Policy narratives about the European Green Deal:

Computational text analysis of policy narratives on the transition from internal combustion vehicles to new energy vehicles

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TUDelft

Preface

This study is involved with narrative analysis, policy analysis, natural language processing and so on, which is a little challenging for me. It is an unforgettable experience because I have learned a lot of knowledge during these 7 months.

Thanks for the help from the graduation committee, who provided important advice during the kick-off meeting, mid-term meeting and green light meeting. Thanks for the help from Nihit Goyal and Ema Gushva, who help me in the weekly meeting on Friday, providing suggestions and ideas. I faced lots of troubles when I started to do this research. I did not find a suitable direction to do this research, and I always went far away from the program expectations, but thanks to the help from Zofia, Nihit, Stefan and Ema, I can improve and regulate the research, and finally make sure the direction and the current methods.

Hope you enjoy reading thesis!

Penghui Fan

Delft, September 23, 2022

Summary

This study focuses on the policy narratives on the transition from internal combustion vehicles to new energy vehicles concerning the EU Green Deal, which was adopted by the European Commission at the end of 2019. It aimed to make the EU climate neutral by 2050. As an essential part of the EU Green Deal, reducing greenhouse gas emissions from transportation is more and more mentioned by policymakers, and it is involved with the transition from traditional combustion vehicles to new energy vehicles. Different stakeholders have their own opinions on these policies and consistently share documents to convey information, affect the audience's opinions, and shape the public's beliefs. Narrative analysis is used in this study to help researchers and the public understand the key information in the documents shared by the stakeholders regarding the energy transition in transportation. This study selects the ACEA (European Automobile Manufacturers' Association) and the ICCT (International Council on the Clean Transportation) as representative stakeholders to analyze their narratives. The aim of the research is to identify the key information in the narratives of these two stakeholders. Based on this aim, the main research question is formulated in Chapter 1: *"What is the key information in the policy narratives of different stakeholders in the case of transition from combustions vehicles to new energy vehicles concerning the EU Green Deal?"* Two sub-research questions are formulated to delve into the main research question. The first sub-research question is *"What is the difference between the narratives of the ACEA and the ICCT with respect to the transition from combustion vehicles to new energy vehicles?"* The second sub-research question is *"How did the policy narratives of the ACEA and the ICCT change before and after the EU Green Deal?"* The social relevance and the relevance of this thesis to the CoSEM (Complex System Engineering and Management) program are also discussed in this chapter. Policymakers can make new policies or regulate the current policies based on this study, which can benefit the energy transition in the transportation sector in the EU member countries.

Before designing the study, two literature reviews are conducted in Chapter 2. The first review, about the current studies about the transition from combustion vehicles to new energy vehicles concerning the EU Green Deal, focuses on the stakeholders, the relevant policies, challenges in the transition, and relevant areas relating to the transition. The second review delves into studies on narrative analysis, focusing on their topics, methods, and results. Two key research gaps are identified based on these reviews: most studies about the policies of transition on vehicles concerning the EU Green Deal do not apply computational text analysis to the narratives of the stakeholders, and most narrative analysis studies do not cover the transition on vehicles.

To address these knowledge gap, press releases from the ACEA and the ICCT are selected to conduct the narrative analysis. The comparisons about the stakeholders and the relevant data are described in Chapter 3. Finally, 93 documents from the ACEA and 56 documents from the ICCT published during 2018 - 2022 are collected for analysis. The data processing includes tokenizing the words, removing the stop words, punctuation, and lemmatizing the words. The methods used in this study include over-represented word extraction and topic modeling, which are two common NLP (Natural Language Processing) techniques. Word clouds and the top 20 words in the documents from the ACEA and the ICCT are extracted to identify the words with high frequency in the narratives. The U_Mass coherence score is used to decide the suitable number of topics for the topic modeling analysis. This score suggests that 11 is the appropriate number of topics in this database. To filter the words with lower values, TF-IDF (Term Frequency-Inverse Document Frequency) is used for both two methods.

The results of these two methods are described in Chapter 4. The most commonly used words in the narratives of the ACEA and those of ICCT are different. The words with the highest frequency in the documents from the ACEA include "diesel", "bus", "tax", "automotive", "registration", "public", "petrol", "report", "plan", "unit", "growth",

"register" and "neutral". In contrast, the words commonly mentioned in the documents from the ICCT include "feebate", "renewable", "super", "euro", "hydrogen", "trailer", "fee", "ban", "automaker", "freight", "cycle", "petrol", "recovery". In different years, the words with the highest frequency also change. For example, both these stakeholders always mentioned the words "crisis", "job", "economy" in 2020. As for the results of topic modeling, 11 topics are identified, including "charge points-infrastructure", "purchase policy", "investment", "manufacturer", "market-sale", "emission standard", "policy simulation", "truck", "tax", "fuel", and "regulation-law". The prevalence of topics differs between the documents of the ACEA and those of the ICCT. Also, some topics show obvious change during these years. For example, the topic "charge points-infrastructure" shows an increase in prevalence in these years, and it is mentioned more frequently in the narratives from the ACEA.

The conclusion answers the research questions in Chapter 5. The ACEA cares more about the words "bus", "tax", "registration", and the topic "charge points-infrastructure", "investment" and "market-sale". In contrast, the ICCT focuses more on the words "bonus", "renewable", "hydrogen", and the topic "purchase policy", "manufacturer", and "emission standard". In 2020, words such as "job", "economic" and "recovery" are mentioned more by the stakeholders, which might reflect the influence of the pandemic. The difference between narratives of the ACEA and the ICCT is likely to be related to the interests of these stakeholders. For example, the ACEA mentions more about the "economy", "job", "work" and so on, which can be related to the interest groups represented by the ACEA, such as traditional vehicle manufacturers in Europe. After a discussion of the results, the scientific contribution of this study is explained. This study fills the gap that there are not enough studies applying narrative analysis on the transition from combustion vehicles to new energy vehicles. Based on this study, some avenues for future research are discussed to further or improve the analysis. For example, the researchers can focus on the relation between different topics in future or focus on different stakeholders and data source. The policy implication is also highlighted in the last chapter, which can be helpful for

the government or some policymakers to make new policies or regulate the current policies on the transition from combustion vehicles to new energy vehicles in the EU member countries.

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Abbreviations

ACEA	European Automobile Manufacturers' Association
CoSEM	Complex System Engineering and Management
EEA	European Environment Agency
ICCT	International Council on the Clean Transportation
IEA	Internal Energy Agency
LDA	Latent Dirichlet Allocation
LNG	Liquefied Natural Gas
LSA	Latent Semantic Analysis
NLP	Natural Language Processing
NPF	Narrative Policy Framework
TF-IDF	Term Frequency-Inverse Document Frequency
VAT	Value-added Tax
VDA	German Carmakers Association
U_MASS	University of Massachusetts

Chapter 1 Introduction

Chapter 1 introduces background information about the research and defines the problem to be solved in this master thesis. The study selects the ACEA and the ICCT to analyze their narratives in this chapter. Next, the research objective and research questions are illustrated. Then, the relevance of CoSEM is explained, including the societal relevance. Finally, the thesis structure is discussed at the end of this chapter.

1.1 Background information and problem introduction

Nowadays, climate change and environmental degradation are increasingly serious and considered a big threat to the world (A European Green Deal, 2019). In response to this, many countries are designing and implementing policies to mitigate climate change, like the EU Green Deal. The European Green Deal, approved by European Commission in 2019, is a package of policy initiatives involving different areas that aim to make the European Union climate neutral by 2050 (Tamma et al., 2019). This set of policies focuses on different areas, including clean energy, building and renovation, eliminating pollution, farm-to-fork, sustainable industry, sustainable finance, and sustainable mobility (A European Green Deal, 2019).

To reach the EU Green Deal goal, transport emissions, as an important part of sustainable mobility, deserve more attention from policymakers dedicated to decreasing carbon emissions. Transportation emissions account for almost 25% of greenhouse emissions in the EU, and a major reason share of the urban emissions (Transport Emissions, 2022). Road transportation contributed the biggest share to transportation emissions in 2014. Hence it has the biggest potential for mitigating climate change if traditional combustion vehicles are replaced with new energy vehicles (Transport Emissions, 2022). In July 2021, the "Fit for 55" legislation package was released by the European Commission. It contains guidelines for the vehicles industry, which claimed that all new vehicles sold should be zero-emission from 2035

(Press Corner, 2021). The policies proposed for reaching this target are subsidies on electric vehicles, taxes on combustion vehicles, infrastructures for new energy vehicles such as charging points, and changing the carbon emissions standards on the road (Transport & Environment, 2021).

The influential stakeholders usually issue their narratives on the relevant policies, expressing their standpoints or opinions via the policy narratives, which can affect the public attitudes toward the policy to some extent. This study conceptualizes the word "narrative" as "a written or spoken account of connected events" or "a story". Some stakeholders have more power to spread their narratives through different means, such as newspapers, videos, articles, interviews, and reports, as well as social media, which have more influence on the public. Narratives can be considered one of the most common ways for the individual or the organization to convey information. Narratives have been used for public policy administration for a long time in different areas by policymakers (Suri et al., 2020). Narratives can shape the beliefs of the public and affect the action of the audiences (Jones & McBeth, 2010). Due to this, the analysis of the narratives is usually used for public policy in policy research, which can help the researchers uncover the underlying ideologies in the stories of the policymakers. Policy narrative analysis can help unpack the complexity of interactions between policy stakeholders, policies, events, and contexts, as well as the results (Shanahan, 2018). Narrative analysis can also help the public understand policymakers' standpoints. The stakeholders in the transition from combustion vehicles to new energy vehicles also have regular narratives on the policies in this area, sharing their opinions and attitudes in the narratives, which can help the researchers understand what the stakeholders focus on and the content of relevant policies. These years, especially after the EU Green Deal, the EU member countries have paid more attention and energy to climate change, energy transition and carbon emission, and they need more suitable policies on the energy transition in transportation. This requires the policymakers to understand better the policy situation and problems, which benefits from the stakeholders' narratives. Therefore, a narrative analysis focusing on the relevant

stakeholders is conducted in this study.

Literature review on the policies about new energy vehicles in Chapter 2 shows several influential stakeholders with different standpoints on policies. For example, the International Council on Clean Transportation (ICCT), the European Environment Agency (EEA) and some other associations that work for environmental protection usually support these policies, which can decrease carbon emissions through the energy transition process on the vehicles. However, there are still some opposing voices against the policies, like the German carmakers association (VDA), who criticized the effective ban on combustion vehicles, including hybrid engines, and insisted that the choice of consumers may be restricted by the policies (Staff, C. B., 2021). Also, the European Automobile Manufacturers' Association (ACEA) has a similar response to the policies, saying that it is not rational to restrict a single technology at this stage (ACEA, 2021). Those stakeholders can be considered influential in expressing their narratives, which reaches wide audiences.

The ACEA and the ICCT are selected to analyze their narratives in this study from these stakeholders. The selection of the stakeholders in this study depends on whether the stakeholder's data is suitable and abundant, whether the stakeholder can be represented in relevant areas, and whether the stakeholder is influential. The ACEA and the ICCT can be considered representative in transition from combustion vehicles to new energy vehicles. The ACEA is an association which unites Europe's 16 major vehicle, truck, van, and bus makers (ACEA, 2021). It can be considered an important voice of the auto industry, and it can be a technological leader, providing different transportation solutions. The ACEA, as an actor in the auto industry, reflects the interests of mobility manufacturers, auto industry workers, transportation operators and users, and dwellers in the EU member countries. This association advises policymakers, helping them make suitable decisions on transportation and other relevant areas. The founding members of the ACEA include Daimler-Benz, BMW, Ford, Porsche, Volkswagen, and some other vehicle manufacturers. Another selected

stakeholder, the ICCT, is a group dedicated to decreasing the influence of climate change, increasing energy efficiency in transportation, and improving environmental performance (ICCTA, 2022). Founded by ClimateWorks Foundation, the William and Flora Hewlett Foundation, the Energy Foundation, and other foundations in 2001, this association aims to provide unbiased research on environmental regulations and multidisciplinary policy perspectives to policymakers.

Additionally, the narratives from the ACEA and the ICCT are abundant on their official website, more than the rest of the stakeholders, and these two stakeholders are influential enough in the transition between the combustion vehicle and new energy vehicles. Therefore, this study selects the ACEA and the ICCT as the stakeholders to analyze their narratives.

1.2 Research objective

After the EU Green Deal, European policymakers pay more effort to energy transition in transportation, especially new energy vehicles. Some policies were made to prompt the new energy vehicles, which can yield some adverse effects on the traditional vehicle manufacturers. Policymakers need to analyze the critical information in narratives from different stakeholders to understand what the stakeholders focus on regarding the policies of new energy vehicles, and then they can improve current policies. However, according to research gaps implied by literature reviews in Chapter 2, no narrative analysis focuses on the transition from combustion vehicles to new energy vehicles. Due to this, the research objective is made.

The purpose of this research is: *"to explore the key information in narratives of stakeholders involved in the transition between combustion vehicles and new energy vehicles concerning the EU Green Deal".* Stories from relevant stakeholders are supposed to be identified in this study, and valuable information should be extracted. The comparisons between narratives from different stakeholders can help explore the

narratives' key information. The trend of the narratives is also a perspective of narrative analysis, which focuses on how the narratives change with time, especially before and after the EU Green Deal. The analysis can yield referential values for policymakers, and it can be helpful for people to understand the different stakeholders' attitudes on the energy transition. Policymakers can better understand narratives from stakeholders involved with the transition from combustion vehicles to new energy vehicles due to this study. This study selects the ACEA and the ICCT as the representative stakeholders to analyze their narratives. Policymakers can improve the relevant policies on new energy vehicles based on the research results.

1.3 Research questions

To achieve the aforementioned research objective, the main research question is posed below:

Main research question:

What is the key information in the policy narratives of different stakeholders in the case of transition from combustions vehicles to new energy vehicles concerning the EU Green Deal?

To answer the main research question, there are some sub research questions, shown as below:

Sub research questions:

1. *What is the difference between the narratives of the ACEA and the ICCT with respect to the transition from combustion vehicles to new energy vehicles?*

2. *How did the policy narratives of the ACEA and the ICCT change before and after the EU Green Deal?*

1.4 Relevance with CoSEM

This study can be considered a narrative analysis of energy transition in transportation, especially focusing on the transition from combustion vehicles to new energy vehicles. This transition process can be considered to happen in a complex system, involving different stakeholders, policies and the interactions between the stakeholders. Stakeholders can be policymakers, traditional vehicle manufacturers, workers in the vehicle industry, groups dedicated to energy transition or climate change, customers of vehicles, and so on. Narrative analysis can identify the complexity of the interaction between policy stakeholders, policies, events, and contexts, as well as the results, which are components of the system (Shanahan, 2018). As narrative analysis research, this study explores the narratives of the stakeholders to identify the stories from the narratives, which yield a better perspective of the policies, the stakeholders, and the interactions in this complex system. This can be an element of CoSEM research.

Additionally, CoSEM research is multidisciplinary, involving different domains and subjects. This research focuses on policy issues, energy transition, narrative analysis, and NLP (natural language processing), which cover different subjects and areas to be considered an element of CoSEM research. The technical component is also clear, and both the qualitative and quantitative approaches are used in this study systematically, which means the research steps in this study are consistent with each other, and they form a logical way to conduct the entire study.

