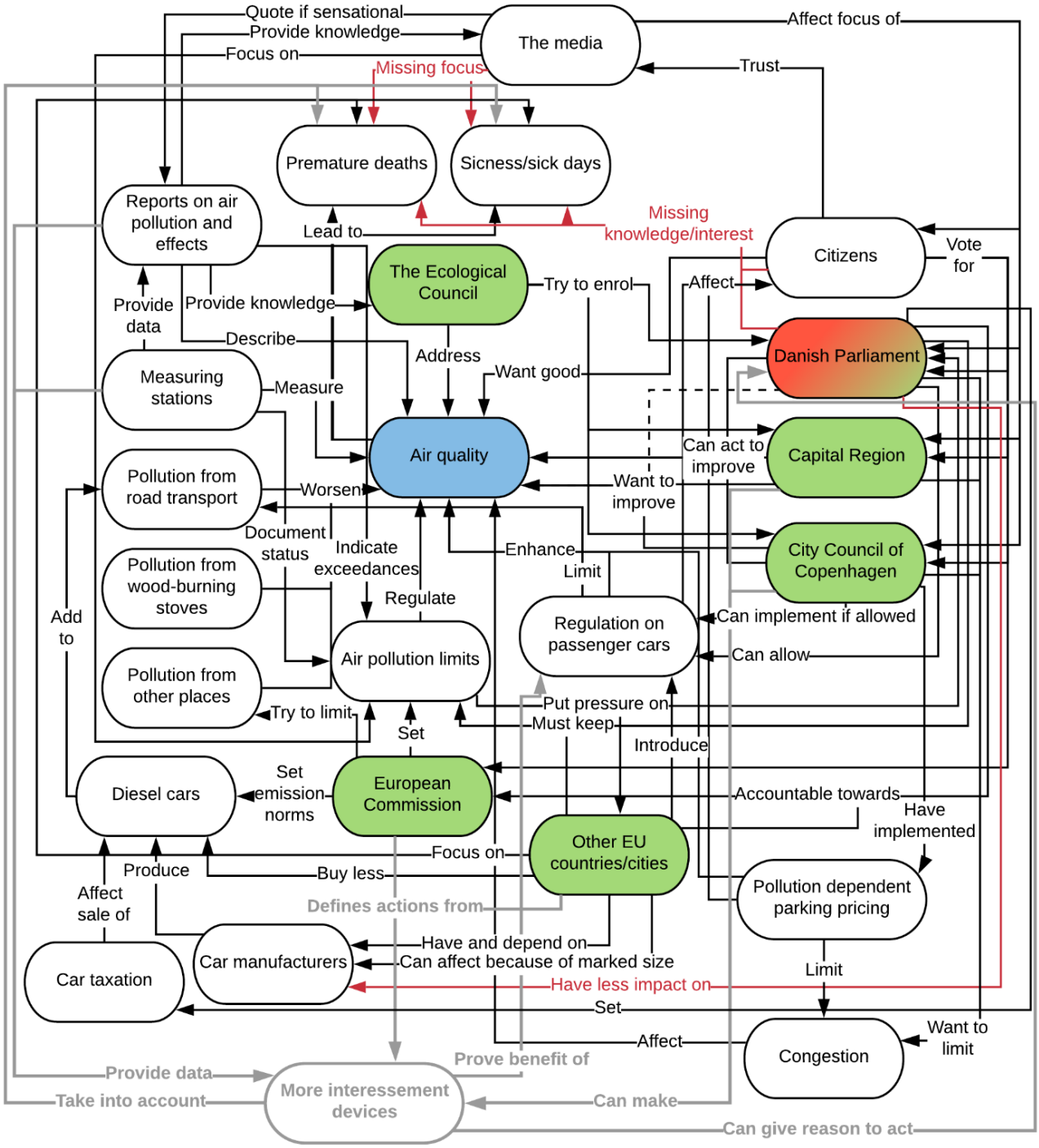
Aalborg University Copenhagen
The School of Architecture, Design and Planning

An actor-network analysis of the introduction of diesel bans on passenger cars in Copenhagen



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0. Preface

This report is a master thesis written as part of the MSc in Sustainable Cities on Aalborg University in Copenhagen in the period February 1st, 2018 to June 8th, 2018.

The subject of the project is the introduction of regulation on passenger cars to limit air pollution in cities, which have been discussed in many European cities, where different models have been introduced. I found it interesting, that in Copenhagen, the proposed model was different compared to the models proposed and introduced other places, as it focussed on not introducing new diesel cars, rather than phasing out the old diesel cars which pollutes the most. It drew my attention to the differences between the Danish and other European governance and regulation systems and to investigate the possibilities to introduce regulation in Denmark.

The discussions of air pollution and traffic regulation has increased rapidly during the project period raising the relevance of the subject further and have continuously provided new knowledge and changed the basis of the analysis. After most interviews were conducted and had provided a certain pool of knowledge, new proposals of diesel car regulation in Copenhagen were released as well as a large report on air pollution in the Capital Region, which affected the investigated network and has been considered in the report, but not in the perception of the interviewees, as it was unknown at that time. This has made the process interesting and dynamic and indicates that the topic is under fast development both during and after the project period.

The project focus on air pollution from passenger cars and how air pollution from these can be limited. Other ways to limit air pollution from traffic by using other forms of transportation, e.g. bikes or public transport, as well as carpooling and minimising the need for physical mobility is thus not discussed in the report and considered out of scope.

I want to thank my supervisor Morten Elle for helping to shape the project and provide insights and considerations on the topic. Furthermore, I want to thank the interviewees for taking time to talk with me and provide central knowledge and insights to the project, without which the project could not have investigated the challenges and possible solutions; Mikkel Krogsgaard Niss, Greta Nedergaard, Kåre Press-Kristensen, Klaus Mygind, Mette Annelie Rasmussen, Annette Kayser, Christian Rabjerg Madsen, Marie Ridley Pryn, and Caroline Schousboe.

I hope you will enjoy your reading.

Christine Kayser Rode
Copenhagen, July 8th, 2018

1. Introduction

Air pollution is the most expensive environmental problem in EU generating socioeconomic costs of DKK 3.750 billion a year, caused by 400.000 premature deaths. Prior to the premature death are often years with serious illness and millions of other people getting sick due to air pollution as well. In Denmark alone, air pollution with fine particles causes 3000-4000 premature deaths per year, which makes it the third largest health risk, only surpassed by smoking and physical inactivity (Press-Kristensen 2013, Press-Kristensen 2018b, Miljøstyrelsen 2014). As opposed to the latter two risks, air pollution is not a risk chosen by the individual but affects everyone and is thus a societal problem even more than smoking and physical inactivity, which are often classified as such (Press-Kristensen 2018b).

1.1. Pollution limits

Air pollution is regulated from an international level through European pollution limits, as the pollution is spread with the wind across borders and cannot be fought by countries individually but requires a common effort (Nedergaard 2018a).

The European Commission has introduced limits for many of the pollutants known to harm human health since 2005 and added new pollutants in 2010, 2012 and 2015 (European Commission 2017). The most relevant limits in relation to health effects in cities are presented in Figure 1, where the first two are particle limits for different sizes of particles and the latter three are gasses. The limits are applied over different periods as the associated health impacts are observed to occur over different exposure times (European Commission 2017).

$PM_{2.5}$	PM_{10}	NO_2	CO	SO_2
25 µg/m³ (1 year)	50 µg/m³ (24 hours) 40 µg/m³ (1 year)	200 µg/m³ (1 hour) 40 µg/m³ (1 year)	10 mg/m³ (8-hour mean)	350 µg/m³ (1 hour) 125 µg/m³ (24 hours)

Figure 1: Air quality standards set by EU for the most relevant pollutants related to health issues (European Commission 2017).

The limits are set to accept one death for every 1,000 humans exposed to the defined level of pollution. Limits in other sectors such as drinking water are set toxicological and allow one death per 1,000,000 humans exposed to the defined levels throughout their lives. This difference in allowed deaths can have multiple causes, one being the relatively recent focus on air pollution. If the limits were set to only allow one death per 1,000,000 humans exposed, it would require massive changes in society, that the current politicians in Europe have not been ready to make. It would require a ban of all combustion engines and wood burning in combination with other radical changes that people should be confronted with and thus larger consequences are accepted for air pollution (Press-Kristensen 2018b). WHO (World Health Organization) has also presented a set of guidelines for air quality where minor

health impact is achieved, setting the limits for particles at around half of the EU limits, with a limit of 10 µg/m^3 for $PM_{2.5}$ and 20 µg/m^3 for PM_{10} (COWI 2018).

However, the EU limits are still exceeded in many European cities, causing larger health effects than accepted, as seen in Figure 2, where the red and dark red dots indicate exceedances of the NO_2 limits (left) and PM_{10} limits (right).

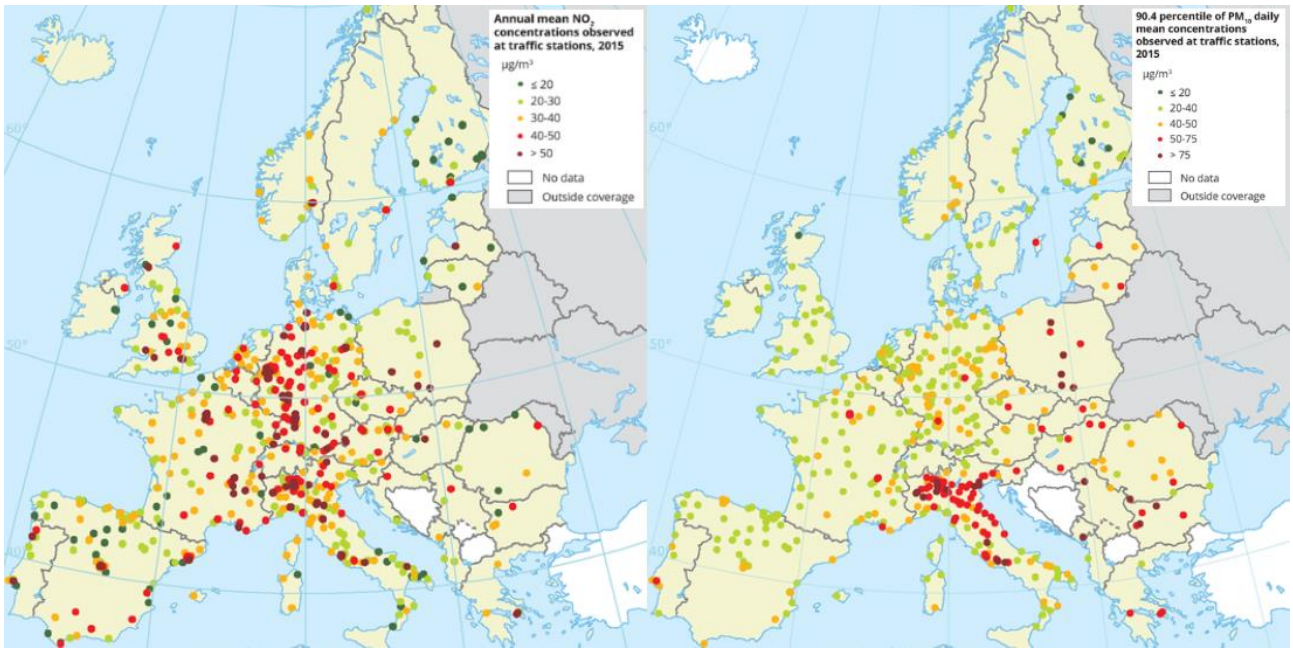

Figure 2: Air pollution levels close to major roads in EU for NO_2 and PM_{10}. Red and dark red dots indicate exceedances (European Environment Agency 2017).

Most of the exceedances of NO_2 occur close to major roads (89%), whereas the exceedances of particles are found both near major roads and in the background measurements (European Environment Agency 2017). Besides these substances, new pollutants are found to be harmful but not yet regulated by limits, as all effects have not yet been researched thoroughly. It is known that ultrafine soot particles, not included in $PM_{2.5}$ also cause premature deaths. In Copenhagen, an excess mortality of 300-500 inhabitants living close to heavily trafficked roads cannot be explained by fine particles and gasses from the traffic, but probably originates from ultrafine particles polluting at a local level (Press-Kristensen 2013).

The largest impact of pollution from traffic comes from particles, which cause most premature deaths and thus most of the socioeconomic costs related to air pollution (Jensen et al. 2017). NO_2 is also harmful to human health and as most of the NO_2 pollution comes from traffic, this is also an important measure in relation to traffic and air pollution (Press-Kristensen 2013).

1.2. EURO norms

To limit emissions from traffic and secure equal competition on the vehicle marked, EU has introduced norms for how much different types of vehicles can emit of certain pollutants. The first set of limits were introduced in 1990 and since then stricter limits have been applied every 4-6 years. Vehicles can be sold up to one year after a new EURO norm is in effect, for car dealers to be able to sell what they have in stock, but after a year, new vehicles must live up to the newest EURO norm.

For passenger cars and light-duty vehicles, the limits have been different for diesel and petrol and until the newest EURO norm 6 introduced in 2014/2015 diesel cars were allowed to emit significantly more NO_X than petrol cars. For particles, the limits have been fixed since EURO norm 5, except for trucks and, as seen in Figure 3 (Press-Kristensen 2013).

	Køretøj	Ikrafttræden fabrik/slag	NO_X-krav	Partikelkrav vægt	Partikelkrav antal
Euro 3	Benzinpersonbil	2000/2001	150 mg/km	---	---
	Dieselpersonbil	2000/2001	500 mg/km	50 mg/km	---
	Varebil (1,3-1,76 ton)	2001/2002	650 mg/km	70 mg/km	---
	Varebil (> 1,76 ton)	2001/2002	780 mg/km	100 mg/km	---
	Lastbil/bus (> 3,5 ton)	2000/2001	5 g/kWh	100 mg/kWh	---
Euro 4	Benzinpersonbil	2005/2006	80 mg/km	---	---
	Dieselpersonbil	2005/2006	250 mg/km	25 mg/km	---
	Varebil (1,3-1,76 ton)	2006/2007	330 mg/km	40 mg/km	---
	Varebil (> 1,76 ton)	2006/2007	390 mg/km	60 mg/km	---
	Lastbil/bus (> 3,5 ton)	2005/2006	3,5 g/kWh	20 mg/kWh	---
Euro 5	Benzinpersonbil	2009/2010	60 mg/km	5 mg/km a)	---
	Dieselpersonbil	2009/2010	180 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Varebil (1,3-1,76 ton)	2010/2011	235 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Varebil (> 1,76 ton)	2010/2011	280 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Lastbil/bus (> 3,5 ton)	2009/2010	2 g/kWh	20 mg/kWh	---
Euro 6	Benzinpersonbil	2014/2015	60 mg/km	5 mg/km a)	$6 \cdot 10^{11}$ part./km a)
	Dieselpersonbil	2014/2015	80 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Varebil (1,3-1,76 ton)	2015/2016	105 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Varebil (> 1,76 ton)	2015/2016	125 mg/km	5 mg/km	$6 \cdot 10^{11}$ part./km
	Lastbil/bus (> 3,5 ton)	2013/2014	0,4 g/kWh	10 mg/kWh	$8 \cdot 10^{11}$ part./kWh

Figure 3: Limits for NO_X, particle weight and number of particles for EURO norm 3-6 for petrol passenger cars, diesel passenger cars, vans, and trucks/buses. a) only for petrol cars with direct injection (Press-Kristensen 2013, p. 16).

All vehicles sold in Europe are tested under specific circumstances in laboratories to comply with the limits before they can be released on the market. However, emission measures made during the last seven years have shown that the emissions are very different in the test laboratories and during real driving leading to larger emission from road transport than

expected from the EURO norms of the vehicle fleet (Press-Kristensen 2013). On paper, the emissions from diesel cars should have decreased by 85% between 2000 and 2014, but only a 40% decrease was reached, as illustrated in Figure 4 (Moving Britain Ahead 2016).

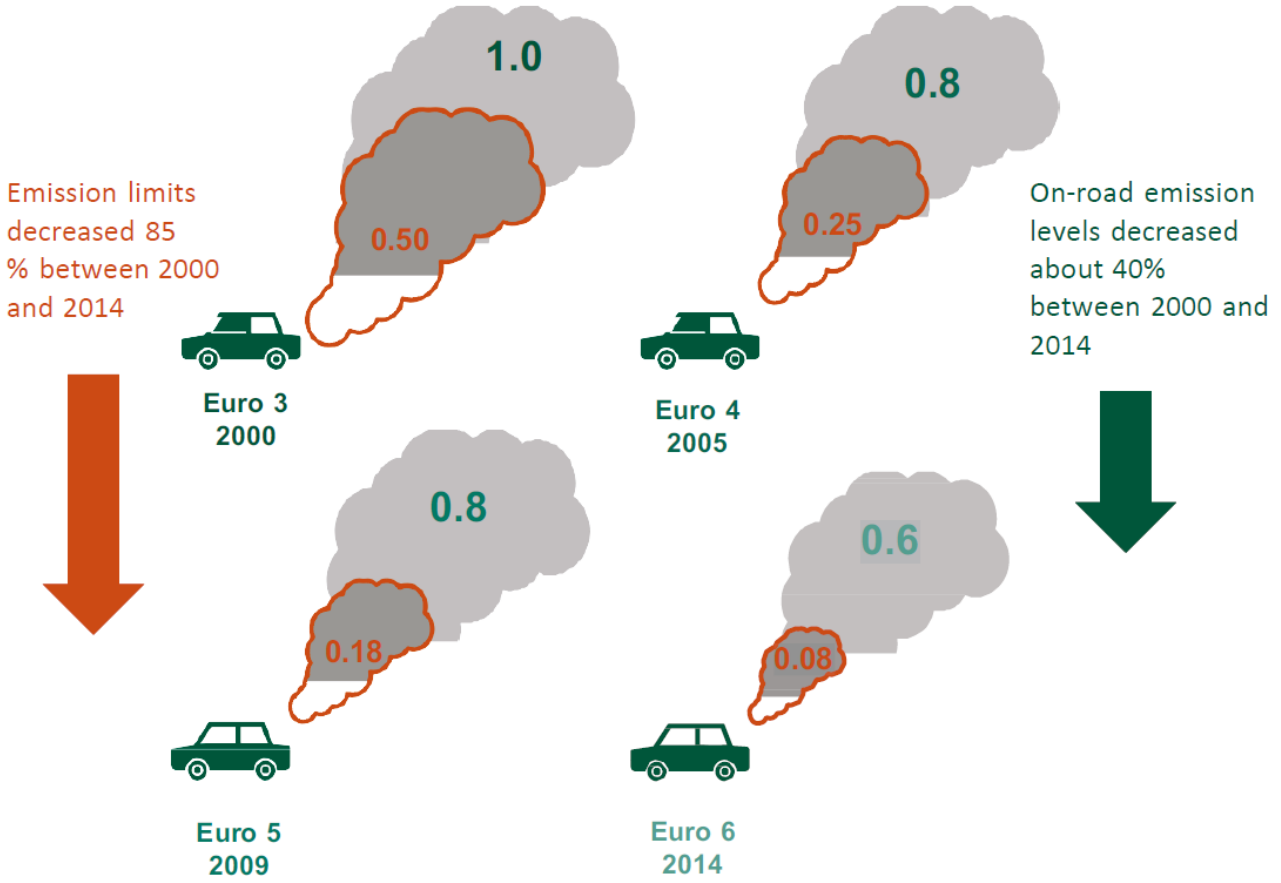

Figure 4: Difference between emission limits and measured on-road values for NO_X from diesel cars in g/km (Moving Britain Ahead 2016, p. 10).

The difference between emissions during tests and real driving is caused by multiple factors. The particle filters installed to limit particle pollution works best under certain circumstances depending mainly on the temperature of the engine and the surroundings. NO_X emissions are generated by high peak temperatures and thus more NO_X is emitted from a hot engine than a cold. The most common laboratory test; NEDC (New European Driving Cycle) is conducted on a cold engine where the whole vehicle including oil and coolant is 20-30°C. It is under these circumstances that the vehicle must fulfil the limits to be approved. When comparing the result of this test to tests conducted on a hot vehicle, as it would be during most parts of real-world driving, emissions were higher and, in many cases, breached the limits with an average result 21% higher than the limits in a UK test, visualised in Figure 5.

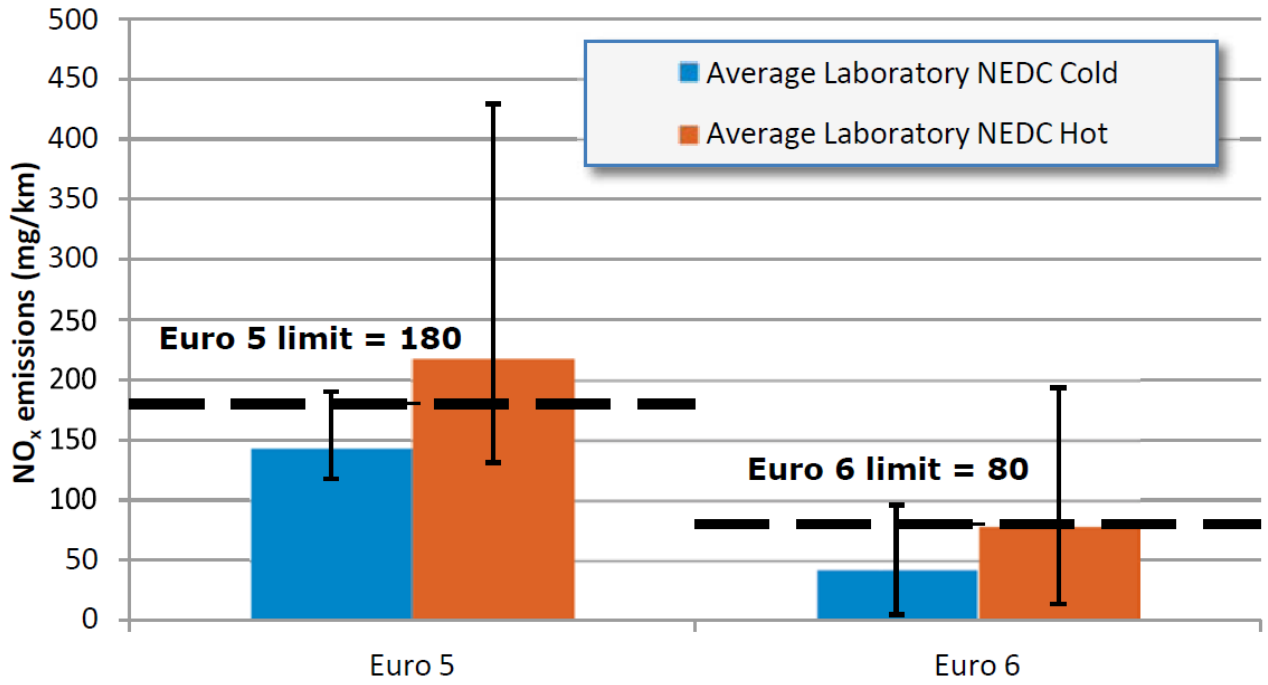

Figure 5: Comparison of NO_X emissions under laboratory tests on hot and cold passenger cars complying with EURO norm 5 and 6 (Moving Britain Ahead 2016, p. 20).

When the NEDC tests were performed on a track instead of in the laboratory, the emissions were on average 4.5 times higher than the hot test in the laboratory for EURO norm 5 cars and 70% higher for EURO norm 6 cars, visualised in Figure 6. The case was the same when testing on-road emissions, where the result varied a lot between the different cars, but the averages came close to those from the test-track and no cars complied with the limits under these tests (Moving Britain Ahead 2016).

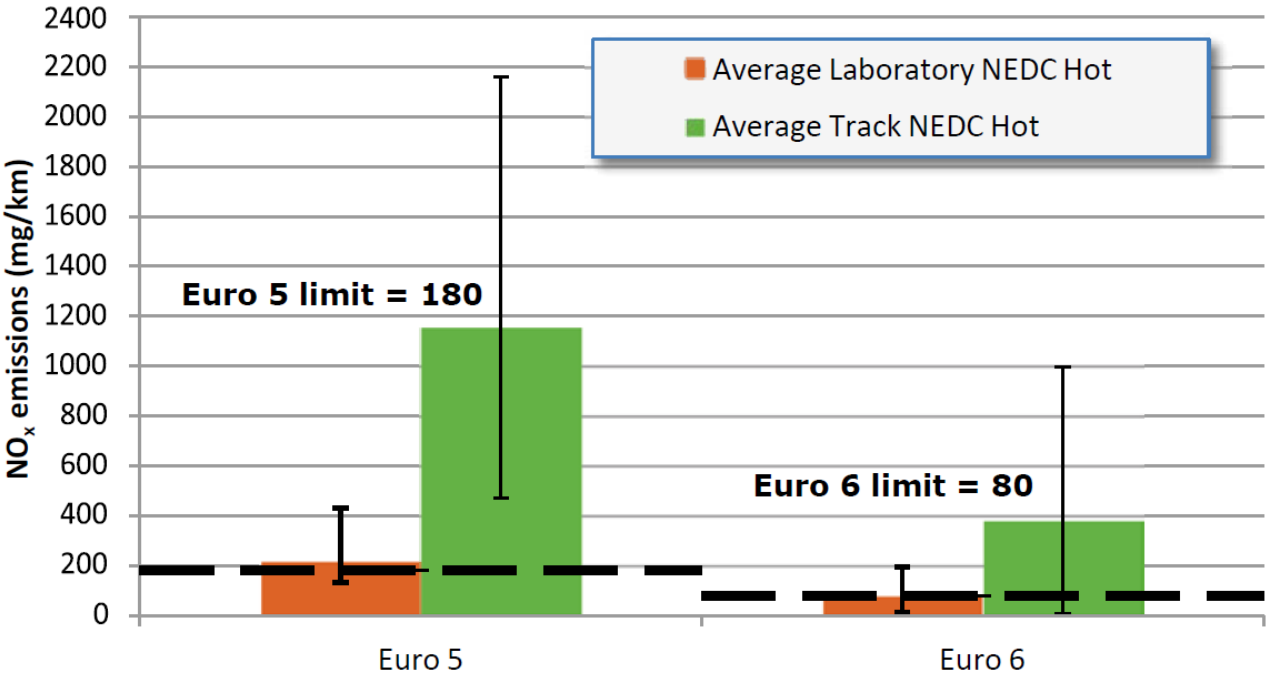

Figure 6: Comparison of NO_X emissions under hot laboratory tests and track tests of passenger cars complying with EURO norm 5 and 6 (Moving Britain Ahead 2016, p. 21).

