverheid.nl	Gov.uk	Search engines, company websites		NexisUni	
Types of documents (amongst others)	Reports, legislation, statistics		Sector report, business research, trade association publications, market research		News, opinion pieces	
Specification	Department of Transport, Finance, Enterprise Offices		Consulting firms, Academia, transport organisations		Quality Newspapers	

For both the UK and the Netherlands, official government documents included research reports by government agencies, and notes and agenda pieces from parliamentary meetings. Reports from private actors included sector reports from industry and trade associations, research publications or policy assessments from private actors. The queries used to collect the documents can be found in Table 2.

Table 2: Queries used to search for documents

Queries used to search for documents	
English	**Dutch**
'Electric Vehicle'	'Elektrische Auto'
'Hydrogen Vehicle'	'Waterstofauto'
'Zero Emission Vehicle'	'Emissievrije auto'
'Charging infrastructure'	'Laadinfrastructuur

In total, 77 documents were collected and analysed. 41 documents were published in the Netherlands, 36 in the UK. A list of the documents and the distribution of these articles over time can be found in appendix A. The documents ranged from about one page for some of the news documents to multiple tens of pages for the policy or private documents.

The documents were numbered based on the type of organisation, the time, and their sequence within that timeframe. For example, a document published by the Dutch government, published in period 3, and the first in that period would be named: "NL (the country) G (government) 3 (time period) – 1 (the first document)": NLG3-1.

Interviews

This study used semi-structured interviews by actors active in ZEV policy discourse in two ways. First, their own activities and role were elaborated upon to add to the information in the documents. Second, and most importantly, they were asked about their perception of the discourse over the studied period to obtain their perspective on changes in discourse and compare these to those of the researcher. During the semi-structured interviews, the researcher stuck to general themes, but no strict structure or question set was used across interviews (Yin, 2018). This allowed for greater emphasis on the interviewee's own perspectives (Yin, 2018).

As only actors that participated in ZEV policy discourse were relevant to this study, the interviews were limited to them. If an actor was found to be active in ZEV policy discourse from the document analysis (due to publishing a document or participating in one), their information was collected. Another option through which respondents were approached was if they had a relevant position in an organisation that was present in the document analysis but were not explicitly mentioned in the documents themselves. Additionally, respondents were asked after the interview if they knew any other people that might be relevant to this study and would be open to doing an interview. This resulted in several additional respondents that were not directly present in the documents but were working for relevant organisations and had either relevant functions or an overview of the discourse due to their career history. It was aimed to select a varied sample of respondents from different (types of) organisations to analyse as many perspectives in the discourse as possible and ensure internal validity. Actors were approached via email.

3.3 Operationalisation

An operationalisation was made to improve external reliability (Yin, 2018). An overview of the studied concepts can be found in table 3. Central to this study were the concepts of policy discourse and change in policy discourse. Policy discourse was linked to framing and its previously mentioned framing processes. Change was derived from convergence and divergence and policy change. Convergence and divergence were analysed based on comparing the belief landscape (see 2.2) over time. To further guide this, the indicators for complexity, contestation, and uncertainty proposed by Wanzenböck et al. (2020) were used as markers to look out for in the text (Table 4). Policy change is determined by the elaboration on topics that fit in the first, second, and third order notions of policy change defined by Hall (1993)

Table 3: Operationalisation table

Category	Characteristic	Concept	Example
Policy Discourse	Framing	Diagnostic framing	A general problem is identified: "*Road transport contributes to climate change*"
			A problem that is specific to a (competing) solution is identified: "*Hydrogen is not widely commercially available*"
		Prognostic framing	A solution to the general problem is identified, in favour of EVs: "*EVs have no exhaust pollution*"
			A solution for the problems of another (competing) solution is identified: "*Hydrogen solves EVs range issues*"

		Motivational framing	A call to policymakers to support hydrogen vehicles through subsidies: "*The introduction of subsidies will aid adoption of hydrogen vehicles*"
			A call to other actors to introduce standards for charging infrastructure, aiding adoption of EVs: "*collaborating on EV charging infrastructure will reduce range anxiety for consumers*"
Change	Policy Change	First order policy change	Boundaries and details of policy are changed (in policy documents); or called to be changed (in other documents)
		Second order policy change	New policies (e.g., subsidy schemes, regulations) are introduced, or existing policies are structurally changed (in policy documents); or changed is called for (in other documents)
		Third order policy change	The goals the policy aims to achieve are changed (policy documents), or called to be changed (other documents)
	Convergence and divergence	Similarity in beliefs and framing in the beliefs landscape compared to the previous time frame	Less complexity, contestation, and/or uncertainty exist around hydrogen vehicles in period 2 compared to period 1 (convergence)
			More complexity, contestation, and/or uncertainty exist around EVs in period 2 compared to period 1 (divergence)

The categories and the indicators derived from Wanzenböck et al. (2020) are summarized in Table 4. The analysed texts were compared against these indicators to identify which categories that make up convergence were present in the discourse. The same descriptions were used for each text to ensure the analysis was most reliable. For example, if a claim about the opportunities a solution offered to businesses was made, this was noted as contestation taking place on the solution side. If a statement like "*Government should take action on solving climate change*" was found, it matched most closely with the discussion of who should hold responsibility for the problem. This statement would then be linked to complexity being discussed on the problem side. With this, a structured identification of complexity, contestation, and uncertainty on both problems and solutions was possible to better study convergence.

Table 4: The categories and indicators of wickedness as proposed by Wanzenböck et al. (2020)

	Category	Indicator
Problem	Complexity	Responsibility
	Contestation	Differing claims
	Uncertainty	Lack of knowledge or limited evidence regarding causes, consequences, and (side-)effects
Solution	Complexity	Alignment or combination of socio-technical systems,
	Contestation	Feasibility, opportunities and threats for businesses, society, and users
	Uncertainty	Lack of fragmentation of knowledge on feasibility, existence of multiple solutions without a definitive best one within a reasonable timescale, lack of clarity of (side-)effects

3.4 Data Analysis

To obtain insights into the discourse itself and the dynamics within it, the data analysis was split into four steps, as described below. In the *first* step the discourse analysis will be conducted to analyse the policy discourse around ZEV on an actor level by coding their beliefs and framing processes. The *second* step is to map the discourse into the PSS framework by analysing the results of the first step. The second step also allows the identification groups of actors based on their alignment, or the study of alignment within predefined groups like academics or policymakers. In the *third* step semi-structured interviews will be conducted and analysed to complement the document analysis, to gain actor's perceptions of discourse development, and to put the results into context. In the *fourth* step, the cases of the UK and the Netherlands will be compared by studying the results from the single case analyses in the first three steps. A visual representation of these steps can be found in Figure 4.

Figure 4: Visual representation of the steps taken in the data-analysis process

Step 1: Period definition and Discourse Analysis

To study the evolvement of framing processes over time, timeframes within the analysed period were identified. Each timeframe was compared to the previous one with the first one serving as a baseline as comparing ZEV discourse to the previous discourse on traditional vehicles was not insightful here. In line with Heiberg et al. (2020) time periods were based on 'periods of crisis or contestation', or influential events, to allow for more relevant differences between periods. These events could be introductions of new technologies, landmark legislations, or other impactful events. The time periods might be different between the UK and the Netherlands. While this hindered clear chronological analysis, it allows the highlighting of periods where discourse in one of the countries might have taken longer to adapt than in the other. The landscape of what and how topics were covered was then compared between timeframes, allowing for the identification of shifts in topics covered and whether and how their degree of convergence changes (in terms of *complexity*, *contestation*, *uncertainty*, and framing).

NexisUni was used to identify periods of crisis or contestation. Appendix A shows results for 'elektrische auto' by month over the observation period. The NexisUni graph was used to identify periods with relatively more articles published on the topic. Based on this strategy, the time periods used for each country were defined. Table 5 provides an overview of the five time periods considered for each country.