As for the societal relevance, policymakers can make new policies or regulate the current policies about the energy transition on vehicles based on this study. This can help the policymakers improve the policies, which can benefit the energy transition process on the vehicles in the EU member countries. After the EU Green Deal, the EU member countries tend to focus more on climate change and energy transition, which need suitable policies. From the stakeholders' narratives, the policymakers can better understand the problem and make more suitable policies. Better policies can motivate

potential customers to purchase new energy vehicles, decreasing carbon emissions and accelerating the energy transition process. This can rebuild citizens' commuting habits and purchase vehicles, increasing the share of clean transportation, which is positive for decreasing climate change in the long term.

1.5 Thesis structure

Chapter 1 will first describe the background information and then illustrate the problem, research objective, the research questions of this study, relevance with CoSEM, and thesis structure. The second chapter comprises two literature reviews about some policies of new energy vehicles according to the EU Green Deal and narrative analysis studies, respectively. The data will be selected in Chapter 3. Then two methods will be illustrated and applied in this chapter. In Chapter 4, the results of narrative analysis by computational text methods will be described. The last chapter includes the conclusion, discussions, scientific contributions of the study, the limitation of the research, avenues for future research, and policy implications.

Figure 1 shows the structure of this thesis. In Figure 1, orange rectangles mean the research steps, green rectangles indicate five chapters, blue rectangles mean research methods, and blue arrows in Figure 1 means the relationship between different research steps. Figure 2 shows the legend. Each chapter is based on the previous chapter as a continuation, so there are several blue arrows between the adjacent chapters. The research steps in Chapter 3 show progressive relationships, so there are some arrows between the steps. In Chapter 4, comparison of the narratives is based on analysis of the results. So, there is a blue arrow between these two steps.
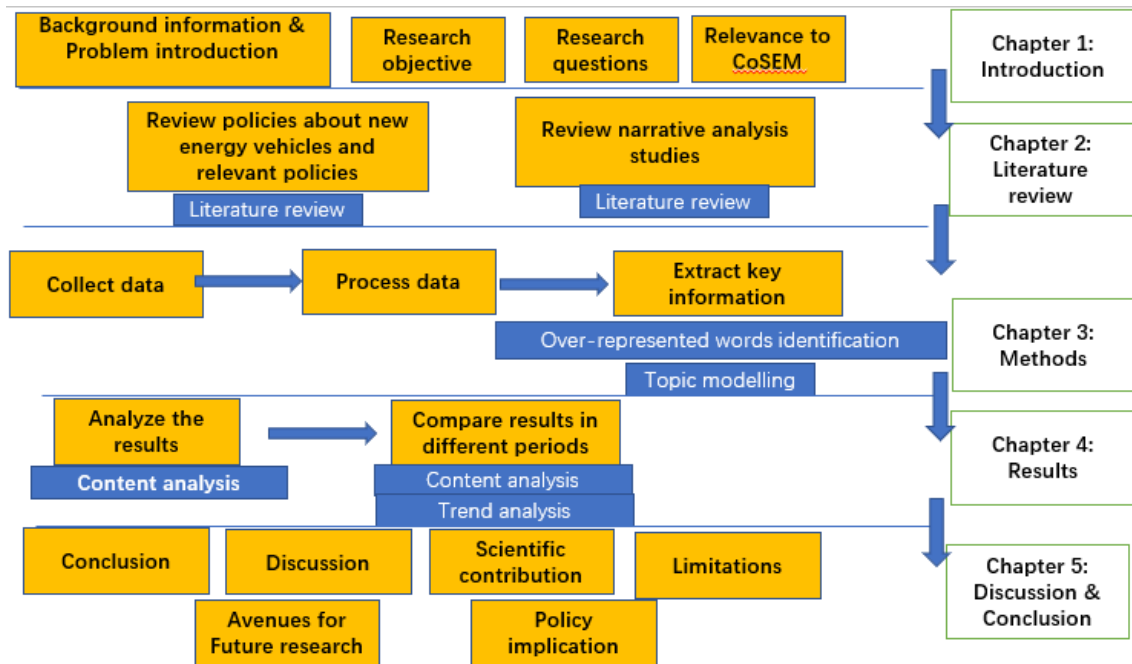
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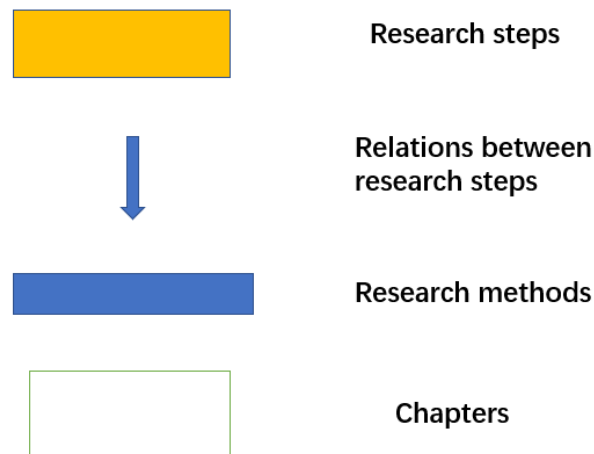
Figure 1: Research Flow Diagram

Figure 2: Legend of diagram

Chapter 2 Literature Review

Chapter 2 is about two literature reviews, including a review of the articles about the policies of new energy vehicles about the EU Green Deal and a review of the methods used in narrative analysis. The literature review results can yield the research gap at the end of the chapter.

2.1 Review of current studies about the transition on vehicles concerning the EU Green Deal

The EU Green Deal, approved in 2020, has been focused on by researchers dedicated to energy transition and environment protection in European countries, which has yielded lots of literature in recent years. This study selects some articles about the policies regarding the transition from combustion vehicles to new energy vehicles according to the EU Green Deal, focusing on the primary stakeholders involving the relevant policies, the main challenges to the policy, the relevant areas, and some specific relevant policies. Some keywords are used to select the literature on the *Web of Science*, including "electric vehicle", "electric car", "new energy vehicle", and "new energy car". This literature review selects seven articles regarding energy transition policies on vehicles in Europe. Noticeably, no relevant research conducts a narrative analysis of this topic.

Stakeholders in most of the selected articles include the EU parliament, which can be considered the most important policy maker in the EU member countries, making different kinds of policies about the new energy vehicles. For example, Haas, T., & Sander, H. (2020) showed the EU parliament making the policy regarding vehicles emission standard, and Magdalena KAUP et al. (2021) explored how the EU parliament make policies about the investment of the electric vehicles charging points. Apart from the EU parliament, some relevant associations like the EEA (European Environment

Agency) are also considered in some papers, such as Tsakalidis, A. et al. (2020), which discussed the transition of alternative fossil fuel and the new energy vehicles in the European countries. On the other hand, there are some stakeholders may have different opinions on the policy regarding the transition between combustion vehicles and new energy vehicles, including drivers and some associations like the ACEA, which is shown in Seo, D. S. (2021). The ACEA thinks the Green Deal policies can be negative for some traditional industries, such as oil companies and traditional vehicle manufacturers, and some countries like Poland cannot benefit so much from the economic structure. Additionally, there are still other stakeholders or areas in the selected articles, like Ortega-Cabezas et al. (2021), discussing the local workers under the new policy regarding the vehicles, and Tsakalidis, A. et al. (2020), which focused on the collaboration between governments, enterprises, and academia sectors to make the relevant policies. Haas, T., & Sander, H. (2020) also discussed the vehicle manufacturers in the EU member countries, showing how they will face the EU Green Deal policies.

These studies also show some challenges to the relevant policies under the EU Green Deal. For example, Tsakalidis, A. et al. (2020) indicated that society often shows reluctance towards embracing new technologies and the transport sector, falling within the "legacy sector" categorization, has been showing signs of resistance towards the introduction and scale-up of innovations. Haas, T., & Sander, H. (2020) showed that recently climate issues are usually heavily politicized, so sometimes the relevant policies cannot benefit some industries and some countries. The EU's existing power balance and institutional configurations inhibit a more far-reaching and problem-adequate approach to the ecological crisis in the transport sector. Some selected papers illustrate the specific laws or policies about the transition between combustion vehicles and new energy vehicles. For example, Magdalena KAUP et al. (2021) introduced some relevant regulations, such as Directive 2014/94/EU, regarding the deployment of alternative fuels infrastructures, and the Act of January 11, 2018, by the Polish government about the electromobility in Poland. Haas, T., & Sander, H.

(2020) introduced the EU Green Deal regulations, which is that vehicle manufacturers are supposed to decrease the average carbon emissions of their combustions by 37.5% during the next 10 years, according to the EU Green Deal. Noticeably, there is no existing research about the EU Green Deal covering the policy narratives of the stakeholders. Most relevant studies only focus on policies and regulations. This can be considered a research gap for this study.

2.2 Review of the literature on narrative analysis

Apart from reviewing the policies of the EU Green Deal, this study also selects some articles about the narrative analysis, which can yield the research gap and be referential to finding the methods used in this study. This review focuses on the literature topics, the database of the studies, and how the researcher conducts the studies.

Some keywords are used to select the literature on *Web of Science*, including "narrative analysis" and "narrative policy analysis", which results in 2032 articles. About 15 pieces of literature are chosen to conduct the literature review in this study, including the theories of narrative analysis like Brathes & Duisit (1975) and the application of narrative analysis such as Mura & Sharif (2016) and Muto (2017). Some studies applying narrative analysis use NPF (Narrative Policy Framework), like Shanahan et al. (2011), and some papers use NLP (Natural Language Processing) to analyze the narratives, like Jing & Ann (2021).

Narrative analysis is a popular approach for researchers in social science, which can be used on different topics. For example, Mura & Sharif (2016) focused on the narratives from employees working in tourism, while Murray (2000) analyzed the narratives about health psychology. Upham et al. (2016) selected the narratives about energy and sustainability, focusing on different participatory energy scenarios. Apart from this study, Muto (2017) also focused on energy, involving the discussion of smart grids.

There are also some narrative analysis studies about history and religion, like Rehm (1999). Additionally, Bontje & Slinger conducted a narrative analysis in 2017 involving coastal management and governance. The topic of O'Leary et al. (2017) focused on public health. Some literature analyzes the narratives from the policymakers involving public place management policies like Shanahan et al. (2011).

The type of database can also be a part of the review. Narrative analysis studies select different types of narratives, including journals, videos, speeches, reports, interviews, articles, and even content from the social media of the stakeholders. For example, Mura & Sharif (2016) analyzed the narratives in journals, including the papers published until the end of February 2016, from 61 journals about tourism and hospitality. Some articles use the narratives from the official websites of the policymakers, like O'Leary et al. (2017). Video can also be the data source to conduct the narrative analysis study, like McBeth (2010), which used YouTube as the database in the study. Some databases of the selected literature are taken from the articles published in the newspapers, which can represent the policy makers' standing points, like Blair & McCormack (2016) and Jing & Ann (2021) focused on narratives in social media, selecting twitters from politicians from different parties in the US during the pandemic. Upham et al. (2016) selected transcripts from different cities in all scenario sessions. Bontje & Slinger conducted a narrative study in 2017, selecting the interviews of the stakeholders from September 2013 to November 2015 in the workplace as the database. Muto (2017) selected the discourses about the policies of smart grid standardization in recent years.

As for how the researchers conduct the narrative analysis study, some narrative analysis studies use NPF (Narrative Policy Framework), focusing on narrative elements and narrative strategies. Table 4 in Appendix A shows a review of 10 NPF studies, including the areas, the data source and methods used in the NPF studies. For example, Brown M. (2019) focused on narrative elements, classifying the narratives by character identification, which means the data can be considered to belong to "Hero", "victim",

or "Villain". Some NPF studies also classify the data by narrative strategies like N. Ertas & A.N. McKnight (2020), which focused on the causal mechanisms of the narratives, dividing the data into different types of causal mechanisms. Some paper use devil-angel shift based on the narrative elements, like Schlaufer et al. (2021). Based on the narrative policy framework, frequency analysis is often used to get the percentage of a different type in the framework shown in the narrative basements from some stakeholders. Apart from NPF, many selected pieces of literature take a structural approach without NPF to conduct the narrative analysis. For example, like NPF, Franzosi (1998) divided the narratives into different groups by criteria, such as "whether this narrative violates the law". Brathes & Duisit (1975) and Mura & sharif (2016) also structurally conducted the narrative analysis, dividing the selected narratives into different groups, showing the percentage of data from specific stakeholders to some specific groups. Additionally, some researchers use some NLP methods to analyze the narratives. For example, Jing & Ann (2021) analyzed Twitter from politicians of the democratic party and the Republic party during the pandemic, using some NLP methods to extract useful information, which includes over-represented words count, micro-frame analysis and semantic role labelling, resulting in the comparison between the narratives from these two parties. Heidenreich et al. (2019) used topic modeling to analyze the narratives about the refugee issues in European countries, resulting in different topics of the narratives. Also, casual inference can be used in narrative analysis, like Valeri & Coull (2016), which analyzed the gender bias from the narratives.

2.3 Research gap

The literature review above implies some research gaps relevant to this study. According to the review of the current studies about the EU Green Deal, the selected studies always discuss how the policies affect the stakeholders and what is the content of the relevant regulations. However, it is hard to find studies using the structural approach to analyze the narratives. According to the EU Green Deal, most studies do

not apply NLP methods to analyze the transition between combustion and new energy vehicles.

As for the literature review on the narrative analysis studies, firstly, some research focuses on energy issues, such as Upham et al. (2016) and Muto (2017), but the narrative analysis studies cover the transition between combustion vehicles and new energy vehicles is limited. Moreover, most studies do not focus on how the policy narratives change along with the time before and after the policies are released. The policy and public attitude toward the new energy vehicles can be considered a long period, which needs several years to observe by the researchers. Due to this, this study tends to compare the narrative before and after the relevant policies across the level of several years.

Chapter 3 Methods

This research applies computational text analysis to identify the main narratives of the selected stakeholders in the mobility transition. This chapter describes how the data is selected and processed and the text techniques in this research, including over-represented word identification and topic modeling. Ninety-three press releases from the ACEA and 56 press releases from the ICCT published during 2018 - 2022 are collected in this research. Also, the motivation for choosing these data will be described. TF-IDF is used to filter the unimportant words before applying the computational text techniques. Frequency count and topic modeling identify the over-represented words and topics in narratives.

3.1 Data collection

The type of data to be used to analyze should be clear. In the narrative analysis, there are different kinds of data, including press, interviews, reports, newspapers, videos, and even social media, which have different advantages, and disadvantages. The press release will be used in this research. By comparison with social media, the content of press releases can be considered abundant to extract the key information from one unit of data, especially for relation extraction, which needs enough content to identify the relationship between different stakeholders shown in the narratives. Compared with interviews, position papers and speeches, the number of press releases from stakeholders is higher, which can be easier to collect the research data. Additionally, by comparison with media reports, press releases will be collected involving stakeholders directly. For example, potential stakeholders have websites which can provide enough press releases about the relevant topics, expressing the stakeholders' opinions or insights on the policies. Some specific search terms relevant to the topic can be used, and the data should be classified by different years.