The results also depend on the ambient temperature, which is fixed in the laboratory but varies under real circumstances. During cold weather exhaust gas recirculation, one of the most used technology to control NO_X emissions, is less effective, as less gas can be recirculated, leading to higher levels of NO_X leaving the vehicle. This is also the case for other technologies, which all have an optimal temperature of operation that is not reached year-round for real-world driving (Moving Britain Ahead 2016).

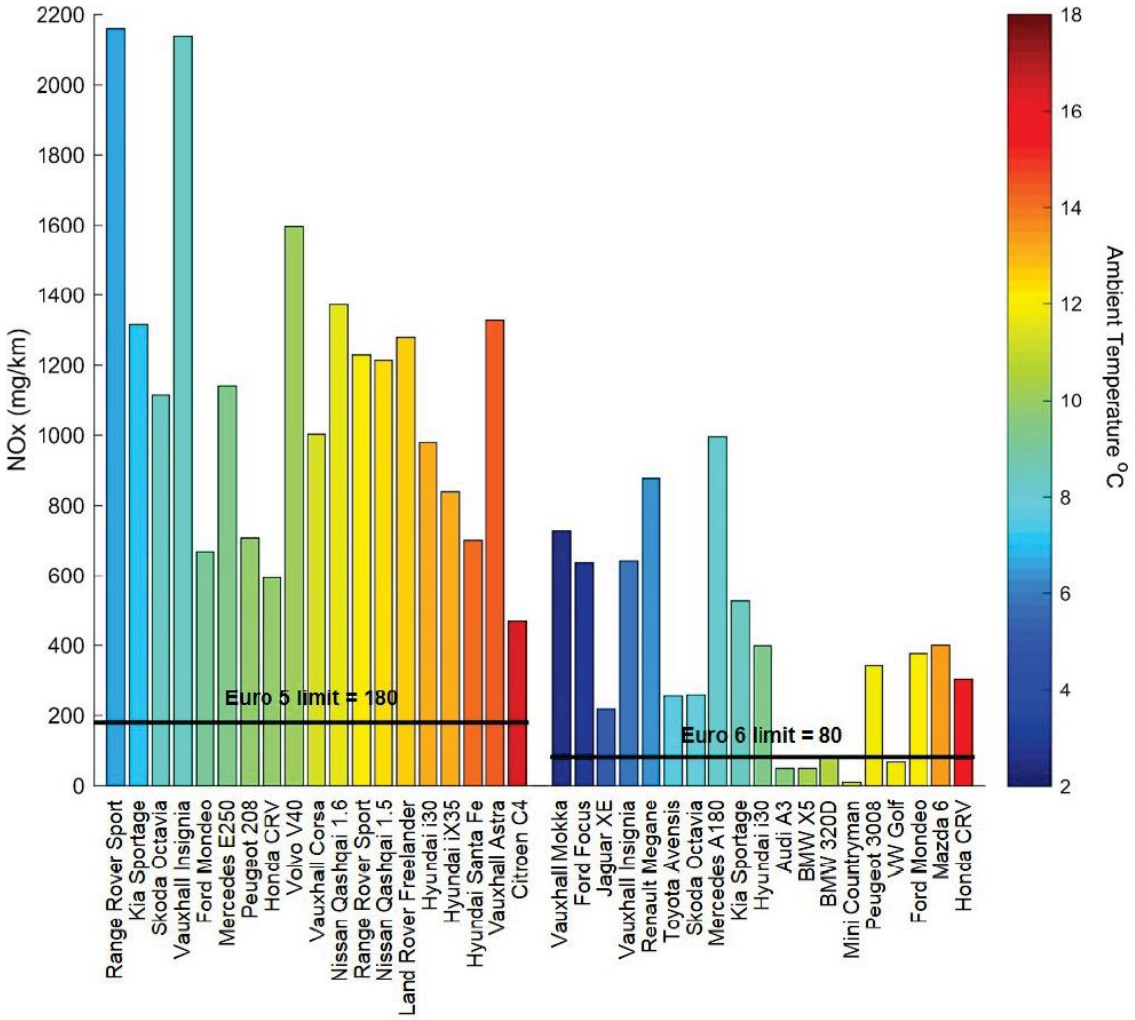

Figure 7: Track test results plotted in ambient temperature order for EURO norm 5 and 6 diesel cars, showing that diesel cars, in general, emit more NO_X under lower temperatures (Moving Britain Ahead 2016, p. 25).

Besides these legitimate differences between laboratory tests and real-world driving, it was found that Volkswagen Group had fitted their diesel passenger cars with defeat devices to emit less pollution during the test cycles. This meant that the vehicles could recognise the NEDC test cycle and reduce emissions by operating differently than under normal circumstances. By restructuring the elements of the test, the vehicle would not be able to recognise that it was being tested and higher emissions were found as illustrated by the green line (normal operation) and the orange line (test recognised) in Figure 8 (Moving Britain Ahead 2016).

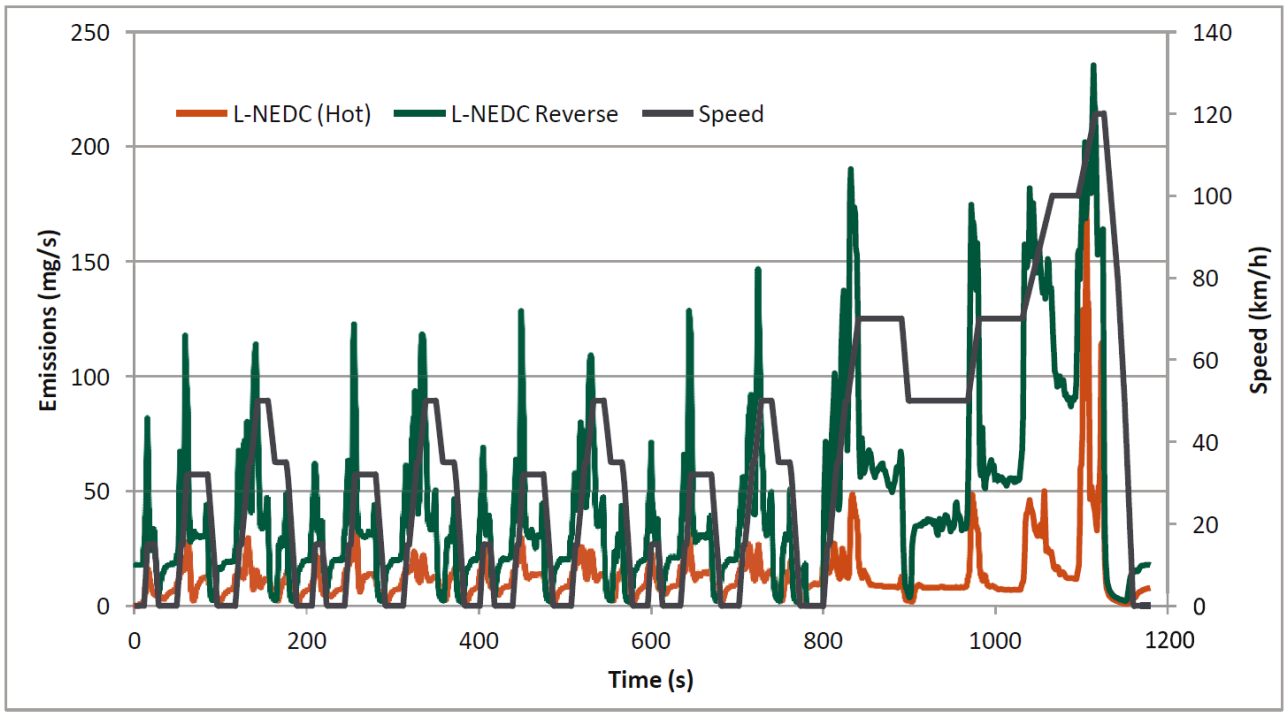

Figure 8: Comparison of NO_X emissions on NEDC tests when recognised by Volkswagen's installed software (orange) and not recognised (green) (Moving Britain Ahead 2016, p. 19).

The scandal with defeat devices has been covered by the media as Diesel Gate and caused much focus on emissions from diesel cars and distrust in the EURO norms' ability to improve car technology and reach lower emissions from diesel cars.

1.3. Diesel bans

As a reaction on Diesel Gate, many European cities have discussed bans of diesel cars, at least those of the earlier EURO norms, as the limitation of emissions have not lived up to the standards of the regulation. The air pollution problem is largest in cities where many people live in small areas, leading to large health effects from even minor degrees of pollution and thus the bans target the traffic in large cities (Nedergaard 2018a, Mygind 2018).

In Germany, Deutsche Umwelthilfe, a German NGO working to protect the environment, started a lawsuit towards two of the most polluted German cities for not reacting properly to the pollution levels. The German government had earlier rejected to introduce any type of restrictions on diesel cars, but the court decision allowed the cities to introduce bans towards the most polluting diesel cars. This judgment can influence all German cities exceeding air pollution limits, which according to Deutsche Umwelthilfe is at least 70 cities (McGhie 2018c). Already hours after the judgement, Hamburg was ready to introduce the first restrictions on some roads in the city coming into effects from April 2018 (McGhie 2018a).

London has also reacted on the emission challenges from transport and introduced an Ultra-Low Emission Zone coming into force April 8th, 2019, where vehicles not meeting certain

emission standards must pay a daily charge (Transport for London n.d.). The zone covers the central part of London and sets different standards for different types of vehicles. As seen, diesel cars must meet stricter norms than petrol cars, because of the different limits set in the EURO norms for petrol and diesel cars:

- *"Euro 3 for motorcycles, mopeds, motorised tricycles and quadricycles (L category)*
- *Euro 4 for petrol cars, vans, minibuses and other specialist vehicles*
- *Euro 6 for diesel cars, vans and minibuses and other specialist vehicles*
- *Euro VI for lorries, buses and coaches and other specialist heavy vehicles"* (Transport for London n.d.)

Other cities have proposed bans as well and in Copenhagen, the Lord Mayor, Frank Jensen from Socialdemokratiet, wants to ban all new diesel passenger cars registered after January 1st, 2019 (Jensen n.d.). The ban towards new diesel cars is based on the distrust in EURO norms and their relation to real-world emissions and seeks to not introduce new diesel cars to the city, no matter their emissions in a laboratory. As new diesel cars have proved to pollute almost as much as older cars, according to Figure 4 on page 6, the effect of banning old diesel cars and replacing them with new diesel cars will be limited (Niss 2018). The ban is though still less ambitious than in other cities, as the ban only affects the purchase situation and not the current car fleet and thus lets the old and most polluting cars stay (Mygind 2018). Other parties in the City Council of Copenhagen have addressed a diesel ban as well and currently, the civil servants in the Technical and Environmental department are investigating possible diesel ban models and their effects, including the suggestion from Frank Jensen, a diesel-free zone, and an option where older diesel cars are phased out faster than the natural replacement of cars (Nedergaard 2018b).

However, the Municipality of Copenhagen does not have authority to implement such bans themselves as national regulation must be changed for this to be allowed. It is thus not enough for the politicians in the City Council of Copenhagen to agree; the national government must also concede the need for a diesel car ban. Recently, the national part of Socialdemokratiet has agreed to stop introducing new diesel cars and phase out the old ones but the government do not agree that bans are the correct path to choose, as they do not want to bother the citizens with a green transition (Domino, Bloch 2018).

The current discussions of diesel bans in both Denmark and other European countries indicate that this is an area in great development, with differences among the different parties, political levels and countries. It poses a complicated network of involved actors, studies, and measures that can improve knowledge and limit air pollution and its consequences. This project will focus on the possibility to introduce regulation on passenger cars in Copenhagen, as it has happened and is discussed in other European cities.

2. Problematisation

Air pollution is among the largest global health problems in Europe and regulated from EU by general pollution limits and EURO norms setting requirements for new vehicles sold within Europe. The limits should protect the European citizens against the negative effects of air pollution but allow one death per 1,000 people exposed to the defined values and the EURO norms are exceeded by most passenger cars during real-world driving. Where the first fact is little known to laymen, the EURO norm exceedances caused a large scandal some years ago, lessening the trust in the diesel technology and leading to discussions of diesel bans for passenger cars in many large European cities.

In Denmark, such bans are discussed in Copenhagen on both municipal and national level and would require collaboration among different political levels and other actors affected by the ban and the air pollution. It is thus a complex task to implement stricter regulation of passenger cars to limit air pollution in Copenhagen, why this project will investigate the following questions:

How can regulation on passenger cars be introduced in Copenhagen to limit air pollution?

- **Which actants are involved in the network related to air pollution and passenger car regulation in Copenhagen and how are their relations?**
- **Which barriers are present for a translation of the network to succeed and how can they be overcome?**

The above questions will be answered using actor-network theory as a framework for the analysis, by mapping the current network and defining the actants' roles and relations. The translation of the network will be analysed in relation to the four phases of a translation and the current status of the network will be discussed in relation to the next steps necessary to make the translation succeed.

3. Methodology

The investigation of the introduction of stricter regulation on air pollution from traffic in Copenhagen is carried out using a hands-on approach, studying a concrete case. The study of a specific case provides context-dependent knowledge, which is important for a nuanced interpretation of reality and as a basis for practical action (Flyvbjerg 2010).

The study includes elements from both natural and social sciences. The knowledge about air pollution and its effects on humans is based on scientific data and reports proving the challenges with NO_2 and particle emissions and new knowledge is continuously established e.g. on the effects of ultrafine particles. However, the problem with air pollution cannot be expected to be solved by natural science and technology alone, as much of our society is based on polluting technologies that cannot easily be replaced by non-polluting technologies. In some areas, alternatives exist, but from the development until now, a transition is not happening on its own and must be supported or forced by other parts of society. This is typical for transitions towards sustainable technology as the better alternative for society and for the common good often does not pose obvious benefits for the end-users, who are thus less interested in making the technological shift as well as the manufacturers who must invest in new technology without direct economic benefits (Geels 2011). It is, therefore, necessary that public actors support such transition if it is decided desirable, to initiate radical changes in the area, in this case, the passenger car fleet.

The study mainly focuses on the actions that can be taken to support a sustainable transition by introducing regulation on passenger cars to limit the air pollution in Copenhagen, and thus puts much focus on social science and the actions and interactions among the relevant actors, who can affect society. This is based on *Phronesis,* a philosophy concerning humans and politics. It provides a third type of knowledge going beyond both *Episteme*, which describes invariable knowledge obtained by the natural sciences such as the knowledge about air pollution and *Techne*, which account for the production of things and thus concerns another level of learning than the focus of this project (Flyvbjerg 1992).

Phronetic research does not seek to provide context independent theories that can be generally applied as Epistemic research but deeply examines a concrete case through thorough investigation and dialogue, in this case concerning the actions in Copenhagen towards air pollution. By studying real history, politics and rationality and researching the context of relevant decisions and proposals, the subject can be unfolded and examined. The study revolves around three core questions for phronetic research:

1. Where are we going (here concerning the air quality in Copenhagen)?
2. Is this development desirable?
3. What should be done? (Flyvbjerg 1992)

To answer these questions an in-depth investigation of the ongoing process in Copenhagen is performed, based on personal interviews and relevant publications, providing a broad knowledge of the development and ongoing actions in Copenhagen and in other locations for comparison. Some of the publications used are not yet published, but acquired through actors working with the subject, such as the proposed models for a diesel ban and the expected effects for particle and NO_2 emissions (Nedergaard 2018b). The knowledge and material are obtained by starting with small questions but gaining larger answers and expand the area of investigation. Instead of starting with the 'important problems' and 'large questions' to explain the current result, phronetic research focuses on understanding the results in relation to the process, found by searching in the detail and finding both detailed and general knowledge (Flyvbjerg 1992).

The process studied is ongoing and continuously developing, both in sense of the scientific knowledge on air pollution effects and the political standpoints and statements, which in both Denmark, EU and other European countries are discussed and develops along with the new knowledge presented and changing attitude from the people (Press-Kristensen 2018b). This can be challenging, as new knowledge or specific events can alter the circumstances for the development and decisions and thus a different result might be achieved, that could not be foreseen during the investigation. However, the study can better explain the decisions taken during the process, as these are based on the current knowledge and, as well as the study, is unaware of new knowledge possibly presented later in the process, changing relevant measures, intentions or priorities. Considering the events in hindsight can be problematic, as decisions can seem obviously wrong from the latter viewpoint, but in the situation might be based on reasonable arguments and be the best decisions the involved parts could reach at the time (Akrich, Callon & Latour 2002a). In the study of innovation management, multiple studies have been made, but only a few have avoided conclusions clear only after the result was given:

> *"While the management of innovation literature fills entire libraries, the case studies which avoid the trap of retrospective explanation still remain scant, even if they are beginning to grow in number."* (Akrich, Callon & Latour 2002a)

Beside avoiding judging actors and decisions by later known details or events, it makes the study more relevant and closer to reality, which is important in phronetic research. By anchoring the investigation in the context of the study and expose the findings to reactions from the surroundings and society, more can be learned. Assumptions and conclusions will be questioned, in this case, through interviews but possibly also by readers of the report, if the investigation is carried on after the report is published and in the thesis defence (Flyvbjerg 1992).

The phronetic research investigates daily practice within the field of study, in this project especially the political field in Copenhagen and the collaboration with the national politicians and other relevant actors. Here it is also an advantage to investigate a current project as it is based on the current practices and the actors' present opinions on the subject. Likewise, it makes it easier to secure dialogue which is central in phronetic research to investigate practical rationality based on social conditions. This dialogue includes both the ones studied, other researchers, policymakers and the public, in this study established through interviews with relevant persons from these categories (Flyvbjerg 1992).

3.1. Interviews

The ongoing process related to passenger car regulation in Copenhagen cannot simply be researched through published papers but concerns the relations and development between actors and how they see the world, which can be obtained through interviews. Qualitative interviews are conducted to understand how people understand their world and learn about their experiences, feelings and hopes, making it a relevant method for this investigation (Kvale 2007).

Interviews are basically structured conversations with a purpose defined by the interviewer, who carefully questions and listens to the interviewee. Interviews can be more or less firmly structured depending on the purpose. In this project, the interviews were conducted as semi-structured interviews to get the most relevant knowledge from the interviewee but also allowing the interviewees' interpretation of the world to emerge (Kvale 2007). As the interviewer, I have mostly guided the interview to obtain knowledge on relevant aspects that should be explored in relation to the subject, but the form has been free to enable the interviewee to provide the knowledge he/she finds interesting and relevant, to get perspectives that might not be apparent prior to the interview.

The interviewees represent both civil servants in the Municipality of Copenhagen and the Capital Region responsible for delivering knowledge about the subject of air pollution and possible measures, politicians who can make or initiate decisions to act on the subject and a specialist with extensive knowledge on the subject of air pollution. The following list provides an overview of the interviewed persons and their role in relation to the air pollution/regulation discussion. The list is in chronological order by when the interviews were conducted:

- **Mikkel Krogsgaard Niss:** Head of Section and Project manager in the Finance Department of the Municipality of Copenhagen, which is the Department of the Lord Mayor, who has proposed a ban towards new diesel passenger cars in Copenhagen (Niss 2018)

- **Greta Nedergaard:** Works in Technical and Environmental Management in the Municipality of Copenhagen with air pollution and is currently responsible for providing possible models of diesel bans and their effects as feedback on a proposal from SF (Nedergaard 2018a)
- **Kåre Press-Kristensen:** Expert in air pollution working in the Ecological Council, a Danish NGO trying to put more focus on the air pollution challenge in Copenhagen and elsewhere (Press-Kristensen 2018b)
- **Klaus Mygind:** Member of the Technical and Environmental Committee of Copenhagen from SF, who has proposed an investigation of possible models for diesel bans and more measuring stations monitoring air pollution in Copenhagen (Mygind 2018)
- **Mette Annelie Rasmussen:** Member of the Technical and Environmental Committee of Copenhagen from Radikale Venstre, who has asked political questions for the Finance Department related to air pollution (Rasmussen 2018)
- **Annette Kayser:** Works in Technical and Environmental Management in the Municipality of Copenhagen with traffic planning and participates in the EUROCITIES collaboration (a network of major European cities) and thus has knowledge about actions and approaches in other European cities/countries (Kayser 2018)
- **Christian Rabjerg Madsen:** Member of the Danish Parliament, spokesperson for environmental issues from Socialdemokratiet (Madsen 2018)
- **Marie Ridley Pryn** & **Caroline Schousboe**: Work in the Capital Region with mobility and technology and responsible for air pollution incentives from the region (Pryn, Schousboe 2018)

A follow-up interview was conducted with Kåre Press-Kristensen to provide further knowledge on specific events and measures at the end of the project period when I had gotten more knowledge from other sources and had a deeper understanding of the importance of the work of the Ecological Council (Press-Kristensen 2018a). These aspects were hard to include in the first interview, as this was early in the investigation and the process had not yet been unfolded.

The interviews have been conducted in Danish, as all interviewees were Danish. Some interviews were conducted face-to-face, while others were phone interviews due to practical circumstances regarding time and distance. The interviews have been transcribed in Danish to secure the knowledge and important points and statements from the interviews and thus without marking pauses, mmhs, and repetition of words directly after each other unless this changed the meaning of the statement/sentence. I have personally done all transcriptions, to secure the same form and level of detail, as transcriptions can vary depending on the transcriber and as more detail can be gained by transcriptions made by the interviewer. Some details or moods might only be known from being there and not captured in the

recording and if the recording quality is low at some points, the interviewer better knows the conversation from being there (Kvale 2007). The transcriptions can be found in Appendix A.

In this project, the knowledge gathered from the interviews will be used to map the actor-network and the relations within a Danish context and in relation to other European cities and countries. The interviews also clarify where relations or knowledge are missing for a translation to success and thus makes this project able to present proposals for changes that enables regulation on passenger cars to limit air pollution in Copenhagen and thus combines theory with practical experiences to create context-dependent knowledge as phronetic research aims for (Flyvbjerg 1992).

4. Theoretical approach

In order to include knowledge from both the natural and social sciences and examine the interactions of the two types of knowledge, actor-network theory is applied. This theoretical framework is usable to study translation processes, which in this case is the processes necessary to implement regulation on passenger cars with the aim of reducing air pollution and the consequences of this (Callon 1986a).

In translation processes, multiple human actors are involved, such as politicians, civil servants, citizens, car producers, and NGOs combined with several non-human elements, such as European and national regulation, reports about air pollution effects, measuring stations, and measurements. In actor-network theory, all these elements are considered equal and described as *actants* that can affect the process of translation. It is the actants and the relationships between them that forms the most important elements in actor-network theory and the development of these relations that is the main element of the study (Callon 1986a).

4.1. Actor-networks

Actor-network consist of a number of actants and relationships between them, that can develop over time. An actor-network is thus studied at a specific time from where possible changes can be discussed. The studied actor-network will always be a simplification, as reality, in theory, is infinite. Thus, in the illustration of an actor-network as points and lines between them, the points must be understood as its own networks held in place by their own relationships, stabilising the network to be part of another network (Callon 1999). To exemplify the theory, the actor-network surrounding the car will be used, but the examples should not be understood as part of the analysis of the project. In the passenger car network, users, manufacturers, cars, politicians and regulation are considered relevant actants, but each of these represents smaller networks, that can be divided into other actants. For example, can the car be broken into its own network of parts and processes, as if a mechanic should find out what is wrong in a broken-down car, illustrated in Figure 9.