Table 5: Overview of the identified time periods

Country	Event	Explanation	Period
United Kingdom	March-April 2009	Start of structural support for ZEVs by government	1: March 2009 – March 2010
	March 2010	Green fund and budget are introduced	2: March 2010 – January 2011
	January 2011	Plug-in vehicle grant is put into effect	3: January 2011 – January 2016
	January 2016	Department for Transport allocates additional money for EV infrastructure development	4: January 2016 – July 2017
	July 2017	Announcement that fossil-fuelled ICEs sales will be banned from 2040 onwards	5: July 2017 ~ December 2018
The Netherlands	April-May 2009	Money is allocated to improve charging infrastructure, low taxes for low-carbon cars introduced	1: April 2009 – November 2011
	Mid-late November 2011	Discussion about Autobrief 1	2: November 2011 – January 2014
	January 2014	Higher taxes for EVs are introduced	3: January 2014 – September 2015
	June - September 2015	Autobrief 2 introduced (June), Dieselgate (September)	4: June 2015 – October 2017
	October 2017	Announcement that sales of fossil-fuelled cars will end from 2030 onwards.	5: October 2017 ~ December 2018

As can be seen in Figure 5, the distribution of documents in the UK is skewed towards P3. This has two causes. Firstly, the period was the longest identified, allowing for a long window for documents to be published in. Secondly, useful documents in the other, but especially the two early periods were hard to find for the UK. It was decided to continue with the current distribution of documents as it was felt that this represented the way discourse developed in the UK.
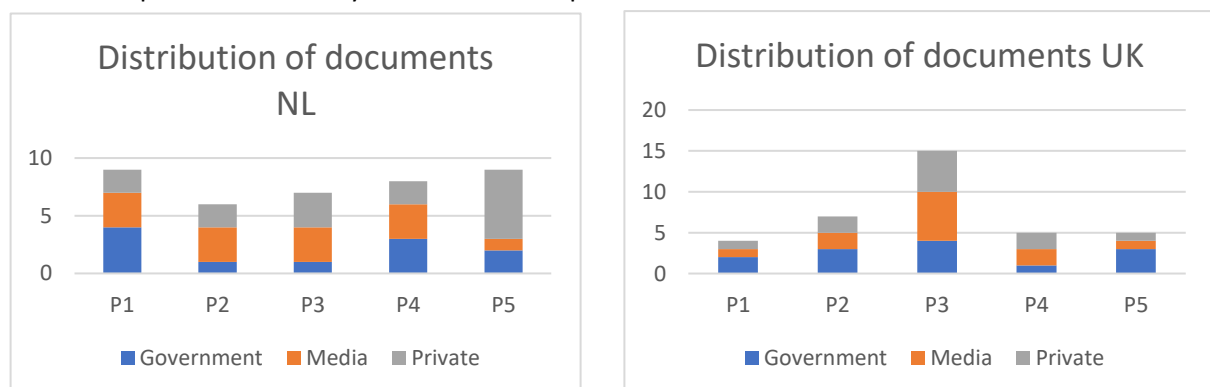

Figure 5: Distributions of the studied documents over the identified time periods

To study policy texts in the context of societal dynamics, Critical Discourse Analysis (CDA) was used. With CDA different texts can be analysed to understand how they represent the world and how these texts are shaped by underlying motives (Taylor, 2004). As CDA is suitable for analysing competing discourses in policy discussions, on both shaping and implementing policy (Taylor, 2004), it was useful in mapping ZEV discourses in the context of the PSS. By tracking changes in discourse on ZEV on the axes of the PSS it allowed for the identification of convergence of policy trajectories.

In this study CDA in the form of a qualitative content analysis was used to analyse documents (Mayring, 2014). After the data collection the documents were organised by country, type, and date to structure the analysis. The documents were coded based on *complexity*, *contestation*, and *uncertainty* around problems or solutions, and framing strategies (*diagnostic, prognostic, motivational framing*), as outlined in section 3.3. Next, the text elements coded were divided into whether they discussed problems or solutions and then analysed in-depth, with respect to the topics and the order of policy change they address. *Fragmentation of control* and *socio-technical system implementation* were found as new indicators for *solution complexity* from the data. Especially *fragmentation of control* was also indirectly mentioned in the interviews, where respondents were not able to answer questions about *problem responsibility*, instead focusing on which parties were able to take the initiative in addressing a challenge. These two indicators were created and helped to map solution complexity.

In total, 1242 pieces of text were coded over 74 documents. Three documents turned out not to provide useful information due to limited text or other constraints that were not found in the initial scan. The solution categories accounted for most codes: 1074 versus 168 for the problem categories. This is not surprising as ZEV can be considered as one clear solution to a range of problems, like climate change and local air pollution. Furthermore, 547 codes were put under diagnostic framing, 573 under prognostic framing, and 122 under motivational framing. This distribution can be explained by the fact that actors were often clear in stating the problems they were concerned with and what type of solutions or benefits they proposed. Calls to action were made less often and were often not recognisable as such due to vague terminology.

Step 2: Mapping the discourse

In step two, the actors involved in the discourses and the way they framed their positions was analysed. In line with Heiberg et al. (2020) organisations were assumed to be aligned with each other when they co-mentioned topics (problems or solutions, and technologies or certain regulations), and used the same framing strategy (*diagnostic, prognostic*, or *motivational*). In addition, it was studied if actors were active in a specific category. For example, an actor could mostly focus their efforts in discourse on emphasising solution complexity or problem uncertainty. This allowed for the identification of groups with similar views without necessarily being connected. These groups were then compared to the views of pre-defined groups of actors such as policymakers or businesses to study their alignment with peers or competitors. Based on the previous coding of framing, topics, and categories of convergence in both problems and solutions, the actors were grouped on these variables.

Step 3: Interviews

The interviews encompassed both the interviewee's own activities and their perspective on how discourse has changed. The questions posed to the respondents emerged from several sources. First, the respondents were asked about their view on the identified topics (e.g., technologies and policies) and narratives present in the documents and earlier interviews. Interviewees were also asked to identify events or moments that greatly influenced discourse to reflect on the time periods decided upon in the analysis. An overview of the interview guide can be found in appendix B. General information on the interviews can be found in Table 6. The interviews lasted between 30 and 75

minutes. Most actors have been active around ZEVs or broader sectors like the automotive, energy or mobility industries for at least 6 years at the time of the interview.

Table 6: General information about the conducted interviews

Respondent	Country	Type of organisation	Further details
1	NL	Government	Policy analyser
2	NL	Private	Trade association
3	UK	Private	Consultancy
4	NL	Media	Newspaper
5	UK	Media	Newspaper/magazine
6	NL	Government	Ministry
7	NL	Private	Consultancy
8	UK	Government	Embassy
9	NL	Private	Mobility provider
10	UK	Private	Consultancy
11	UK	Private	Trade association
12	UK	Private	Grid operator
13	NL	Government	Enterprise agency

The interviews were used to validate the findings from the documents and to acquire more knowledge on topics and events that were unclear in the documents. Therefore, structurally comparing the interviews to each other and the documents was not useful. Instead, the interviews were recorded and relistened. Topics that the respondents emphasised or topics that the researcher found to be coherent with the findings from the document analysis were noted. Topics that differed were reflected upon. This was done to improve the conclusions drawn from both documents and interviews, making them more robust. In addition, mentions of how different actors approached topics were categorised into their used framing strategies and whether they were based on complexity, contestation, or uncertainty. This allowed for addition to the document analysis and reflection on the consistency and accuracy of the coding. Finally, the findings were compared to the findings of the documents and changes were made to the initial conclusions to better account for the additions and perspectives presented in the interviews. By comparing the perspectives of the respondents to the findings from the documents, validity was further improved.

Step 4: Comparison and reporting

Finally, the steps were compared between the UK and the Netherlands to answer the main research question. First, to include sub question one, the overall discourses in the countries were compared based on how similar events (e.g., the first introduction of subsidies) affect discourse and what different events happened. This was done to analyse differences in timing and how similar processes took place in the two discourses. Afterwards, to include sub question two, the actors in the discourse were compared both on whether the actors themselves differed in terms of the type of organisation they belong to and how they positioned themselves in terms of framing. This was done to see if certain groups behaved differently between the countries. The topics that were found to have the most relevant information to compare the two countries were chosen, divided into problems and solution to allow for comparison on both axes of the PSS. For each topic the types of framing used by actors and the degrees of complexity, contestation, and uncertainty were elaborated upon. This was done to study how the topics were represented differently in the discourses of the countries.

4. Results

This chapter presents the results of this study. First, an overview of the collected data will be presented, from which the case descriptions of the UK and the Netherlands will be elaborated upon. This is done to provide context for the results of the analysis presented afterwards.