Relevant press releases about the transition from traditional combustion vehicles to

new energy vehicles in European countries can only make up a part of all narratives from their official websites. The narratives from these stakeholders also include other vehicle domains but are not relevant to the new energy vehicles. Due to this, some keywords are used to select the relevant narratives, including "electric vehicle", "electric car", "new energy vehicle", "new energy car", and so on. The EU Green Deal was made in December 2019, so the time scoping of the narratives to be selected should be near the time of the EU Green Deal. Moreover, the release time of the data should not be so far from the EU Green Deal. In this study, the time scoping of the narratives is set from 2018 to 2022, which means only the data from this period should be selected. The data in 2022 is selected until June 30th. Figure 3 and Figure 4 show the number of press releases selected in different years from the ACEA and the ICCT, respectively. The numbers of the selected data of the ACEA from 2018 to 2022 are 29, 16, 19, 18, and 11, respectively, while the numbers of selected data of the ICCT from 2018 to 2022 are 13, 5, 15, 15 and 8, respectively. In total, there are 149 narratives to be analyzed in the database of this study.
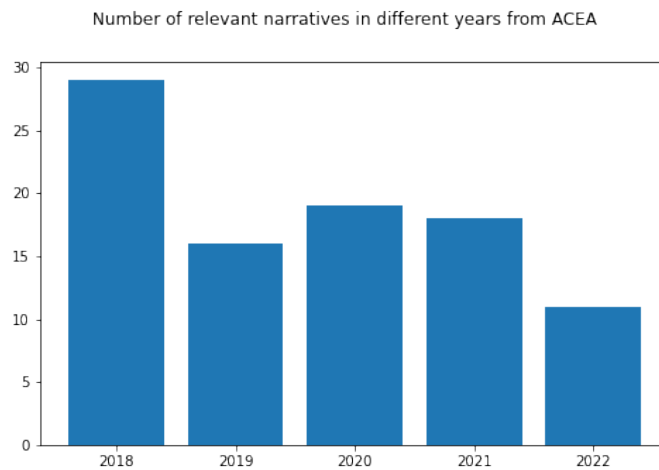
Figure 3: Number of relevant narratives in different years from the ACEA
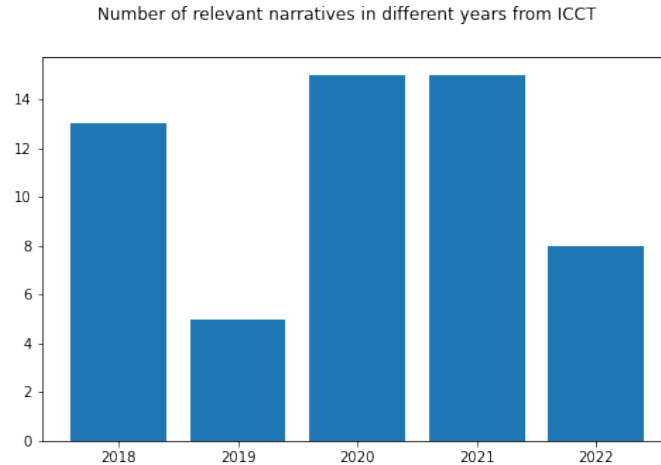
Figure 4: Number of relevant narratives in different years from the ICCT

3.2 Data processing

After selecting the narratives, the data should be processed as other NLP studies for the next research step. Firstly, the punctuation in the text should be removed according to the punctuation from the String package. Then tokenization should be conducted, which is a necessary task to split the sentences, resulting in individual words to be applied by the NLP methods in the next step. This study uses the *Spacy* (Honnibal, M., & Montani, I., 2017) to tokenize each word in the narratives. For example, a sentence, "I love the Netherlands", will be split into three separate words, including "I", "love", and "Netherlands". After tokenization, the words should be transferred into the lower case, and then the stop words in the text should be removed. Both steps use the package *NLTK* (Bird, S., Klein, E., & Loper, E., 2009). Stop words are a set of words commonly used in all texts, including "be", "and", "the", "is", "so", and so on, which should be filtered in the NLP tasks. Finally, lemmatization should be done for the words by the package *Spacy* (Honnibal, M., & Montani, I., 2017), meaning each word should be transferred to the base root form. For example, "cars" should be switched to "car". After these steps, the NLP tasks can be conducted in this study.

3.3 Over-represented words

The first NLP task in this study is over-represented words identification, counting words

with high frequency in the narratives, by the package *NLTK* (Bird, S., Klein, E., & Loper, E., 2009), which can yield a list with the words shown mostly and their frequencies. This method can help researchers understand what the stakeholders focus on in different periods of the mobility transition policies, and according to the difference between the frequently-used words from different stakeholders in different years, the researchers compare the narratives and focus on how the narrative change.

However, some words often appear in every narrative but do not have a high value, similar to the stop words, which makes it hard to get valuable results because these low-valuable words with high frequency will make up the list in the results. To solve this problem, TF-IDF should be used to process the data. TF-IDF means "Term Frequency – Inverse Data Frequency", which can filter some words always shown in every data with a lower value. In this technique, each word will get a TF-IDF value by the formula below:

$$w_{i,j} = tf_{i,j} * \log(\frac{N}{df_i})$$

tfi,j means the number of occurrences of the word I in document j, dfi indicates the number of documents containing the word i, N means the total number of documents, and the formula of tfi,j is shown below:

$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{i,j}}$$

This study applies the package *Gensim* (Rehurek, R., & Sojka, P., 2011), which can automatically get the values of each word in the narratives. According to the definition of TF-IDF, the word is more important if its TF-IDF value is higher. The threshold value can vary in this study. Some threshold values are used to filter the unimportant words. After comparing the results, 0.03 is selected to be the threshold to show the over-represented words, which means if the value of the word is lower than 0.03, it will be removed. After filtration, the words with high frequency will be counted. The results are shown in the next chapter.

Another way to visualize the words with high frequency is the word cloud, by the package *WordCloud* (Oesper, L. et al., 2011). In the result of the word cloud, the word has a higher frequency if it has a bigger size in the figure. *WordCloud* is used after the filtration by TF-IDF. The results are shown in the next chapter.

3.4 Topic modeling

The second NLP task applied to this study is topic modeling. Topic modeling is a commonly used method to find the latent topics in the narratives, and it can help researchers have summarization and interpretation to the selected data (Luo et al., 2020). To conduct topic modeling, LDA (Latent Dirichlet Allocation) can be used to identify the latent topics. As an unsupervised algorithm, LDA does not need to make the topic labels for training manually. Each topic is characterized by a word distribution, and the narratives are mixed over the latent topics (Blei. D et al., 2003). In this study, the package *Gensim.LDA* (Rehurek, R., & Sojka, P., 2011) is used to gain latent topics. Noticeably, to increase the performance of the topic modeling, some steps should be done before applying LDA. Similarly, TF-IDF should also be used to filter some unimportant words, and the threshold is set as 0.035. Noticeably, the threshold value of TF-IDF used in topic modeling differs from that in over-represented words. By several experiments with different threshold values, 0.035 can be considered a suitable value to make the coherence have a local minimum value with a small number of topics. Other thresholds can have a local minimum value when the number of topics is more than 20, which makes each topic too trivial to be labeled. Therefore, the suitable threshold of TF-IDF is selected as 0.035 for this study.

The number of topics should also be considered in the topic modeling. *Gensim.LDA* can yield a set of topics and corresponding topic words, and the number of the topics is a parameter of *Gensim.LDA*, which researchers should set. To decide the number of topics, the U_Mass Coherence Score is used. This study uses the package *CoherenceModel*, imported from *Gensim.model* (Rehurek, R., & Sojka, P., 2011). The

model has different coherence scores when the number of topics in the model varies, resulting in a coherence score figure, where the X-axis means the number of topics and the Y-axis means the coherence score. Generally, the suitable number of topics in the model is at the lowest point in the figure.
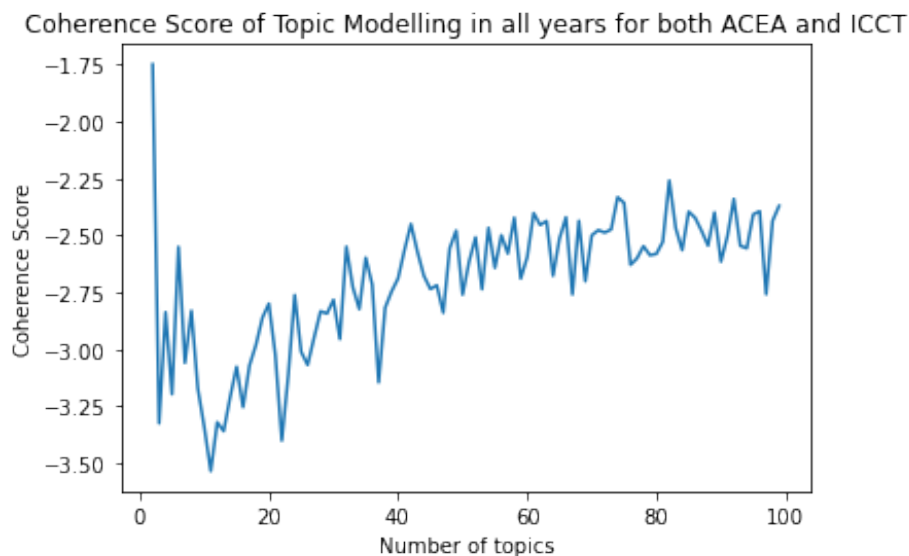
Figure 5: Coherence score of topic modeling in all years for both ACEA and the ICCT

According to Figure 5, when the number of topics is 11, the U_mass coherence score is lowest, which means the model performs well. So, there will be 11 topics extracted from the database.

To show the results of the topic modeling better, *pyLDAvis.gensim_models* (Chuang, J. et al., 2014). Figure 6 shows an example of the visualization by pyLDAvis.gensim_models. It is an intertopic distance map which illustrates topics in a two-dimensional space. This method can gain the topic proportion in the whole database, which means the percentage of contents related to the topics. The size of the topic circles is proportional to the number of words related to the topics in the database. The X-axis and Y-axis in Figure 6 shows two properties of each word vector belonging to each topic word, which is projected in this two-dimensional figure. The

topics located close to each other indicate that the meanings of topic words belonging to these two topics are similar.
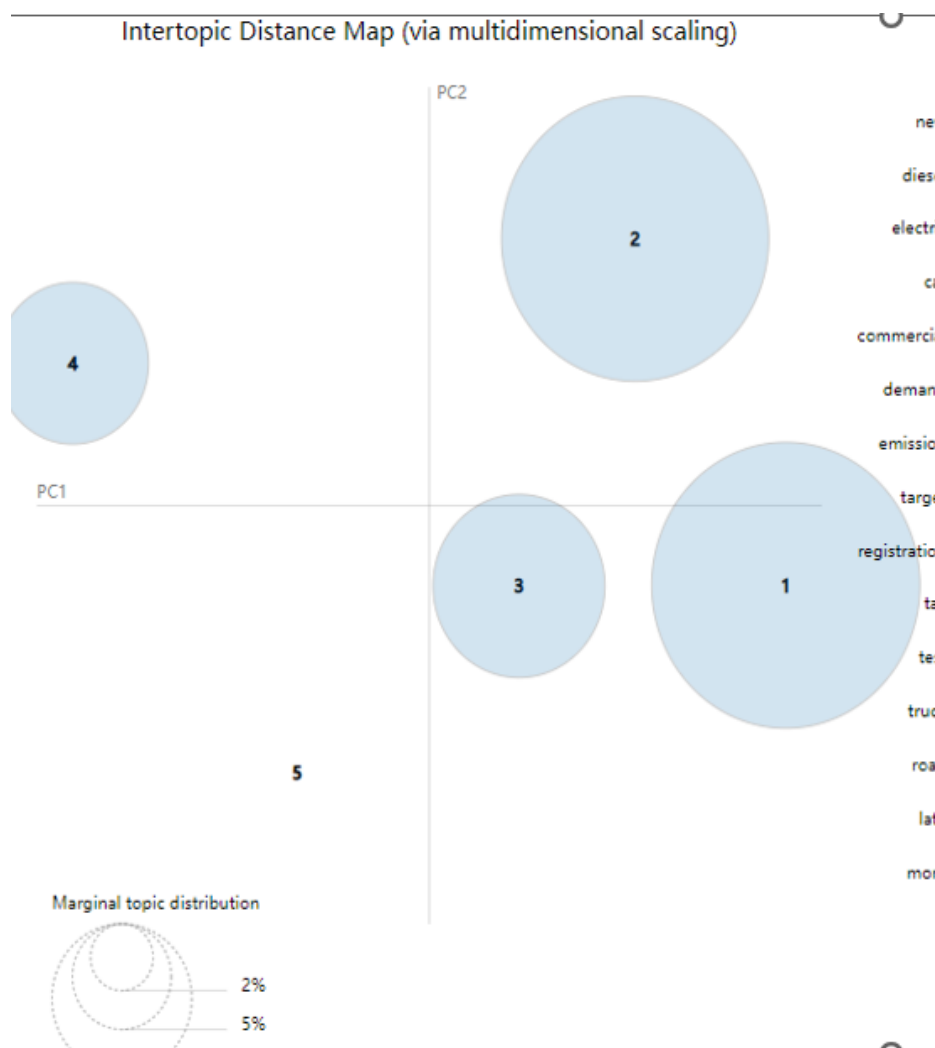
Figure 6: Example visualization of the intertopic distance map

The topic distribution in each narrative will be gained by *get_document_topics*, which is still a function of the *Gensim.Model* (Rehurek, R., & Sojka, P., 2011), which can result in how much percentage of the content in each narrative is related to the topics. For each topic, an average percentage of a set of narratives from a stakeholder in a period can be calculated. This step is prepared for comparison between different stakeholders in different years. The narratives from stakeholders in different years obtain the topic percentage.

Chapter 4 Results

This chapter illustrates the results of the study. First, the word clouds and the top 20 words with the highest frequency from the stakeholders in different years will be described to show the over-represented words in the narratives. Then the results of the topic modeling will be described, including the introduction of 11 topics, the topic distribution by stakeholders, and topic trends. The detailed figures are put in some tables in the Appendix. After both techniques, the summary of the findings will be described.

4.1 Results of the over-represented words

The results of over-represented words are described in this sub-chapter, including the results of narratives from the ACEA and the ICCT, respectively, as well as the summary of the results.

4.1.1 Results of the over-represented words of the ACEA

The results of word clouds for ACEA are shown in the figures below, from Figure 7 to Figure 12, which describe the words with high frequency in the narratives of the ACEA in all years, 2018, 2019, 2020, 2021, and 2022, respectively. The higher the word frequency, the bigger its size in the word clouds. Noticeably, some words seem meaningless, like "zipse", a manager's name from the ACEA, and "re", a prefix. These unimportant words are not analyzed in this study but are just shown in the figures and the table to keep the initial results.

According to Figure 7, the most commonly used words in the narratives from the ACEA in all years include "bus", "diesel", "public", "growth", "registration", "charger", "operator", "report" and "petrol". In 2018, the most commonly used words in ACEA's narratives include "diesel", "vote", "report", "test", "legislation", "benchmark", "tax", "cost", "availability" and so on, which is shown in Figure 8. In 2019, the words with high frequency from narratives of the ACEA include "diesel", "tax", "public", "refuel",

"report", "plan", "electricity" and so on, which is shown in Figure 9. According to Figure 10, the words most frequently shown in the narratives from the ACEA in 2020 include "registration", "automotive", "economy", "bus", "diesel", "neutral", "job" and so on. In 2021, the most frequent words from narratives of the ACEA include "bus", "charger", "bind", "tax", "neutral", "review", "sustainable" and so on, which is shown in Figure 11. Figure 12 shows the commonly used words in narratives from the ACEA in 2022, including "public", "unit", "charger", "stop", "operator" and so on.