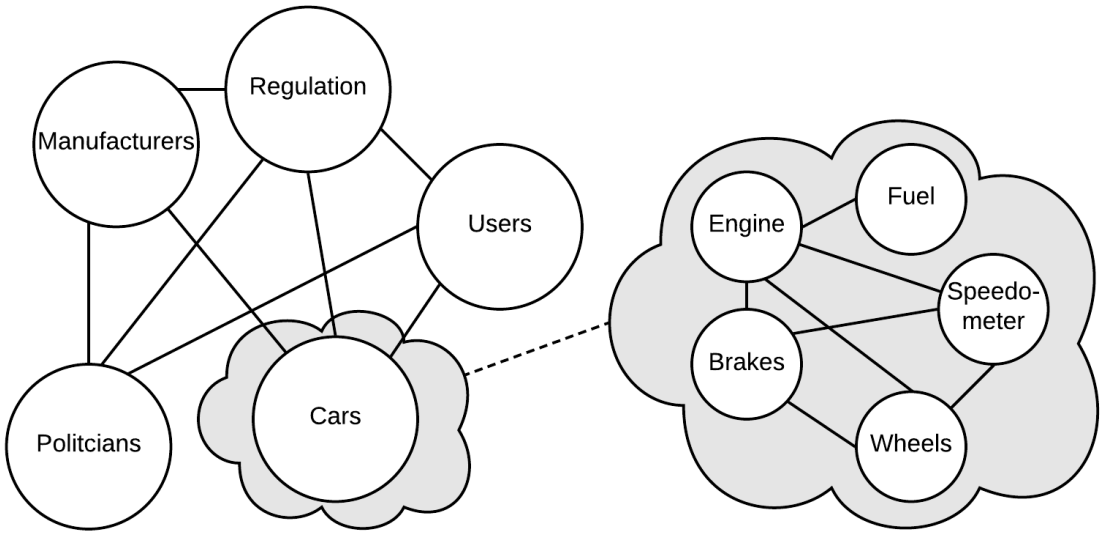

Figure 9: Actor-networks consist of actants and their relationships, but each actant can also be divided into its own actor-network. Simplifications are made to study the networks, but if the underlying networks become unstable, it can affect the other networks as well. Own production.

As long as these underlying networks are stable, they fit into the simplification and can be understood as actants in larger networks, but if changes occur in the relationships in these networks, it can highly affect the networks they are part of as well. If the passenger car engines were changed from internal combustion engines using petrol or diesel to electric engines running on batteries that had to be charged, the entire network of the passenger car was bound to change to support charging instead of refuelling and the users should plan their tours accordingly. For the same reasons, networks are often stable and hard to change, as the other actants can be unwilling to change and the networks are thus stabilised through both the bonds between the actants and the stability of the simplified networks and the larger networks they are part of (Callon 1999).

4.2. Translation of actor-networks

The translation of an actor-network depends on the resilience of the different actants and how willing they are to change (Callon 1999). This willingness is strongly affected by the actant who wants to change the network, called the protagonist. The protagonist works to translate the current actor-network in a certain way that benefits the actant itself and the other actants in a new network. The process of translation consists of four steps, of which at least the last steps must be fulfilled. If some actants agree on the translation and share beliefs with the protagonist from the beginning, the first steps might not be necessary to recruit these actants, but the last two must always be performed:

1. Problematisation
2. Interessement
3. Enrolment
4. Mobilisation (Callon 1986b)

4.2.1. Problematisation

In the first step, the actants that should be part of the new network must be identified and recognise their common interest in a change, defined as the obligatory passage point (OPP). The actants do not need to have the same reasons for reaching the OPP and will often achieve different goals, but they all need to agree to the proposed change. In the problematisation it is thus important to make the goals clear for the actants and often these goals will be blocked for the actants to reach on their own, whereby they must agree to the OPP to reach it and achieve the desired outcomes (Callon 1986b).

In the example concerning the shift from internal combustion engines to electric engines in passenger cars, this shift would be the obligatory passage point, but the actants in the network would have different goals to reach by entering the new network, as seen in Figure 10. It is also possible that some actants are replaced, e.g. the existing car manufacturers can choose to be enrolled and produce the new type of engines/cars or to be excluded from the new network and leave space for new manufacturers for electric engines and cars. It is also possible that some car/engine manufacturers are enrolled in the new network, whereas others do not agree with the OPP and are excluded.

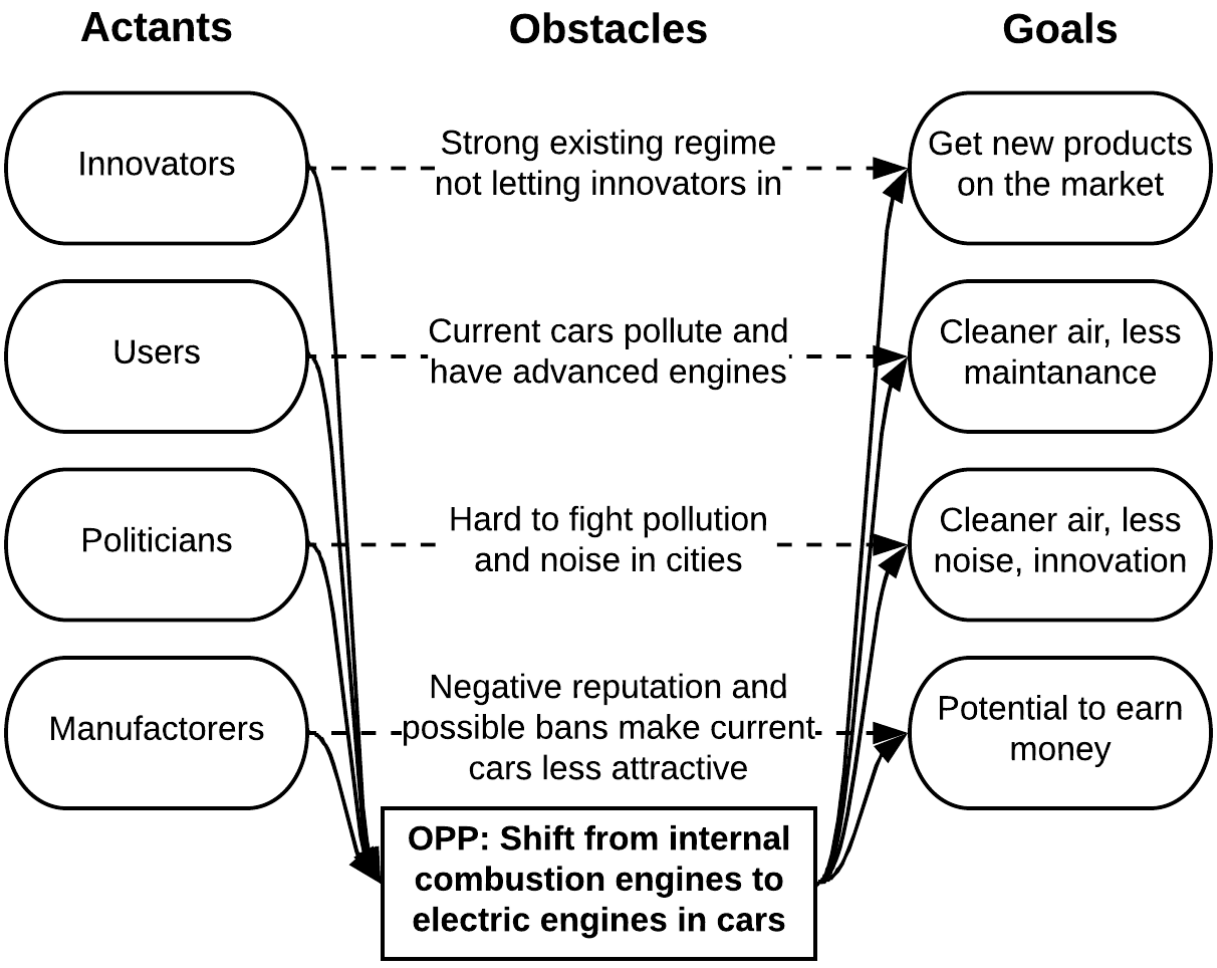

Figure 10: Actants and their goals in relation to OPP in the passenger car network. Own production.

4.2.2. Interessement

When the relevant actants, their identity, and their goals have been defined in the problematisation, it must be stabilised in relation to other networks they are part of, that also tries to define their identity. The protagonist must interest each actant in participating in this new network, rather than other networks by weakening or cutting the links to other groups of entities. During this process, the properties and identity of the actant can be redefined and consolidated by the relationship with the protagonist. This can be done using various interessement devices from seduction to force, depending on the power of the protagonist and how willing the actant is to accept its position in the new network and resist other networks trying to define its identity (Callon 1986b).

Hansen et.al defines interessement devices as *"non-human elements which are circulated by key actors in order to inspire other actors to support the change"* (Hansen, Clausen 2017, p.346) and see them as key conceptual elements in the change process. This supports Callon's view of interessement devices as something that can be placed between actors and other entities that try to define them, to secure their position in the network and thus the devices help to define the relations between the key actors in the network and other actants (Callon 1986b, Hansen, Clausen 2017).

Interessement devices can have many forms and be more or less tangible spanning from concrete reports, analyses and calculations to support certain views or statements, to narratives that can convince actants to support change, as well as meeting or workshops where actants are persuaded or convinced to support the changes. Different interessement devices can work in conjunction, e.g. an analysis can support or be a basis for a certain narrative or event, but in the same way, calculations can contradict narratives and create tension in the network (Hansen, Clausen 2017). Where calculative devices are used, these are based on certain epistemic practices affected by various knowledge-producing activities and thus perceives the world in a certain way, depending on the focus of the responsible institution who has produced the knowledge. The interessement devices are thus not neutral but can both in themselves and their use support different interessement of actants and different narratives in the network (Jensen, Cashmore & Elle 2017).

In the theoretic example of the shift to electric cars, the innovators facilitating the translation as protagonist do not have the option themselves to force the other actants to accept their identity in the new network, but by highlighting the negative consequences of the internal combustion engine supported by interessement devices such as reports and calculations, they can emphasise the need for electric engines and persuade the users to prefer electric cars and/or the politicians to make regulation to secure the shift to the new technology/network.

4.2.3. Enrolment

During the enrolment, the devices of interessement are tested to whether they actually lead to alliances and enrolment in the new network. The enrolment phase consists of negotiations between the protagonist and the other actants to get the latter to take part in the new regime and resist other externalities affecting the process. If an actant has agreed with the protagonist from the beginning and accepts their role, they can be enrolled without resistance, but for other actants, this is a critical part where they can choose to accept their role and be enrolled or be excluded from the new network. This phase can collapse the translation if important actants cannot be enrolled in the new network (Callon 1986b).

In the example, the users must truly be willing to change their current car, possibly forced by politicians willing to implement changes and the manufacturers must change production or new manufacturers must be enrolled in the network, as it cannot exist without manufacturers producing the cars. If this is not possible and the negotiations with the protagonist collapse, the new network of electric cars cannot be established, and the old network will continue to be dominating.

4.2.4. Mobilisation

In the last phase of the translation, the actants agreements to the problematisation, interessement and enrolment are tested and the representativeness of the spokesperson who has been enrolled from each actant is questioned. The translation will only be successful if the actants follow the agreements made by the spokesperson, who has represented the actant in the first three phases of the translation (Callon 1986b). For electric cars, it is not enough that some spokespersons for the users agree to shift technology, the majority or at least part of the users must agree with this and do the same.

The choice of spokesperson is important for the translation, as the spokesperson decides whether to accept the problematisation and be enrolled in the new network, but for the translation to be successful, the represented actant must also agree with this in general. If the spokesperson does not represent the actant well, an actant might be enrolled in the translation, but later withdraw themselves from the network and possibly collapse the translation. In some cases, different spokespersons can represent the same actant with completely different opinions, depending on which spokesperson is chosen (Akrich, Callon & Latour 2002b). In our example, the choice of political spokesperson would be crucial for the enrolment and to enrol the actant, it would be obvious to choose a spokesperson from an environmentally friendly party, that could be convinced by arguments about pollution and climate changes, but it would be just as important that this spokesperson represents the majority of the political actant and not only their own party. If the wrong spokesperson is chosen, the process can get far but might never reach the translation because of an

unsuccessful mobilisation, where a better choice of spokesperson could lead to a harder problematisation, interessement and enrolment of the actant, but in the end might lead to a successful mobilisation and thus translation (Akrich, Callon & Latour 2002b).

The division of the process into four linear steps is a simplification, as the process towards translation will usually be much more complicated. Actants can be involved at different times and sometimes change perspective, requiring the process to go one or more steps back, to get all actants included and persuaded to be part of the new actor-network (Callon 1986b).

In the following chapters, the actor-network related to passenger car regulation in Copenhagen will be mapped, and the translation of the network will be discussed.

5. Actor-network

To identify the relevant actants in a translation towards regulation of passenger cars to limit air pollution in Copenhagen, the actor-network must be mapped. The network is unfolded gradually by investigating the Danish air pollution discussion from the beginning, considering the firstly enrolled actants and expanding the network by identifying later enrolled actants and their relations to the other actants. For a translation of the network to succeed, the central actants must agree to an Obligatory Point of Passage (OPP) based on individual goals for the actants and obstacles to reach the goals without agreeing to the OPP. As this project investigates the decision process to introduce regulation of passenger cars to limit air pollution in Copenhagen, this is defined as the OPP.

5.1. Publications on air pollution effects

The effects of air pollution were little known when the use of polluting technology started. The problem was acknowledged in the World Commission's report *"Our Common Future"* and in the Environmental Protection Agency's Action Plan of 1985 referring to suggested limits for CO and NO_2 set by WHO as well as in a publication of the Traffic Agency in 1993 (Miljøstyrelsen 1985, Trafikministeriet 1993). According to Kåre Press-Kristensen, the first knowledge about the air pollution effects came from Germany, where a focus on air pollution from diesel vehicles has started and the investigations also affected other countries (Press-Kristensen 2018a). The focus on air pollution increased through the 1990'ies and in 2005 a lot of reports were published putting further focus on the area from 2005 to 2010 (Press-Kristensen 2018b). Before this, the health effects and socioeconomic costs had not been calculated, which in combination with the lack of solutions and knowledge about pollution sources lead to a missing articulation of the subject among politicians, green organisations, and the citizens, who knew little about the problem (Press-Kristensen 2018a).

5.2. The Ecological Council

The Ecological Council was the first NGO to address air pollution issues in Denmark and have followed the debate since. Other green organisations were more focused on pollution of drinking water and destruction of nature and thus left out an important health aspect of the environmental problems. Around 10 years ago, the air pollution focus in the Ecological Council shifted from being primarily voluntarily based to include project employment, part-time and since full-time employment as the focus grew and more money and work was put into it (Press-Kristensen 2018a). This strengthens the Ecological Council's role in the actor-network, which currently include them, the reports on air pollution and its effects providing knowledge and working as an interessement device to enrol more actants to the network, and the air quality that should be improved.

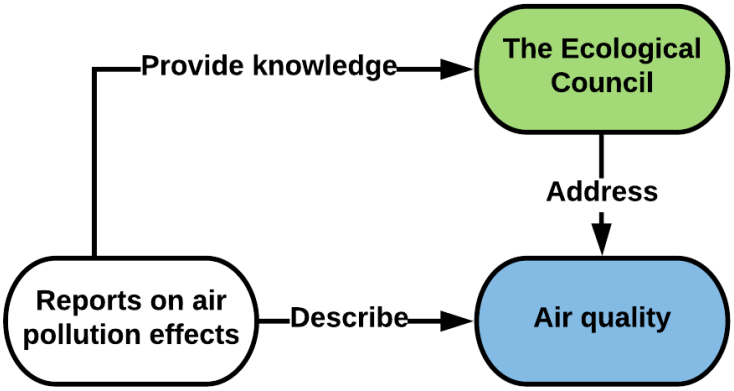

Figure 11: The first actants in the network surrounding air quality. The green box indicates that the actant works to secure better air quality. Own production.

The Ecological Council started by focussing on air pollution from traffic, where most research was done in the beginning and have since broadened their focus to include wood-burning stoves, ships, planes, work environments, and indoor pollution, as new knowledge has been presented and new health effects were discovered (Press-Kristensen 2018a). These pollution sources also affect the actor-network to various degrees, but most air pollution-related effects originate from other places and are transboundary, crossing both municipalities and countries. Local particle pollution accounted for around 10% of the particles measured in Copenhagen in 2013 and the same in the Capital Region in 2014 (COWI 2018, Jensen et al. 2017). Only 5% of the premature deaths caused by air pollution in Copenhagen in 2013 were caused by local emissions, and where this 5 % is the easiest to regulate locally, the pollution from other sources must also be included in the network. The local pollution sources that contributed to premature deaths in Copenhagen are illustrated in Figure 12, showing that around one-third was caused by road traffic, one-third from wood-burning stoves and the rest from other sources such as waste management, product usage and maritime transport (Jensen et al. 2017).

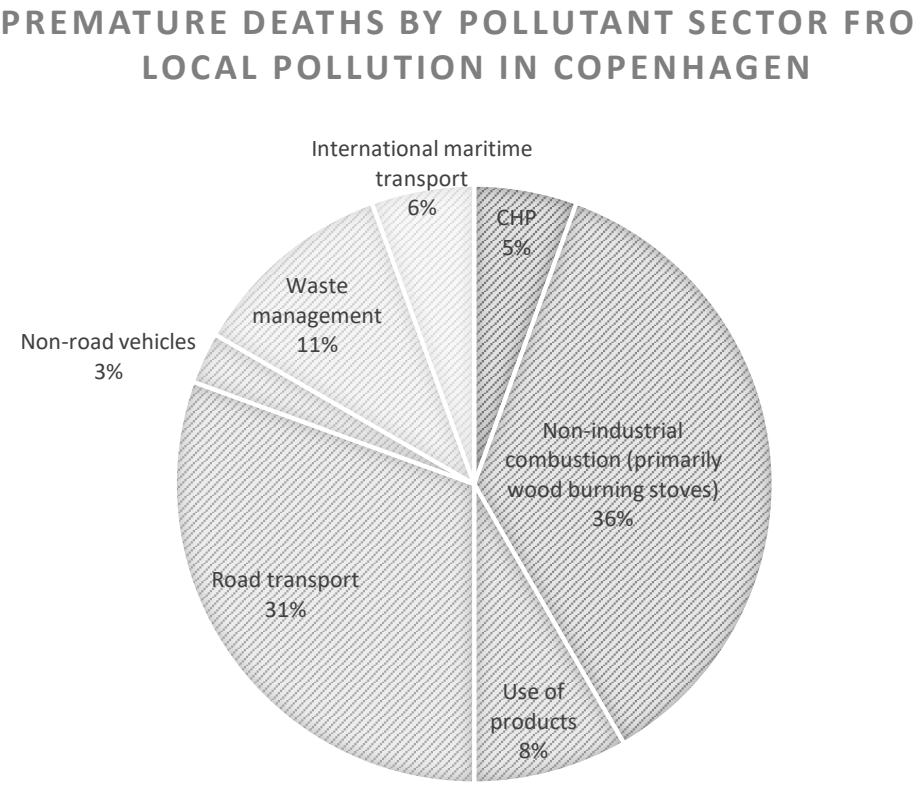

Figure 12: Calculated premature deaths per year in the Capital Region caused by local emissions in Copenhagen divided by pollutant source. Own production (Jensen et al. 2017).

The two largest local pollution sources are included in the actor-network, as these can be regulated on the local/national level and affect the air quality most in combination with the pollution from other places.

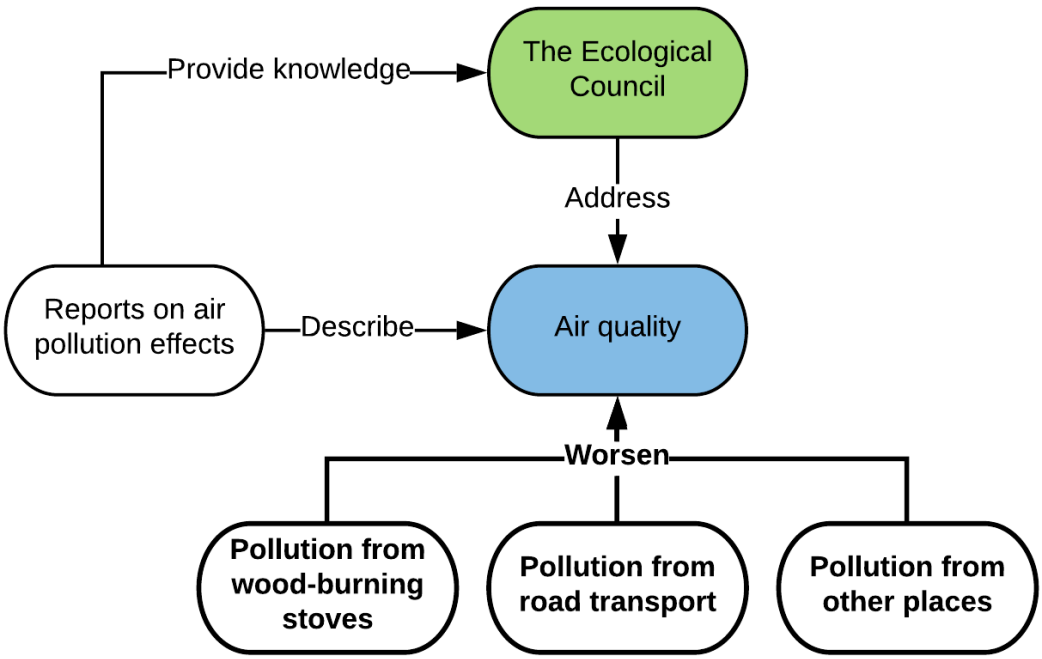

Figure 13: The actor-network including the main pollution sources. New actants and relations are marked with bold. The green box indicates that the actant works to secure better air quality. Own production.

The Ecological Council does not have any measures of their own to secure better air quality and thus must introduce more actants to the network to start a translation. At this point, the Ecological Council thus acted as the protagonist in the network, since they worked actively towards a transition, by identifying and enrolling more actants to the network. The goal was to make people understand the importance of air pollution as well as explain it to the politicians to get them to act. Their strategy was to provide information and communicate the technical knowledge provided by universities and research institutes in an understandable language, accessible by laymen in the form of pamphlets at eye level of the people. An example of this is a short article and three related documents published during the debate of toll rings in 2011, supporting a neutral/positive dialogue with experiences from Stockholm (Det Økologiske Råd 2011).

The Ecological Council established a dialogue with other associations such as the Danish Cancer Society and Asthma-Allergy Denmark and other green organisations working with traffic and started an unofficial collaboration, but no formal association was established. Kåre Press-Kristensen believes that they would stand stronger if they were more united and explains that they have tried to do so without success but are getting closer and experience more interest from the patient associations in Denmark (Press-Kristensen 2018a). The Danish Heart Foundation has started to focus on air pollution effects and concluded at the end of 2017 that around 2140 of the yearly premature deaths in Denmark caused by air pollution is caused by heart deceases and 900 Danes per year die from cardiovascular diseases because of air pollution from traffic (Jørgensen et al. 2017). This report adds to the already introduced report actant and makes the interessement device stronger, by including more sides and consequences, but as the collaboration among the associations has not been established, they are not included directly in the network. According to Kåre Press-Kristensen, each association have their own focus area, where the Danish Cancer Society focus on smoking and the Danish Heart Foundation primarily focus on smoking and physical inactivity (Press-Kristensen 2018a).

5.3. Political actants

Introduction of new regulation is dependent on political decisions, and thus relevant political actants must be involved in the network. In Denmark, three political levels are present; the municipality, the region, and the parliament. Each actant has different areas of authority and can be relevant in different parts of the translation, but all levels are relevant for the air pollution network and its translation, as they can act to improve the air quality.

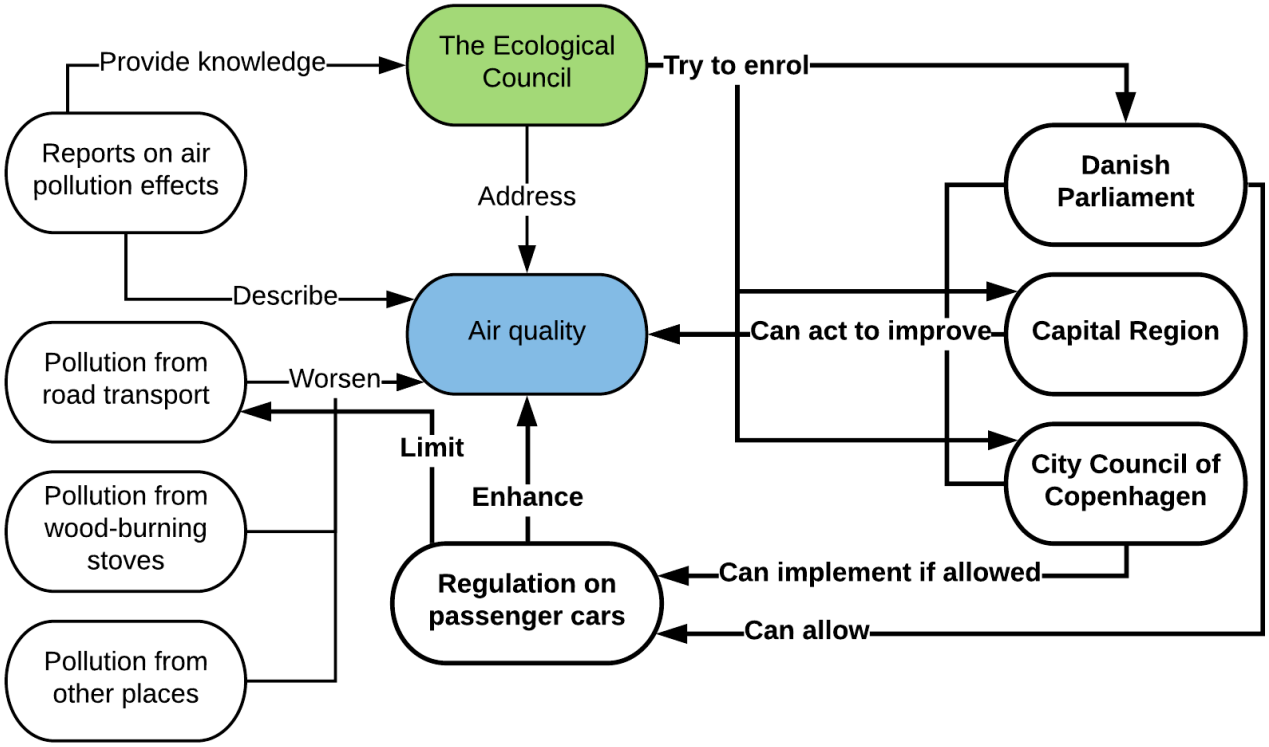

Figure 14: Network including political actants that can act to improve air quality. New actants and relations are marked with bold. The green box indicates that the actant works to secure better air quality. Own production.