4.1 Case context of the UK and the Netherlands

Overview of the covered topics

For problems, a difference between local and global air quality issues was distinguished. While both are understood to emerge from vehicle emissions, local air quality issues can lead to health problems while global air quality issues are related to global warming through the emission of greenhouse gases. Problems with local air quality can and can be caused by both exhaust gases and emissions caused by braking and tyre wear. Greenhouse gas emissions are entirely emitted through exhaust gases. Additionally, noise pollution and energy dependence are identified. Noise pollution can, like local air pollution, lead to health risks. Energy dependence can make a transport system vulnerable to outside influences, such as instability in oil-producing nations.

The identified solutions were categorized into vehicle technologies and systemic measures. The most covered technologies were BEVs, where electricity is directly charged into the battery from outside the vehicle, and Hydrogen Fuel Cell Electric Vehicles (HFCEVs), where hydrogen is used to generate electricity (through a fuel cell) which then powers batteries and propulsion. Fuel Cell Electric Vehicles (FCEVs) are a more general term that encompasses all vehicles using a fuel cell to generate electricity out of a fuel through a fuel cell, where fuels can include hydrogen (HFCEV) but also fossil fuels. In general, FCEVs are not considered ZEVs (unless powered by hydrogen) but are considered in the discourse as they were influential in shaping discourse before BEVs became more viable. Systemic measures included both infrastructure and policies to increase adoption of ZEVs and expand infrastructure. Infrastructure included both EV charging infrastructure, hydrogen fuelling, and digital technologies that improved or enabled new use cases like Mobility as a Service. Policies included upfront purchasing subsidies for ZEVs, where consumers were eligible for reduced purchasing prices of vehicles. Other financial measures for vehicle purchasing included tax reductions on road taxes and tax-deductible driving ('*bijtelling*'). Furthermore, road pricing schemes where taxes would not be based on vehicle ownership but on distance covered were also covered as a potential future revenue stream for government. Finally, subsidies for (public) charging infrastructure were a prominently discussed policy on the infrastructure side.

Case contexts

For ZEV policy in the UK, ambitious goals were set between 2008 and 2011 by UK policymakers like wanting 'all new cars' to be electrically or hybrid driven by 2020 (GreenCarGuide, 2008) and wanting to introduce 100,000 EVs in London in a few years (Jha, 2009). However, little progress was made on these goals, with only 3,000 EVs in London by 2014 (BBC, 2014) and a ban on ICEs for 2040 not being introduced until 2017 (Asthana & Taylor, 2017). In 2021 the UK is to host the COP26 climate conference. This is also seen as a driver for stronger policy to diffuse ZEVs (R5, R10).

Regarding specific policy instruments, from 2011 onwards a grant was introduced that reduced the purchasing costs of eligible cars by 25% up to £5,000 (Green Car Congress, 2010). While initial funding was limited, the grant has been extended several times, but reduced to a maximum of £3,000 in 2020 (Department for Transport, 2020). Furthermore, incentives have been provided to Nissan's factory in the UK to increase EV production (Smith, 2009). Additionally, government pushed for the development of charging infrastructure, but usage of these charging points lagged (BBC, 2014).

The Dutch ZEV policy was more moderate with an initial goal of introducing 15 to 20 thousand EVs before 2015 (Rijksdienst voor Ondernemend Nederland, 2014, 2020). On a national level both tax exemptions and grants were implemented as major instruments. Initially, EVs did not require road taxes and registration fees. From 2014 onwards a small fee was introduced (Ministerie van Financiën, 2014). The initial savings on the purchase of an EV amounted to approximately €5,000 (Groen7, 2011). In addition, national government offered a subsidy of €3000 which was extended to €5000 in several urban areas like Amsterdam in 2013 (Rijkswaterstaat, 2014). However, this only applied to taxis and delivery vans. Furthermore, deployment of charging infrastructure was relatively fast in the Netherlands too, rising to 6280 chargers per million inhabitants in the Netherlands, second only to Norway in Europe, and higher than the UK's 933 (IEA, 2016). Publications of the 'Motie Groot', or Autobrief 2, lead to further discussions around further improving EV uptake around 2015 (R1).

In both countries Volkswagen's Dieselgate affair around 2015 was stated to be a major point of change in discourse (R9, R10). In addition, the introduction of Tesla vehicles from 2012 onwards was also seen as a driver of discourse change (R5, R7).

4.2 Analysis of the ZEV discourses in the UK and the Netherlands

4.2.1 Problem-related discourse

United Kingdom

In the UK, ZEVs were first seen as means to address the problem of **local air pollution**, such as related to congestion in big cities, and less so for climate change. This focus on local air pollution remained, but eventually climate change was also seen as a problem that could be addressed by further diffusing ZEVs. **Noise pollution** by cars is seen as a problem too, but the lack of noise produced by ZEVs and the risks this poses is also a topic covered. **Energy dependency** was another problem that was diagnosed early on by multiple organisations.

The early focus on local air pollution can be found in government reports. *Diagnostic framing* was used to address the problems around that topic: "*We also want our roads to become safer, less congested and less polluted. So, we will support the introduction of the latest technologies, encouraging the use of electric and other ultra-low emission vehicles, to make transport cleaner and greener*" (UKG2-3). This implies that the topics that are contested for being the main problem occur at a local level, with issues like global warming not being in the scope of mobility policy. Additionally, it was described how local governments viewed local pollution: "*London implemented the congestion charging 15 years ago or so, a number of other cities across the UK now are implementing access restrictions for not only combustion engines but private cars in general. So I think there has been a reassessment that certainly combustion engines have with city centres*" (R12). This further strengthens the notion that the problem initially contested and diagnostically framed was that of local air quality.

Moreover, the lack of noise produced by ZEVs, was mostly framed diagnostically by businesses: "t*he lower levels of powertrain noise from EVs might have implications for the safety of other road users.*" (UKP2-1), as mentioned by a research organisation, continuing about the use of auditory cues by cyclists and pedestrians to spot traffic. This indicates that ZEVs were not seen as a solution to this problem.

Both government and private organisations *diagnostically frame* energy dependence: "*… governments are looking to simultaneously reduce their reliance on foreign energy imports*" (UKG3-4). This statement highlights the contested problems but also problem complexity, with many actors sharing the responsibility of addressing the problems. This view on energy dependency is shared by a research organisation, indicating that the view on energy dependence is shared between different actors (UKP2-1).

Many societal benefits for ZEVs were *prognostically framed* by the UK government. As was elaborated upon by respondents in the UK on the role of local emissions: "*Initially the work* (on ZEVs) *came from air quality and zero tailpipe emission arguments. But the benefits for climate change became clear as well. (…) but the main immediate benefit was that of zero emissions* (locally)*. This was also seen in the clean air zones, where the goal was mainly to reduce local emissions*" (R11). In addition, the benefits ZEVs could bring to reduce noise pollution were *framed prognostically* both by businesses and governments in later periods (UKP3-4, UKG5-1). This indicates that the contestation of the problem revolved around local air pollution more so than on global warming in early periods.

Prognostic framing around energy dependency for ZEVs is mostly done by government, hinting to problem complexity due to the involved market actors too: "*the Government is committed to growing the market for plug-in vehicles in the UK. This is due to the contribution that they (…) can make across our economic and environmental priorities – (…), energy security*" (UKG2-3). And: "*With almost all major car manufacturers (…) now close to developing commercially viable hybrid and electric vehicles, they have the potential (…) to reduce our oil dependency*" (UKG1-1). This indicates that energy dependence was one of the first topics that was accepted as a problem that ZEVs could address.

Moreover, in both early and later phases *motivational framing* was used by government and businesses to call each other to action. This also indicates the complexity of addressing the problem. An example of this is: "*The public sector will have to put forward funding to enable the new generation of vehicles to reach commercialisation*" (UKM1-1). Such motivational framing that pointed towards other actors' actions was very prevalent in the UK, indicating that little willingness to collaborate existed.

The Netherlands

In contrast to the UK, in the Netherlands **local air pollution** was seen as an issue early on, but always together **with global warming**. The effect of ZEVs on reducing emissions was challenged initially but gained more acceptance. In addition, the ability of ZEVs to reduce **noise pollution** is more emphasized compared to the risks related to reducing noise pollution. This is different from UK discourse as noise pollution was not seen as a problem that could be addressed by ZEVs in the UK. **Energy dependency** was covered early on but reduced in prominence.