Figure 7: Word Cloud of words with high frequency in narratives from the ACEA in all years

Figure 8: Word Cloud of words with high frequency in narratives from the ACEA in 2018

Figure 9: Word Cloud of words with high frequency in narratives from the ACEA

in 2019

Figure 10: Word Cloud of words with high frequency in narratives from the ACEA

in 2020

Figure 11: Word Cloud of words with high frequency in narratives from the ACEA

in 2021

Figure 12: Word Cloud of words with high frequency in narratives from the ACEA in 2022

Table 1: Words with high frequency in narratives from the ACEA

	2018	**2019**	**2020**	**2021**	**2022**	**all year**
1	diesel	public	automotive	bus	public	diesel
2	vote	diesel	re	charger	unit	bus
3	report	petrol	recovery	bind	stop	tax
4	test	tax	plan	review	charger	automotive
5	fact	refuel	bus	tax	operator	registration
6	realistic	report	registration	re	almost	public
7	automotive	work	gas	global	freight	petrol
8	registration	system	diesel	neutral	quarter	re
9	recharge	plan	energy	goal	association	report
10	tax	growth	covid	hand	period	plan
11	month	compare	economic	zipse	location	unit
12	legislation	global	economy	stop	system	vote
13	explain	confirm	neutral	average	diesel	system
14	reality	bus	job	almost	registration	growth
15	simply	electricity	crisis	diesel	analysis	work
16	development	operator	register	suitable	hand	operator
17	condition	meaningful	unit	short	growth	grow
18	benchmark	lack	production	operator	vote	quarter
19	so	association	chain	network	ramp	neutral
20	environment	barrier	renewable	ceo	different	register

Table 1 shows 20 words with the highest frequency in the narratives of the ACEA from 2018 to 2022, and the words with high exposure from all years are also shown in the table. Table 5 attaches the frequency of these words in Appendix B.　According to Table 1, the narratives from the ACEA in different years have some common frequently used words which are frequently shown in different periods, like "diesel", "registration", "tax", "petrol", "bus", "operator" and so on, which are always shown in different years.

4.1.2 Results of the over-represented words of the ICCT

The results of word clouds for ICCT are shown in the figures below, from Figure 13 to Figure 18, which describe the words with high frequency in the narratives of the ICCT in all years, 2018, 2019, 2020, 2021, and 2022, respectively. According to Figure 13, the narratives from the ICCT in all years (from 2018 to 2022) mention some words most frequently, including "renewable", "super", "fee", "euro", "hydrogen", "feebate", "saving", "trailer" and so on. In the data of the ICCT in 2018, "feebate", "super", "fee", "euro", "trailer", and "ban", and some words are most frequently shown, which is described in Figure 14. In 2019, the most commonly used words in ICCT's narratives included "super", "taxation", "freight", "brand", "adjust", and "delivery", shown in Figure 15. In 2020, the words with high frequency from narratives of the ICCT included "recovery", "crisis", "scrappage", "stimulus", "aid", "reform", "control", and so on, which is shown in Figure 16. According to Figure 17, the words most frequently shown in the narratives from the ICCT in 2021 include "hydrogen", "renewable", "lease", "installation", "grid", "recharge", "producer" and so on. In 2022, the highest frequent words include "legislation", "feebate", "saving", "percentage", "align", "pledge" and so on, which is shown in Figure 18.

Figure 13: Word Cloud of words with high frequency in narratives from the ICCT in all years

Figure 14: Word Cloud of words with high frequency in narratives from the ICCT in 2018

Figure 15: Word Cloud of words with high frequency in narratives from the ICCT in 2019

Figure 16: Word Cloud of words with high frequency in narratives from the ICCT in 2020

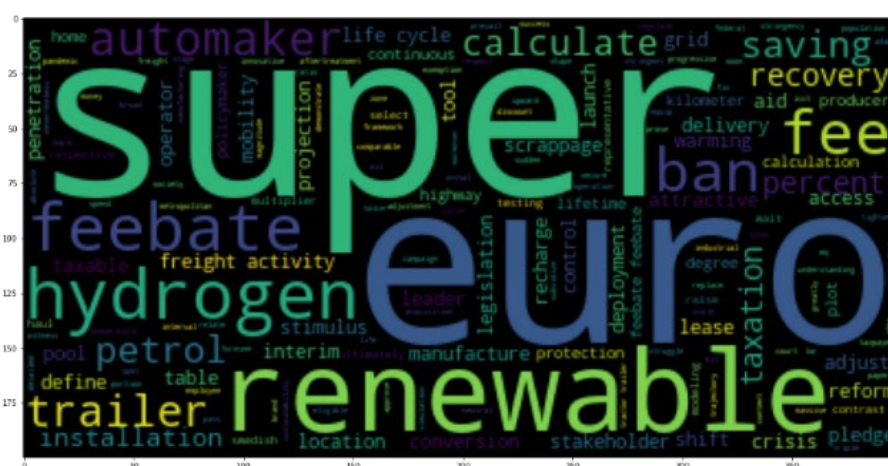*Figure 17: Word Cloud of words with high frequency in narratives from the ICCT in 2021*

Figure 18: Word Cloud of words with high frequency in narratives from the ICCT in 2022

Table 2: Words with high frequency in narratives from the ICCT

	2018	2019	2020	2021	2022	all year
1	feebate	super	recovery	renewable	feebate	feebate
2	trailer	taxation	scrappage	hydrogen	commit	renewable
3	super	freight	aid	installation	percent	super
4	ban	activity	reform	grid	brand	euro
5	euro	brand	stimulus	lease	pool	hydrogen
6	fee	adjust	crisis	operator	align	trailer
7	automaker	consequence	oxide	life	saving	fee
8	freight	delivery	operation	warming	legislation	ban
9	activity	cc	control	producer	pledge	automaker
10	leader	dead	metropolitan	taxable	cycle	freight
11	table	ratio	taxation	deployment	trajectory	activity
12	plot	reward	petrol	location	life	life
13	saving	former	mobility	projection	interim	cycle
14	calculate	mileage	zone	spot	degree	saving
15	swedish	payload	conversion	interim	fee	petrol
16	multiplier	haul	euro	eq	statement	interim
17	calculation	regulated	management	recharge	petrol	brand
18	court	shift	simulation	planning	euro	zone
19	overcome	manufacturing	testing	orient	stringency	calculate
20	topic	corporate	nitrogen	stakeholder	scope	recovery

Table 2 is the result of 20 words with the highest frequency in the narratives of the
ICCT from 2018 to 2022, and the statistic from all years is also shown in this table. Table
6 includes the frequency of these words in Appendix B. According to Table 2, there are
some words frequently shown in the frequently used word list in different years, like
"feebate", "super", "freight", "saving", "fee", "euro", "automaker", "taxation", "brand",
"petrol", "interim" and so on, which are always shown in a different time.

4.1.3 Summary of the findings regarding over-represented words

Based on the frequency count, a summary of findings is illustrated, which shows what the stakeholders emphasized in different years.

The narratives from these two stakeholders in different years have different words with high frequency. From 2018 to 2022, ACEA focused more on the transition from combustion to new energy on the bus, tax policies on different types of vehicles, neutralization of the climate, and the registration of vehicles. In contrast, ICCT spotlighted more on cost systems like feebate, hydrogen vehicles, the manufacturer of the vehicles, some bans on different types of vehicles, and so forth. In 2018, ACEA focused on registering different vehicles, but ICCT emphasized the cost of different vehicles. In 2019, the narratives from the ACEA frequently mentioned more vehicle types, but ICCT concentrated on tax relevance, freight issues, and vehicle manufacturers. This year, both the narratives from the ACEA and the ICCT focused on tax. The EU Green Deal was held at the end of 2019. In 2020, both data from these two stakeholders addressed some negative influences of the pandemic, involving the economy, crisis, and aid. ACEA focused more on the bus, the jobs in the vehicle industry, and so on this year, but ICCT emphasized reform, management, and control more. In 2021, these two stakeholders focused on charging relevance, electric network deployment, and tax. ACEA addressed bus issues and diesel more, but ICCT focused on hydrogen and other renewable fuels. In 2022, ACEA focused more on the charging issues and registration this year, but ICCT focused on the vehicles' cost system and the vehicles' legislation.

Some common frequently used words are always frequently shown in different periods, like "diesel", "registration", "tax", "petrol", "bus", "operator", "feebate", "super", "freight", "saving", "fee", "euro", "automaker", and so on, which means that the stakeholders always focus on the tax, the cost of the vehicles, different fuels, and manufactures and so on.

4.2 Results of topic modeling

According to coherence score, the suitable number of topics for the topic modeling was selected as 11. Figure 19 shows the topics and the term frequency about data from the ACEA and the ICCT in all years, made by *pyLDAvis.gensim_models* (Chuang, J. et al., 2014). The topic circle with a bigger size shown in the figure means the topic is relevant with a higher proportion in the database, which means more content in the narratives is related to the topic. The topics located close to each other imply that the meanings of these two topics are similar. Figure 19 also shows the top 15 most salient terms about the topic, and each topic has corresponding topic words shown in the model. The topic modeling results include introducing the 11 topics, the topic distribution by stakeholders, the topic trend and summary of findings regarding the topic modeling.
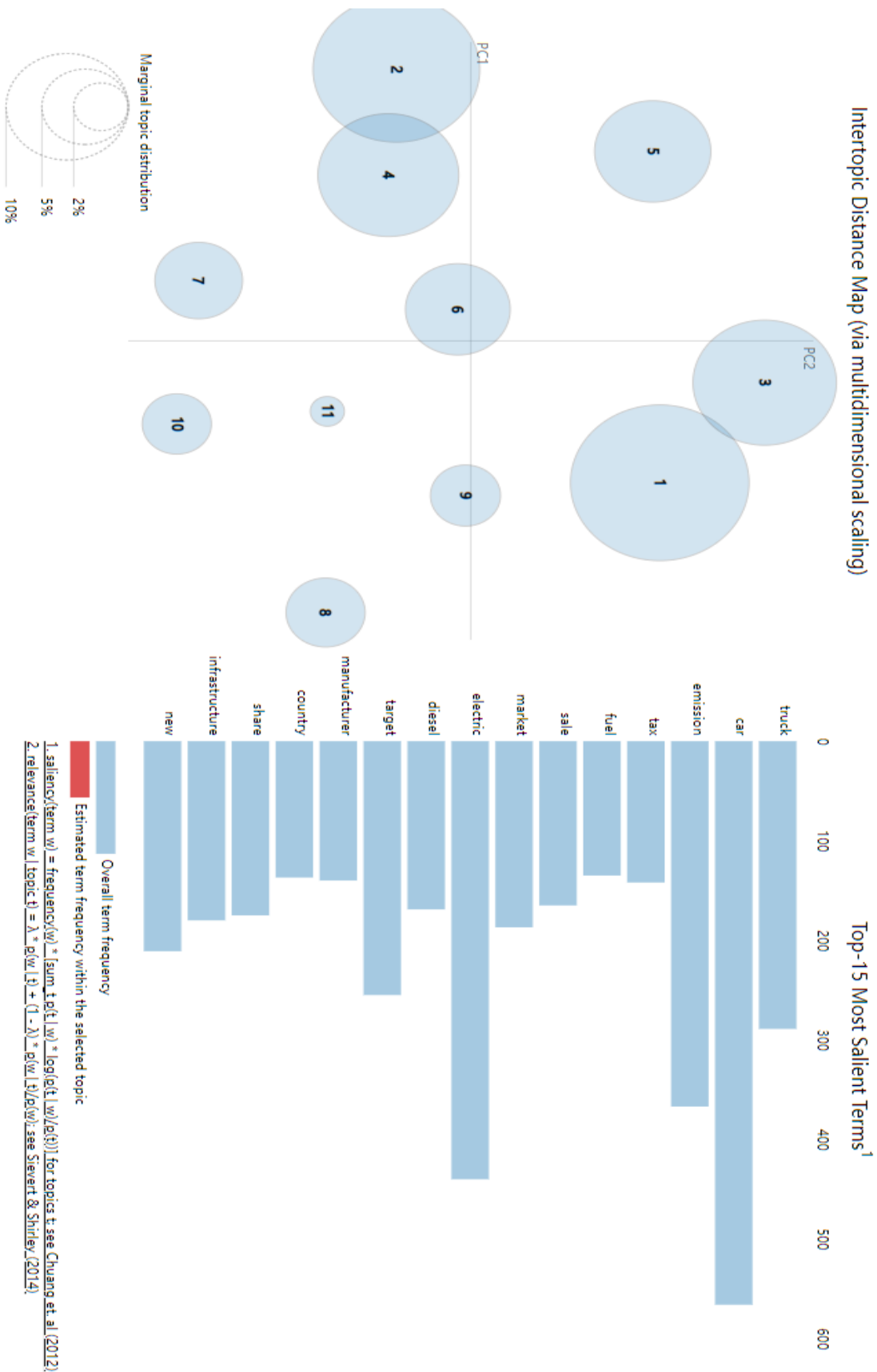
Figure 19: The topics and the term frequency about data from the ACEA and the ICCT in all years

4.2.1 Topic introduction

Table 3: Identified topics and topic words by LDA for ACEA and the ICCT in all years

Topic	Topic label	Topic words	Topic proportion
1	charge points-infrastructure	charge, target, point, sector, need, electric, infrastructure, transport, policy, transition, road, charging, require, proposal, emission	21.3%
2	purchase policy	car, electric, emission, high, year, tax, km, purchase, registration, passenger, new, government, company, plug hybrid, bonus	18.6%
3	investment	infrastructure, industry, charge, target, need, investment, sector, station, member state, mobility, right, support, technology, transport, auto	13.8%
4	manufacturer	electric, manufacturer, target, share, market, sale, car, new, diesel, increase, city, level, about, average, proposal	13.3%
5	market-sale	car, country, market, sale, last, electric, diesel, unit, fuel, total, bus, registration, petrol, increase, sell	9%
6	emission standard	emission, standard, manufacturer, reduction, new, co, baseline, do, average, trailer, super credit, bus, report, have, value	7.3%
7	policy simulation	emission, datum, real-world, test, system, regulation, use, technology, fee, french, utility factor, truck, feebate, rebate, value	5.1%

Table 3 (continued).

8	**truck**	truck, stop, diesel, location, energy, technology, use, study, renewable gas, call, already, approach, area, station, such	4.2%
9	**tax**	tax, emission, fuel, budget, road, base, motor, standard, country, transport, taxation, taxis, government, datum, scenario	3.3%
10	**fuel**	fuel, hydrogen, use, emission, logistic, system, renewable, base, solution, fossil, map, letter, renewable electricity, standard, technology	3.2%
11	**regulation-law**	ban, city, diesel, limit, court, datum, sale, cause, ruling, measure, story, implication, real-world, air pollution, judicial	0.8%

Table 3 illustrates the 11 topics extracted by topic modeling, the relevant topic words, the topic label, and the corresponding topic proportion in the database. The topic with a bigger proportion is put in the upper row, which means topic 1 is relevant with most content in the narratives. The topic labels are gained manually, according to the results of LDA topic modeling, based on the top 15 most salient topic words. Figure 24, and Figure 25 in Appendix C, show the topic distribution for each narrative selected from the ACEA and the ICCT, respectively. The labels of the Y-axis describing the narratives shown in these two figures are marked by different years.