For these actants to become interested and enrolled in a translation of the network, they must have reason to agree to the OPP and thus goals and obstacles must be identified and relevant actants for this must be included in the network.

5.4. EU

When the effects of air pollution started to be clear though investigation and reports on the subject, the European Commission introduced limits for the pollutants known to harm human health, as described in the introduction. These limits must be measured and kept in all EU countries and thus affect the air pollution network in Copenhagen. The air pollution limits put a certain pressure on the Danish Parliament, who are responsible for compliance with the limits, and their goal became to keep these limits. If the limits are kept, no obstacles hinder the parliament from obtaining this goal and give them a reason to agree to the OPP and support a translation of the network, but if breaches are documented, the parliament must react and consider agreeing to the OPP.

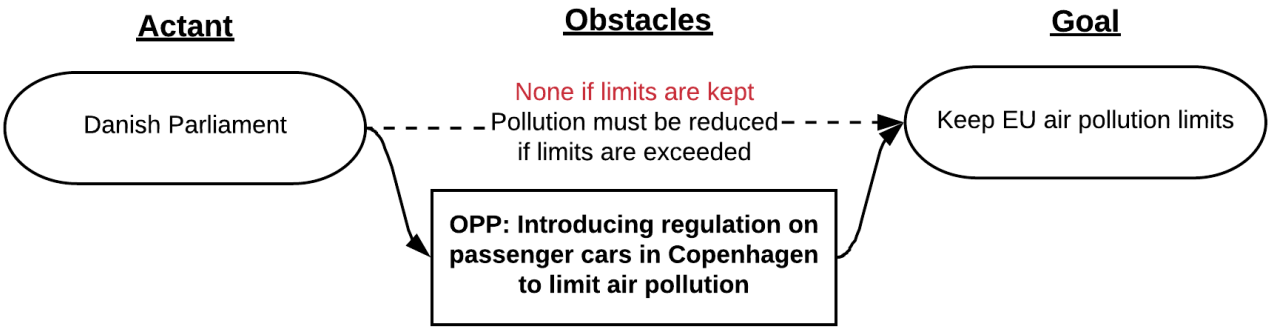

Figure 15: Reasons related to EU goals for the Danish Parliament to agree to OPP. Own production.

The measuring station on H.C. Andersen's Boulevard in the centre of Copenhagen had since 2010 indicated exceedances of the NO_2 limits after a bus lane was removed and the traffic had come closer to the measuring station. This lead to critique from EU, but after discussion between the Municipality of Copenhagen and the government, the measuring station was moved, and the limits kept, thus letting the parliament reach their goal of complying with air pollution limits, without further obstacles (Bredsdorff 2016).

The process of moving the measuring station at H.C. Andersen's Boulevard

After the bus lane on H.C. Andersen's Boulevard was closed and the other traffic came closer to the air pollution measuring station, the Environmental Agency wanted to move the station to secure a true indication of the development of air pollution on the location, where measurements were made since 1983 (Bredsdorff 2016). The Municipality of Copenhagen had to approve the relocation as they owned the plot, but after a political process, the proposal was declined. As the EU limits were exceeded something had to be done, and instead of following the wishes of the City Council of Copenhagen and addressing the air pollution from the traffic, the state took over the management of the case and let the Road Administration handle it. They approved relocation of the measuring station and thus it was moved further from the road, still complying with the criteria from EU and with measurements no longer exceeding the limits (Niss 2018).

The process of moving the measuring station indicated a difference in goals for the municipality and the parliament, as the Mayor of Technology and Environment in Copenhagen rather wanted to solve the exceedances by introducing an environmental zone for cars and limiting the pollution than simply moving the station (Bredsdorff 2016). At least part of the City Council of Copenhagen was thus interested in improving the air quality and not only keeping the EU limits, whereas the Danish Parliament did not indicate any willingness to limit the air pollution. It seems that the Ecological Council's work as protagonist to prove the importance of air pollution had started to work and the interessement devices in form of reports on air pollution and its effects had affected the City Council of Copenhagen, whereas the Danish Parliament was not yet interested in improving air quality or put focus on the area. Kåre Press-Kristensen experiences that the change of focus and increased will

to act on air pollution is happening over time, and where specific events such as Diesel Gate or published reports put pressure on the network, the main changes of attitude are obtained in the long haul (Press-Kristensen 2018a).

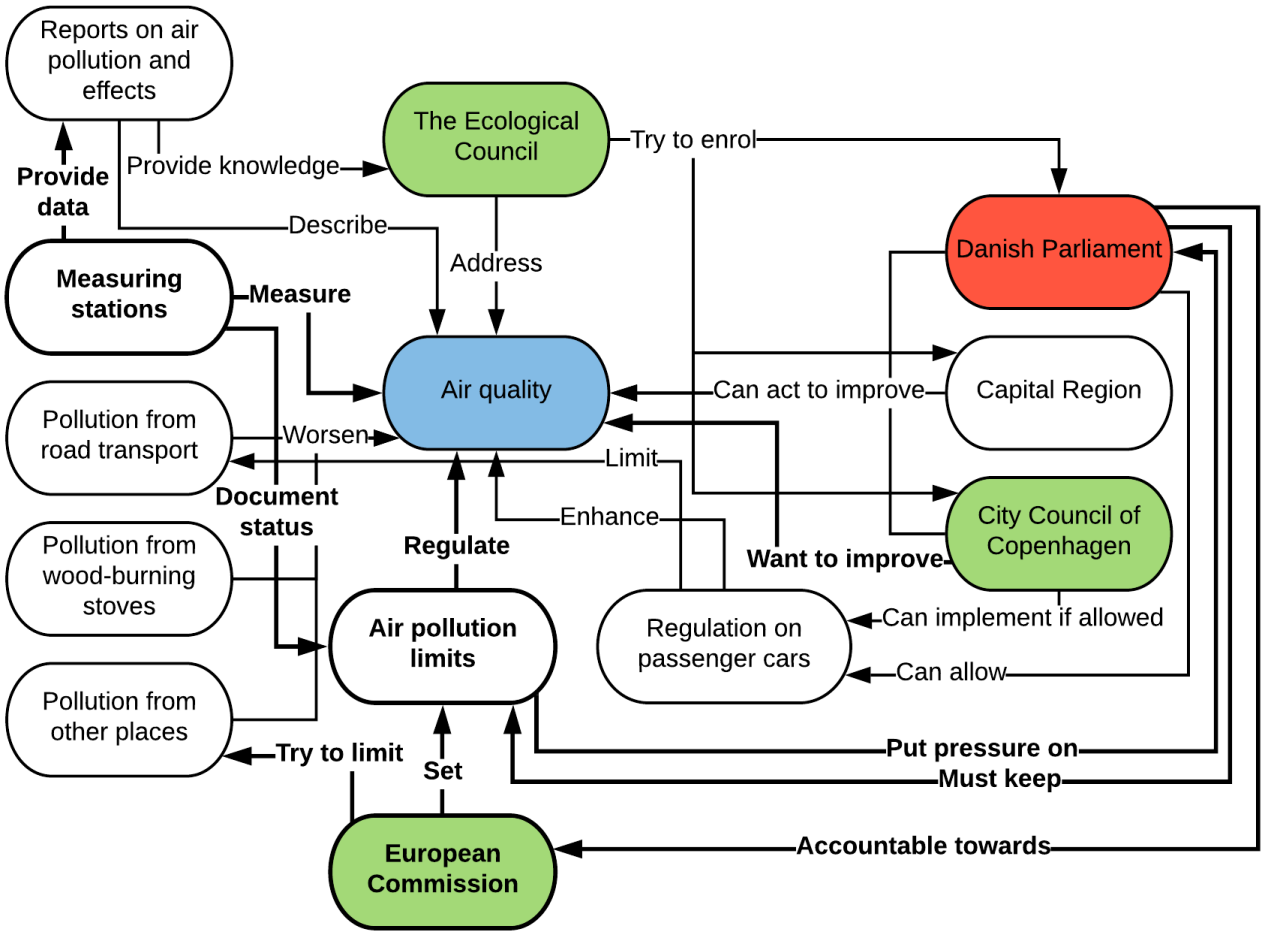

Figure 16: Network including the European Commission and their air pollution limits. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Own production.

5.5. Citizens

At this point, many reports proved air pollution to have fatal consequences for citizens and make people sick. The politicians thus had reason to improve the air quality to limit these consequences, both to limit the costs of the health issues and missing tax income caused by sickness and premature deaths and to secure the health of their voters and securing the citizens that it was healthy to live in the city.

"Air pollution was neglected for many years, maybe because there were other things to get hold of. Suddenly a lot of resourceful citizens come to Copenhagen. We want to do many things with Copenhagen and we also want to make sure that we do not get sick because of the air we are breathing." (Nedergaard 2018a)

This can be one reason for more concern among the citizens, together with the direct experience of air pollution, e.g. behind a truck or bus. After environmental zones were introduced for trucks and buses, people could feel that the air was cleaner with fewer soot particles and 'clean air' became a desire for the citizens (Kayser 2018). The goal later set by the municipal politicians in Copenhagen has also been to provide 'clean air' for the citizens, which underlines the direct impact of the voters' wishes on the political visions and goals (Mygind 2018, Niss 2018).

On the other hand, Kåre Press-Kristensen experience that the Danish population have a certain respect for authorities and trust that the pollution limits set by EU will protect them:

"The authorities have specified some limits. If the limits are fulfilled everything is good, if the limits are exceeded everything is bad." (Press-Kristensen 2018b)

The fact that the limits are based on large differences in accepted consequences as described in the introduction is not known by laymen and thus the blind trust in the limits can be misplaced. A couple of years ago, only around 6% of the population worried about air pollution. In comparison, one-fourth of the population worried about the quality of drinking water, which cause less than five deaths per year in Denmark, compared to 3000-4000 premature deaths caused by air pollution per year (Press-Kristensen 2018b). Traffic accidents also tend to get more focus and public money are spent to make the roads safer, even though less than 200 people died in traffic accidents last year and the number has been below 400 per year the last 10 years (Vejdirektoratet 2018). Deaths in traffic have a direct dose-response connection and it is obvious that when a cyclist is hit by a car and dies, the car caused the death. Deaths caused by air pollution is harder to understand and address as they often happen after years of exposure and in the form of different diseases and are thus harder to relate to, why it is easier to trust the set limits that can be kept or exceeded (Press-Kristensen 2018b).

"I used to say that if people walked around on the street and their heads exploded so that every year we had 4000 Danes who's head exploded, and they fell dead, I promise you that we would have no air pollution. No politicians would possibly accept it, because it hit totally random […] but if people die from thrombosis, then geez, a lot of people die from that. So, I think that it is also a reason [for missing focus], that it is not visual." (Press-Kristensen 2018b)

It can be hard for citizens to understand the calculations behind the 3000-4000 deaths caused by air pollution and they are thus sceptical of the number and the real effects of air pollution. For smoking, the estimated 13,000 deaths per years are also calculated, but people do not consider that, and many believe that when a person who has smoked die, the body is autopsied, and it is concluded that the death was caused by smoking. The same goes for deaths

related to physical inactivity, but in reality, such autopsies are not possible, as multiple factors can be part of the explanation for death and thus the number of deaths caused by various health issues are always calculated. This can, however, be too abstract and complex for people to understand and the numbers and expert knowledge become less relevant and less trusted, as the expert knowledge on a large part of the health area changes rapidly (Press-Kristensen 2018a).

"The general population has a healthy scepticism towards experts; >>It is all those experts who say that I cannot eat fried pork and I have to exercise and then coffee gives diabetes and three years later it does not, they say so much. << A certain disbelief in experts has started among the citizens." (Press-Kristensen 2018a)

Mette Annelie Rasmussen agrees that air pollution can be hard for the citizens to relate to, similar to the CO_2-term because it is hard to understand what it is. If the pollution is translated to health effects, it is easier to understand that it can help get a better life and become a stronger signal to send to the citizens and get them to agree that limiting air pollution is the right way to go (Rasmussen 2018). This can make it more legal for the politicians to introduce measures towards air pollution:

"If you were to forbid wood-burning, if the people are not informed about the extent of the health damages it causes, then it is not politically legal to do. Whereas in other countries where the people are informed about all these aspects, then it is legal to do and something you earn votes on and not something you lose votes on." (Press-Kristensen 2018b)

The knowledge and wishes of the citizens thus set the focus of proposals and decisions of the politicians, because of the representative democracy. More resourceful citizens worried about their health can increase the focus on air pollution, while less enlightened citizens can limit the focus. Even if the politicians know more about air pollution and believe in the calculated premature deaths because they and their boards know that they are produced by leading experts, their focus can be changed by the perception among their voters (Press-Kristensen 2018a).

In most European countries the share of diesel cars has fallen in 2017 as a reaction to the Diesel Gate scandal and increased knowledge about the effects of diesel engines. For the first time since EEA (European Environment Agency) started registering it in 2009, more petrol than diesel cars were sold in EU in 2017, even though fees on diesel fuel are lower than on petrol in most European countries (European Environment Agency 2018, FDM 2017b). However, in Denmark the share of diesel cars had increased with 6.9% of new cars sold, a tendency found in only one other EU country as well; Italy with an increase of 0.6% (European Environment Agency 2018). This could indicate that the Danish citizens are less

concerned about air pollution consequences and the Diesel Gate scandal than other European citizens, which is supported by Kåre Press-Kristensen's experiences and the described survey about which environmental issues the Danes are most concerned about (Press-Kristensen 2018b).

Because of these views, it cannot necessarily be assumed that the citizens of Copenhagen know about the health effects of air pollution and their willingness to support a network with less air pollution can be questioned if it affects other aspects of their everyday life as well. As mentioned, the more resourceful citizens in Copenhagen want to be sure that they do not get sick of the air they are breathing and thus focus on air pollution, but the focus cannot be expected to be general (Nedergaard 2018b).

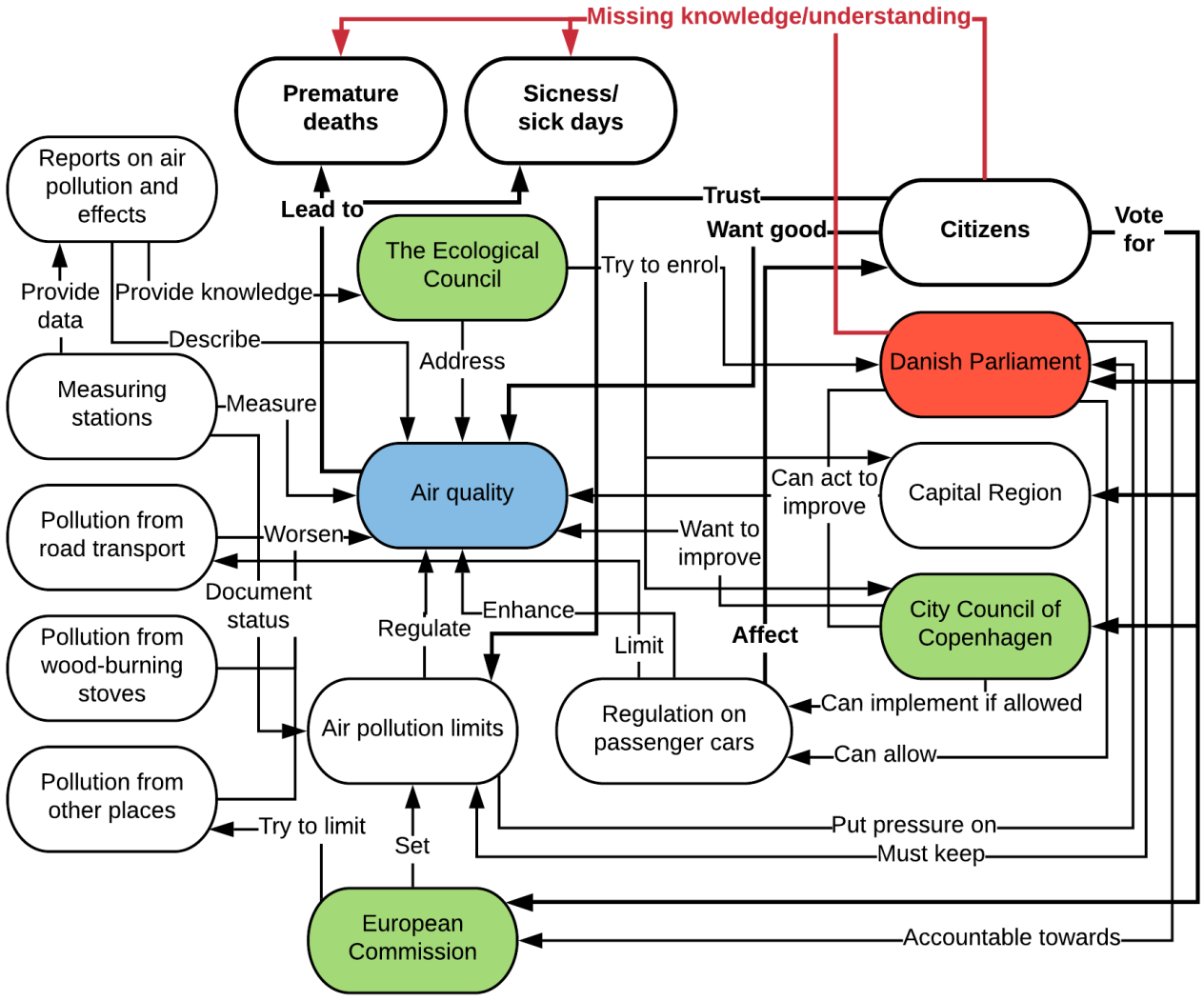

Figure 17: Network including citizens and health effects of air pollution. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

The enrolment of political actants and citizens to the network suggests that the Ecological Council are succeeding in their task as protagonist to interest more actants to become part of the network and support a translation of the network. However, it is not only the Ecological Council that brings attention to the subject, as the media also have a large impact on the focus of the citizens and politicians (Press-Kristensen 2018b).

5.6. The media

The media plays an important role in the network by distributing new knowledge to the citizens and thus set their focus on either air pollution or other subjects and through this affect the focus of the politicians. The media is called the fourth authority of the state and supplements the official authorities; the parliament, the government and the court. The media adjusts the focus on the people and try to get them to become involved in society and ask questions of *what should be done about this case?* for currently important subjects, strengthening their role in the network (Svalgaard, Arrouas 2017).

If the media does not focus on the consequences of air pollution, the topic gets less attention among citizens and politicians, which has been the case until recently and one of the reasons for missing action on air pollution identified by Kåre Press-Kristensen (Press-Kristensen 2018b). The focus of the media, citizens, and politicians also have a self-perpetuating effect since investigations are started on these areas and when the results are out, the media often covers it and increase focus on the area. This has been the case with pollution of drinking water, where exceeded limits have attracted attention from the media and caused more investigations and thus the subject has gained more focus in the media when the results were published. The focus has primarily been on exceedance of EU limits, which is also the case for air pollution, rather than to focus on the health effects caused by the pollution levels. This indicates a missing relation in the form of knowledge between the media and the health effects of air pollution and possibly the meaning of the limits, as exceedances of drinking water limits and air pollution limits are covered equally, whereas the latter leads to much larger consequences as described in the introduction. This understanding is also missing when it comes to the national politicians according to Kåre Press-Kristensen, where many are still surprised when he tells how many people die from air pollution per year in Denmark (Press-Kristensen 2018b).

According to Kåre Press-Kristensen, the media are to a large extent responsible for the distorted risk perception among the citizens, as most news focus on sensations without reflection of the actual consequences compared to other subjects. Traffic accidents are visible and relatable, and people read the articles and the media companies make money. 80 drinking water drillings not complying with pollution limits is a sensation, no matter the non-existing health consequences and thus drinking water becomes a health issue among the citizens

(Press-Kristensen 2018b). The health consequences of air pollution are significant, but not visible for people, and thus also needs sensations to be relevant for the media to cover, why the focus has been missing until recently.

"As a journalist, you take part in keeping the Danish population's focus on an environmental issue that does not impact the health of the people much, rather than focussing on the issues that mean a lot for the health and should get political focus." (Press-Kristensen 2018b)

Like the sensation with drinking water exceedances, a report published by the Capital Region showed that air pollution limits for NO_2 are exceeded in 1,066 locations in Copenhagen, based on modelling of the current pollution levels (COWI 2018). This fact got some focus in the media and increased the focus on the current proposals to limit air pollution (McGhie 2018b, Persson 2018). Diesel Gate was another large media sensation in 2015, where much attention was brought to pollution from diesel cars, misleading test results, and defeat devices used by Volkswagen Group (Moving Britain Ahead 2016). This enhanced the importance of diesel passenger cars in the network, where earlier the focus on road transport primarily targeted larger vehicles such as trucks as buses. Suddenly the passenger cars also became relevant to regulate and many European countries started to discuss bans, as mentioned in the introduction.

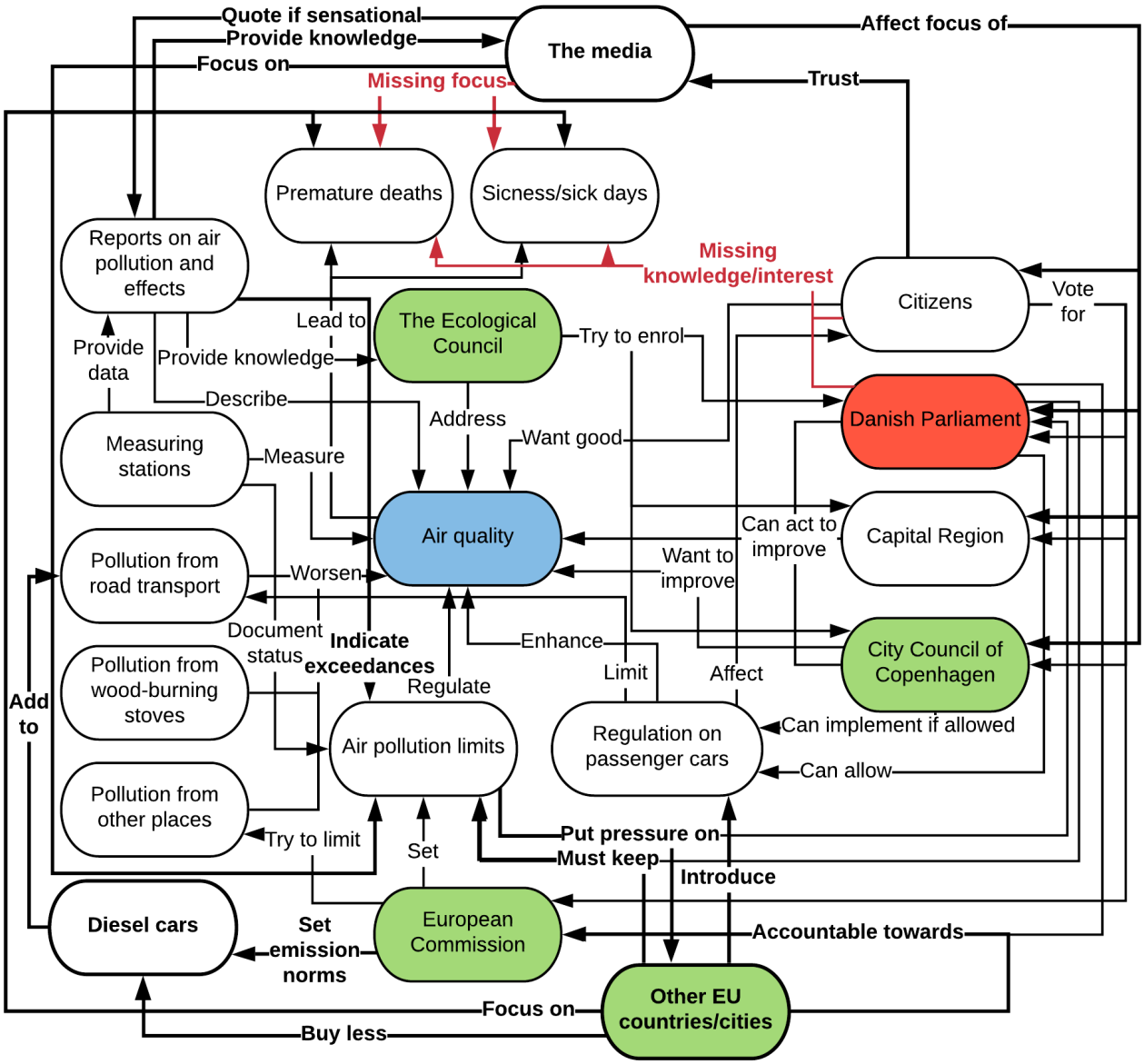

Figure 18: Network including the media, other EU countries/cities and diesel cars. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

5.7. Car industry

The Diesel Gate debate has also affected the car manufacturers, who play a role in the network as well. If stricter requirements on air pollution from passenger car are introduced, it is necessary that the car industry follow and deliver more environmentally friendly cars to fulfil the needs of the users. According to Christian Rabjerg Madsen, this can be a challenge for a small country as Denmark:

"Opposed to many other questions, where it is easy to make decisions from the national level, the car industry does not see it as their most prominent job to produce [cars] depending on the norms and regulation in Denmark. They adapt to the larger markets, e.g. the German and European." (Madsen 2018)

He thus argues that the size of the country is important for the possibility to be a first-mover on the regulation of air pollution from traffic, as the car manufacturers must be pushed to adapt by regulation of a larger market (Madsen 2018). However, a collaborate action across multiple large cities will affect both pollution and the market even further, as limited pollution in Copenhagen will lead to less background pollution, polluting other cities less, which goes the other way around as well and push the general car market (Niss 2018). Klaus Mygind supports that if the large cities collaborate, they can increase the pressure on technological development and pose a new force in the climate debate (Mygind 2018). Even without a structured collaboration between the cities, Christian Rabjerg Madsen acknowledges that the focus in other countries and cities will affect the Danish agenda and proposals discussed and introduced in other countries will shortly after be affecting the Danish discussions (Madsen 2018).