Multiple types of actors *diagnostically framed* several environmental concerns. For example, already in an early phase it was mentioned that: "*In addition, this concerns the environmental issues around climate, air quality, and sound*" (NLG1-2). Also, private actors contested for multiple environmental issues related to both local and global emissions such as: "*more intensive land use is leading to relatively larger emissions problems (sound, CO2, PM)*", and also: "*CO2 reductions continue to be a challenge*" (NLP2-1). This indicates that ZEVs were seen to be able to address a multitude of problems.

The impact of ZEVs on reducing local pollution was uncertain initially as BEVs are heavier than internal combustion engine vehicles (ICEVs), leading to increased tyre wear (a source of local pollution). Especially businesses and media draw on *diagnostic framing* practices to address this negative side-effect: "*about 90% of PM in traffic is no longer from tailpipes, but from things like tyres*" (NLM4-3).

Concerns about road wear decreased over time, as illustrated in a Dutch government report *prognostically framing* the benefits of EVs: "*EVs are usually heavier (….) which can lead to increased road and tyre wear. (…) However, road wear is mostly caused by freight transport. In addition, other local pollutants do not play a role for EVs*" (NLG5-2). Additionally, this report also mentions the reduced braking emissions by EVs: "*PM emissions from braking are significantly lower for EVs than traditional cars due to the regenerative braking via the battery and electromotor instead of braking regularly."* Thus, it appears that the impact of ZEVs on local pollution have been thoroughly studied, and

uncertainties and contestation around local pollutants decreased over time in both the UK and the Netherlands.

Noise pollution was not seen as an issue in the Netherlands. This is illustrated by government's prognostic framing: *"There appears to be no increased risk of collisions with pedestrians due to the lack of an engine sound"* (NLG3-1), where the claim that reduced noise causes issues is refuted relatively early on already and uncertainty is reduced.

Especially government *prognostically framed* EVs specifically as a way to reduce dependency: *"Electric driving helps reduce our dependency to finite stocks of fossil fuels and oil producing countries"* (NLG1-2). This indicates another early push for EVs by government.

Conclusion

In the UK, problem discourse converged around local pollution and energy dependence. Contestation also happened around global warming in later periods. Complexity was mostly based on the market actors based in the country and was *framed diagnostically* by government.

In the Netherlands contestation happened on the UK's topics, but also on global warming. In addition, more certainty existed that noise pollution was a problem that could be addressed by ZEVs. Complexity was less prominent too. Convergence therefore happened on more issues with less uncertainty existing on the causes and effects of local pollution.

4.2.2 Solution-related discourses

In this section, the solution-related discourses in the UK and the Netherlands will be analysed. The section is split up in two parts: vehicle technologies and systemic measures to distinguish between the technologies making up ZEVs, and the measures that enable their adoption.

Vehicle technologies

United Kingdom

In the UK, HFCEVs were seen as a feasible option especially in early periods. Later, the potential of the technology is mentioned, but few mentions of progress are made. BEVs increasingly became more accepted as the best solution.

At the beginning, uncertainty and contestation were prevalent for issues related to the environmental impact of the production of batteries, especially in countries with low renewable electricity shares (UKM3-1); the dependency on rare materials (UKG3-4); the weight of BEV, which increases tyre degradation (UKG3-4); and the emissions produced to power BEVs (UKG1-2). Concerns that the electricity grid could not handle a sudden rise in charging demand were voiced too (UKP2-2). Different actors, like government and trade associations, shared these concerns.

The automotive sector has been important for the UK's economy and industrial base, given the number of production sites and jobs it provides (R8). This lead to additional *diagnostic frames*. Government and industry wanted to guide the sector so the strength and competitive advantage of the sector would be preserved (R11). In early periods, this meant focussing on making existing technologies (ICE and PHEVs) cleaner. Transitioning to technologies that required larger shifts in expertise, like BEVs, would disadvantage the industry (R3).

UK media and businesses *prognostically framed* hydrogen vehicles at several points (UKP2-1, UKP4-1, UKM3-4). In later periods the technology is mentioned as a feasible future alternative to EVs, but little change in language used was found compared to earlier periods. This implies that while effort is still put into developing the technology, it is not ready for large scale introduction. Respondents

acknowledged the relative lack of progress (R3, R8). Thus, solution uncertainty seems to reduce, with BEVs becoming a more accepted solution.

While manufacturers moved more towards BEVs over time, it is still claimed that government should have put more effort in the transition. For example, by increasing awareness among consumers and investing into new production lines (R3, R11). Providing more clarity about future pathways was mentioned too (R11). This highlighted the complexity of implementing a solution and did not aid convergence.

The Netherlands

Discourse in the Netherlands was focused on (B)EVs from early on. Hydrogen was mentioned in early periods as an alternative but was already seen as less viable.

Diagnostic frames for EVs in the Netherlands were mostly concerned with batteries (NLG1-2). Batteries require rare materials, demand was expected to increase, increasing dependency, the impact is unclear. An example of the *diagnostic framing* of uncertainties is found in a government report: "*regarding the impact (…) on the use of rare materials, there is a lot of spread in studies. This varies between about equal to a factor three higher for EVs*" (NLG3-1). Furthermore, media appear to be sceptical of BEVs throughout the periods, arguing that ICEVs and PHEVs will remain more cost effective for a while (NLM1-3, NLM2-2, NLM3-1). This indicates that for EVs the feasibility remains unclear and solution contestation remains high.

Hydrogen is still mentioned from time to time, but also in early periods it is not seen as equally viable as EVs (NLG2-1). In addition, several threats to society are identified, like safety hazards and the emissions emerging from generating hydrogen (NLM1-1, NLM1-2, NLG2-1). In addition, in P4 and P5 businesses state that EVs will likely remain dominant for at least the coming years, but that hydrogen might still develop further (NLP4-2, NLP5-5). These findings are backed up by statements in the interviews, which state that hydrogen was never seen as a viable alternative in the Netherlands (R2). R4 commented on the early perception of hydrogen: "*I do not think there was a lobby* (to not focus on hydrogen). *Rather, people were quick to calculate that it was not feasible yet.*" This indicates that early discussion took place but was quickly discarded. These findings make clearer that in the Netherlands hydrogen was seen as less of an option than in the UK.

EVs were already advocated early on by especially government: "*The opinion of the cabinet is that the (currently small scale) market preparation for electric driving offers our country good chances to become a global frontrunner*" (NLG1-2). An interviewee stated that while Dutch policy was technically designed to be 'technology-neutral', in practice only EVs were eligible for the policies at the time: "*Government chose an 'electro-oil' strategy, (…) which made for complicated and ineffective policy that only subsidizes EVs. Other techniques did not obtain such a stimulus.*" (R9) Hence, focus was on EVs early on even though it was not converged on.

This early focus on BEV occurred for several reasons: firstly, as the Dutch automotive industry did not heavily depend on fossil fuel propulsion systems, and government and industry were in favour of growing business around new technologies such as digital technologies, there was relatively little to lose by abandoning a focus on ICEVs. An early government document stated that: "*While the Netherlands has no large automotive industry, it does have a large supply industry and potential.*" (NLG1-2). This is also illustrated in the interviews: "*the Netherlands is an important but weird player on the zero-emission dossier. It is easy for us to shout that we want everything zero-emission as we have no car industry. (…) The Netherlands can take a different role in the industry (…) mostly in the new industries a transition brings: producing charging infrastructure, smart software, producing alternative fuels. (…) in that transition there is a more prominent position to gain.*" (R9). This indicates that both

government and industry *prognostically framed* the opportunities BEVs could bring, accelerating convergence.

Lease and sales businesses were also willing to push for increased adoption of EVs. Commercial or sales incentives were mostly described in the interviews, but not expressed strongly in written documents. One interviewee noted: "*those car dealers wanted to get rid of the car sales tax, because they wanted to sell more cars. They prefer to tax use instead of ownership. So, if they sold more newer cars, old polluting ones would be replaced by cleaner ones, decarbonising the fleet.*" (R1). R2 also mentions the topic: "*Ultimately lease businesses made the difference. They enabled it because customers wanted to present themselves as sustainable.*" Later, when further asked about these reasons, R2 answered: "*let's be real: it was commercially driven.*" A measure the automotive sector took to drive EV sales was the 'Formula-E Team' where different industry actors aimed to promote electric driving by making it more visible towards business owners. R2 describes this as successful: "*…that really worked. We bought a Tesla Roadster and lent it to CEOs to try it out. That made them really consider EVs as an option in their fleets.*" As for later periods, R2 continues: "*it seems like drivers like Formula-E are no longer necessary. EV is visible everywhere. It is becoming normal*." As different actors in the Netherlands had similar (positive) views on BEVs from early on, this likely aided convergence by reducing uncertainty around different feasible solutions existing.