The first topic involves 21.3% of the content in the database, and it is the biggest topic according to the result of topic modeling, which can be labeled as "charge points-infrastructure" by the topic words "charge", "point", "electric", "infrastructure" and so on. This topic focuses on the charge points of electric vehicles and some relevant issues about infrastructures. According to Figure 24 and Figure 25 in Appendix C, some narratives seem highly relevant to topic 1. For example, Peters (2021) discussed how

to decrease the time for electric vehicle charging and illustrates the challenge of the charging points building and using in the current situation, and this whole narrative from the ACEA is about charge points.

Topic 2 is relevant with 18.6% of the content in the database, and the corresponding topic words include "registration", "tax", "purchase", "bonus", and so on. The label of this topic can be "purchase policy". According to Figure 24 and Figure 25 in Appendix C, the narratives from the ACEA do not have much relevance to this topic, while some narratives from the ICCT have high relevance to topic 2. For example, Sandra. W & Uwe.T (2018) described the purchasing policies of the new energy vehicles and took the Swedish government as an example, which shows a system to provide different bonuses and policies according to the emission of the vehicles.

Topic 3, labeled as "Investment", consists of 13.8% of the content of all the narratives from the ICCT and ACEA in all years, and it has some topic words, including "infrastructure", "industry", "investment", "sector" and so on. This topic is about the investment from the governments and the vehicle industry. Some narratives from the ACEA have high relevance with the topic, while the narratives from the ICCT do not have obvious relevance with topic 2. For example, Peters (2019) showed that the public transport sector and the mobility industry hope the EU member states invest in the infrastructures like charge points and refueling alternatively powered buses and discussed the target of the investments of some associations.

Topic 4 consists of 13.3% of the content in the database, and it can be labeled as "manufacturer-target", relevant with some topic words including "target", "manufacturer", "share", "market", "sale", and so on. This topic concerns the manufacturer of vehicles in EU members, their policies, and how the transition will affect their development. The data from the ACEA do not show a close relation with topic 4, while some narratives from the ICCT seem relevant to this topic. For example, the narrative from Peter Mock et al. (2018) discussed how the regulations about

emission standards can affect the profits and development of the vehicle manufacturer and what is the challenge for the traditional vehicle manufacturers according to the transition from internal combustion vehicles to the new energy vehicles.

Topic 5, closely related to 9% of the content in the database, can be labeled as "market-sale", which has some topic words including "market", "sale", "registration", and so on. Some narratives from the ACEA highly relate to topic 5, while the data from the ICCT do not show the obvious relevance of this topic. For example, ACEA (2018) discussed the market of vehicles in EU member states, describing the sale of all kinds of vehicles, including traditional diesel vehicles, electric vehicles, and some other new energy vehicles.

Topic 6 is relevant with 7.9% of content in the database, and its topic label can be "emission standard", with some topic words including "emission", "standard", "reduction", "co", and so on. The selected data from the ACEA cannot show strong relevance to topic 6, while some narratives from the ICCT strongly relate to this topic. For example, Felipe Rodríguez (2018) illustrated the emission standards in EU member states, how the sectors monitor and regulate the emission, and how the emission will reduce if the standard changes.

Topic 7, labeled as "policy simulation", makes up 5.1% of the content of the database with some topic words including "emission", "datum", "test", "system", and so on. This topic is about the simulation of emissions under different policies. The narratives from the ACEA do not have obvious relevance to topic 7, while some narratives from the ICCT strongly relate to this topic. For example, Jan Dornoff (2021) described a simulation of the system about how the emission change according to some conditions, like the policies for the new energy vehicles.

Topic 8 is relevant with 4.2% of the content, labeled as "truck", with some topic words

including "truck", "stop", "diesel", "location", "energy", and so on. Some narratives from the ACEA relate to the topic, and some data from the ICCT also seem to be related to this topic. For example, Felipe Rodríguez (2020) discussed the trucks running on liquefied natural gas (LNG), involving the up-to-date policies and the cost for the drivers.

Topic 9, closely related to 3.3% of the content in the database, can be labeled as "tax", which has some topic words including "tax", "taxation", "budget", "emission", and so on. Both the narratives from the ACEA and the ICCT show relevance to the topic. For example, ACEA (2018) described the taxation on motor vehicles in some EU countries, including registration tax, sale tax, annual circulation tax, road tax, and fuel tax. The new tax guide includes the tax related to emissions. The tax gets higher when the vehicle releases more emissions.

Topic 10 consists of 3.2% of the content in the database, with "fuel" as the topic label, including some topic words like "fuel", "hydrogen", "use", "renewable", "fossil", and so on. The selected data from the ACEA cannot show strong relevance to topic 10, while some narratives from the ICCT strongly relate to this topic. For example, Chelsea.B & Stephanie.S. (2021) illustrated hydrogen, e-fuels, and other renewable fuels, involving the current situation of these different fuels, their pollution of them, and the prospects of these fuels.

Topic 11 only makes up 0.8% of the content in the database, labeled as "regulation-law", and its topic words include "ban", "limit", "court", "ruling", "implication", "judicial" and so on. Only the second narrative from the ICCT is related to this topic. For example, Drew Kodjak (2018) discussed the implications of the bans on some types of vehicles in some European cities. The author also described the relationship between the regulations on traditional combustion vehicles and air pollution.
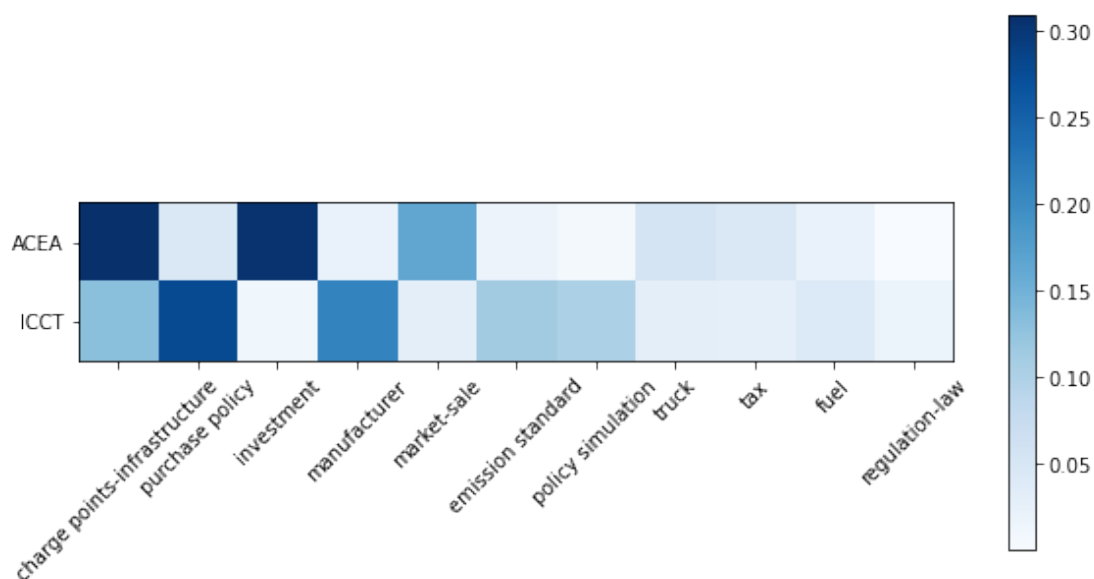
4.2.2 Topic distribution by stakeholders

Figure 20: Topic distribution by stakeholders

Figure 20 shows the topic distribution by stakeholders, describing the average percentage of topics shown in narratives from the ACEA and the ICCT. According to Chapter 3, the topic distribution of each narrative can be gotten, and the proportion in this figure means the average percentage of each topic shown in the narratives from the ACEA and the ICCT. The percentages of content related to all topics are illustrated, and the color of the square is deeper if the corresponding topic involves a higher percentage of content in the narratives. The table with the detailed percentage of the topic distribution of each stakeholder is put in Table 7 in Appendix D.

The ACEA and the ICCT focus on different topics. Some topics from the ACEA are more frequently shown than that in the narratives from the ICCT, including "charge points-infrastructure", "investment", "market-sale", "truck", and "tax". The biggest topic in the narratives from the ACEA is "charge points-infrastructure", which is involved in 30.97% of the data of the ACEA averagely, similarly to the second biggest topic "investment" for ACEA, with 30.53% averagely, while these two topic average percentages in data of the ICCT are only 13.06% and 1.16%, respectively. The third biggest topic for ACEA is

"market-sale", which is relevant with 16.58% of the content of data from the ACEA, while this topic is only related to 3.03% of the content from the ICCT.

The topics in data from the ICCT show different distributions with the ACEA. The top three biggest topics of narratives of the ICCT are "purchase policy", "manufacturer", and "charge points-infrastructure", which are averagely involved at 27.75%, 21.02%, and 13.06%, respectively, while the average percentages of relevant content about these three topics in narratives from the ACEA are 4.61%, 2.15%, and 30.97%, respectively. As for the topic "emission standard" and "policy simulation", on average, they are more frequently involved in the data of the ICCT, with 11.18% and 10.29%, respectively, while the corresponding percentages of the two topics for the ACEA are only 1.82% and 0.64% on average respectively. However, the ICCT focuses less on the topic "truck", "tax", and "fuel" than the ACEA, and the percentages of these two topics in the data of the ICCT are only 3.15%, 2.93%, and 4.24% on average, respectively, while the percentages of these two topics for the ACEA are 5.59%, 4.46% and 2.20% on average respectively. The topic "regulation" shares the least proportion in the data from the ACEA, with 0.06% on average, while the average percentage of this topic in data of the ICCT is 1.92%.
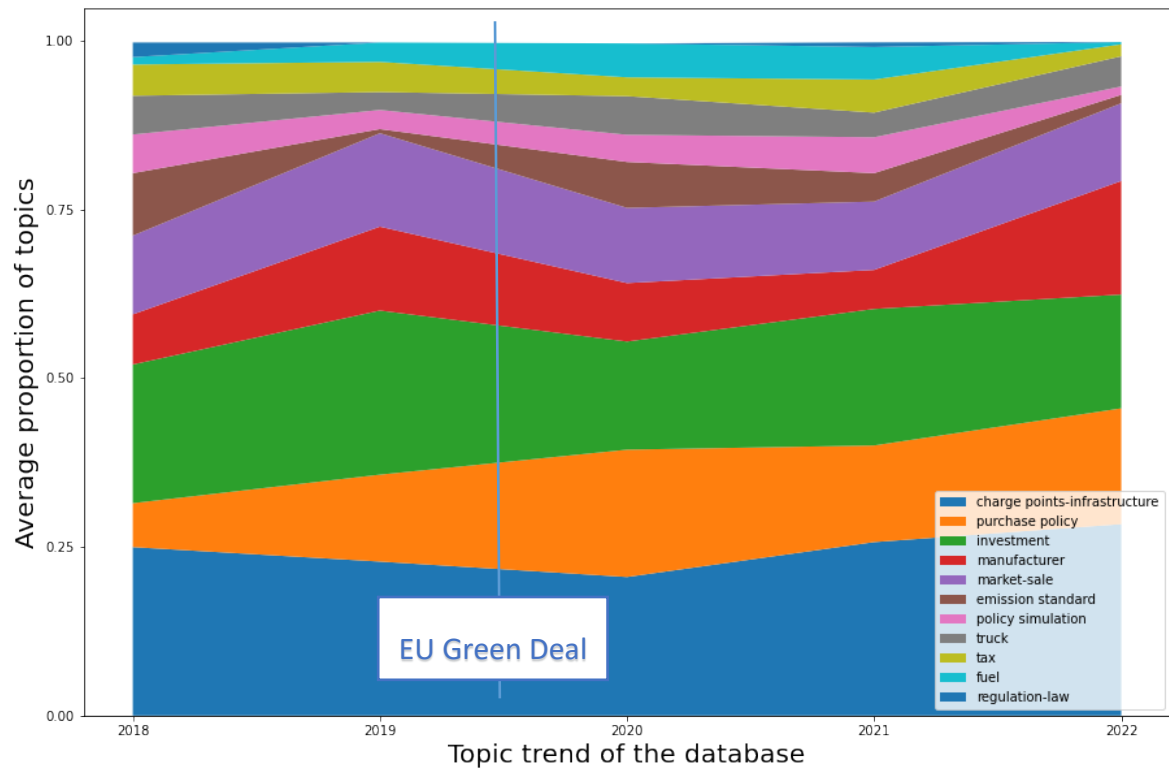
4.2.3 Topic trend

Figure 21: Topic trend of narratives from the whole database

In this study, the topic trend is analyzed based on the average percentage of content related to the 11 topics in narratives from different years. Figure 21 shows the topic trend of the whole database, including the 149 narratives from the ACEA and the ICCT from 2018 to 2022. Y-axis means the average percentage of the topics shown in the narratives from different years, and the detailed proportions are put in Table 8 in Appendix E. The average percentage of the biggest topic, "charge points-infrastructure", in the narratives from 2020 gets the lowest value, 20.52 %, and it shows an upward trend after the EU Green Deal, ending at 28.35% in 2022, which reaches the highest percentage. In the narratives, the average percentage of the second biggest topic, "purchase policy", starts from the lowest proportion, with only 6.51%, and reaches the highest value in 2020, with 18.86%. The average percentages of the narratives from the years after the EU Green Deal are higher than before. The average percentage of the third biggest topic, "investment", gets the highest value in