He also recognises that the location of the car industry can have a symbolic meaning, but only to a similar extent as the Danish influence on windmills, where many manufacturers are located in Denmark but produce for a global market (Madsen 2018). Annette Kayser finds, however, that the location of the industry can have an impact on decisions and regulation, as the countries with car manufacturers as an important source of income and jobs are dependent on these:

"In Germany for example, there has been a great interest from the state to put pressure on the car industry and that is from a global point of view to cope with the global competition because they are pressured from Asia and especially China, that accelerates on the electric car market, but also from the USA and other places. Making demands on the car industry can also be in the interest of a car producing country from some concerns." (Kayser 2018)

Greta Nedergaard agrees that countries with car industry are interested in developing the industry and expand it to other types of motors and environmentally friendly fuels. She compares it to the strong Danish medical industry, that has been pushed by strict regulation and requires the industry to have high standards (Nedergaard 2018a).

Klaus Mygind points out, that the Danish car industry is criticising the Danish vehicle taxation system to promote people driving in old cars with outdated technologies, as the taxes on new cars are high. This can lead to more air pollution, but there is also a consideration for resources, where the prolonged use of a vehicle is more sustainable, and lower taxes and thereby prices will often be expected to lead to more cars sold and thus more cars emitting pollution (Mygind 2018). When the taxation on cars was lowered last year, the Ministry of Finance did not expect the changes to cause more cars on the road, but this surprises Mogens Fosgerau, professor in transport economics at the University of Copenhagen, who find it natural to expect more new cars to be sold (Bredsdorff 2017). The car dealers also expect to sell more cars in 2018, where 85% expect to sell more or the same number of cars as in 2017 and 20% expect to hire more personal in 2018 (Friis 2018). The actual tendency has not yet been possible to examine.

The relations between the car industry and the political actants are thus complex, as both sides want to create jobs and growth, but the strategy can differ. Where the car industry can be less willing to change and make investments in new technology, which as mentioned is typical for sustainable transitions, the political actants might wish to push the car industry to secure that it complies with the need of the future to keep the industry and jobs in the country. Especially in countries with a large car industry sector, lobbies supporting the car manufacturers, dealers and drivers also affect the network, but in Denmark it is mostly FDM (United Danish Motor owners), that supports the car owners and their right to drive and have less focus on the car industry (FDM 2017a). They are not included in the network, as they mostly represent the citizens' interests related to other subjects than those of this network, but their role in the translation could be discussed if lobbyism and organisation of citizens were unfolded further.

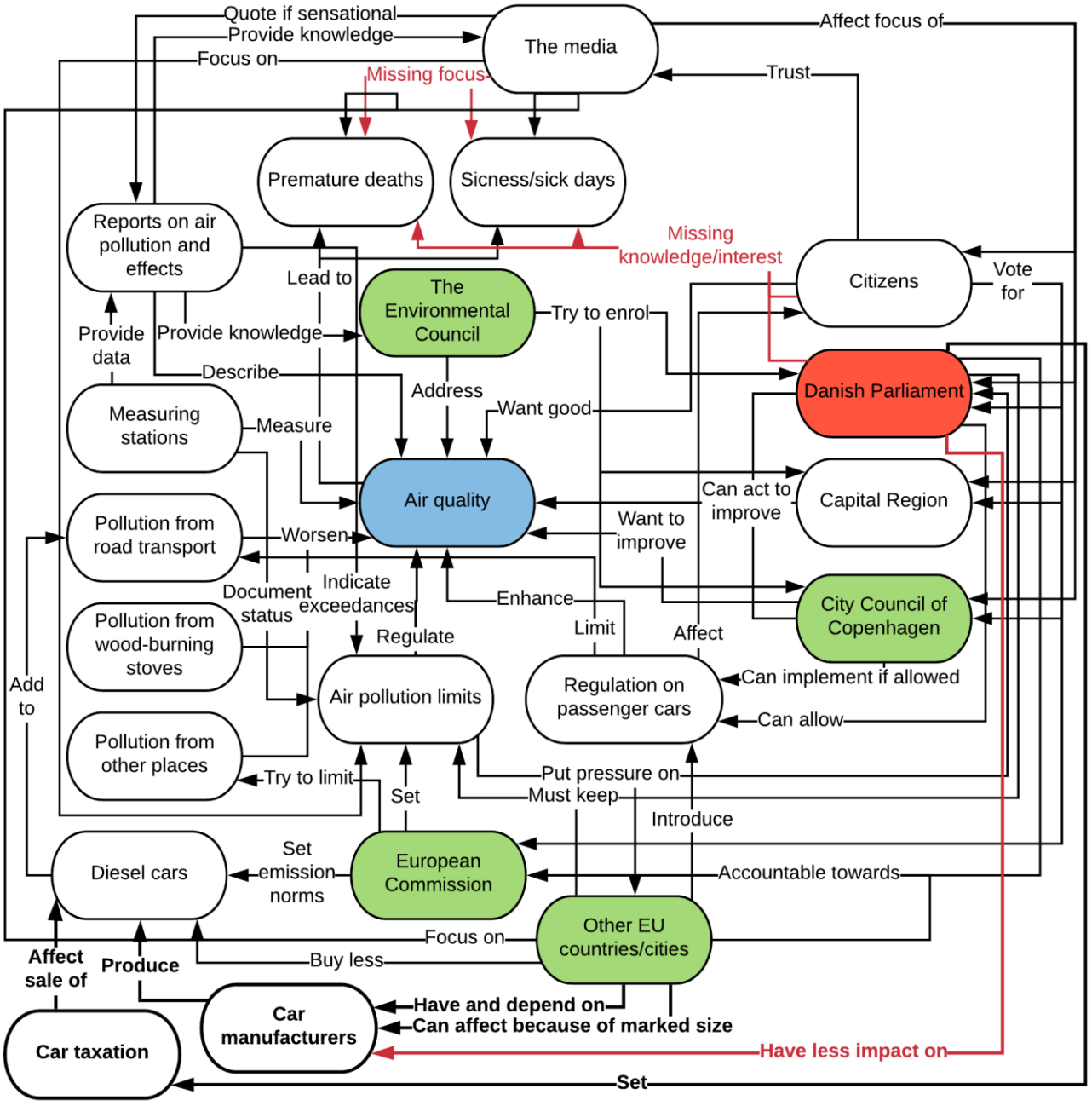

Figure 19: Network including car manufacturers and taxation. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Grey indicates a possible actant, that is currently not part of the network but could be enrolled. Red lines indicate missing relations. Own production.

5.8. Possible local regulation

Since bans of vehicles cannot be introduced in Copenhagen without support from the Danish Parliament, the City Council of Copenhagen has introduced other measures to reduce air pollution and push a green transition. Some of these are related to the municipality's own vehicles and the buses they operate, which can be categorised as changes within the sub-network of the municipality, while others affect the investigated network (Mygind 2018).

Radikale Venstre made a proposal to expand the paid parking zones in Copenhagen and differentiate the prices for resident parking licenses based on the environmental class of the vehicle, after this was allowed in the Executive Order on Parking on Public Roads in 2015 (Transport- 2015). The difference can be of up to DKK 5,000 per year, which means that the benefits will primarily be on yearly licences, as a rebate on daily or hourly parking would be hard to administer. The incentive is thus also regulated nationally, and it is for example not possible for the Municipality of Copenhagen to provide free parking for electric cars that do not emit NO_2 or particles from the engine, as visitors who often park in Copenhagen will pay more than DKK 5,000 for parking a year and thus exceed the amount that can be saved in a year (Transport- 2015, Lykke-Nedergaard 2015).

From January 2017, a resident parking licence costs from DKK 100 to DKK 1,150 per year, based on the environmental impact of the car and thus supporting the 'polluter pays' principle (Rasmussen 2018, Københavns Kommune 2015). The differentiation should push a green transition of the car fleet and at the same time address the increasing congestion issue in Copenhagen. This way the proposal had multiple purposes and affects both the network of air pollution and the network related to congestion, where this is also one incentive among many (Rasmussen 2018). According to Mette Annelie Rasmussen, the time where incentives were considered good for *either* health, CO_2, or congestion are over, and the silo mentality is limited with the introduction of FN's world goals that spans over health, environment, and technique (Rasmussen 2018). Klaus Mygind agrees that by combining multiple purposes, proposals can be easier to get through and mentions the combination of clean air and accessibility for the business community, which is also related to congestion (Mygind 2018). Congestion is thus included as an actant in this network, as some of the measures introduced will also affect congestion, as well as incentives to limit congestion will have a direct impact on the air pollution from traffic. It is though important to keep in mind that this is a simplification of another dynamic network that the actants can have different approaches to than necessarily those related to air pollution.

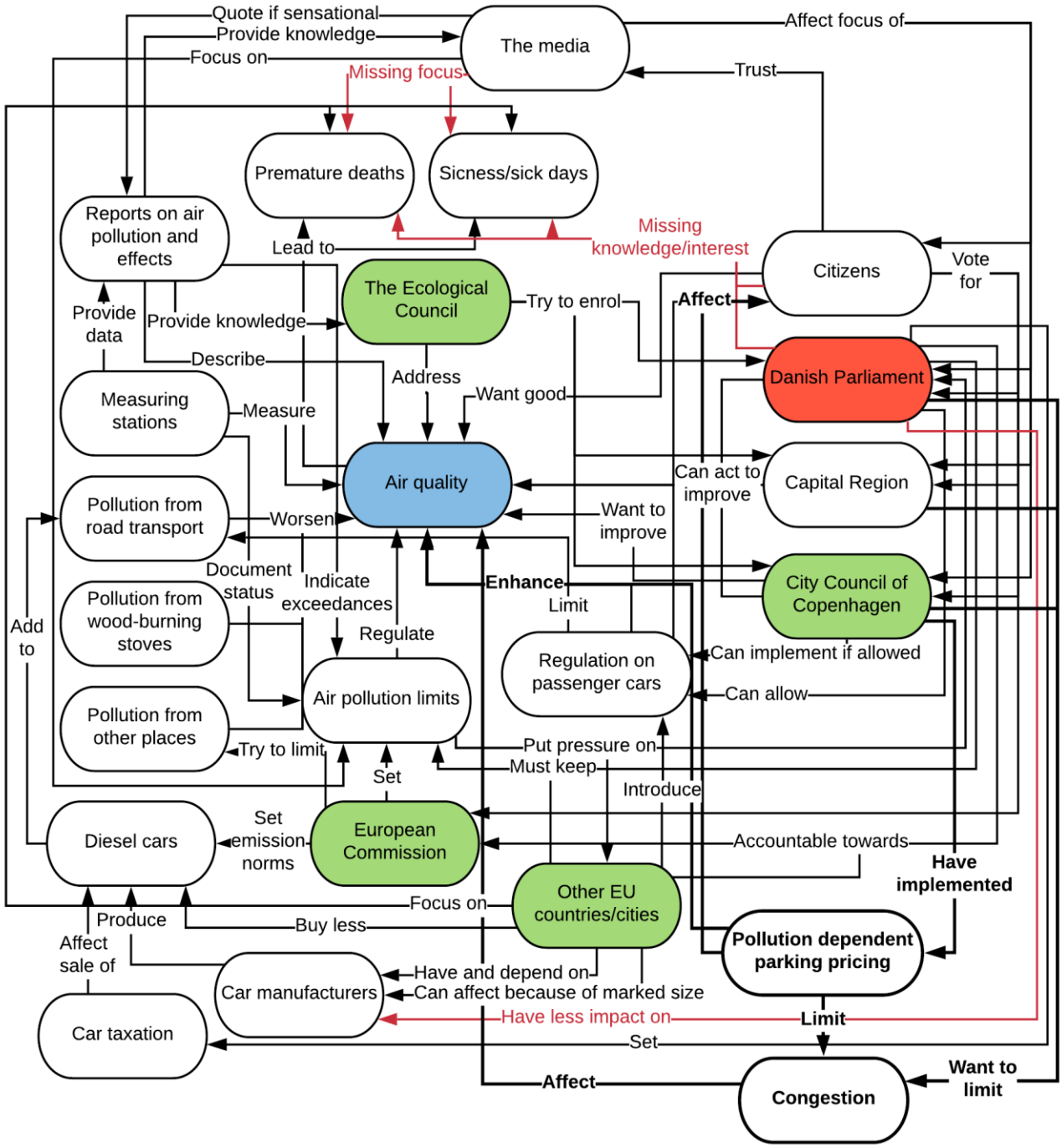

Figure 20: Network including pollution dependent parking pricing and congestion. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

5.9. Changed focus among political actants

With the increased focus on air pollution and incentives starting to affect the network, the attitude and focus of the political actants have changed since they were introduced to the network. The report from the Capital Region revealing expected exceedances of limits that got attention in the media indicates that the region has started to focus on air pollution and they have used some of their development funds to investigate the consequences of the

pollution in the region. According to Marie Ridley Pryn, all parties in the region supports the regional focus on air pollution, but currently, no more funds have been granted for air pollution incentives or investigations (Pryn, Schousboe 2018). The focus is one among many in the regional development and before the latest report, when Googling *Capital Region air pollution* (in Danish: R*egion Hovedstaden luftforurening*), the main part of the results concerned pollution of earth and the one result from their website concerning air pollution was a 6-page report about noise and air pollution in the region, without further actions on what should be done about the problem (Google 2018, Tetraplan A/S 2014). The focus from the region thus seem to have started from a low level, but now adds to an increased focus on the subject and adds knowledge about the status and consequences of air pollution in the region.

Part of the national politicians has also started to focus on air pollution. At the end of April 2018, Mette Frederiksen from the national department of Socialdemokratiet presented a proposal in collaboration with Frank Jensen from Socialdemokratiet in Copenhagen to stop selling diesel cars from 2030, phase out old diesel cars and make Copenhagen a diesel free zone. SF and Radikale Venstre have responded that they also see petrol cars phased out and gladly already in 2025, whereas Venstre is against bans and rather want to make electric cars more attractive and not bother the citizens with the green transition but keep their support in the transition by securing options to choose green alternatives. (Domino, Bloch 2018).

These attitudes are expected according to Christian Rabjerg Madsen, who finds the parliament split with the left-wing parties willing to find and implement radical solutions to limit air pollution and act on it, but the right-wing parties being more conservative and not willing to introduce measures affecting the business community, but rather to be green by introducing new technical solutions and maintain the free choice (Nedergaard 2018a, Madsen 2018). Part of the parliament thus still require more interessement devices to become interested and enrolled in the new network and implement incentives to limit air pollution, whereas the other wing is willing to limit the air pollution by introducing radical measures. These changes within the sub-network of the parliament could make the translation more likely to succeed, but the majority is still against strong measures towards air pollution. This could change after an election or if one party from the government change their attitude towards the problem because of the rising awareness from their voters.

Seven years ago, under a left-wing government, Socialdemokratiet and SF suggested a toll ring in Copenhagen to limit congestion and pollution but had to draw back the proposal because of too much resistance from society and too little loyalty from the government parties. SF had the primary interest in the toll ring and Socialdemokratiet did not support the suggestion 100% according to the political commentator Niels Krause-Kjær and in addition,

Radikale Venstre wanted a referendum about the toll ring (Ritzau 2012, Grøn 2012). The failure of this incentive has also affected the current suggestion about a diesel ban, as Socialdemokratiet are aware of the bad situation and does not want to suggest something that they have to pull back again (Madsen 2018). Klaus Mygind agrees that the toll ring has also inhibited SF and their proposals because of the lack of success last time, which is supported by Greta Nedergaard who believes that the citizens must become mature for such suggestions to succeed (Nedergaard 2018a, Mygind 2018). The proposal of diesel bans from Socialdemokratiet could thus indicate that they experience more maturity among the citizens to fight air pollution than earlier, as they have suggested radical measures again.

The timing of the current proposal is similar to the proposal of the toll ring and Frank Jensen's proposal to stop new diesel cars from driving in the Municipality of Copenhagen, as they have all been announced close to an election, where clear messages on certain subjects are often declared (Mygind 2018). Both on the national and municipal level, the theme of air pollution tends to be part of election campaigns and lose some of the focus between elections, according to Annette Kayser and Greta Nedergaard (Nedergaard 2018a, Kayser 2018).

"When election campaigns are ongoing, the focus is on air and after the campaigns, there are some aftereffects and then the interest falls until it starts all over again." (Nedergaard 2018a)

Mette Annelie Rasmussen agrees that some candidates, herself included, have made it a theme during the election campaigns, but also sees it on the agenda between elections, especially in relation to the climate plan, where the main focus is on CO_2 neutrality, but NO_X and particle pollution are included as well and will keep air quality on the agenda for the next four years (Rasmussen 2018, Technical and Environmental Administration 2016). The focus is thus present in both the City Council of Copenhagen and the Danish Parliament, which indicates that a translation of the network might be getting closer with more actants agreeing on the OPP. The protagonist has thus succeeded in interesting different actants in the translation, but as the Ecological Council has no decision power and only affect the network with knowledge on the area, which has increased from various sources, their role as the protagonist might not lead to success. The City Council of Copenhagen has been positive towards the translation from early on and has started introducing their own measures to reach better air quality and tries to push the parliament to let them experiment with more methods, indicating that they have taken over the role of the protagonist, which can be one of the reasons for the proposal from the national part of Socialdemokratiet, as the political parties communicate between the national and local level (Madsen 2018).

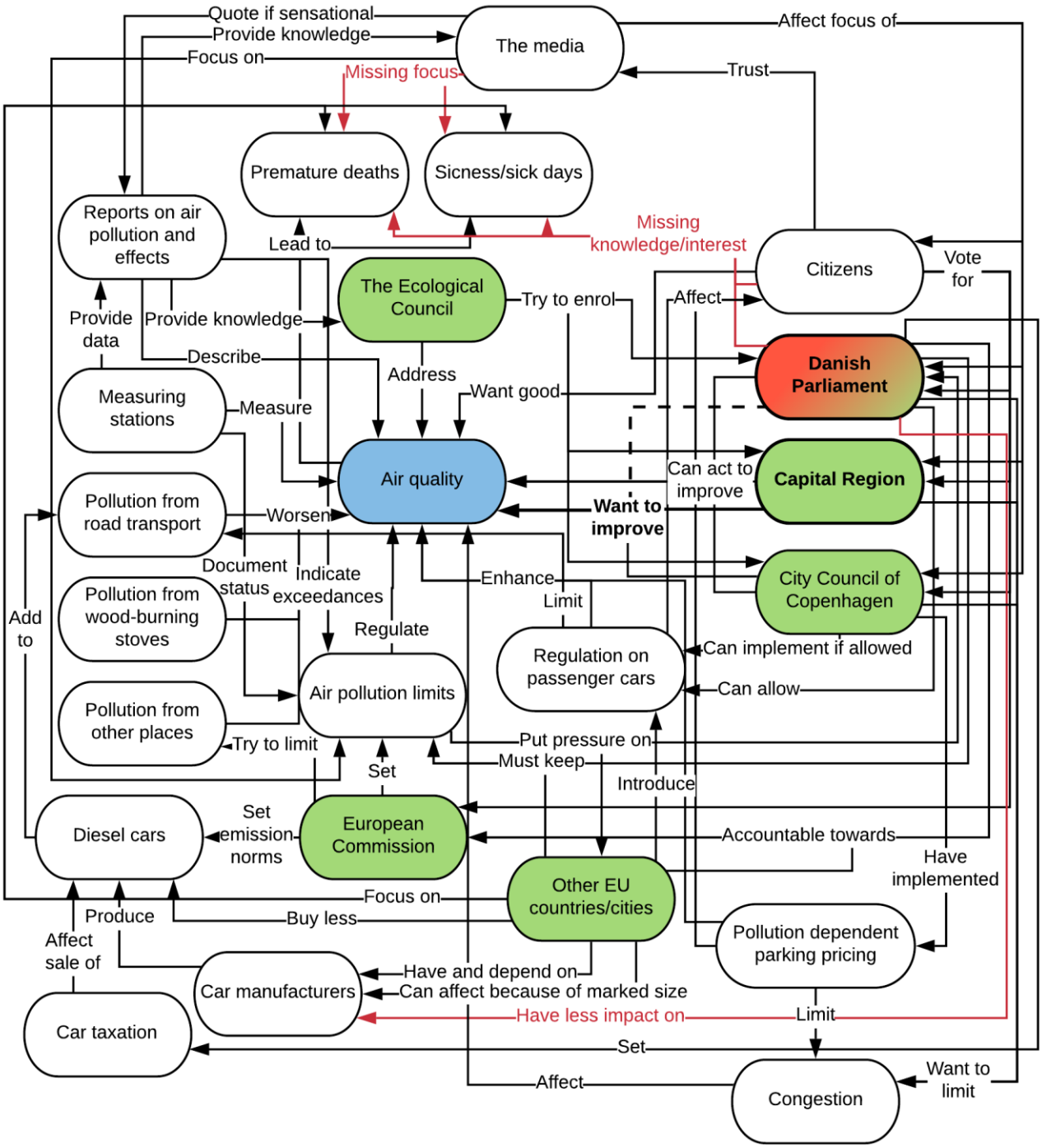

Figure 21: Network updated with a changed focus among the political actants. Changed actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

5.10. Sub-conclusion

In the previous sections, the actor-network that must be translated to introduce regulation on passenger cars to limit air pollution has been unfolded and both human and non-human actants have been identified. In the beginning, the Ecological Council tried to attract focus to air pollution and functioned as the protagonist, enrolling political actants, EU limits, and

citizens to the network, while the media also affected the focus of the actants and primarily focussed on the defined limits and not the consequences of air pollution. With time and more reports and knowledge on the area, the City Council of Copenhagen and the Capital Region also set focus on air pollution, as well as the left-wing parties in the parliament, has recently addressed the issue. With these changes, the city council took over the role as protagonist and some actants in the network were already enrolled in the translation towards stricter regulation. The parliament still does not seem to be enrolled and do not have reason to agree to the OPP and thus represent the largest barrier for the translation, as it was also mentioned in the interviews (Press-Kristensen 2018b, Nedergaard 2018a, Mygind 2018, Niss 2018, Rasmussen 2018). More interessement devices are thus necessary for the translation to succeed and will be discussed in the following chapter.