Systemic Measures
United Kingdom

In the UK, the development of infrastructure was largely left to private organisations. In later periods, more government involvement emerged and the role for government in organising systemic measures became clearer.

While the UK has seen increasing charging infrastructure development alongside a developing industry, early roll-out appeared to be slow (R3). Little *diagnostic framing* was identified in early periods. The concern that the electricity grid would be too heavily impacted by a sudden increase in BEV charging became a prominent topic (UK2-2). In addition, businesses and media state that government had failed in operating charging networks (UKM3-2, UKM3-3, UKP2-1). Additionally, little mention is made about integrating charging networks with ITS and other digital technologies early on, only appearing later. From P2 to P3 there is a shift in government approach, changing from a national plan to more local initiatives (UKG2-1, UKG3-1). This indicates that convergence starts to emerge in later periods.

However, public networks were outcompeted by private ones, and local councils had trouble with locating optimal charging locations (R5, R10). This implies that while the sector is starting to mature, with private organisations seeing a business case for charging, especially rural areas are still underdeveloped and might benefit from more government support (R8). However, lack of public charging is not seen as a barrier to BEV adoption in the UK, instead focussing on work and destination charging (R10). This also indicates that convergence only accelerated in later periods.

Government also *prognostically frames* the role the country can play in developing and manufacturing ZEVs (UKG1-1, UKG2-2, UKG2-3). R11, however, mentions a separation between what government says it wants to accomplish and what instruments accomplish: "*you want to attract battery gigafactories to the UK (…), but then cut the plug-in car grants in the UK, which was one of the main market mechanisms in the UK*". In addition, the issues with the plug-in vehicle grant were commented on by R5: "(claim that not a problem was seen with the grant, but with availability of models)." This indicates misalignment between government strategy and claims, leading to divergence and uncertainty.

Motivational framing where actors mostly call other actors to action, is more present in the UK. Government wants businesses to act, and businesses want government to act. Especially in the documents these seem to be one directional discussions with little desire for collaboration. In later stages there appears to be more willingness by especially government to enter collaborations more explicitly. In the interviews this was not mentioned explicitly, but discussions still revolved around businesses *motivationally framing* towards government. A struggle for the division of roles and who should take initiative remains too. National government moves between overarching plans, wanting local government to act, and business to show leadership, not showing a clear direction. Businesses stay constant in expecting investments on both supply and demand sides, not really aiming for collaboration. This lack of collaboration might be a source of delay in convergence on especially solutions.

The Netherlands

EV charging infrastructure roll-out started early in the Netherlands. In the periods leading up to, and early in this development, several mentions about the needed infrastructure were made in the documents

Little coordination appeared to exist between government agencies early on, leading to a lot of incentives for ZEV driving as multiple branches of government introduced incentives (R9). In addition, as not only BEVs were eligible but also FCEVs, cars that could technically drive fully electric but often did not do so in practice became popular. An example was the Mitsubishi Outlander (R7, R9). However, when asked about the consequences of this policy, respondents stated that in hindsight it turned out well (R1). In addition, some stated that the goal was appear constant with the effect of the policy instruments. R1 illustrates this: "*You shouldn't say 'I subsidized 10 000 Outlanders' (…), no, you caused electric driving to move from a theoretical hobby to a comfortable way of driving. Plus, the infrastructure started to be put in place as people wanted to use it"*. Thus, while the initial approach faced criticism and was contested, this reduced over time. In addition, it accelerated convergence on EVs.

Factors that would explain this development were also identified by interviewees. R4 states that very early on Rijkswaterstaat was already playing a very strong role in expanding networks and allowing private firms to bid on spots to install chargers. R7 states that while early expansion was rapid, there was no clear strategy. R1 states that it was not quite clear how the Netherlands became a frontrunner in infrastructure but says that local governments were willing to work on it. Proper infrastructure was seen as a requirement, but it was thought that it would develop by itself. Furthermore, media and businesses *diagnosed* the need for extensive infrastructure to charge all planned EVs (NLM1-3, NLP2-2). The interviews indicate that the proactive stance of government was a major factor in the development of infrastructure.

The Dutch market and industry for charging equipment and charging itself also developed rapidly. Not only the physical equipment, but also the integration of the infrastructure with new technologies like smart charging, digital payments, and Intelligent Traffic Systems grew rapidly: "*Dutch innovations (…) just grew rapidly, now taking over New York*" (R6). This is also seen in the documents, where these new technologies were embraced in an early stadium by, for example, government actors (NLG1-2, NLG1-4). This was also aided by the fact that Dutch government made a strong push for standardisation and collaboration in the industry (R6). These developments and framing practices indicate that businesses saw opportunities and governments *prognostically framed* the opportunities too.

From the first years of EV introductions, Dutch government was explicit that it saw collaborations as a way to successfully transition the mobility system. This includes collaborations between national and

local governments, but also public-private collaborations. This view is also shared by businesses who call on themselves to work in collaborations, but also want government to collaborate.

Conclusion

In the UK, moving industry towards cleaner ICEVs and PHEVs was a strategy proposed by actors in early periods. This was covered by business, but also government. While BEVs are discussed as an option, it is only in later periods that discourse seems to converge around them as the most feasible option. This is also reflected in the development of infrastructure, where only in later stages successful development and adoption took place. Government and businesses aimed to rely on each other to act and provide stability, using motivational framing to try and make this clear. However, this lead to a situation where neither actor committed to a single technology.

In the Netherlands, solution convergence took place rapidly around BEVs. This was caused by a strong government preference for this technology over others. Convergence was aided by actor's willingness to accept BEVs and collaborate with government to increase adoption. Early on policy also seems relatively converged upon, with mostly fiscal arrangements for the demand side. Government and business saw little risk in choosing BEVs as the clear best technology, instead seeing opportunities. Motivational framing towards other actors was less common compared to the UK. This also lead to increased development of infrastructure and new entrants.

5. Conclusions

In recent years, governments have tried to increase the adoption of ZEVs to address the negative effects of a fossil-fuel based road transport system. In forming the policy needed to do so, actors engage in discourse and framing to influence policy in a way that suits their interests. Thus, policy discourse evolves, and at best, converges around clear problem and solution statements to achieve effective and legitimate policy. This thesis aimed to understand policy formation by studying the role and effects of framing in the ZEV discourse in the UK and the Netherlands. Framing practices are studied as actors use them to make sense of situations and guide collective action. A comparative study of policy developments in both countries from a discourse and framing perspective is insightful because they are culturally and institutionally similar. In addition, the two countries are considered to have different rates of early adoption of ZEVs, with the Netherlands being more successful. The following research question was posed: "*How does the policy discourse on ZEVs between 2007-2018 differ between the UK and the Netherlands, and how did it influence the adoption of ZEVs in both countries?*" A qualitative approach was used in which documents were analysed to study how the discourse developed. Interviews were used to validate these findings. Two sub questions were posed to help answer the main research question. These are answered and discussed below.

To answer the first sub-question "*What are the topics covered in policy discourse and how do they change over time in the UK and the Netherlands?*" the shift in the topics covered in discourse over time was analysed. The UK had an early focus on addressing energy dependence and local air pollution. However, as pressure to reach sustainability targets increased, government became influential in driving the discourse around the impact of transport on global warming. Discourse moved away from energy dependence as problem discourse converged around local air quality and global warming. Hydrogen remained a fuel source that was discussed as feasible for a long time, but discourse converged on BEVs. The UK automotive industry played a role in this late convergence as hydrogen or fossil fuel powered vehicles would have allowed them to use more of their existing expertise compared to BEVs.

In the Netherlands, while energy dependence was discussed in early periods, the problems of local air pollution and global warming were converged on quickly. Both government and businesses were driving forces in this. BEVs were converged on early, also leading to a focus on developing charging infrastructure. Especially government but also the Dutch automotive industry and trade associations were willing to commit to EVs as it offered few economic downsides.