2019, with 24.30%, which is about 50% higher than its lowest percentage in 2020, and the proportions after the EU Green Deal are lower than before. The average percentage of the fourth biggest topic, "manufacturer", reached the lowest value in 2021, but it gets highest in the next year, with 16.82%. The average percentage of the fifth topic, "market-sale", gets lower after the EU Green Deal, reaching the lowest value in 2021, with only 10.12%, but the highest proportion is in 2019, with 13.84%. The average proportion of the sixth topic, "emission standard", gets highest in 2018, at 9.25%. As for the seventh biggest topic, "policy simulation", the average percentage in the narratives from 2018 reached the highest value, with 5.73%, but the lowest percentage appears in 2022, with only 1.24%. As the eighth biggest topic, the average percentage of the topic "truck" also gets highest in 2018, with 5.74%, but gets lowest in the next year. The average percentage of the ninth biggest topic, "tax", gets highest in 2021 with 4.90% but gets lowest in the next year. Similarly, the average percentage of the topic "fuel" gets the lowest value in 2022, with only 0.33%, but it gets highest in 2020, with 5.03%. As for the smallest topic, "regulation-law", the average percentage of it shows 0% in 2019, 2020, and 2022, and the percentage for 2018 gets the highest value, with 2.16%.
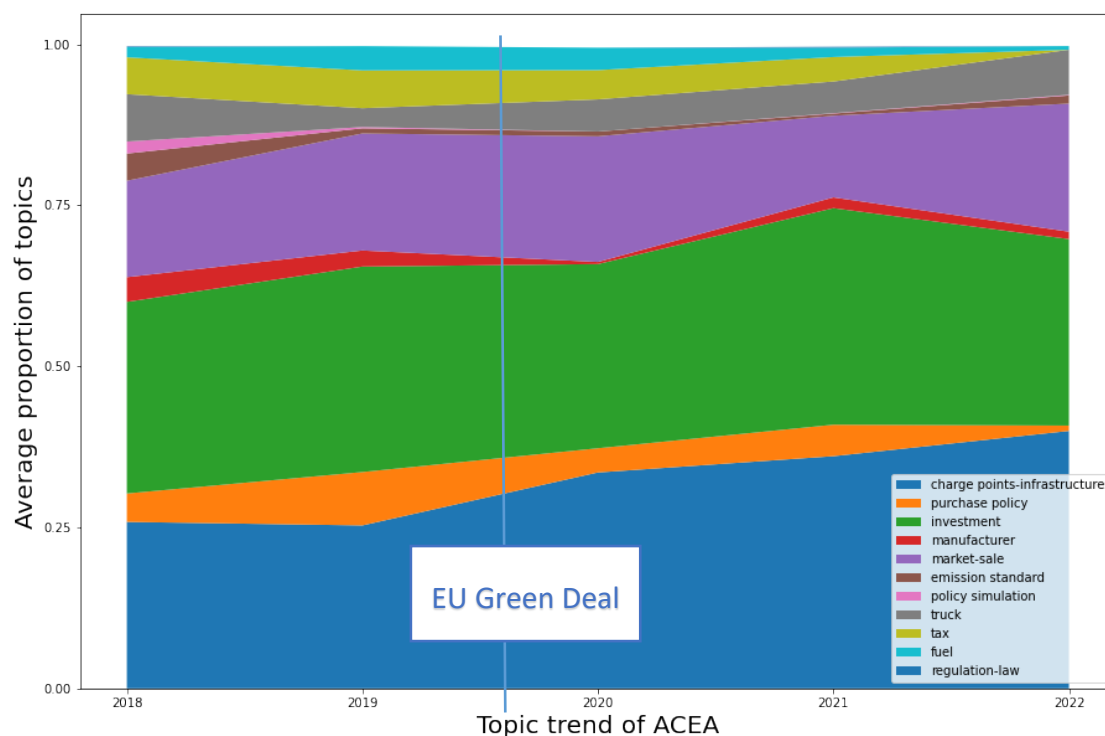

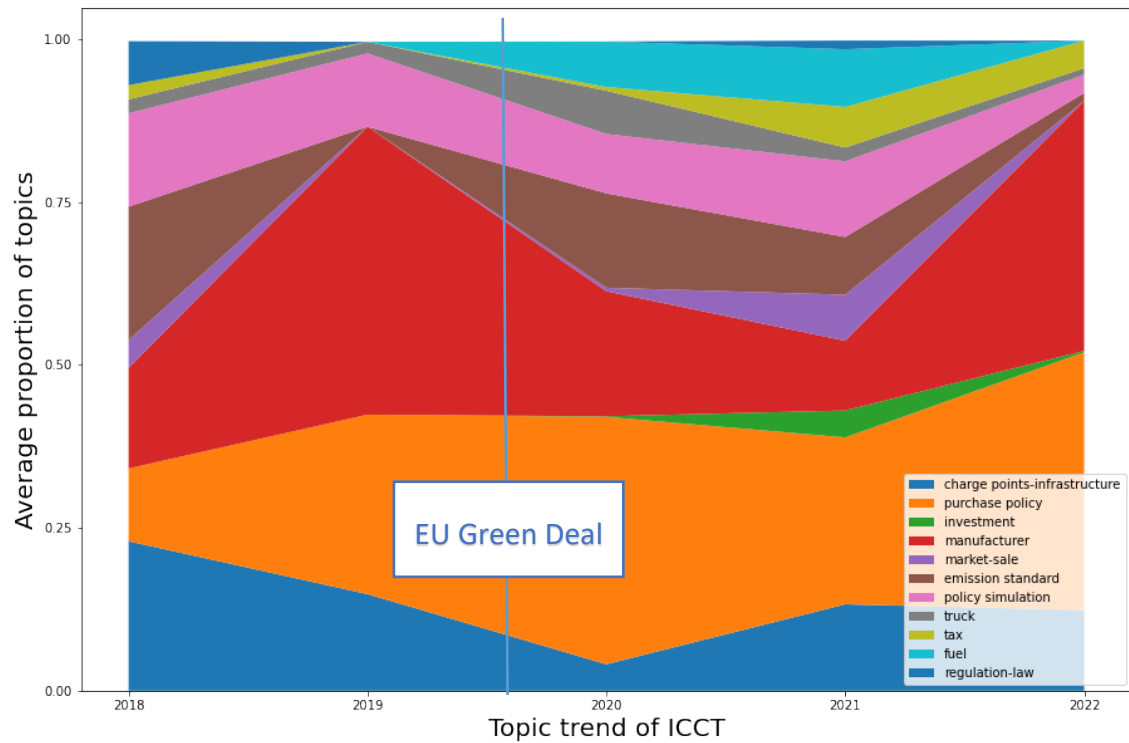*Figure 22: Topic trend of narratives from the ACEA*

Figure 23: Topic trend of narratives from the ICCT

Apart from analyzing the topic trend in the whole database, it is also necessary to conduct an individual analysis of the two stakeholders. Figure 22 and Figure 23 show the topic trend of narratives from the ACEA and the ICCT, respectively. The Y-axis means the average percentage of the topic in the data from a specific year from the stakeholders. According to Chapter 3, the topic distribution of each narrative can be gained, and the proportion in these two figures means the average percentage of each topic shown in the narratives from the ACEA or ICCT in different years. Two tables show the detailed proportion of the topics in different years from the ACEA and the ICCT, which are put in Table 9 and Table 10 in Appendix E, respectively. The EU Green Deal was held at the end of 2019, so there is a line between 2019 and 2020, which means the time of the EU Green Deal.

The biggest topic, "charge points-infrastructure", shows an upward trend in the narratives from the ACEA, and the average percentage of this topic starts at 25.85% in 2018 and ends at the highest value in 2022, with 39.97%, while this topic in the data

of the ICCT is mostly shown in 2018 with 22.95% averagely in the narratives, and reaches at the lowest average percentage in 2020, with 4.06%. The topic is more frequently shown in the narratives of the ACEA after the EU Green Deal than before, but it is involved in less content of the data from the ICCT after the EU Green Deal. The second biggest topic in the database, "purchase policy", keeps a relatively low proportion in the data from the ACEA, and the highest average percentage of this topic is in 2019, with only 8.29%. After the EU Green Deal, this topic keeps less proportion in the data of the ACEA, and it is relevant with the least percentage of the content in 2022, with only 0.83%. As for the data from the ICCT, this topic shows relation with the least average percentage of content in 2018, with only 11.18%, and ends with the highest proportion, with 39.60% averagely. The average percentage of the third biggest topic, "investment", is the green line, which shows a stable trend from 2018 to 2022 in the data of the ACEA, reaching the highest point in 2021, with 33.62%. As for the narratives of the ICCT, the topic shows an upwards trend, especially after the EU Green Deal, and it does not show obvious relation with the narratives before the EU Green Deal, with 0% in 2018 and 2019. The topic was mostly shown in 2021, and the average percentage of this topic is 4.14% in the narratives from this year. The topic "manufacturer" is the fourth biggest topic in the database, which keeps a downward trend for ACEA from 2018 to 2022, relevant with the most percentage of the content in 2018, with 3.84% averagely in the narrative from this year. After the EU Green Deal, the average proportion of this topic for ACEA seems to get less. As for ICCT, the average percentage of this topic reached the highest point in 2019, with 44.20%, while it gets the lowest value in 2021, with only 10.71%. The fifth biggest topic in the database is "market-sale", which keeps a stable trend in the data from the ACEA. The average percentage of this topic fluctuates between 12.67% and 19.88%, and it ends at the highest value in 2022, with 19.88%. As for ICCT, this topic stays at a low level, and the data in 2019 and 2022 do not show obvious relation with the topic, but on average, 7.05% of the content in narratives in 2021 show relation with the topic. The topic "emission standard", the sixth biggest topic in the database, keeps a low level during these years in the data from the ACEA, reaching the highest average percentage in

2018, with only 4.22%. Similarly, the data from the ICCT also have the highest average percentage on this topic in 2018, with 20.48%, but it does not show any relevance in the next year in the data from the ICCT. After the EU Green Deal, it shows a downward trend in the data of the ICCT. For ACEA, the average percentage of the topic "policy simulation" gets the highest value in 2018, with 5.73%, but it reaches the lowest value is 2022, with only 1.24%. As for the average percentage of this topic from the ICCT, it gets the highest value in 2018, with 1.87%, but it got 0% in 2020. The average percentage of the next topic, "truck", gets the highest value in the data of the ACEA in 2018, with 7.35%, but in the next year, on average for each narrative, only 2.92% of the content from the ACEA is about this topic, sharing at the lowest proportion in these years. As for ICCT, on average, 6.65% of the content from the ICCT is about this topic, which reaches the highest proportion in these years. After the EU Green Deal, it shows a downward trend in the data of the ICCT. The topic "tax" shows a downward trend in the data from the ACEA, and after the EU Green Deal, there is less relevant content about this topic in the narratives of the ACEA. In 2019, most content were related to this topic in the data of the ACEA, which gets the highest percentage during these years. After the EU Green Deal shows a downward trend, the average percentage becomes 0% in 2022. As for ICCT, the narratives seemed to focus most on this topic in 2021, and the average percentage on the topic this year is 6.23%. The topic "fuel" is the second smallest topic in the database, which is most frequently in 2019 in the narratives of the ACEA, with 3.77% on average. After that, it shows a downward trend in the data of the ACEA. As for ICCT, this topic is only shown in 2020 and 2021, with 6.99% and 8.85% on average, respectively. For ACEA, the smallest topic, "regulation-law", is only shown in 2018 and 2021, with 0.11% and 0.14% on average in the narratives, respectively. Similarly, it only appears in 2018 and 2021 in the data from the ICCT, with 6.74% and 1.34% on average, respectively.

4.2.4 Summary of the findings regarding topic modeling

According to the U_Mass coherence score, the suitable number of the topics is 11,

including "charge points-infrastructure", "purchase policy", "investment", "manufacturer", "market-sale", "emission standard", "policy simulation", "truck", "tax", "fuel", and "regulation-law". To compare the topic distribution in different years and different stakeholders, the topic distribution in each narrative is obtained, resulting in percentages of all topics in each narrative, and then the average percentages of the topics in the narratives from different years and different stakeholders are calculated, which can be helpful for comparison between different stakeholders and the topic trend from 2018 to 2022.

According to the result of topic distribution by stakeholders, ACEA focuses more on "charge points-infrastructure", "investment", "market-sale", "truck" and "tax", while ICCT focuses more on "purchase policy", "manufacturer", "emission standard", "policy simulation", "fuel" and "regulation-law". It seems that ICCT, as a group founded by some foundation about environment and climate, focuses more on the emission and regulations of different types of vehicles, and ACEA, as an association created by different vehicle manufacturers, focuses more on the market of vehicles, infrastructures of the new energy vehicles, and tax.

Topic trend can show how the topic distribution change in different years, and this study also considers the EU Green Deal, held at the end of 2019. The biggest topic, "charge points-infrastructure" shows the upward trend after the EU Green Deal in the narratives from all the stakeholders, and this topic is more frequently shown in the narratives of the ACEA after the EU Green Deal than before but involved in less content of the data from the ICCT after the EU Green Deal. As for the second biggest topic, "purchase policy", the average percentages of the narratives from the whole database in the years after the EU Green Deal are higher than before. After the EU Green Deal, this topic keeps less proportion in the data of the ACEA. Regarding the third biggest topic, "investment", the exposure after the EU Green Deal is lower than before in the database. But this topic shows an upwards trend in the narratives of the ICCT, especially after the EU Green Deal. As for the fourth biggest topic, "manufacturer",

after the EU Green Deal, the average proportion for the ACEA seems to be less. The average percentage of the fifth topic, "market-sale" gets lower after the EU Green Deal in the narratives from the whole database. Regarding the topic "emission standard", "truck", and "tax", after the EU Green Deal, they show a downward trend in the data of the ICCT. Also, the topic "tax" shows a downward trend in the data from the ACEA after the EU Green Deal. Other topics cannot show pronounced change before and after the EU Green Deal.

Chapter 5 Conclusion and Discussions

This chapter describes the conclusion and discussions of the study based on the results in Chapter 4. The conclusion is drawn based on results in Chapter 4 to answer the research questions. Then the discussion at a higher level will show the extracted valuable information from the results of computational text analysis, which are supposed to be related to the reality of the policies of the new energy vehicles in the EU member countries from 2018 to 2022. Then the scientific contribution of this study is described. Some limitations and potential avenues for future research are also discussed in this chapter. Lastly, the policy implications are illustrated at the end of this chapter.

5.1 Conclusion

The study results show the critical information extracted from narratives about the transition from combustion vehicles to new energy vehicles by identifying the over-represented words and extracting the topics. Ninety-three narratives from the ACEA and 56 from the ICCT published from 2018 to 2022 are collected.

The first sub-research question is, *"What is the difference between narratives from different stakeholders involving the transition from combustion vehicles to new energy vehicles?"* The ACEA mentions more about "diesel", "bus", "tax", "registration" and so on, and it focuses more on the topic "charge points-infrastructure", "investment", "market-sale" and so on. However, ICCT emphasizes more the word "feebate", "renewable", "hydrogen" and so on, and it focuses more on the topic "purchase policy", "manufacturer", "emission standard" and so on. This can answer the first sub-research question about the difference in narratives from stakeholders.

The second sub-research question is, "*How did the policy narratives change before and after the EU Green Deal?*" The narratives show some trends during these years. Some

words are always mentioned in the narratives including "diesel", "registration", "tax", "petrol", "bus", "freight", "saving", "fee", "automaker", and so on, but some words are only shown in a specific year. Some words like "job", "recovery" and "economic" in 2020, can result from the pandemic. Some topic trends are obvious in the whole database. The topic "charge points-infrastructure" show an increasing trend during these years, especially after the EU Green Deal, and the topic "purchase policy" shows more exposure after the EU Green Deal than before. But the topic "investment" and "market-sale" shows a lower proportion after the EU Green Deal than before. Some trends are only shown obviously in narratives from one specific stakeholder. The topic "purchase policy" keeps less proportion in the data of the ACEA. The topic "emission standard", the topic "truck", and the topic "tax" show a downward trend in the data of the ICCT after the EU Green Deal. Also, the topic "tax" shows a downward trend in the data from the ACEA after the EU Green Deal. Other topics cannot show obvious change before and after the EU Green Deal. This can answer the second sub-research question about the trend of narratives.