6. Translation

For a translation to succeed, the protagonist must define goals and obstacles and get the actants to agree to these and accept the OPP. As described, the Ecological Council and the Capital Region has already agreed on the OPP as a mean to limit air pollution and have agreed to the goal of the protagonist:

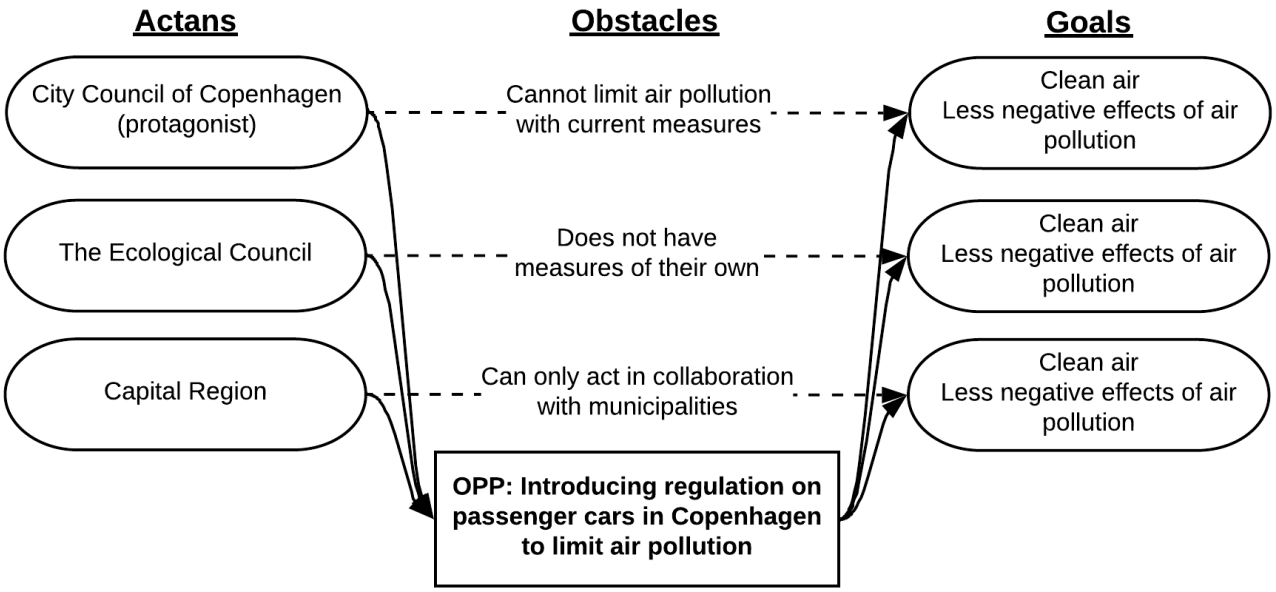

Figure 22: Enrolled actants and their goals and obstacles, making them agree to the OPP. Own production.

For the parliament and the citizens, however, the perception of the air pollution problem differs and the goals to reach by agreeing to the OPP can be less clear. The problematisation and interessement are thus not completed for these actants, and the protagonist must introduce more interessement devices to the network to make the goals and obstacles clear for them and get them to agree to the OPP. The politicians and citizens are both actants consisting of larger groups of individuals with different attitudes towards air pollution. Among both actants, their knowledge about air pollution and its consequences differ and thus their interest in the translation. However, not all individuals represented by the actant must agree to the translation, as long as the majority makes a decision. In the parliament, this is handled by direct voting on proposals, whereas the citizens' opinions are represented by the politicians they have elected. Because of this, the citizens' interests are more indirect and affect the choices made by the politicians, but it is not necessary to enrol the citizens directly and have them agree to the OPP if the politicians can be persuaded to agree to the OPP without the citizens' accept. As discussed it will, however, be hard to enrol the politicians without support from the citizens, as the politicians work to be re-elected:

"There are only a few idealists, it is about having a job. And they [the politicians] are reemployed by the voters every fourth year which means that a lot of the politicians – not all because there are still idealists left – does what is popular among the citizens." (Press-Kristensen 2018b)

In the following paragraphs, possible interessement devices that can be used to support the translation is presented and their effect on the network and the enrolment of the actants are discussed.

If the enrolment does not happen before the next national election and the constitution of the government is changed, it might not be necessary to introduce more interessement devices to the network, as the left-wing parties as mentioned already seem to be enrolled. However, this requires more of the citizens to vote for parties supporting the limitation of air pollution, and thus still require enrolment of this actant. These possibilities support that actor-networks are dynamic and can only be described at a certain time, as changes in the sub-networks of the actants and surroundings will continuously affect the network. Currently, some parties in the City Council of Copenhagen are awaiting a new constitution of the government and hope that they can get some of their incentives through if the mandates are split differently after next election which at latest will be in the summer of 2019 (Rasmussen 2018).

Besides the Danish Parliament and the citizens, the car manufacturers have been identified as an actant that must change to support the translation. However, as other large markets have started introducing diesel bans and affect the global car industry as well as the fact that only diesel cars are discussed banned currently, leaving the option to use petrol cars instead, makes this a minor barrier, that can be expected overcome before regulation of passenger cars is introduced. As seen in all current suggestions in Denmark, the regulation and bans will come into force some years from now, leaving extra time for the car industry to adapt (Jensen n.d., Domino, Bloch 2018).

6.1. Letter of formal notice/lawsuit from EU

One interessement device that can be introduced to the network is related to the EU pollution limits, that the national parliaments are accountable to keep. If the limits are proved exceeded, the European Commission can sue Denmark and force the parliament to act on the subject. In August 2016, the commission sent a letter of formal notice to Denmark and requested further information about the efforts to limit air pollution in Copenhagen, where the limits had been exceeded. This is the first step in a possible lawsuit against Denmark if the limits continue to be exceeded and the parliament does not secure that sufficient measures are introduced (Saietz 2016).

Formal procedure if an EU country does not comply with EU laws

If the European Commission identifies a possible infringement of EU law based on its own investigations or complaints from citizens, businesses, or other stakeholders, the Commission will try to solve it through a structured dialogue. If this is not successful, the Commission sends a *letter of formal notice* to which the country must send a detailed reply with information on the subject, typically within two months. If the Commission still believe that the country does not fulfil its obligations, it may send a *reasoned opinion*, which is a formal request to comply with EU law and the country should inform the commission about measures taken, typically within two months as well. If the country still does not comply with the EU law, the matter can be referred to the *Court of Justice*. If the country still fails to communicate measure, the Commission can ask the Court to impose penalties. If the Court agrees that EU laws has been breached, the national authorities in the country must act to comply with the Court judgement (European Commission n.d., Europa-Kommissionen 2014).

In the letter of formal notice, the Danish Parliament's proposal to reduce the measurements on H.C. Andersen's Boulevard because of the removed bus-lane is declined, as the measuring station complies with the regulation and adjustments in reported values are not allowed.

Reactions from the politicians differed as expected, where the former Environment and Food minister, Esben Lunde Larsen from Venstre, defended the Danish exceedances and pointed to the fact that 19 other European countries also exceed the limits, whereas the environmental spokesperson from Enhedslisten, Maria Reumert Gjerding, wanted the government to take action, instead of making excuses (Saietz 2016).

After the measuring station on H.C. Andersen's Boulevard was moved as described earlier, the exceedances could no longer be proved, and a lawsuit has not been made. However, according to Kåre Press-Kristensen, this might be the only way to get the parliament to react, as even the earlier left-wing government did not succeed in banning the oldest and most polluting vans in Copenhagen and thus limitation of pollution from traffic seem distant to him, if the national politicians should implement it voluntarily (Press-Kristensen 2018b). Klaus Mygind agrees that Denmark is conservative on the traffic area and much is required to introduce changes. If a lawsuit was initiated, the parliament would be forced to react and because of this, SF and Enhedslisten have made a proposal to the city council to set up more measuring stations in Copenhagen (Mygind 2018). It was approved in the city council in April 2018 and contained different points to improve the knowledge about the health consequences of air pollution in Copenhagen (SF, Enhedslisten 2018). This fact supports the city council's role as protagonist in the translation, as they work to create obstacles for the Danish Parliament, making it necessary for them to agree to the OPP to reach their goal.

The first point in the SF/Enhedslisten proposal was to install municipal NO_2/particle sensors, fulfilling the criteria from the Air Quality Directive on selected locations with high and harmful pollution from (diesel) cars and other sources. A model to report the outcome to the EU Commission should follow to give an accurate representation of the pollution in Copenhagen (SF, Enhedslisten 2018). These points support the possible lawsuit from EU, which could pressure the government to become part of the new network (Mygind 2018).

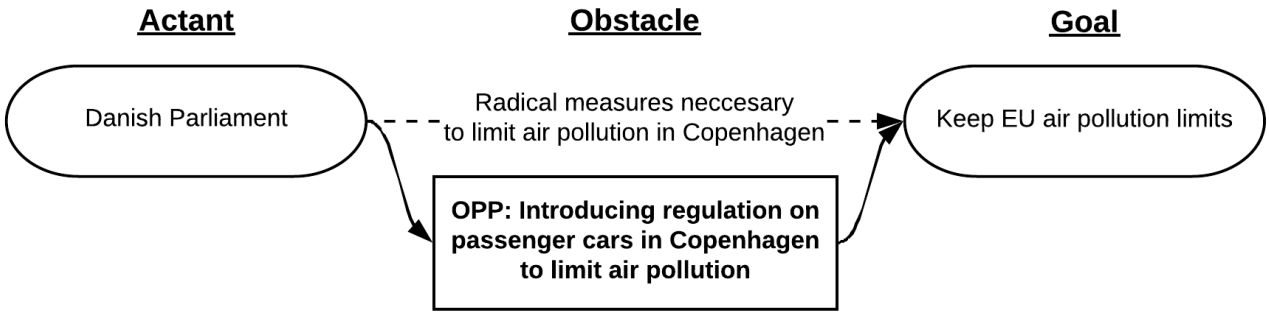

Figure 23: Reason for the Danish Parliament to agree to OPP if measurements proved exceedances of EU air pollution limits and a lawsuit was made. Own production.

In Germany, the diesel bans that are currently introduced in a some of the cities with largest pollution problems are based on a court decision, where the national court judged that the cities had not done enough to limit air pollution (McGhie 2018c). However, Christian Rabjerg Madsen considers it unlikely that the air pollution issue will end up in court in Denmark, as the justice system and traditions in Denmark differ from other European countries and the EU system itself. It is rare that the Supreme Court will interfere with decisions made by the parliament and thus the possibility of air pollution becoming a legal issue rather than a political decision in Denmark is small (Madsen 2018).

If the matter ended up in the court and forced the parliament to react, the citizens attitude towards the OPP and perception of the importance of limiting air pollution would be secondary and they could be forced to accept the new network where regulation was introduced, since they have voted for the politicians and given them the authority to make such decisions. Still, the attitude among the citizens would have an impact on the measures taken, as they should re-elect the politicians, so if the politicians did not believe in the public support, they could try to find other measures to reach their goal and keep the air pollution limits. As mentioned at the beginning of the mapping of the actor-network, the pollution comes from various sources, of which the most impactful local sources were road transport and wood-burning stoves. This means that is it also possible to limit the air pollution through stricter regulation of wood-burning stoves and thus get the pollution below the EU limits.

According to the theory, the protagonist must interest other actants to agree to the OPP and become part of the translated network, rather than to become enrolled in other networks (Callon 1986b). However, in this case, the City Council of Copenhagen has also suggested regulation of wood-burning stoves to limit pollution and thus try to interest the parliament in both a translation of the transport regulation and of regulation concerning wood-burning stoves (Nedergaard 2018a). If motivation is found to make the parliament agree to the translation of both networks, it would improve the air quality further and have a positive impact. Yet, if the goal for the parliament is only to keep EU limits, one of these translations might be sufficient and thus the attempt to enrol the actant in both networks can make the actant able to decide which translation they are willing to support, no matter which translation the protagonist prefer. According to Greta Nedergaard, it could be easier to address the wood-burning stoves and Christian Rabjerg Madsen mentions that he would be more willing to delegate the regulation of wood-burning stoves to the municipalities, than the traffic regulation (Nedergaard 2018a, Madsen 2018). If the parliament chose to support regulation of wood-burning stoves, another goal and motivation would be necessary for the translation of the analysed network.

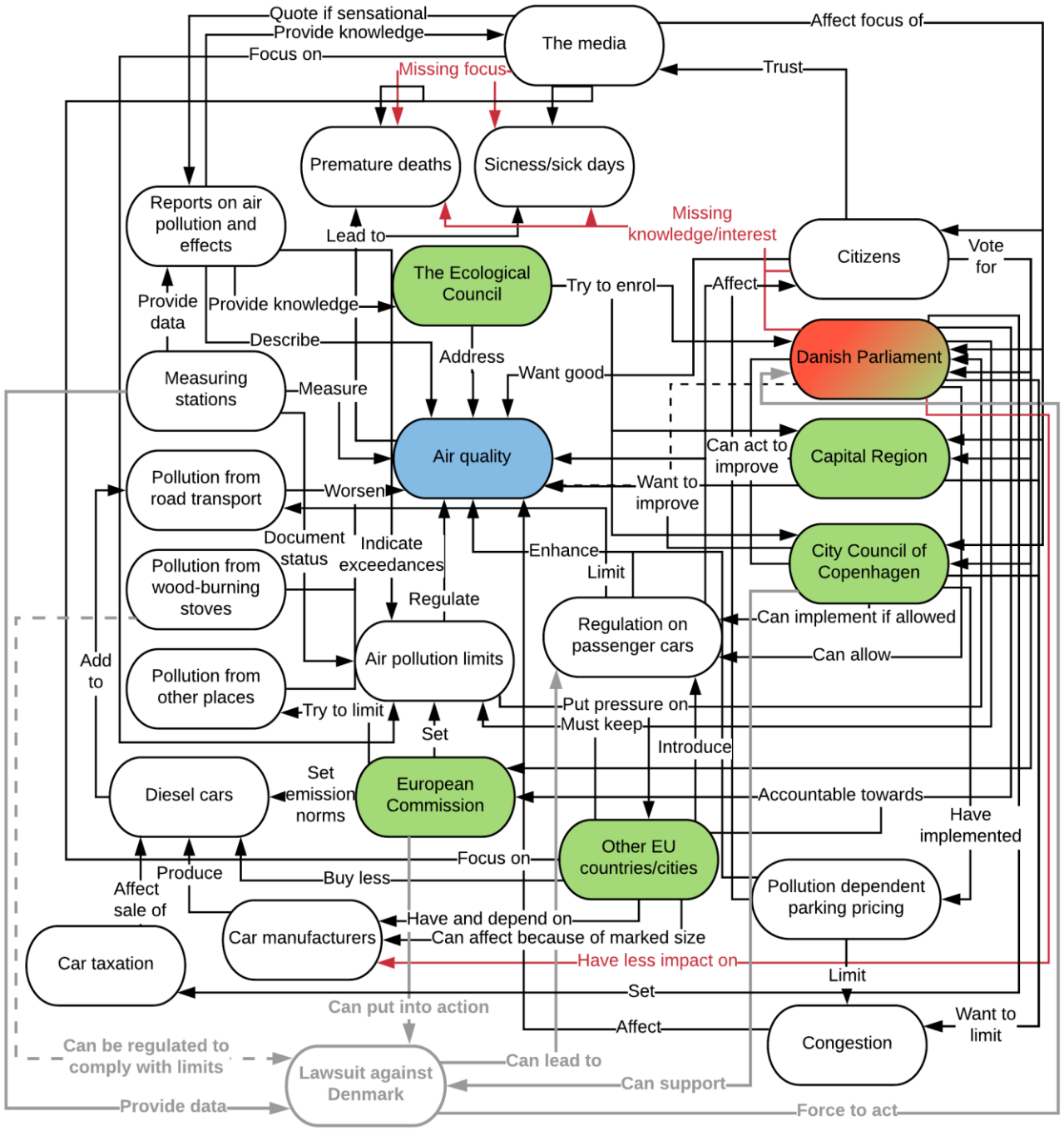

Figure 24: Network including a possible lawsuit, marked with grey as it is currently not part of the network, but could be enrolled as an actant. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

6.2. Enlightenment of citizens

The SF/Enhedslisten proposal to introduce more measuring stations was twofold, and besides supporting the possible lawsuit, it concerns information to the citizens and politicians in the form of a yearly analysis of the health-related consequences of air pollution and its sources and a website with real-time data from the NO_2/particle sensors, to let anybody follow the pollution during the day at the chosen locations (SF, Enhedslisten 2018). These

points should provide knowledge for the citizens in a usable format, enabling them to check the pollution just as when you check the weather forecast or as an automated way to let the citizens check whether it is healthy to go out, as they do in China, where they have coal and particle meters outside their windows (Mygind 2018, Rasmussen 2018). By providing information to the citizens the current blindness towards air pollution effects is addressed and the subject might get more attention and force the politicians to act. In Bristol, a health researcher could prove how many died from air pollution and how vulnerable the poorest parts of the city were, which made people react and added to the acceptance of the ultra-low emission zone in London, described in the introduction (Nedergaard 2018a). Enlightenment is thus another interessement device, that can persuade the national politicians to become part of the new network, as their goal will be to protect the citizens from the consequences of air pollution.

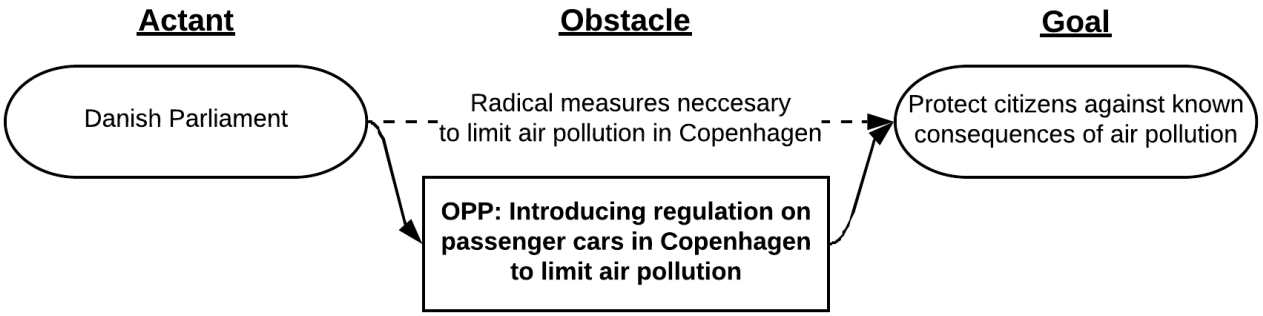

Figure 25: Reason for the Danish Parliament to agree to OPP if the citizens were more enlightened. Own production.

The effects of enlightenment are twofold, as it can both add to the citizens' understanding of radical incentives and make them comply with a high level of ambition for limiting air pollution, as well as it can make the citizens react and actively act on the subject and force the politicians to act as well. Greta Nedergaard thinks, that for the air pollution incentives to gain focus, a public movement is required, where citizens continue not to accept the pollution levels and consequences (Nedergaard 2018a). Annette Kayser agrees that the influence of the citizens is important and experiences that clean air is important among the citizens, which is supported by Mette Annelie Rasmussen, who finds that much focus is on air pollution, but the knowledge on the subject is poor because of missing data (Rasmussen 2018, Kayser 2018). Kåre Press-Kristensen sees the missing information as the largest challenge for the air pollution issues and the reason for missing action on the subject (Press-Kristensen 2018b).

The proposal from SF and Enhedslisten could provide more knowledge for the citizens, and the approval in the city council is the first step to reach this, but the action points must also be financed in the municipal budget of 2019 (SF, Enhedslisten 2018). This can be challenging, as even though the politicians from most parties in the Municipality of Copenhagen agrees

that something should be done about air pollution and approves incentives to limit the pollution, when budgets are to be made the priorities differ among the parties and some incentives might not be financed (Rasmussen 2018). The sub-network of the city council thus becomes clear and disagreements on priorities can affect the possibility of realising the incentives.

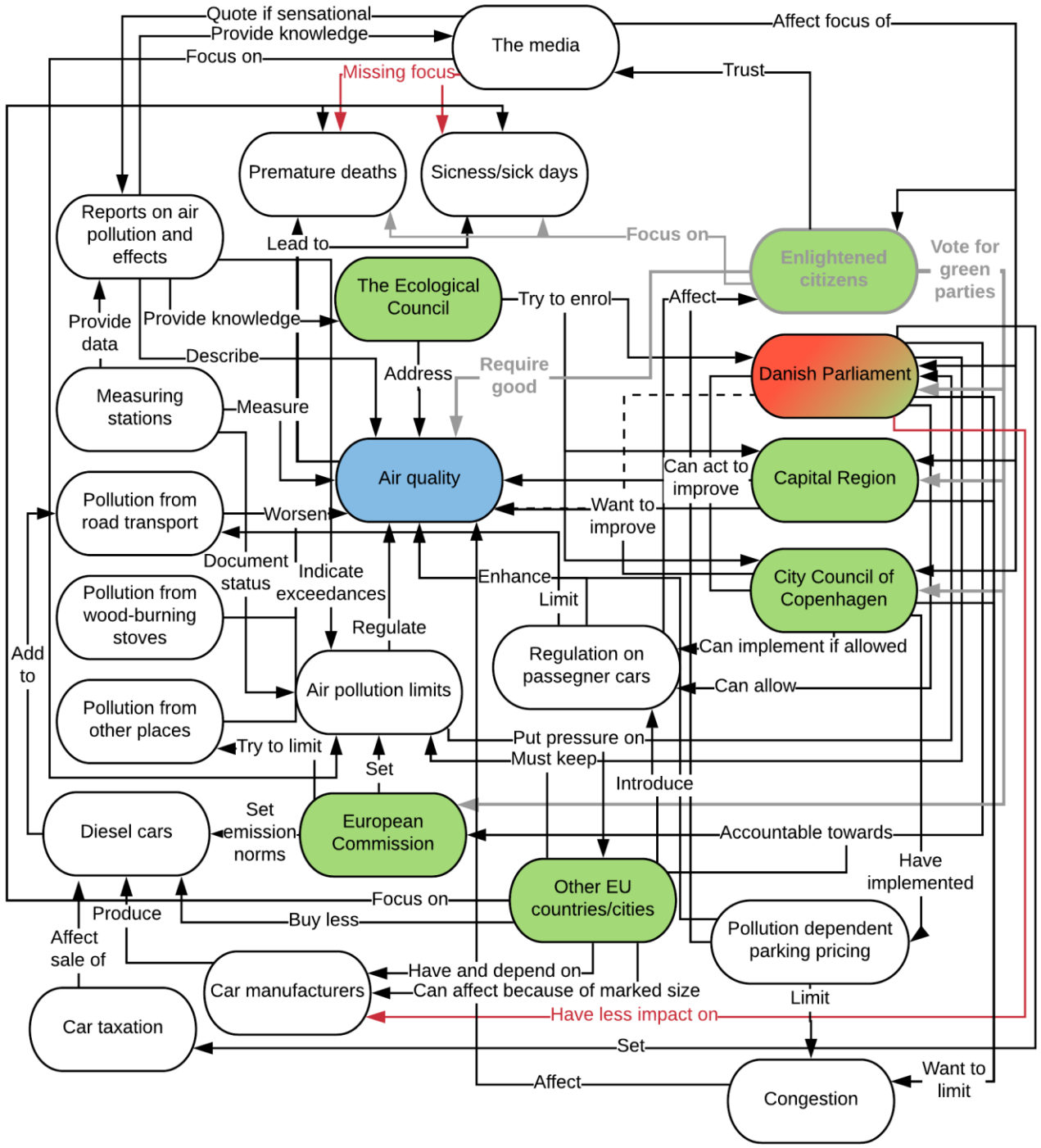

Figure 26: Network including enlightened citizens, marked with grey as it is currently not part of the network, but could be enrolled as an actant. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

Many of the interviewees have experienced that citizens in other countries are more aware of air pollution consequences and it is more legal to introduce strong measures to limit the pollution, as explained. This is partly caused by the focus of the news, that is primarily focussed on sensations regarding air pollution in Denmark but have a more general focus on air pollution in other European countries (Press-Kristensen 2018b). The awareness and focus can also be caused by more severe air pollution problems in other countries, which enlarge the motivation for action (Kayser 2018).

"Both London, Paris, and Milan are located in valleys. Milan has the challenge of mountains behind the city, causing the wind blowing from Milan to the alps to get right back to the city, making the concentration [of particles and NO_2] really bad there." (Nedergaard 2018a)

Considering a map of the air pollution in Europa, illustrated in Figure 27, it is found that Danish measurements indicate good air quality (green), where many of the measurements in other European cities indicate acceptable air quality and some places unhealthy air for sensitive groups or for everyone (yellow, orange, and red). This can also be a reason for the minor focus in Denmark compared to other European cities, as the citizens' health is less affected in Copenhagen, even though both premature deaths and health issues have been proved in Copenhagen (Jensen et al. 2017).