Convergence on both problems and solutions happened earlier in the Netherlands compared to the UK. This is likely due to government and business actors sharing a stronger desire to adopt BEVs compared to the UK.

For the second sub-question *"What actors are involved in the policy discourse, and which framing practices do they apply in each country?"* the stance of the different actors in the discourses was studied. In the UK, government was very active in diagnostically framing problems that could be addressed by increasing uptake of ZEVs. It left initiative to the automotive industry and was technology neutral in early periods, addressing both EVs and hydrogen powered vehicles. Only in later periods did prognostic framing of BEVs become more common, indicating a push for convergence around BEVs. Industry was relatively active in diagnostically framing problems around BEVs, indicating that private actors aimed to converge discourse away from BEVs. Motivational framing was used to call government to action. However, little direct intervention by governments was asked for. This indicates that private organisations wanted to keep initiative around developing solutions and increasing uptake of specific technologies to themselves. Media shared many framing practices with private organisations, diagnosing problems around BEVs and government action.

UK government appears to have a strong role in influencing discourse on both problems and solutions as in both categories discourse converged around topics and frames it pushed. Framing strategies did not always align between governments, private actors and media but convergence did occur in later stages.

In the Netherlands, government, private actors, and media used relatively similar framing strategies for problems. Problems diagnosed by these three actors were those of local air pollution, noise pollution, and global warming. Government strongly prognostically framed the benefits of BEVs. While prognostic framing was also done on HFCEVs, more problems about the development and time paths needed were diagnostically framed. Additionally, private actors used motivational framing strongly to call governments to action, but also acknowledged their own roles in increasing ZEV adoption.

The three types of actors were mostly aligned in discourse and used motivational framing to call for collaboration on addressing the existing problems and increase the uptake of ZEVs. The fact that the actors openly call for collaboration suggests that not only the early alignment lead to accelerated convergence, but also the willingness of actors to address the challenges together.

In sum, in the Netherlands discourse converged early both on problems and solutions and changed relatively little over time. In the UK convergence happened in later periods. The earlier convergence in the Netherlands might be a factor in the faster uptake of ZEVs in the Netherlands compared to the UK. From this study, several potential causes for the differences in uptake are identified. First, Dutch government was quick to focus its efforts on EVs instead of hydrogen fuelled vehicles, as opposed to the UK's more technology neutral policy. Furthermore, the different actors in the Netherlands were more willing to collaborate and create a system that worked together to encourage ZEV adoption. In the UK, the various actors had different visions on the future of road transport and the role that industry should play. This caused a lag in the implementation of suitable policy in addition to the resistance from important private actors to the adoption of ZEVs.

6. Discussion

6.1 Theoretical implications

The findings of this study offer several implications for the theory on the PSS and framing. This was the first study that operationalized the PSS (Wanzenböck et al., 2020) in combination with the discourse and framing literature (Hajer & Versteeg, 2005; Snow & Benford, 1988). This approach was used to gain insights into how discourse converges and how actors influence convergence. It has been shown that such a discourse and framing perspective proved useful to reveal which actors were driving forces for specific frames. Additionally, it was illustrated how changes in the perception of these frames affected convergence around ZEVs as a solution for a range of problems. These findings illustrate how mission-oriented policies emerge from discourse and framing, and how discourse and framing influence the success of these targeted policies. This means that the PSS can be used to study discourses through conceptualizing framing as presented in the *landscape of belief systems* in this study. This provides a useful tool for researchers to perform discourse analyses on societal challenges and aid the acceleration of addressing problems.

However, delineating between prognostic and motivational framing appeared more difficult as the two were often intertwined in text. This left little possibility to categorise texts in one of the two categories. This difficulty was also encountered by Voytenko Palgan et al. (2017). Combining framing practices and indicators for the convergence categories worked well in general. However, several combinations were found to be insufficient. An example was the combination of *diagnostic* framing and *feasibility* (solution contestation). In this combination the problems surrounding the feasibility of solutions would need to be mentioned. However, another indicator *Lack of knowledge on feasibility* (solution uncertainty) corresponds to a subset of the diagnostic framing that could take place under *feasibility*. Therefore, efforts need to be devoted to the developing indicators reflecting a clearer delineation between the framing strategies and convergence categories. Two indicators are proposed in this study: *fragmentation of control* and *socio-technical system implementation*. These indicators help better identify complexity on the solution axis of the PSS by covering two areas that were not previously covered by the proposed indicators. While other indicators for solution complexity concern themselves with changes in the socio-technical system itself, *fragmentation of control* concerns the complexity of the actors that can influence the system. Socio-*technical system implementation* covers the need of new technologies and ideas to be integrated into existing socio-technical systems. Thereby, it extends on the *alignment* and *combination* of socio-technical systems, instead highlighting situations where the socio-technical system is, or needs to be, expanded upon. Future studies can use these indicators to better map solution complexity.

Furthermore, this paper presents points that connect societal challenges and convergence to Varieties of Capitalism literature. While the findings discussed earlier offer insights into the specifics of how convergence around challenges manifests itself in different context, these contexts can also be compared to Varieties of Capitalism characteristics (Hall & Soskice, 2003). For example, in this study there is a clear distinction of market dynamics in the UK, and a more Rhineland style in the Netherlands. This is in line with earlier categorizations of these countries (Hall & Soskice, 2003; Sluyterman, 2014). As this indicates that contexts and dynamics that influence convergence are to an extent parallel to those of Varieties of Capitalism, it can allow the approach used here to help further understand Varieties of Capitalism characteristics.

In addition, more studies have been conducted on ZEV policy in the past. An example is Wesseling (2016) where BEV policies were studied in multiple countries. In this study, it is found that government targets do not correlate with policies. Instead, differences in policy are better explained by a

government's role in a national economy (for infrastructure policy, where statist governments invest more in this), and the economic role of a car industry in a country (where governments tend to invest more on technology development instead of diffusion). This is roughly consistent with the findings of this study, where investments into the UK's automotive industry are more prominent than those in the Netherlands. In addition, infrastructure development took off earlier in the Netherlands due to both government and business action. This study, however, shows more insights into the dynamics that caused these different strategies to emerge, highlighting the role of trade associations and government agencies. These insights can be used to further study the effects of different types of government intervention and how useful they are in different countries.

Hype cycle framing has also been used to study how actors shift their focus on different ZEV technologies. Bakker (2010) and Bakker and Budde (2012) analyse hype cycles for hydrogen powered cars. They note that manufacturers might have framed hydrogen cars such that it attracted favourable conditions for them to develop FCEVs, possibly not having seen hydrogen as a truly feasible option. The authors propose that this lack of commitment meant the lack of success for hydrogen powered vehicles. This study also finds that hydrogen never truly broke through as a feasible option compared to other technologies. However, it adds the government discourse to the mostly media and industry documentation studied in Bakker (2010) and Bakker and Budde (2012). This highlights that hydrogen was not truly committed to in Dutch policy and, while more so, not in the UK either. In addition, media documents were found to be not stronger in their explanatory power than business or government documents.

6.2 Policy implications

The results of this study provide several implications for the implementation of societal challenge-based policies. It has been shown how reaching convergence on solutions or problems can help accelerate implementation of solutions. In situations like those in the UK, convergence might be accelerated by facilitating collaboration between actors. One way to enable such a situation to emerge can be through having close collaborations between government and industry in early phases of the development of a solution. While the Netherlands is known to have this traditionally, in this case it allowed for the rapid creation and implementation of strategies around the topic of ZEVs. While a more market-oriented economy like the UK has this less so historically, finding a way to have more mutual trust early on could have helped to better scope policy and streamlined the gradual strengthening of policy over time. In addition, creating a clear long-term vision from government can make clearer to businesses what the government's goals are. In the UK's case this might have helped sway industry away from fossil fuel powered hybrids earlier as carbon reduction goals were clearer.

The formation of these choices in the Netherlands was caused by a sector and a government that were willing to be proactive and collaborative. While the government in both countries had a leading role, Dutch industry lacked a strong incentive to stick to ICE and hybrid technology. Instead, the sector saw opportunities that could be seized, especially with government leaning towards EVs already. The understanding on both sides lead to a move to EVs that had a broad backing. This shows that a degree of openness from business, in combination with an open government that had a desire to move forward with a solution, can lead to accelerated acceptance and convergence.