The main research question is *"What is the key information in policy narratives of different stakeholders in the case of transition from combustions vehicles to new energy vehicles concerning the EU Green Deal?"* The answer to this main research question is related to the critical information of the narratives from the ACEA and the ICCT, the difference between these two stakeholders' narratives, and how the narratives changed from 2018 to 2022. It can be answered based on the answers to two sub-research questions. Also, some key information in narratives is at a higher level. The ACEA cares more about the interests of the traditional vehicle industry, emphasizing more regarding the word "economic", "job", and the topic "market-sale", which reflect the benefit of vehicle manufacturers and workers in this industry. In contrast, the ICCT focuses more on promoting new energy vehicles, addressing the word "cost" and the topic "purchase policy" to illustrate the advantage of new energy vehicles, which can accelerate the transition from combustion vehicles to new energy vehicles. This implies that the policy narratives always reflect the stakeholders'

interests regarding what the ACEA and the ICCT represent.

5.2 Discussion of the results

In this section, the key findings are discussed. From the perspective of the stakeholders selected in this study, ACEA seems to care about the interests of the vehicle industry, including the workers in the vehicle companies and the manufacturers of the EU member countries. As an association made by different vehicle manufacturers, ACEA mentions more about the "economy", "job", "work" and so on, especially in 2020, which can be related to the pandemic all over the world, resulting in the decreasing demand of the vehicles and the destruction of the supply chain of the vehicle industry because of the pandemic. According to Sonsoles Díaz et al. (2021), the new registrations of passenger vehicles in most of the EU member countries dropped sharply in 2020, and the total decreasing amount is 11.7 million, about 25% less by comparison with 2019. For the interests of vehicle manufacturers, another evidence is the topic "market-sale" extracted from the narratives of the ACEA, which is related to a higher proportion of the content than data of the ICCT. ACEA (2018) and some other press releases from the ACEA discussed the market of the vehicles in EU member states, describing the sale of all kinds of vehicles and the trend of the sale. Another unique word frequently shown in the narratives from the ACEA is "diesel", which is not so often mentioned by the ICCT. This can be related to the stakeholder ACEA, founded by some traditional vehicle manufacturers such as BMW, Ford, Porsche, Volkswagen, and so on, which have to consider the benefit of diesel vehicles and relevant policies. According to Ludwiniak, A. (2021), there are more and more bans on the diesel vehicle after the EU Green Deal, especially in some cities, which can affect the benefit of diesel vehicles for the traditional vehicle manufacturers, although most of them have already focus on the new energy vehicles, the diesel vehicles still make up a large percentage of their market. According to Ewing. J (2022), European citizens showed higher demand for diesel vehicles than in other areas because of the lower fuel price and tax. Still, these years, the new registration of the diesel vehicles dropped, replaced by the

electric vehicles, because the diesel vehicles yield more pollution and emission, which can be affected by the rules and regulations based on the EU Green Deal.

The ICCT, as an association dedicated to improving the energy efficiency in transportation systems, focuses more on the cost of the vehicles considering different policies for the new energy vehicles and traditional vehicles, which can spread the updated policies of new energy vehicles to potential customers to increase the sale of new energy vehicles. The word "fee" and "feebate" are frequently shown in the narratives from the ICCT. Discussing the policies regarding the fee of different kinds of vehicles, the ICCT illustrates the advantages of the new energy vehicles, including electric vehicles, hydrogen vehicles, and so on, which have lower fees and taxes, especially in recent years by comparison with the increasing price of traditional fuels like petrol or diesel. Especially after the EU Green Deal, more and more cities in the EU member countries release relevant policies. New energy vehicle is environmentally friendly but always more expensive, which can be an obstacle to their promotion in the market (Compare the Market, 2021). To reach the target of carbon neutralization in the EU member countries, the governments in the EU release all kinds of policies as incentives for the new energy vehicles to decrease the fee for the customers, including purchase subsidies, registration tax, ownership tax, VAT (value-added tax) benefits and so on, which can be considered as a fee system to motivate the citizens to buy new energy vehicles.

The most prominent topic shown in the narratives from the ICCT, "purchase policy" can also be evidence that the ICCT focuses on the cost of different types of vehicles. Sandra. W & Uwe.T (2018) discussed the bonus system and policies based on the emission of vehicle in Sweden. The higher bonus will be gotten when the vehicle's emission is lower. In this way can, the government motivate potential consumers to purchase new energy vehicles, which can be helpful for the transition from combustion vehicles to new energy vehicles. As for the type of new energy vehicles, the ICCT focuses more on hydrogen vehicles, which is not mentioned frequently in the

narratives from the ACEA. But both focus on electric vehicles considered a primary type of new energy vehicles. One potential reason for this difference is that hydrogen is harder to store in the hydrogen refueling station because of the high cost and possibility of explosion, which can be challenging to prompt the hydrogen power vehicles. This can decrease the motivation for the ACEA, who prefer to focus on other power-type vehicles to make more profit. But the ICCT focuses on the energy transition to consider all potential ways for the transition on vehicles, including hydrogen, considered a vital energy transition approach apart from electrical power.

Another narrative analysis perspective is how the narratives changed from 2018 to 2022. The trend shown in the narratives can be related to the regulations and policies released in these years. After the EU Green Deal, the database's exposure of infrastructures and charge points shows an increasing trend. According to IEA (International Energy Agency) statistics, in 2021, the slow publicly available chargers in Europe increased from 61000 to 307000 between 2015 and 2021. Noticeably, the increasing speed of the number of slow public chargers in Europe got higher, which can be considered the influence of the EU Green Deal at the end of 2019. According to the European Court of Auditors report in 2021, the EU Green Deal updated the estimate of the number of public charge points in 2025 to 1 million. Additionally, narratives after the EU Green Deal show more content about purchase policy than the data before the EU Green Deal. According to Press corner (2021), some actions are done to accelerate the transition from combustion vehicles to new energy vehicles by the European Commission. For example, a fund named "Social Climate Fund" will be 72 billion euros, open to all EU member states. It can be used to help citizens purchase a cleaner vehicle. Different countries have policies to motivate their citizens to buy new energy vehicles, including subsidies, bonuses, and taxes.

However, some results do not meet prior expectations. For example, the topic "regulation-law" is only related to 0.8% of the content in the database, and it has a low prevalence in all years. According to the EU Parliament, there are many policies

formulated during these years, especially near the EU Green Deal. As the stakeholders, both the ACEA and the ICCT do not mention the content of the laws and regulations as much as some other topics.

5.3 Scientific contributions

This study makes some scientific contributions. Through the computational text analysis about the transition from combustion vehicles to new energy vehicles, the narratives of two key stakeholders, the ACEA and the ICCT, are identified. The comparison between different stakeholders and different years is analyzed in this study, which has not been focused on by the researchers in other studies. Additionally, the narrative analysis applied to the transition from combustion vehicles to new energy vehicles is conducted in this study, which has not been done in other studies according to the literature review in Chapter 2. According to this study, other researchers relevant to policy can combine narrative analysis with policy issues by automatic text analysis. They can find the difference between all stakeholders involved in some policies from their narratives and the trend of the narratives in different periods. This can help the researchers better understand the stories told by policy stakeholders.

5.4 Limitations

There are some limitations to this study. Firstly, some restrictions are on this research's stakeholders and data. The data in this study is only selected from the press release of the ACEA and the ICCT. Still, the EU Green Deal is made by the EU Parliament, which can also be a suitable stakeholder in this research to explore the EU Green Deal policies, especially the EU Parliament's politicians. Additionally, the press release can be an appropriate data type in narrative analysis, but some press releases selected in this study seem to conclude with repetitive content. For example, some narratives from the ACEA focus on the sale of different types of vehicles, but they use the same sentence structure and similar words to describe, which can increase the frequency of the words shown in these narratives in some years. This can affect the researchers to

get the other valuable words with high frequency because so many words with high frequency express the limited information from these repetitive narratives. Another limitation is the label of the topic in topic labeling. In this study, some issues and corresponding topic words can be gained after applying LDA. After that, each topic's label is made manually, which can be affected by the subjective judgment of the researchers, probably resulting in the inaccurate label. The manual label can also vary from person to person due to the different opinions on the topic.

5.5 Avenues for future research

Based on the current study, there are some potential works for future research that can improve the methods, make the analysis more profound, or explore the research in different approaches.

As aforementioned in limitation, they were manually labeling in the topic modeling, which can be affected by the subjective judgment. Lau et al. (2011) applied the automatic method to allocate the topic labels according to the topic words from LDA or LSA, which can be beneficial in solving the problem. The top 10 or 15 topic words are put in the search engine together, which yields some pages to show the result. Then the most commonly shown terms in the result pages are collected by a web crawler, and the most frequently shown word can be the suitable label for the topic words.

Some other potential avenues can make the topic modeling research further, based on the current result of the topic modeling in this study. Ding, K. et al. (2020) can provide a potential approach for future research. They focus on the correlation between different topics based on the result of topic modeling. According to the correlations, they get the estimated correlation map, which can show the relationship between various topics and the strength of the connections. In this way can, the researcher find which pair of topics are always shown together, which can make researchers

understand the topics further. Another potential avenue to further the study is combining the topic modeling and document clustering, which was conducted in Kolini, F., & Janczewski, L. (2017). Before the topic modeling, the selected narratives can be clustered into some groups. Each document's topic distribution can be generated, which can put the documents according to the result of document clustering. This combination can explore the relationship between topics and the characteristics of the document groups, which may be applied in the narratives of this study.

Another potential avenue for future research is the correlation between the topic trend and the EU Green Deal. This study illustrates some topics which make up a higher or lower percentage in the database after the EU Green Deal. However, it is hard to conclude that the EU Green Deal changed the proportion because it is also possible that their proportion still gets higher or lower without the EU Green Deal. Therefore, the correlation between the topic proportion trend and the EU Green Deal can be focused on, which can help researchers understand to what extent the EU Green Deal affects the trends of the topics.

Apart from the ACEA and the ICCT used in this study, this study can also be applied to the case of other stakeholders, which can be other associations, or different governments in some countries, resulting in a better understanding of the focus of the stakeholders.

5.6 Policy implications

Narratives can shape the public's beliefs and affect the audiences' actions (Jones & McBeth, 2010). According to Shanahan (2018), narrative analysis can discover the complexity of interactions between policy stakeholders, policies, events, contexts, and results, which means narrative analysis can be helpful for the government to have a better understanding of the policies in some areas. This can be beneficial for the policymakers to make new policies or regulate the current policies. So, some policy

implications can be made from this narrative analysis study.

Based on this study, the policymakers in the EU member states can regulate the current policies or release new guidelines regarding the transition from combustion vehicles to new energy vehicles. Governments should focus more on the job positions relevant to the traditional combustion vehicles because the traditional vehicle manufacturers focus on the jobs affected negatively by the vehicle transition. The vehicle shift can create more job opportunities for new energy vehicle manufacturers like Tesla. Still, the government should consider the interests of traditional vehicle workers. Also, the economy of the traditional vehicle industry should be focused on. New energy vehicle manufacturers may threaten the economy by decreasing the market share of traditional vehicle manufacturers in Europe. Additionally, governments can invest more in hydrogen vehicles, frequently mentioned by some associations dedicated to the energy transition in transportation. It can be a potential direction to prompt the new energy vehicles apart from the electric vehicles. Government should also focus on the purchase policies of the vehicles to incentive the citizens to purchase the new energy vehicles. The policies of the Swedish government described by the ICCT can be a good reference for other countries. Additionally, governments can focus more on the charge points of electric vehicles. This topic shows an upwards trend these years, which is the most crucial topic in the narratives, showing the importance of the vehicle industry. Public charging points can make charging more accessible, motivating citizens to purchase electric vehicles. As for hydrogen vehicles, the government can invest in research on how to store the hydrogen safely and decrease the cost of the hydrogen vehicle and infrastructures, which can be a potential revolution in the energy transition of the vehicles in the future.

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Appendix

Appendix A. Literature review on NPF studies

Table 4: Literature review on NPF studies

	Literatures	Areas	Data Sources	Methods
1	McBeth et al (2012)	Wild animals, Environment protection	YouTube videos from the BFC YouTube channel (N=88) from April 4th, 2005, to May 23rd, 2010. The lengths of the videos vary from 1 minute to 5 minutes.	NPF (narrative strategies (rhetorical devices, costs and benefit, stance), narrative elements (characters, plot, story type, solutions, causal stories, causation theories)), Case study, Composite index of narrativity (Cronbach's index), Correlation between Narrativity, and Views, Frequency analysis
2	N. Ertas, A.N. McKnight (2020)	Education equity, Charter schools	To make up the database, the researcher used "charter school" and "school choice" as the keywords, from January 1st, 2006, to December 31st, 2016, deriving from three local newspapers, resulting in 150 articles after removing some irrelevant articles. The selected articles can be divided to three parts, including descriptive articles, neutral articles, and position articles. This research mainly focuses on the position articles.	Statistical test (chi-square or t-test), Moderatum generation, NPF (characters, story type and causal mechanism), Frequency analysis

Table 4 (continued)

| 3 | Crow et al. (2017) | Climate change, Natural disasters | The data is from local newspapers including The Gazette, Fort Collins and The Denver Post, which have 1847 articles satisfying the searching requirements for the researchers. The time is from June, 2012, the period before the fire, to June 22th, 2013, the period after the fires. | NPF (policy problems (definition and presence), solutions, and characters), Hypothesis test (chi-square test), Data visualization, SPSS (for codebook reliability), The Krippendorf alpha to increase rigor, Cramer's Value, Frequency analysis |
| 4 | Shanahan et al. (2011) | Environment protection, Public place maintenance | The data is from the articles of the two associations. Cody Enterprise can be considered aligned with the Old West coalition, while the USA today is aligned with the other association. And 194 students express their attitudes before and after the media coverages can be selected as the data. | Pro-test & Pre-test, Hypothesis test, NPF, Surveys |

Table 4 (continued)

5	Suri et al. (2020)	Natural disaster, Emergency issues	Use land and forest fires, fire quantity, smoke and land keywords to search articles. The search was conducted mainly on three media, Kompas.com in Bengkalis, Pelalawan and Rokan Hilir, followed by Mediaindonesia.com and Pekanbaru.tribunnews.com. The date of the articles is from 2014 to 2016.	Nvivo 12 plus (a qualitative research software), NPF (policy issue, characters, policy solution), Frequency analysis
6	Mainenti (2020)	Sex robot, Innovation moral,	Use the search string [" sex robot "] to identify research on sex robots. The results showed 46 documents between 1935 and 2019, all published within the past 10 years.	NPF [meso] (actor, moral, policy solution, setting, plot, solution, narrative strategy), Excel (for statistics and data visualization), Data visualization (world cloud), Frequency analysis
7	Blair and McCormack (2016)	Media, Hydraulic fracturing, Environment, Energy	The researchers gained the data from Boulder Daily Camera and the Colorado Spring Gazette, from 2008 to 2013, resulting in 132 articles	NPF (characters), Frequency analysis

Table 4 (continued)

8	Brown, M. (2019)	Climate change, Energy safety	The data is from Expert Committee, which is written statements pertaining to the parliament's proposal (HE 175/2017), relevant with a new renewable energy. The researcher selected 23 statements from 70 statements, from experts in different areas.	NPF (Problem Statement, characters, moral of the story, policy solutions), Hypothesis test, Questionaries
9	**Schlaufer et al. (2021)**	Building renovation, Transport, Waste handling.	The data source is from the website and social media where there are lots of debate about the relevant topics. Firstly, the actors involving the issues are selected, then add the search conditions to narrow the scoping. The data includes 4144 texts initially, and then the researcher select 764 texts.	NPF (Devil– angel shift，Causal mechanisms，Issue expansion– containment), Cramer's value, Chi-square value, Hypothesis test, Frequency analysis
10	**O'Leary et al. (2017)**	Public health, e-cigarette，legislation	This research gains the data from three sets of texts, including contextual information about vapour device, the claims presented in the document, and regulatory results. The researchers get the data from survey in the official website, journals, and reports.	NPF (characters, story plot), Frequency analysis