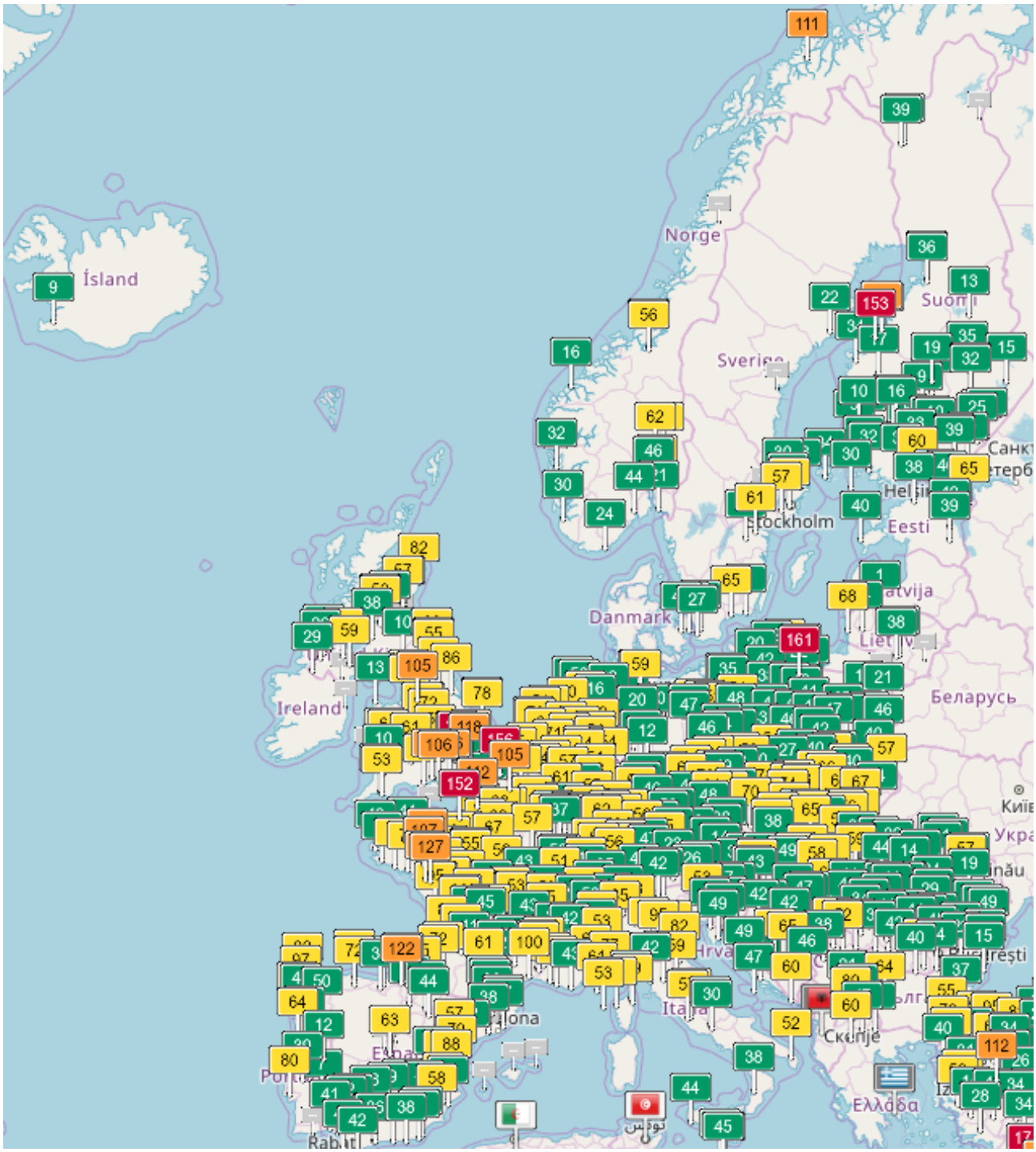

Figure 27: Air pollution index of Europe May 8th, 2018 15:51. Green indicates good air quality that poses little or no risk, yellow indicates acceptable air quality, orange indicates unhealthy air quality for sensitive groups, and red unhealthy air quality where everyone begins to experience health effects. Two more groups are defined; very unhealthy and hazardous air quality but were not present at the time of the snapshot (World Air Quality 2018).

The increased focus and actions in other European cities, whatever the reasons behind, could also be used as a measure, not only by increasing the general interest and knowledge about air pollution and increase focus in the media, but also if the politicians visited other cities and saw their solutions and the citizens' reactions. For political projects on transport

it is not uncommon that projects are unpopular amongst the population until they are implemented, but afterwards, no one express opposition, which has been the case for the Great Belt Bridge in Denmark (Grøn 2012). This has also been the case for the toll ring in Stockholm, where the support dropped below 40% during the public discussions of the incentive, but after a 6-month trial when the effects became clear, the support grew, as seen in Figure 28 (Meyer 2017). At the time of the referendum 53% voted for the toll ring and 5 years later, the toll ring was supported by 67% of the citizens (Det Økologiske Råd 2011).

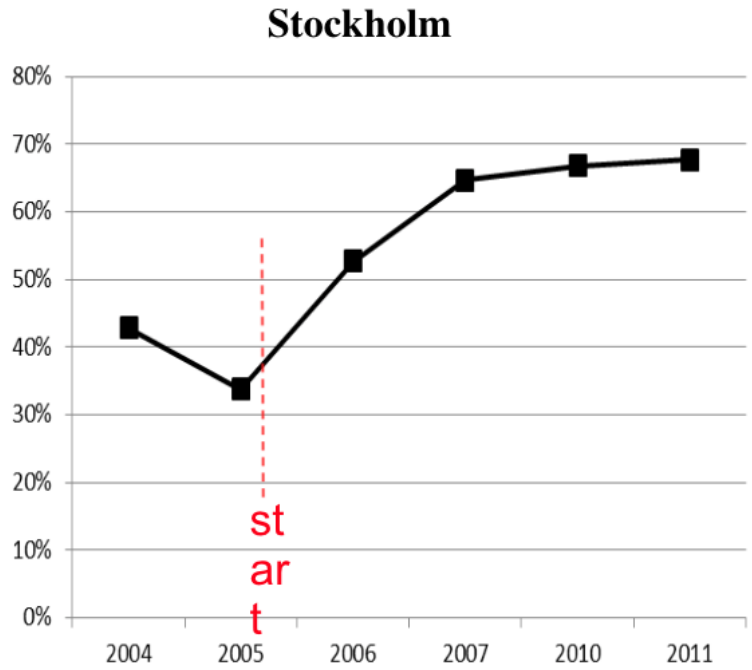

Figure 28: Support for congestion pricing among Stockholm residents in relation to trial period (Meyer 2017).

These examples could enlighten the politicians to dare to make radical decisions on the transport area if they saw and was inspired by incentives in other European cities with similar problems and saw the citizens acceptance of the solutions other places.

6.3. Socioeconomic calculations and cost-benefit analyses

Beside the possibility to enlighten the citizens and let them set focus on the air pollution effects, the effects can be converted to socioeconomic costs, that can be compared to the cost of actions against the problem. According to Kåre Press-Kristensen, the Danish politicians would take action immediately if the focus was on the health issues and socioeconomic costs, as it is in many other European countries:

"There is a lot more focus on it [air pollution], very much more in other countries. Here you have a more risk related approach where you say; how large are the damages from this and then you prioritise from the result." (Press-Kristensen 2018b)

In Copenhagen, the goal is to have *clean air that does not pose a risk for the citizens to breathe in*, but the current effects of air pollution are not included in the Eco Metropole vision, where the goal is defined (Teknik- og Miljøforvaltningen 2007). The specific goal set is to meet national and international limits for air pollutants in 2015, but as mentioned, this does not secure that the air does not pose a risk for the citizens, as it allows one death per 1,000 exposed people (Press-Kristensen 2018b). In the Economic Department of the Municipality of Copenhagen, the focus is not on these limits, but rather of the health of the citizens, and Klaus Mygind supports that he sees premature deaths and sick days as argumentation to take action but perceives 'clean air' to be a good enough goal in itself (Mygind 2018, Niss 2018):

"Clean air in a proper city. And that's actually enough in itself, I think. And then we can start discussing with experts, if there have been 500 deaths a year or it is 900, that is not so important, the important thing is a clean city." (Mygind 2018)

However, Mikkel Krogsgaard Niss also acknowledges that the municipal goal about clean air is not recognised in the Danish Parliament, that would work with other goals, which is supported by Kåre Press-Kristensen, who points to the fact that the goal does not present a burning platform that makes it necessary to act, why the parliament is not interested in bothering the citizens by introducing radical measures directly affecting them or the business community (Press-Kristensen 2018b, Niss 2018). The need for a quantitative goal is supported by an investigation of cycling in Copenhagen, where new measurements were introduced to shift focus from cyclists as a safety issue to a health-producing and part of a liveable city. One interviewee expresses:

"There were some discussions regarding qualitative or quantitative goals in regard to the cycle policy. A qualitative goal could be, for example, to ensure better condition for cyclists. But we put numbers on it. This means that there is something concrete to relate to each time we issue a new bicycle account. This is alpha and omega. If you don't have quantitative goals, you might as well have no goals at all." (Jensen, Cashmore & Elle 2017)

The quantitative focus can be secured by socioeconomic calculations, where different options can be compared and in EU, there is an increased pressure in air pollution solutions because the European Commission make decisions based on technical cost-benefit analyses, where the cost of reducing emissions of 1 kg NO_x from a certain source is compared to the socioeconomic gains representing saved lives and reduced sickness. If it is cheaper to limit the pollution than to pay for the consequences, regulation is introduced (Press-Kristensen 2018b). However, in Denmark the debate is more focused on what the voters seem to want, that does not affect their lives too much, than on the general benefits for society.

In the Capital Region, air pollution was estimated to cost DKK 9.5 billion in 2014 and in a socioeconomic analysis by DCE and COWI, clean-air zones banning the use of older passenger cars and vans was estimated to save health-related costs of DKK 581 million compared to a loss of value on the car and missed taxes of DKK 130 million, leading to socioeconomic savings of DKK 451 million (COWI 2018). Another example is a proposal of taxation on wood-burning stoves to limit air pollution, that was supported by both the Ecological Council, the Economic Council, and some large Danish health organisations. It was calculated to save DKK 4 billion in socioeconomic costs and 400 Danish lives per year, but the politicians did not support the proposal seemingly because of the risk of losing the 1 million voters who have a wood-burning stove (Press-Kristensen 2018b).

"A lot of the politicians does what is popular with the population and then they supersede science and national economy and so on. That does not mean much, what is important is; what will get you more voters." (Press-Kristensen 2018b)

This relates back to the missing knowledge and distorted risk perception among the citizens, but socioeconomic calculations might make the importance and possible savings of reducing air pollution clearer for both politicians and citizens. The current calculations on diesel bans in Copenhagen conducted by the Technical and Environmental Management only include calculations of saved NO_2 and particle emissions and the effect on the concentration of these compounds in the air on H.C. Andersen's Boulevard, but no calculations of the health effects or the socioeconomic outcomes of the regulation are included. This limitation is made based on the task from the politicians, as all aspects cannot be implemented, and the cut must be made somewhere to avoid drowning in detail, calculations, and speculations (Nedergaard 2018a). Such calculations are thus another interessement device that could be included in the network to convince the Danish Parliament to agree to the OPP, as it is used in many other European countries and EU itself.

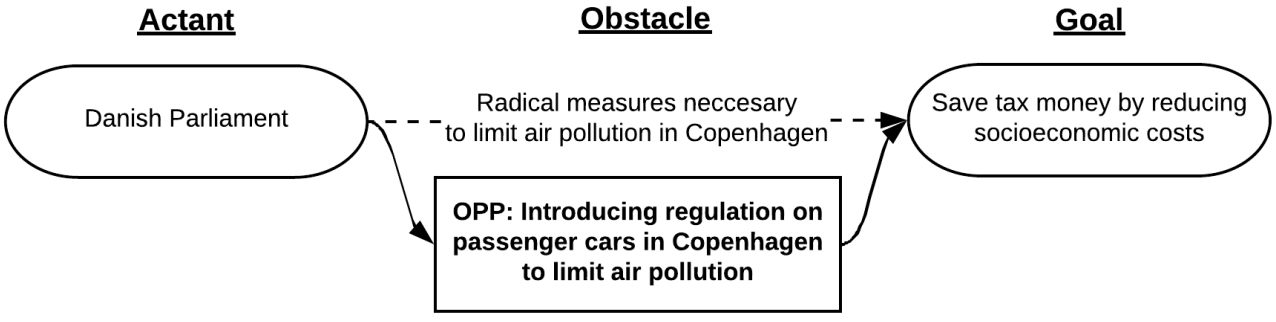

Figure 29: Reason for the parliament to agree to OPP if socioeconomic calculations and cost-benefit analyses were conducted. Own production.

This would impact many of the same actants as the possible lawsuit and provide more knowledge to make the politicians act, instead of converting it to a legal issue and having to include the European Commission to make a lawsuit.

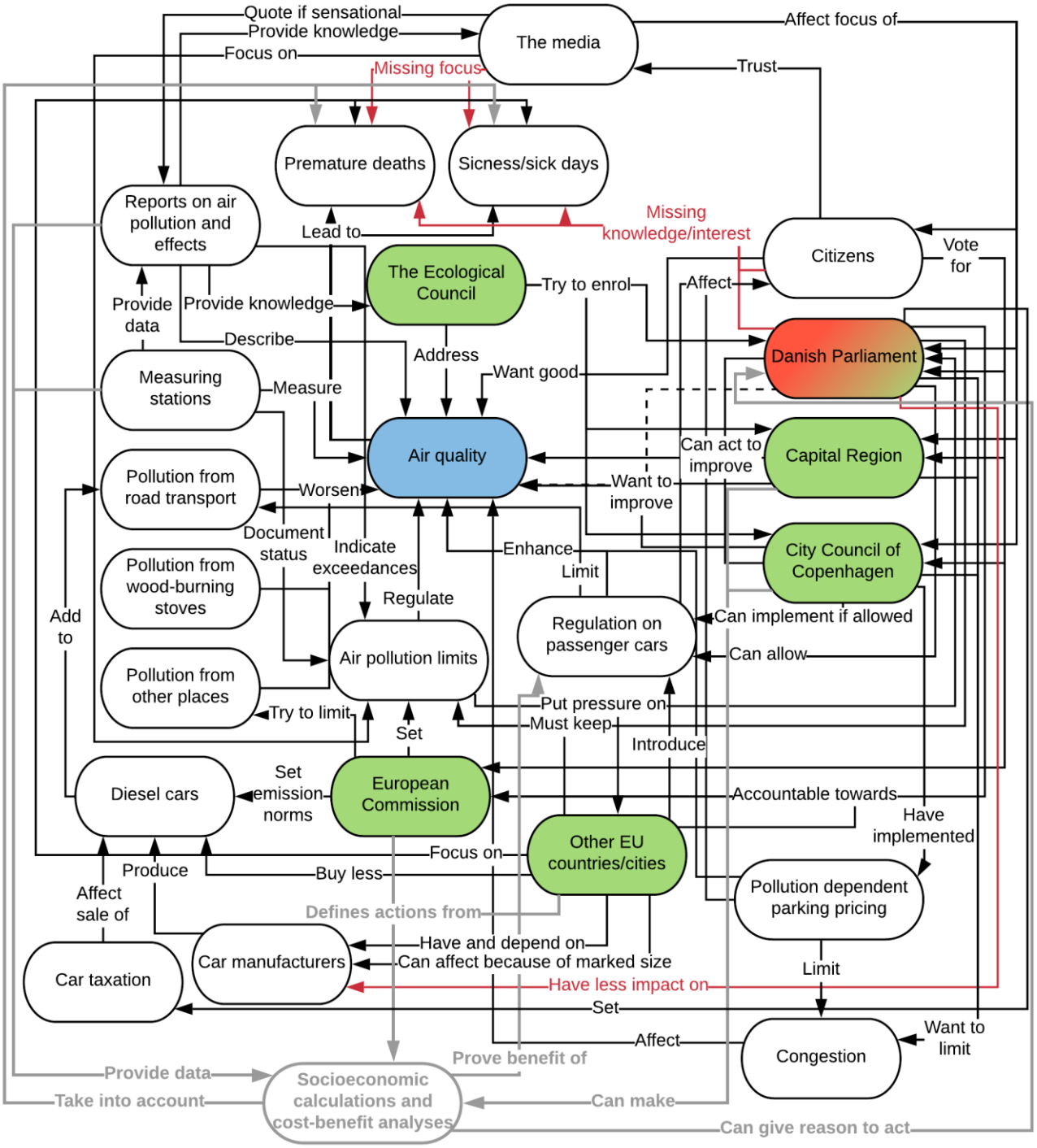

Figure 30: Network including possible socioeconomic calculations and cost-benefit analyses, marked with grey as it is currently not part of the network, but could be enrolled as an actant. New actants and relations are marked with bold. Green boxes indicate that the actants work to secure better air quality, the red box indicates an actant not willing to implement measures to enhance air quality. Red lines indicate missing relations. Own production.

6.4. Sub-conclusion

For the translation to succeed, the Danish Parliament must be enrolled and agree to the OPP, as regulation cannot be introduced without their approval. Three different interessement devices have been discussed, which can be used individually or in combination to present a relevant goal for the parliament, where obstacles will force the actant to agree to the OPP. The first interessement device addresses the current goal of the parliament; to keep EU limits and creates an obstacle with more measurements proving that the goal is currently not reached. The second device is the enlightenment of the citizens, which affect the politicians' will to introduce radical measures and currently more knowledge and focus is necessary to make a new goal for the parliament, that they must agree to the OPP to reach. The third device concern socioeconomic calculations and cost-benefit analyses, which add another goal for the parliament, as it has done in many other European countries that focus on air pollution. It can also increase the focus among the citizens and these two interessement devices are thus closely related.

If the protagonist succeeds to enrol the parliament, the translation will reach the final phase of mobilisation, where it is tested if the actants are willing to carry out the actions they have been enrolled to. Some actants might be persuaded to agree to the OPP, but when it comes to taking the necessary action fail to do so and thus the translation will fail. This risk is discussed in the next paragraph.

Another option for translation is to address the authority of the different political levels, as the responsibilities and possible gains of reducing air pollution are distributed in a certain way, whereas the possible means to limit the pollution are primarily held at the national level. If the distribution of authority was changed among the political actors and the municipality could introduce more measures themselves, it would not be necessary to enrol the parliament, which is discussed at the end of this chapter.

6.5. Risks during mobilisation

If the enrolment of the necessary actants succeeds, the translation will reach the phase of mobilisation, where the actants' will to do what they have promised is tested. If this translation of the current network reaches mobilisation, it means that the parliament has been enrolled and no longer pose a barrier for the translation and all actants must put their words into action.

The Municipality of Copenhagen has been active in the translation and functioned as the protagonist, but up to this point, they have not been able to affect the citizens.

"It is very separated what happens in the state and the municipality you can say that the benefit for the municipality is that they can put pressure on the state. It is a free round to press the state."
(Nedergaard 2018a)

Greta Nedergaard is not certain how interested some of the parties actually are if they could introduce regulation and experience that the right-wing parties in the municipalities are somewhat unenthusiastic (Nedergaard 2018a). The same goes for the Capital Region, where all parties support the focus on air pollution in the region, but as they do not have the authority and cannot regulate the area, it can be a free round for them as well (Pryn, Schousboe 2018). This would still be the case if regulation was allowed by the parliament, as the region cannot make these decisions, but on both levels, it indicates different opinions within the sub-networks of the political actants. This could become important in the mobilisation of the translation, as the chosen spokespersons might not represent the entire actant. As described in the theory, it is important to choose the right spokesperson for each actant to get the actant enrolled and to secure the mobilisation to succeed. For especially the citizens and the political actants, it can be hard to choose a spokesperson representing the entire actant and it is thus important that the chosen spokesperson represent the majority of the sub-network that forms the actant. If not, the spokesperson might agree to the OPP and the actant seemed to be enrolled in the translation but cannot mobilise the necessary changes when required.

During the analysis, the national politicians have been identified to be split between a left and a right wing, respectively for and against regulation of passenger cars to limit air pollution. The City Council of Copenhagen and the Capital Region are both considered to be in favour of limiting air pollution through regulation, but neither of these actants has had to prove any action, as it is not their jurisdiction. In both these instances, the current decisions on the area have been to increase knowledge and investigation, which is not impacting their voters' everyday life. Already at this point, it can be hard to get financing for the incentives in the city council as mentioned by Mette Annelie Rasmussen and in the region, they are also awaiting further funding through the regional budget or the regional growth and development strategy, if additional actions should be taken (Rasmussen 2018, Pryn, Schousboe 2018). This could indicate that the mobilisation of these actants might not be as smooth as indicated during the enrolment.

Depending on the interessement devices used to enrol the parliament, these might also affect the other actants and make the mobilisation more likely to succeed. If the citizens become more enlightened or socioeconomic analyses state the benefits of limiting air pollution through regulation, this will affect the political actants on all levels and could thus improve the willingness to invest and affect the citizens. If the parliament is forced to be enrolled to

keep EU limits, the attitude in the municipality and region might not be changed much, but the division of power will enable the parliament to introduce regulation as they wish, and the mobilisation of the city council and region can be overruled.

6.6. The split of responsibilities and measures

The current network relies on the Danish Parliament to be enrolled and agree to the OPP, but another way to get the translation to succeed would be if the authority to implement such regulation changed.

Today the responsibility to comply with EU limits lies within the parliament, whereas the possible socioeconomic savings are primarily related to the regions and partly to the municipalities, which is also the most local authority that focuses on local challenges affecting the citizens. Each actant thus has a primary goal to reach, but the actants that could gain the most by reducing air pollution does not have access to effective measures, as regulation, bans and fees are regulated nationally. As all political levels also have many other subjects to handle as well, the focus on air pollution can depend on the present problems in other sectors, which might get more attention on the national level, where air pollution is considered a smaller problem because of the currently reached goal. Actions on air pollution must thus compete with many other interests, and where air pollution is becoming an important issue on the local and partly the regional level, the same interest does not seem to be present on the national level.

Actant	Primary goal	Measures	Interest for air pollution
Danish parliament	Keep EU limits (currently achieved)	Regulation, bans, fees	Low
Capital Region	Reduce health-related expenses	Investigation/reports, support municipalities	
City council of Copenahgen	Reduce risk for citizens and early deaths	Change own vehicles, parking regulation	Higher

Figure 31: Primary actants responsible for reducing air pollution and their primary goals, central measures to obtain goals, and interest in limiting air pollution. Own production.

The division of both goals and measures can make the translation harder, as each actant are responsible for only some of the consequences and equally only gain some of the effects of a translation and can thus be less willing to introduce radical measures. The division in itself can also pose a challenge for the actants to understand which responsibility and measures lie among which actants, e.g. in relation to the municipality and the state (Nedergaard 2018a).

According to Mette Annelie Rasmussen, there is a collaborate action on air pollution from the region and the municipality, but if the municipality had held all the health-related expenses the actions might come faster as billions of DKK could be saved, whereas now the focus in the municipality is on the citizens' health, but not on the cost of hospitals and hospitalizations (Nedergaard 2018a, Rasmussen 2018). Klaus Mygind agrees, that where business cases are made the primary focus is on the economy of the municipality and they would be inclined to choose the option best for the municipality, no matter if other options also support the region (Mygind 2018). Kåre Press-Kristensen also experiences that the focus on air pollution in other municipalities than Copenhagen is very limited as they do not see the related expenses, that lies within the region (Press-Kristensen 2018b). This supports that the split responsibility between the region and the municipality can limit the focus on air pollution and willingness to introduce measures and use money, as effects, measures, and gains are unevenly distributed.

Within the Capital Region, there is also a split, as they have one budget for regional development and another for health expenses. Funds to limit air pollution must thus be granted from another pool of money than the money that can potentially be saved by limiting pollution (Pryn, Schousboe 2018).

"We cannot say that we make an effort to limit air pollution and we do that to limit expenses on the health area, then we cannot use the health funds on that, that would never be possible" (Pryn, Schousboe 2018)

This means that even within the region, the gains and measures are divided, and limitation of air pollution is rather a political vision to enhance the life of the citizens than a goal set by a technical consideration of the costs and benefits, as it is in EU and other European countries, as described (Press-Kristensen 2018b). Caroline Schousboe explains, however, that the regional development funds are used from a general perspective of social value added or socioeconomic calculations and not related to the economy of the region itself, as an institution. The regional politicians decide which areas to focus on, which are best for the citizens, and the Centre of Regional Development conducts relevant analyses and act in collaboration with the municipalities (Pryn, Schousboe 2018).

This is similar to the national level, where air pollution incentives are based on the politicians' perception of risk and focus among the voters, in addition to the consequences for the business community and other interests (Madsen 2018). It thus requires much focus among the citizens to make the national politicians act in Denmark and as the consequences of air pollution can be hard to understand because of the unclear relationship between dose and response, this focus is hard to set (Press-Kristensen 2018b). The focus has grown in Copenhagen because of the increasing share of knowledgeable citizens and the experience of

cleaner air than earlier and thus affects the local politicians, but the concern for the business community seems to play a larger role in the government and lessen the willingness to limit air pollution (Nedergaard 2018a, Mygind 2018, Kayser 2018). According to Annette Kayser, it is a general tendency in Europe, that the focus on air pollution is larger in cities than on the national level, as the pollution limits are exceeded in the cities, whereas the pollution on the countryside is more easily spread and cause fewer consequences (Kayser 2018).

However, in European other countries, this is less of a problem, as the local authorities have more power and can introduce stronger measures on their own. Mette Annelie Rasmussen believes that the municipal autonomy in Denmark suffers and Radikale Venstre is investigating some of the differences between the division of authority in Denmark and other countries, for instance why Oslo can make some decisions that Copenhagen cannot, to suggest changes in the Danish system (Rasmussen 2018).