Furthermore, policymakers can facilitate convergence by linking the challenge with potential other goals. In the Netherlands the creation of new jobs in an emerging sector instead of in the existing sector played a big role. This provided a much better fit with EV technology than HFCEVs, which could have helped the UK create more jobs in its existing automotive industry. If the UK government had linked job creation to ZEVs, a case could have been made for either technology earlier: HFCEVs for the existing sector, or EVs for jobs outside of it, providing firms with more clarity on how to respond.

6.3 Limitations

Although this study was conducted to ensure the highest possible research quality, some limitations apply. Due to topic scope, ZEVs were chosen to study in the discourse. However, this meant that the discussion on the understanding of climate change itself (which took place before 2007) was not considered in the discourse. Thus, this study likely leaves out many mentions of problem uncertainty, which would have changed the perspective on when problem convergence happened. However, it is stated that in the UK this was not the problem where ZEV were first used for, instead focusing on local air quality. This indicates that the period analysed was suitable although studying the discourse on the role of transport on greenhouse gas emissions would require studying earlier periods.

Moreover, the identified periods were not recognized by all respondents. Several interviewees stated that the most influential events happened around 2015. This indicates that the time periods initially decided upon might have been less relevant. Instead, there is a clearer early-late division instead of a gradual process over five periods, implying that studying discourse with predefined periods is less insightful than deciding upon the periods afterwards. Therefore, the changes identified from period one to two, or four to five, for example, might be less pronounced than illustrated here. However, the identified changes were validated in the interviews, indicating that while they might be less important compared to the early-late division, they are still relevant to study. Further studies should focus on identifying periods after the analysis.

Furthermore, the most useful documents and interviews were aimed to be gathered. These were not necessarily the most representative ones. While some insights can be generalised to the sectors in either country (or perhaps even similar industries or similar countries), generalisability is restricted. In addition, no respondents from the UK government were available for this study, limiting the quality of the data studied. Instead, validating the document analysis was done via perspectives from other actors in the UK and experiences of Dutch actors with acting in the UK. Many explanations for government actions were able to be identified, but further research could focus on studying the role of UK government in more detail.

6.4 Further Research

Based on the findings of this study several pathways for further research are identified. Firstly, this study only focussed on the ZEV discourse in the UK and the Netherlands. While a rationale is presented as to why these two countries were chosen, several reasons exist why studying the same phenomenon in other countries can prove valuable. Within the Varieties of Capitalism literature, a broader spectrum of country types exists (Hall & Soskice, 2003). Studying countries similar to the UK like Canada, which shares a focus on free market dynamics, and the Netherlands like Denmark, which has a mix between employment protection and free market dynamics (Hall & Soskice, 2003), can further add to the specific contexts within the UK and the Netherlands. It can also provide a more detailed description of how different factors influence convergence in these contexts by identifying them in other countries and studying the role of them in the UK and the Netherlands. Studying different countries like Germany, which has a reduced focus on free market dynamics, can also add to more insights into convergence, making it applicable to more and more different countries. For example, a group of actors might have an entirely different role in discourse than in previously studied countries while being applicable to others.

Furthermore, the structure and dynamics of automotive industries varies between countries (Lieberman & Asaba, 1997; Wesseling, 2016; Zhu et al., 2008). Therefore, studying the same sector in different countries can provide more insight into how future convergence might emerge when the structure of networks is altered. Additionally, the development of infrastructure and ZEV industry has

varied a lot between countries as is seen in Japan (Ishimoto et al., 2017), the United States (Greene et al., 2014), and Germany (Meckling & Nahm, 2019). Applying the findings of this study can help better understand how these countries developed their own ZEV discourse and industry. This in turn can help create better policy for steering them in the future.

Outside of the challenges around ZEVs studied here, other challenges can also be studied. This study highlighted several strengths and additions of the framework proposed by Wanzenböck et al. (2020), who provided cases on second-hand smoke, CCTV, and wind energy. Further studying different missions and challenges can improve the PSS further and test the findings of this study. An example of this was highlighted by the UK government, who stated that they thought that *carbon* was the problem, not *cars*, and therefore focused on decarbonising cars instead of providing alternatives to cars like public transport. Studying situations where countries focus more on biking and public transport, or a combination, can provide more insights into how a broader discourse around mobility can develop. However, not just mobility is faced with societal challenges. Other new and future developments where understanding convergence can play a role are for example the circular economy (Bauwens et al., 2020) and smart cities (Singh et al., 2020).

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Number of documents in NexisUni for quality newspapers in the Netherlands (query:"Elektrische Auto")
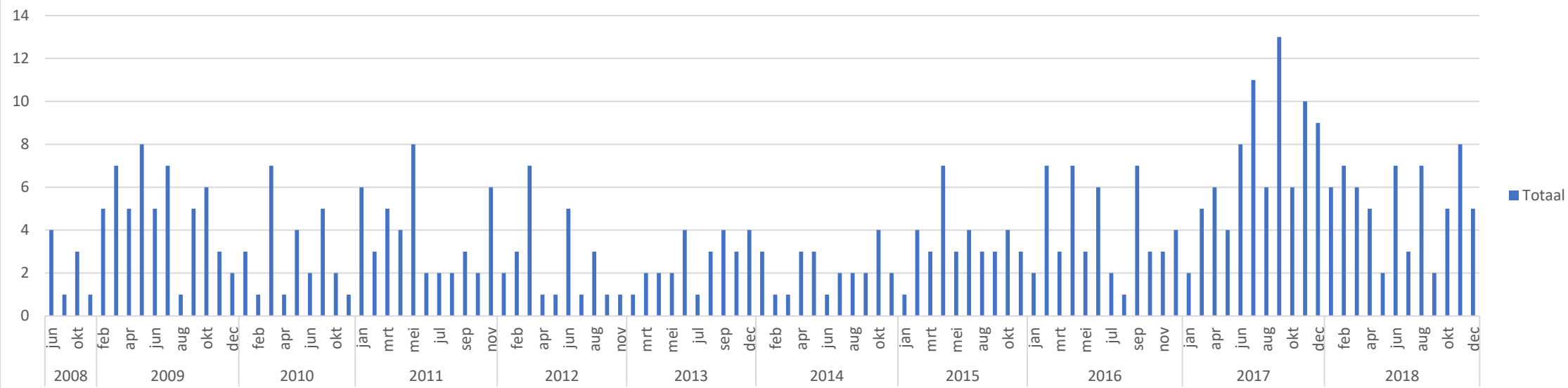
Title	Country	Type of organisation	Period	Code
Actueel overzicht stimuleringspakket	NL	Government – Ministry of Finance	1	NLG1-1
Plan van aanpak elektrisch rijden	NL	Government – Parliament, Ministry of Traffic and Water Management, Ministry of Economic Affairs	1	NLG1-2
Studie naar Transport Emissies van Alle Modaliteiten	NL	Government – CE Delft, Ministry of Housing, Spatial Planning and Environment, Ministry of Traffic and Water Management	1	NLG1-3
Voortgang Kabinetsbrede aanpak duurzame ontwikkeling	NL	Government – Parliament, Ministry of Housing, Spatial Planning and Environment, Ministry of Foreign Affairs	1	NLG1-4
Op weg naar duurzame mobiliteit – Ruimte voor rijden op waterstof	NL	Government – Ministry of Infrastructure and Environment	2	NLG2-1
Energie- en milieuaspecten van elektrische personenvoertuigen	NL	Government – TNO, Dutch Enterprise Agency	3	NLG3-1
Fiche Mededeling Europese strategie voor emissiearme mobiliteit	NL	Government – Parliament, Ministry of Foreign Affairs	4	NLG4-1
Electromobility in the Netherlands Highlights 2015	NL	Government – Dutch Enterprise Agency	4	NLG4-2
Review Adviesrapport 'maak elektrisch rijden groot'	NL	Government – Dutch Environmental Assessment Agency	4	NLG4-3
Mission Zero – Powered by Holland	NL	Government – Dutch Enterprise Agency	5	NLG5-1
Beantwoording schriftelijk overleg algemene rekenkamer naar aanleiding van de door De Ark toegezonden brief over fiscale stimulering van elektrische auto's	NL	Government – Parliament, Ministry of Finance	5	NLG5-2
Commerciële waterstofauto stapje dichterbij	NL	Media - Trouw	1	NLM1-1