Appendix B: Top 20 words with highest frequency in narratives

Table 5: Top 20 most frequently used words and their frequency in narratives of ACEA

2018	fre2018	2019	fre2019	2020	fre2020	2021	fre2021	2022	fre2022	allyear	freall
diesel	27	public	13	automotive	25	bus	21	public	11	diesel	69
vote	27	diesel	13	re	23	charger	17	unit	11	bus	54
report	19	petrol	13	recovery	21	bind	10	stop	9	tax	43
test	14	tax	11	plan	20	review	10	charger	8	automotive	41
fact	14	refuel	10	bus	20	tax	10	operator	8	registration	41
realistic	13	report	10	registration	19	re	9	almost	7	public	39
automotive	12	work	9	gas	16	global	8	freight	7	petrol	38
registration	12	system	9	diesel	16	neutral	8	quarter	7	re	38
recharge	12	plan	8	energy	14	goal	8	association	6	report	37
tax	12	growth	8	covid	14	hand	8	period	6	plan	34
month	12	compare	8	economic	14	zipse	8	location	6	unit	33
legislation	11	global	8	economy	14	stop	8	system	6	vote	32
explain	11	confirm	8	neutral	13	average	7	diesel	6	system	31
reality	11	bus	8	job	13	almost	7	registration	6	growth	30
simply	11	electricity	8	crisis	13	diesel	7	analysis	5	work	29
development	11	operator	7	register	13	suitable	7	hand	5	operator	29
condition	11	meaningful	7	unit	13	short	6	growth	5	grow	28
benchmark	10	lack	7	production	13	operator	6	vote	5	quarter	28
so	10	association	7	chain	13	network	6	ramp	5	neutral	27
environment	10	barrier	7	renewable	12	ceo	6	different	5	register	27

Table 6: Top 20 most frequently used words and their frequency in narratives of ICCT

	2018	fre	2019	fre	2020	fre	2021	fre	2022	fre	allyear	fre
	feebate	30	super	10	recovery	15	renewable	35	feebate	16	feebate	48
	trailer	26	taxation	7	scrappage	12	hydrogen	34	commit	10	renewable	40
	super	23	freight	5	aid	10	installation	12	percent	10	super	38
	ban	21	activity	5	reform	10	grid	11	brand	9	euro	36
	euro	21	brand	5	stimulus	9	lease	10	pool	9	hydrogen	35
	fee	20	adjust	5	crisis	8	operator	10	align	8	trailer	32
	automaker	13	consequence	4	oxide	8	life	10	saving	8	fee	26
	freight	11	delivery	4	operation	8	warming	9	legislation	7	ban	24
	activity	10	automaker	4	control	8	producer	9	pledge	7	automaker	22
	leader	9	dead	4	metropolitan	8	taxable	8	cycle	7	freight	20
	table	8	ratio	4	taxation	7	deployment	8	trajectory	7	activity	19
	plot	7	reward	3	petrol	7	location	8	life	7	life	19
	saving	7	former	3	mobility	7	projection	8	interim	6	cycle	19
	calculate	7	mileage	3	zone	7	spot	8	degree	6	saving	16
	swedish	7	payload	3	conversion	6	interim	8	fee	6	petrol	16
	multiplier	7	haul	3	euro	6	eq	8	statement	5	interim	16
	calculation	6	regulated	3	management	6	recharge	8	petrol	5	brand	16
	court	6	shift	3	simulation	6	planning	7	euro	5	zone	15
19	overcome	6	manufacturing	3	testing	6	orient	7	stringency	4	calculate	15

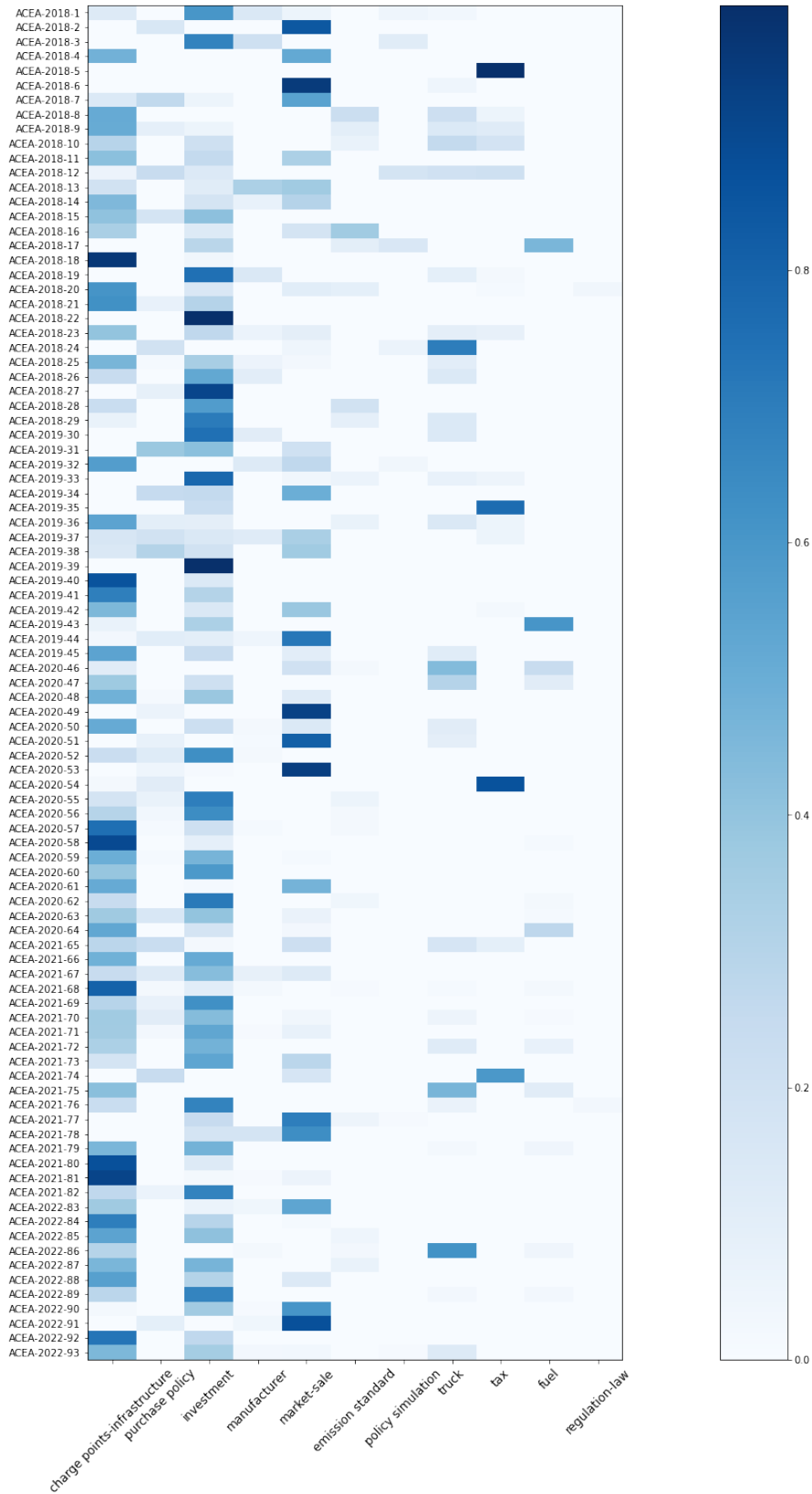**Appendix C: Topic distribution of each narrative**

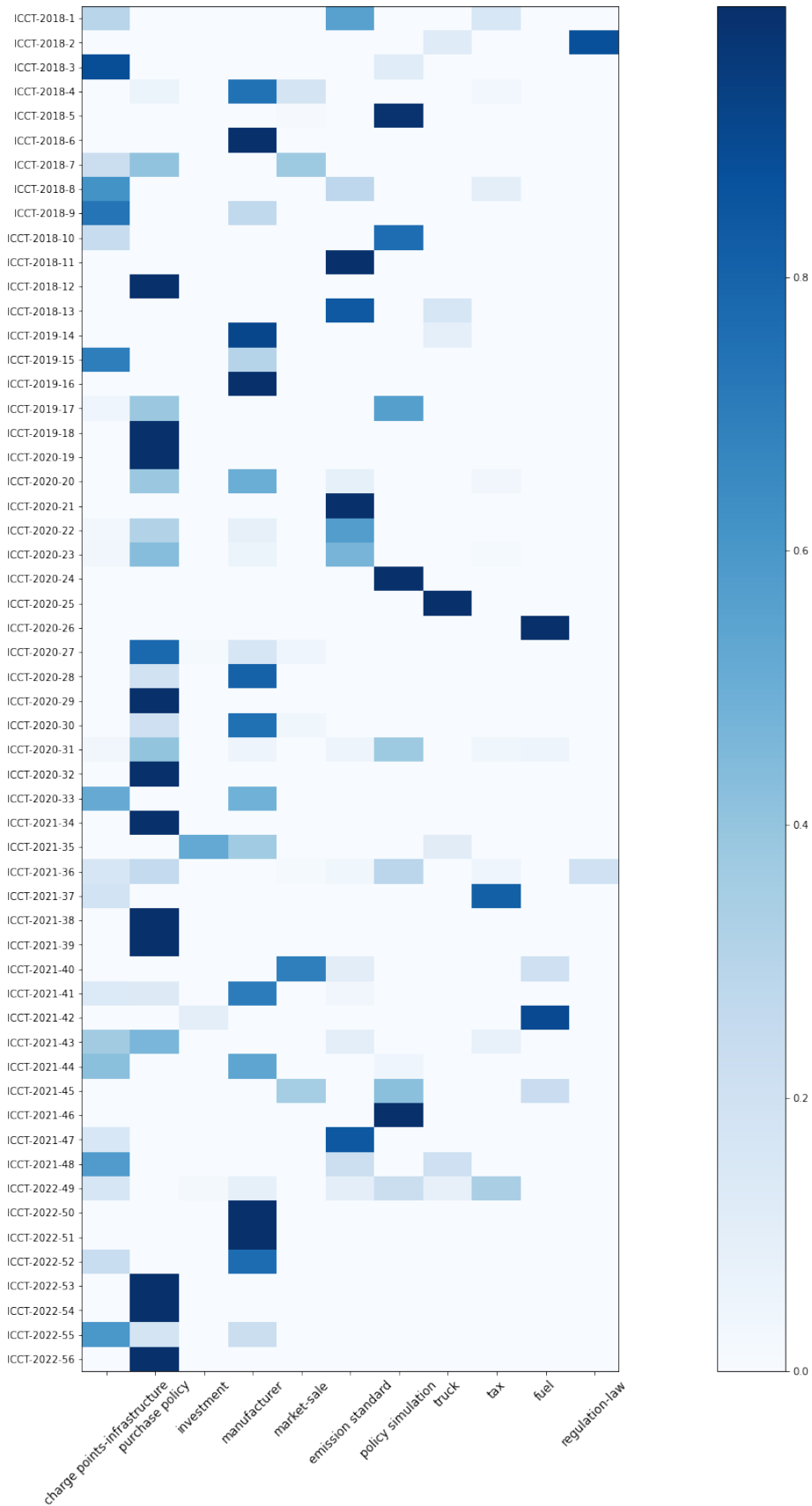*Figure 24: Topic distribution of each narrative of the ACEA*

Figure 25: Topic distribution of each narrative of ICCT

Appendix D: Topic proportion of each stakeholder

Table 7: Average proportion of topics in the narratives from the ACEA and the ICCT

Topics \ Stakeholders	ACEA	ICCT
charge points-infrastructure	30.97%	13.06%
purchase policy	4.61%	27.75%
investment	30.53%	1.16%
manufacturer	2.15%	21.02%
market-sale	16.58%	3.03%
emission standard	1.82%	11.18%
policy simulation	0.64%	10.29%
truck	5.59%	3.15%
tax	4.46%	2.93%
fuel	2.20%	4.24%
regulation-law	0.06%	1.92%
Total	99.61%	99.73%

Appendix E: Topic proportion of each year

Table 8: Average proportion of topics in each year from the whole database

Topics \ Years	2018	2019	2020	2021	2022
charge points-infrastructure	24.95%	22.81%	20.52%	25.69%	28.35%
purchase policy	6.51%	12.87%	18.86%	14.31%	17.15%
investment	20.54%	24.30%	16.01%	20.22%	16.85%
manufacturer	7.43%	12.43%	8.66%	5.78%	16.82%
market-sale	11.66%	13.84%	11.14%	10.12%	11.51%
emission standard	9.25%	0.61%	6.80%	4.21%	1.24%
policy simulation	5.73%	2.83%	4.02%	5.31%	1.24%
truck	5.74%	2.65%	5.72%	3.65%	4.47%
tax	4.63%	4.47%	2.79%	4.90%	1.78%
fuel	1.10%	2.87%	5.03%	4.81%	0.33%
regulation-law	2.16%	0.00%	0.00%	0.68%	0.00%
Total	99.68%	99.68%	99.55%	99.70%	99.75%

Table 9: Average proportion of topics in each year from the ACEA

Topics \ Years	2018	2019	2020	2021	2022
charge points-infrastructure	25.85%	25.30%	33.52%	36.05%	39.97%
purchase policy	4.41%	8.29%	3.76%	4.89%	0.83%
investment	29.74%	31.89%	28.58%	33.62%	28.95%
manufacturer	3.84%	2.50%	0.33%	1.67%	1.15%
market-sale	14.97%	18.16%	19.51%	12.67%	19.88%
emission standard	4.22%	0.80%	0.74%	0.33%	1.26%
policy simulation	1.87%	0.20%	0.00%	0.06%	0.10%
truck	7.35%	2.92%	4.99%	4.92%	6.99%
tax	5.72%	5.87%	4.54%	3.80%	0.00%
fuel	1.59%	3.77%	3.48%	1.45%	0.58%
regulation-law	0.11%	0.00%	0.00%	0.14%	0.00%
Total	99.67%	99.70%	99.46%	99.60%	99.71%

Table 10: Average proportion of topics in each year from the ICCT

Topics \ Years	2018	2019	2020	2021	2022
charge points-infrastructure	22.95%	14.83%	4.06%	13.26%	12.37%
purchase policy	11.18%	27.56%	37.98%	25.62%	39.60%
investment	0.00%	0.00%	0.09%	4.14%	0.22%
manufacturer	15.44%	44.20%	19.20%	10.71%	38.38%
market-sale	4.27%	0.00%	0.54%	7.05%	0.00%
emission standard	20.48%	0.00%	14.48%	8.87%	1.22%
policy simulation	14.34%	11.25%	9.11%	11.62%	2.81%
truck	2.14%	1.78%	6.65%	2.12%	1.00%
tax	2.18%	0.00%	0.57%	6.23%	4.22%
fuel	0.00%	0.00%	6.99%	8.85%	0.00%
regulation-law	6.74%	0.00%	0.00%	1.34%	0.00%
Total	99.71%	99.62%	99.67%	99.82%	99.80%