Dromen van een schone auto	NL	Media - Trouw	1	NLM1-2
Omwenteling bij Big Oil en Big Car al begonnen	NL	Media – NRC Handelsblad	1	NLM1-3
Fiscale regels dwarsbomen introductie waterstofauto	NL	Media - Trouw	2	NLM2-1
Iedereen in een elektrische auto	NL	Media - Trouw	2	NLM2-2
Mierenzuur in waterstoftank: Nieuwe mogelijkheid voor de 'groene auto van de toekomst'	NL	Media – NRC Handelsblad	2	NLM2-3
Elektrische auto komt moeilijk op gang	NL	Media – NRC Handelsblad	3	NLM3-1
Hobbels voor de elektrische auto	NL	Media - Trouw	3	NLM3-2
Verdeel en heers leidt tot innovatieve auto's	NL	Media – De Volkskrant	3	NLM3-3
Elektrische auto vervangt wagens met verbrandingsmotor	NL	Media – Het Financieele Dagblad	4	NLM4-1
Goedkoop vulstation zet waterstofauto terug op de agenda	NL	Media - Trouw	4	NLM4-2
Ook elektrische auto is fijnstofbron	NL	Media – De Volkskrant	4	NLM4-3
Elektrische auto als rijdende opslag	NL	Media – Het Financieele Dagblad	5	NLM5-1
Blik in de toekomst – Verder in automotive	NL	Private - Rabobank	1	NLP1-1
Renaul-Nissan alliance, the new motion partner for zero-emission mobility in the Netherlands	NL	Private - Nissan	1	NLP1-2
Trends in Mobiliteit	NL	Private - RAI	2	NLP2-1
Oplaadpunten voor elektrische auto's in de openbare ruimte	NL	Private - CROW	2	NLP2-2
Electric vehicles in Europe: gearing up for a new phase	NL	Private – Amsterdam Roundtables, McKinsey & Company	3	NLP3-1
Elektrisch Vervoer	NL	Private – Energie Nederland	3	NLP3-2
Transition to a global Zero-emission vehicle fleet: a collaborative	NL	Private - ICCT	3	NLP3-3

agenda for governments				
Een gelijk speelveld voor elektrisch rijden	NL	Private - PwC	4	NLP4-1
De elektrische auto: a convenient truth	NL	Private - Rabobank	4	NLP4-2
Elektrisch Rijden	NL	Private - ANWB	5	NLP5-1
Op weg naar 'zero-emissie-mobiliteit'	NL	Private - ANWB	5	NLP5-2
Electric vehicle charging – overview of the Dutch EV charging market	NL	Private - Deloitte	5	NLP5-3
De EV in opkomst	NL	Private - PON	5	NLP5-4
Position paper – Elektrisch rijden op waterstof	NL	Private - RAI	5	NLP5-5
Position Paper - Europees CO2-beleid personenauto's en lichte bedrijfswagens	NL	Private - RAI	5	NLP5-6
Elektrische auto's: de toekomst, impact en kansen	NL	Private - Rabobank	5	NLP5-7
European Council debate	UK	Government - Parliament	1	UKG1-1
No Title	UK	Government - Parliament	1	UKG1-2
Business Plan 2011-2015	UK	Government – Department for Transport	2	UKG2-1
Electric car revolution revs up	UK	Government – Coalition press release	2	UKG2-2
Making the Connection – The Plug-In Vehicle Infrastructure Strategy	UK	Government – Office for Low Emission Vehicles	2	UKG2-3
Permitted development rights for small scale renewable and low carbon energy technologies, and electric vehicle charging infrastructure consultation: Government response	UK	Government – Communities and Local Government	3	UKG3-1
Hydrogen fuels lower emissions	UK	Government – Department for Business, Innovation & Skills	3	UKG3-2

Investing in ultra low emission vehicles in the UK, 2015 to 2020	UK	Government – Office for Low Emission Vehicles	3	UKG3-3
Driving the Future Today – A strategy for ultra low emission vehicles in the UK	UK	Government – Office for Low Emission Vehicles	3	UKG3-4
Fuel Cell Electric Vehicle Fleet Support Scheme – Guidance Note for Applicants	UK	Government – Office for Low Emission Vehicles	4	UKG4-1
Briefing Paper – Electric vehicles and infrastructure	UK	Government – House of Commons Library	5	UKG5-1
Consultation on proposed transposition of Alternative Fuels Infrastructure Directive - Government Response	UK	Government – Department for Transport	5	UKG5-2
The Road to Zero	UK	Government – Department for Transport	5	UKG5-3
Electric cars are driving the transition to sustainable technologies	UK	Media – The Guardian	1	UKM1-1
Boris Johnson: electric vehicle plan goes flat	UK	Media – The Guardian	2	UKM2-1
UK government blocking green car take-up, say electric vehicle makers	UK	Media – The Guardian	2	UKM2-2
Are electric cars bad for the environment?	UK	Media – The Guardian	3	UKM3-1
Cost of electric vehicles outweighs their 'green' credentials; Customer resistance	UK	Media – The Financial Times	3	UKM3-2
JUST WHO IS IN CHARGE?: Electric car drivers in London are finding it increasingly difficult to find charging points that actually work thanks to the chaotic sell off of the network, says Julian Rendell	UK	Media – The Daily Telegraph	3	UKM3-3

Work gathers speed on sustainable alternatives; Green developments	UK	Media – The Financial Times	3	UKM3-4
You can't beat petrol or diesel	UK	Media – The Daily Telegraph	3	UKM3-5
Zero emissions fuel comes a step closer	UK	Media – The Daily Telegraph	3	UKM3-6
Electric cars could drive the future	UK	Media – The Guardian	4	UKM4-1
Mitsubishi Outlander PHEV: car review; The Outlander is a big, capable 4x4. It's also Britain's bestselling electric vehicle - and Boris Johnson loves it	UK	Media – The Observer	4	UKM4-2
Collective action is vital to keep the electric car revolution on the road	UK	Media – The Sunday Telegraph	5	UKM5-1
Tenth annual sustainability report	UK	Private - SMMT	1	UKP1-1
Implications of the widespread use of electric vehicles	UK	Private - TRL	2	UKP2-1
New Car CO2 Report 2010	UK	Private - SMMT	2	UKP2-2
2012 Automotive Sustainability Report	UK	Private - SMMT	3	UKP3-1
2014 Automotive Sustainability Report	UK	Private - SMMT	3	UKP3-2
Fiscal and regulatory instruments for clean technology development in the European Union	UK	Private – Centre for Climate Change Economics and Policy	3	UKP3-3
New Car CO2 Report 2012	UK	Private - SMMT	3	UKP3-4
New Car CO2 Report 2014	UK	Private - SMMT	3	UKP3-5
New Car CO2 Report 2016	UK	Private - SMMT	4	UKP4-1
2017 UK Automotive Sustainability Report	UK	Private - SMMT	4	UKP4-2
The Road to Zero Strategy – Stuck in second gear?	UK	Private - KPMG	5	UKP5-1

Appendix B – Interview guide

1. Personal introduction and introduction of the research
2. General interview information, ask for consent to record

General questions

3. Can you tell a little bit about yourself?
4. What kind of organisation do you work for?
5. Have you worked for other organisations that are active on the subject of zero emission vehicles?
6. What role do you fulfil within the organisation?

Personal activities

7. How have you participated in the discourse on ZEV?
   a. What kind of activities did you participate in?
8. What is your vision on the direction the ZEV regime should/should have head(ed) in?
   a. Which problem do they solve?
   b. What policy or technique is feasible and desirable?
   c. Who is responsible for the problem?
   d. For who do advantages and disadvantages emerge because ZEVs are adopted?
9. What was the goal of the activities you participated in?
10. Who did you interact with?
11. How did your activities compare to those of peers or competitors?
12. What have been the results of your activities?

Perspective on the discourse

13. How, according to you, has the discourse on ZEV changed over time (last ~10-13 years)?
    a. What events were influential on these changes?
    b. What topics have changed?
    c. How have sentiments changed?
    d. Did coalitions of actors change?
14. Why do you think these changes occurred?
15. How has this changed your personal vision on ZEV?
16. How has this changed the activities you perform in the discourse?

Concluding remarks

17. Is there anything you would still like to add that was not covered?
18. Do you know any other people that might be able to provide relevant information for my research?
19. Thank the interviewee for the time and effort, end the interview