According to Christian Rabjerg Madsen, air pollution incentives are regulated nationally in Denmark because of the comprehensive character and extensive consequences of the subject and he thinks this is the right place to make the decisions. This requires a close collaboration between the national and municipal politicians, which he finds between Socialdemokratiet in the parliament and in Copenhagen (Madsen 2018). Klaus Mygind agrees that there is a dialogue between the national and municipal politicians within each party but finds the lack of a general dialogue to be a weakness. Kåre Press-Kristensen supports that he does not experience a general dialogue between the municipalities and the parliament, but rather a government that says no (Press-Kristensen 2018b). Because much power lies within the parliament and actions must be allowed from a national level, the constitution of the government becomes important in the municipalities and even when a party is represented in the government, it can be hard for the municipal politicians to make the national politicians understand the view from the municipality. Klaus Mygind explains that Venstre in Copenhagen can have the feeling, that the national part of the party does not understand them, which can make it hard to get local incentives implemented (Mygind 2018).

If the authority for local regulation was moved to the municipalities or if trials were allowed as part of the free municipality trials, as Mette Annelie Rasmussen hopes will happen after the next national election, the barrier presented by the parliament would be reduced (Rasmussen 2018). However, it would be the parliament that should allow this, which Christian Rabjerg Madsen does not approve, indicating that this shift might be harder to obtain than allowing regulation on passenger cars directly on the national level (Madsen 2018). On the other hand, if the authority was moved, the national politicians would no longer be responsible for the local regulation and they could blame the local politicians and thus reverse today's blame, where the local politicians can get a 'free round' by blaming the national

politicians for not allowing them to act on the air pollution issue (Nedergaard 2018a). This leads back to the discussion of risks during the mobilisation, where the responsible authority might be less willing to act, as their actions will have immediate consequences for the voters, and thus it is easier to propose radical changes that other actants are responsible for introducing.

According to Kåre Press-Kristensen, the authority should be placed at a higher level in the cases where unpopular decisions must be made, at least if the citizens are not informed about the consequences, as experienced in Denmark. According to him, the focus on re-election and keeping their jobs makes the politicians unwilling to make the important decisions, if they bother the citizens, which hinder their motivation to do what is best for society. When the focus is put on socioeconomic calculations and cost-benefit analyses, it becomes clearer why it is important to make these decisions, but as the focus in Denmark does not rely on scientific investigations, the decisions are hard to make (Press-Kristensen 2018b).

"This is why information and public awareness are so important because people vote based on their intellect and the politicians, of course, focus depending on the peoples' votes. […] And that is why it is important that the risk perception among the citizens is at least roughly in line with reality and that they understand what kill them and make them sick." (Press-Kristensen 2018b)

It is thus important that both the people and the politicians understand and take the challenge seriously in order to act on the subject to their possible extent.

7. Conclusion

This project investigates how regulation on passenger cars can be implemented in Copenhagen to limit air pollution, as the topic got much attention during the last year especially related to the election in Copenhagen in 2017. In the project period, the focus on the subject has risen further related to the national election in maximum a year and the subject are undergoing fast development with new knowledge and political proposals.

The actor-network related to the subject is mapped to investigate the necessary changes for a translation to succeed. According to actor-network theory, the translation depends on four phases; problematisation, interessement, enrolment, and mobilisation, where relevant actants must be persuaded to agree to an Obligatory Point of Passage (OPP) and fulfil a specific role in the translation related to their goals with the translation. The process is driven by a protagonist and if that actant manages to get the necessary actants through all four phases, or at least enrolment and mobilisation, if they agree to the OPP from the beginning, the translation is successful. Because of the focus on regulation on passenger cars in this project, the introduction of such is chosen as the OPP and the regulation is included as an actant, together with the political actants that can act to improve the air quality; the Danish Parliament, the Capital Region, and the City Council of Copenhagen. To get the political actants to act and introduce measures, other actants must be enrolled to the network to put pressure on the political instances. This was driven by the Ecological Council, that started to focus on air pollution and its effect and thus acted as the protagonist in a network and used reports on air pollution effects as the first interessement device to bring attention to the subject. However, the Ecological Council did not have any measures to start a translation towards cleaner air, and thus included and tried to enrol more actants, that could start and push a translation.

The European Commission has set limits for air pollution, which the parliament is responsible for keeping in Denmark as well as parliaments are in other EU countries. This puts a certain pressure on the network, as exceedances of the limits were experienced from 2010 to 2017, where the measuring station was moved further away from the road and thus made the obstacle irrelevant to pressure the Danish Parliament to act. More actants had to be enrolled to increase the pressure on the network and the citizens were included in the network, as the political decisions reflect the attitude among the voters. This focus is largely affected by the media, where sensational news is important. The focus on air pollution in the media had been limited for a long time, but recently the Diesel Gate scandal in 2015 put focus on the effects of diesel cars and included them in the network, as well as a report from the Capital Region that calculated a large number of exceedances of EU limits in Copenhagen, increasing the focus on air pollution and incentives on the area. The car industry was also

included as an actant, as they affect the possibility to use other cars than diesel cars and thus must agree or be pushed to accept the translation. However, they are also pushed by changes in other countries and thus not expected to become a barrier at the point where regulation could be implemented in Copenhagen.

After the introduction of all the described actants, the attitude among the political actants changed and increased the interest in introducing radical measures to limit air pollution among the City Council of Copenhagen, the Capital Region and the left-wing of the Danish Parliament. The city council introduced pollution dependent parking as a measure to limit air pollution, which is included as an actant in the network, but further actions rely on acceptance from the parliament. The Danish Parliament is thus identified as the largest barrier for a translation of the network and more interessement devices must be included in the network to enrol them in the translation of the complex network that is mapped and illustrated in Figure 21 on page 43.

A number of interessement devices can be introduced to the network to support different goals and obstacles for the Danish Parliament. If the EU limits could be proven exceeded, the current goal of the parliament to keep the limits would be relevant, as an obstacle would be present, and a possible lawsuit could force the parliament to act, no matter if the citizens agreed to the OPP, visualised in Figure 24 on page 50. However, as the citizens must re-elect the politicians for the next period, their attitude would still be important, and if they hold a negative attitude towards regulation on passenger cars, other pollution areas might be regulated instead, such as wood-burning stoves, which would impact the citizens' daily lives less.

Another measure to enrol the parliament to the OPP is to change the focus and awareness among the citizens, by enlightening them, as they are recognised to be in other European cities/countries, visualised in Figure 26 on page 52. Here it is more 'legal' among the population to introduce radical measures and regulation to limit air pollution, but this might as well be because the pollution is more severe than in Copenhagen and the consequences are larger. It could also be an option for the Danish politicians to visit and learn from other cities, to encourage them to introduce more radical measure. Besides, EU and other European cities are more likely to make decisions based on socio-economic calculations and cost-benefit analyses, which makes it possible to compare the cost of the air pollution consequences to the cost of limiting the pollution. This can thus also be a way to legalise radical measures, as the costs of the air pollution become clear to both politicians and citizens and are included as the third interessement device visualised in Figure 30 on page 58.

If these interessement devices were introduced to the network, alone or in combination, and convinced the Danish Parliament to allow regulation on passenger cars to limit air pollution,

the translation would reach the phase of mobilisation, where all actants that have agreed to the OPP must take the necessary action. New barriers could appear at this point if the other political actants are not entirely supportive about introducing regulation. Some municipal politicians might dare to agree to these measures as long as they are blocked from a higher level, but when they can actually affect the voters' daily life, the attitude might be different. It is hard to know how severe the risk is, and it will also be affected by the introduced interessement devices, as the enlightenment of the citizens and socioeconomic calculations will affect all political levels. If the protagonist does not represent the majority of the City Council of Copenhagen, the mobilisation of the translation could fail, even if the current barrier of the Danish Parliament was overcome.

Another way to overcome the barrier of parliament would be to divide the authority differently among the political levels. If the municipalities could implement the regulation on passenger cars themselves, the network that must be translated would be simpler and the constitution of the parliament would be less important and thus the parties in the city council would only have to agree with each other and not also convince the national politicians to agree. Even for the parties represented in the government, it can be hard to get local incentives through, which is currently experienced by Venstre in the City Council of Copenhagen and has earlier been problematic for the left-wing parties when they constituted the government but could not get local incentives through in Copenhagen.

The introduction of measures would still depend on the attitude among the municipal politicians and the mobilisation could still be problematic. According to Kåre Press-Kristensen, these decisions should be taken on a higher level, rather than on the local level, as the Danish politicians are not willing to make decisions that can be unpopular among the population and might cost votes for the next election. If such decisions are to be taken it requires more knowledge and a more realistic perception of risk among the citizens, as mentioned as an interessement device.

7.1. Sum up on problem formulation

Below, the questions from the problem formulation are answered one by one to sum up the results of the investigation. First the sub-questions are answered and thereafter the main research question.

Which actants are involved in the network related to air pollution and passenger car regulation in Copenhagen and how are their relations?

The actor-network consists of both human and non-human actants, which affect the discussion and implementation of regulation on passenger cars. In the beginning, the Ecological Council enrolled actants such as reports and pollution sources to interest the political levels; the City Council of Copenhagen, the Capital Region, and the Danish Parliament. To pressure these actants, the European Commission and their regulation were enrolled as well as citizens that could require cleaner air and make the politicians take action. The media play an important role by providing knowledge to both citizens and politicians and affect these actants' focus, which is problematic in the Danish context, where the attention mainly concerns pollution limits, rather than the consequences of the air pollution, in the form of premature deaths and sickness. This is the case in other countries, which also affect the Danish network, e.g. by pushing the car industry, which is another actant in the translation. The focus of some of the political actants has changed and made them more willing to act, but the Danish Parliament is still split and must agree to allow regulation if the translation of the network is to succeed. The network related to air pollution and passenger car relation is thus complex consisting of many human and non-human actants that must agree for a translation to succeed.

Which barriers are present for a translation of the network to succeed and how can they be overcome?

The largest barrier to the translation is the Danish Parliament, since they have the authority to implement the regulation, but are currently not willing to allow regulation of passenger cars in Copenhagen. According to the theory, the actant must be enrolled by introducing new interessement devices to the network and convince the actant to agree to the OPP. This could be in the form of a lawsuit from EU, more enlightened citizens or socioeconomic calculations and cost-benefit analyses showing the possible savings by reducing air pollution. Another way could be a change of authority, where the municipalities had more power and the barrier of the parliament would be avoided. In both cases, there would be a risk during the mobilisation, that the actant that could introduce the regulation might not be willing to when they got the option, as it will affect their voters directly and require a certain accept from the citizens for the translation to succeed.

How can regulation on passenger cars be introduced in Copenhagen to limit air pollution?

The introduction depends on effective interessement devices that can enrol and mobilise the central actants in the complex actor-network related to the regulation. The citizens play a central role, as the political decisions of both the Danish Parliament and the City Council of Copenhagen depend on their focus and acceptance of air pollution as a problem that requires strong actions, such as regulation on passenger cars. It is thus important to enlighten the citizens and secure focus on the air pollution consequences and not only the limits set by EU, that are currently kept but still allow large consequences for the population. Socioeconomic calculations and cost-benefit analyses can support this focus, but the media play an important role by providing knowledge and setting the focus of both citizens and politicians. A change of focus has started and accelerated during the project period in which this report was written, and the focus is expected to increase as it has happened in other European countries, enabling the translation of the network to come closer.

9. Perspectivation

The investigation uncovered some perspectives that could be investigated related to this study but has not been part of the project. An important barrier in the translation was the focus of the citizens and their distorted risk perceptions, which could be investigated deeper as a project of its own, with focus on measures that have led to the current situation and how it could be changed. Another perspective is to investigate the next steps of the introduction of regulation on passenger cars if the translation succeeds. By studying a similar network after the translation has succeeded, the implementation of regulation can be explored and the possibilities and risks in this phase, which could be a project of its own as well. These perspectives will shortly be debated in this chapter.

9.1. Focus and Risk Perception

The missing focus on air pollution among the citizens and thus the politicians at all levels are identified as one of the core barriers for the translation to succeed. As discussed, the distorted risk perception is to some degree established by the media and their focus on sensations and more relatable subjects that are easier to understand, such as deaths in traffic and exceedances of certain limits for e.g. drinking water. The fact that air pollution is hard to relate to makes it difficult to attract focus on and to get people to comprehend.

Two years ago, a large report on public health risks was published by the National Health Service, identifying the largest health factors in Denmark and assessing the socioeconomic consequences of the factors. The factors and their related premature deaths are shown in Figure 32.

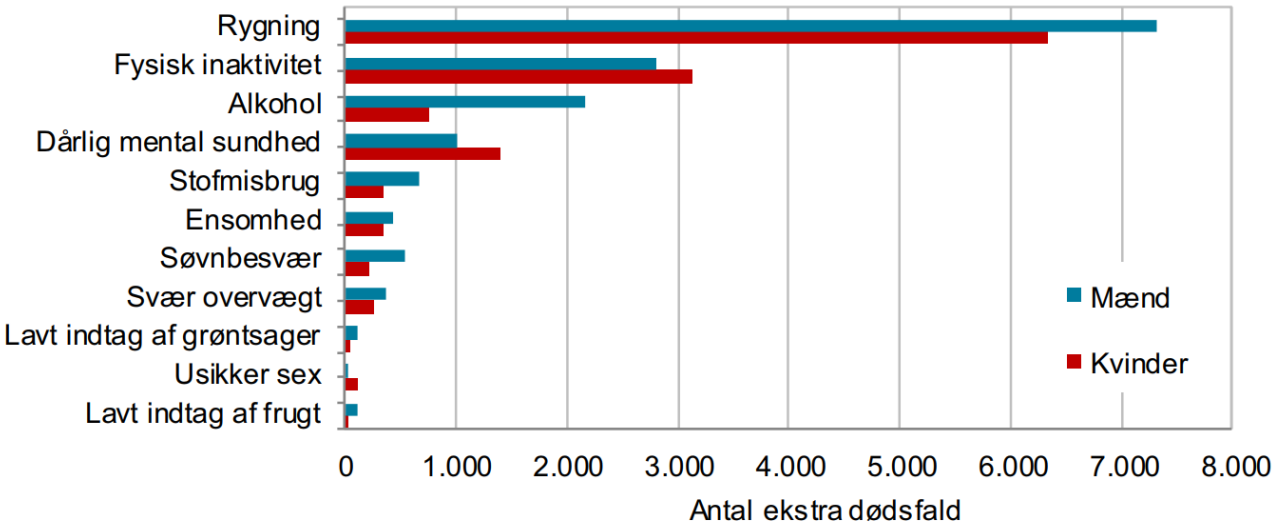

Figure 32: Premature deaths in Denmark related to risk factors, divided by gender. Yearly numbers in 2013, adjusted for smoking, alcohol intake, physical inactivity and BMI. From the top: Smoking, physical inactivity, alcohol, bad mental health, drug addiction, loneliness, insomnia, obesity, low intake of fruit, unsafe sex, low intake of fruit (Eriksen et al. 2016, p. 20).

Air pollution is as mentioned accountable for 3000-4000 premature deaths from fine particles alone, but not included as a risk factor in the report and with no calculations of possible socioeconomic savings by limiting air pollution. It is only mentioned once, in the background chapter, where it is excluded in the report together with some other factors, because there is not enough knowledge, or it is too hard to calculate based on the existing records. The analysis is based on data from different registers containing information about the Danish population and surveys concerning the health and habits of the adult population (Eriksen et al. 2016). The participants have answered how much they smoke, drink, exercise etc. to establish the most important risk factors, but they have not been asked about their exposure to air pollution, as the majority of people have no idea about their exposure level. Because of this, air pollution is not mentioned as a significant health factor to be dealt with, and when the politicians are to introduce incentives to increase the health of the Danish population, they will consider the risks and socioeconomic results of the report and air pollution is be less likely to be dealt with (Press-Kristensen 2018a). This report indicates that the distorted risk perception is not only a problem for the citizens, created by the focus in the media, but also has a direct impact on the political level, where such reports and calculations are trusted and relied on by the politicians and political boards. It can also be a reason for the minor focus on air pollution in Denmark compared to other European countries, where socioeconomic calculations are made for air pollution as well and set in relation to the other identified health risks (Press-Kristensen 2018b).

Currently, the perception of health issues is thus focussed on other aspects than air pollution, that is more based on individual choices, as most of the risk factors identified in Figure 32 can be chosen or avoided by the individual. As briefly discussed, air pollution is different as everyone is affected by the pollution and you cannot choose not to breathe, which increase the importance of a collaborate action on the subject. It could thus be interesting and relevant to further investigate how the current risk perception is established and how it can be changed among both the citizens and politicians and which effect this would have on the debate and incentives that are introduced. The importance of lobbyism and organisation of citizens could also be investigated, to unfold their influence on the attitude towards a translation.

9.2. The next phase of implementation

If the translation of the network succeeds and all actants agree to introduce stricter regulation, the process is still not finished, as the regulation must be introduced and continuously updated, depending on the introduced model. When the Danish regulation was changed to allow trials with environmental zones in 2001, it took 7 years before an environmental zone was introduced in Copenhagen, so even the first step of implementation can take time. In 2007 the national regulation was changed again to allow environmental zones in the five

largest cities in Denmark, and the law specifically states which municipalities can introduce environmental zones and which requirements they can introduce. The municipalities cannot make stricter requirements than this, and if other municipalities wanted to introduce environmental zones, this is not possible because they are limited from a national plan and thus presents a similar situation to the one investigated in this project (Press-Kristensen 2018b).

The environmental zone was an important measure to limit air pollution in Copenhagen, primarily focussed on particles, and fulfil the municipality's goal for clean air, just as the proposed regulation of passenger cars today (Press-Kristensen 2018b, Teknik- og Miljøforvaltningen 2007). The introduction of environmental zones also required changes in the transport actor-network in Copenhagen and includes a slightly different actor-world, as the citizens are less impacted, but the business community is affected to a larger degree, both in Copenhagen and the companies delivering goods to Copenhagen. It is thus another translation but driven by the same purpose and with resistance from the voters, as it affects their daily (work) life.

The translation of this network succeeded, and the introduction of environmental zones reduced the number of ultrafine particles as expected because of particle filters installed on older vehicles and renewal of the vehicle fleet, that can partly be attributed to the environmental zone and partly to the general pressure from EURO norms (Press-Kristensen 2013). The regulation has thus been a success, but today the effects of the environmental zone have decreased, as the regulation was fixed on EURO norm IV or newer and has thus been caught up with by the European requirements to sell vehicles meeting new EURO norms maximum one year after they are introduced (McGhie 2018b). The national regulation only enables municipalities to tighten requirements, if particle limits are exceeded, as the environmental zones were permitted to limit particle pollution and thus Copenhagen cannot change the environmental zone without national approval, as only the NO_x pollution has exceeded the limits, shown in Figure 33, and today no exceedances are measured due to the moved measuring station (Niss 2018).

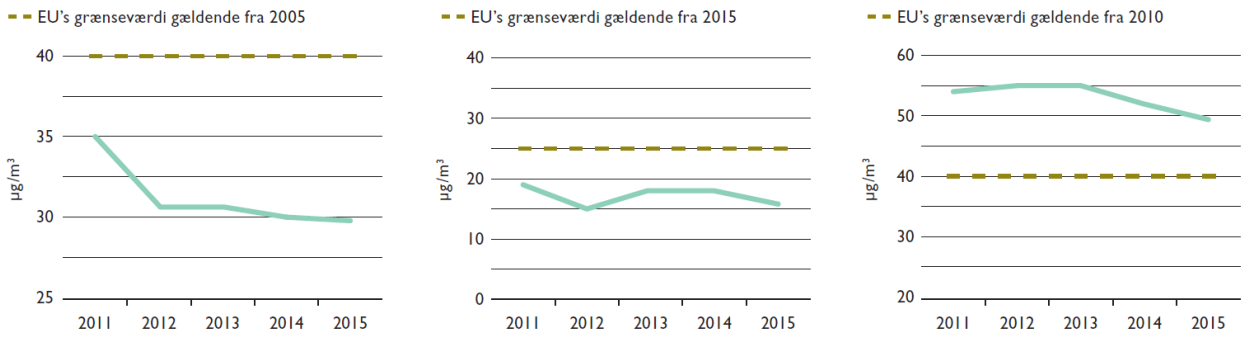

Figure 33: Air pollution at H.C. Andersen's Boulevard in Copenhagen in 2015 compared to EU limits. From left: PM_{10}, $PM_{2.5}$, and NO_2 (Byens Udvikling 2015, p. 16).

The need for an update of the environmental zone 10 years after the introduction substantiate the fast development on the air pollution area and address the issue of introducing sustainable regulation, that does not require translations of entire networks too often, as the process as described is both demanding and takes time, as visualised in Figure 34, showing the timeline of the implementation of the environmental zone in Copenhagen. For the next steps of the investigated translation, it is thus important that the regulation can continuously set requirements that limit air pollution and that not only speed up the replacement of cars now.

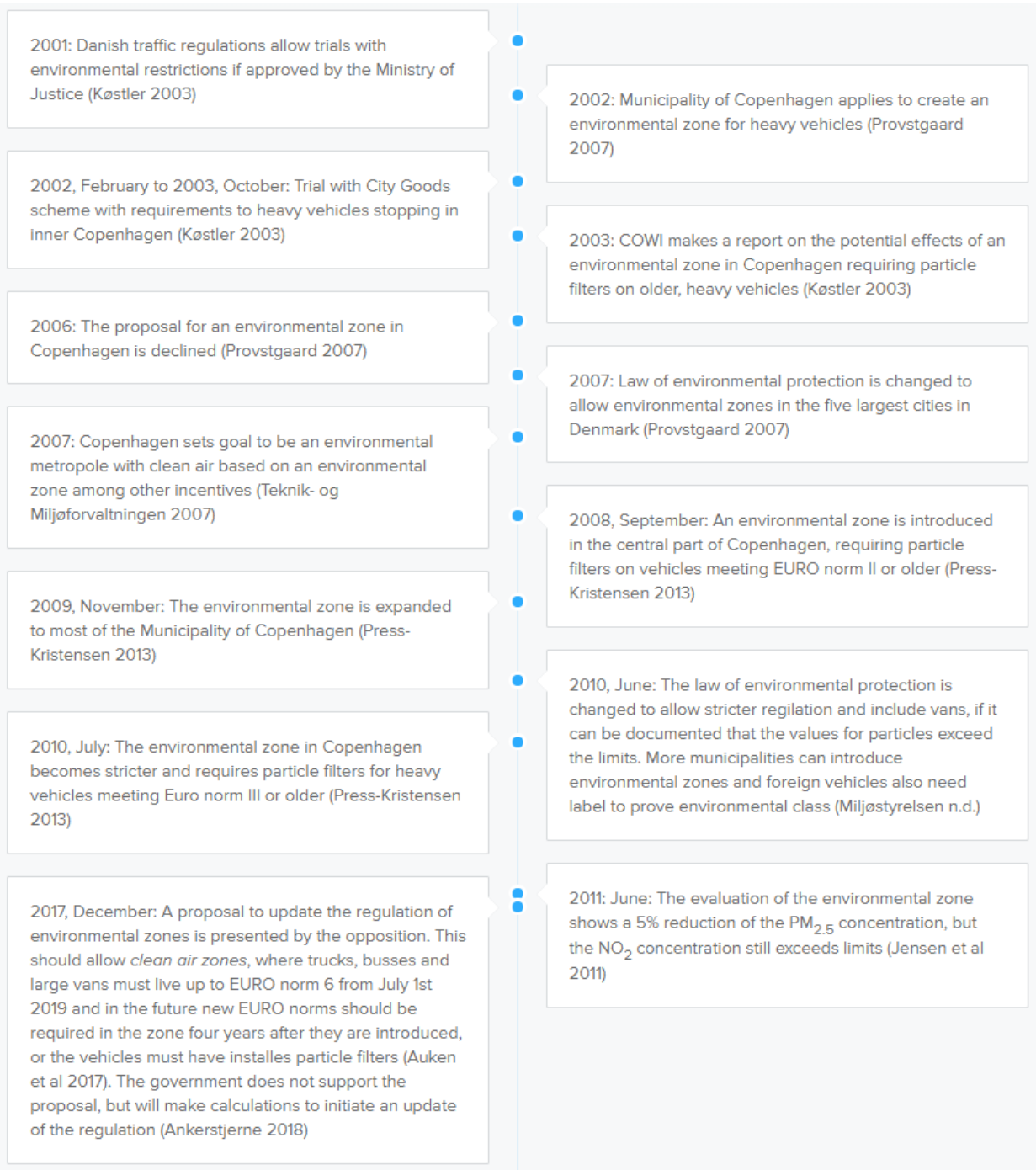

Figure 34: Timeline of events related to the introduction of an environmental zone in Copenhagen requiring particle filters on older, heavy vehicles. Own production.

As seen in the last point of the figure, an update of the environmental zone regulation has been proposed to the parliament but was declined and instead further analyses will be made on the subject (Ankerstjerne 2018). The process has thus started again, as the implemented regulation is still largely regulated from the national level and require enrolment of the parliament to change again. In this case, it is also the left-wing politicians who vote against changes, however, this process and proposal came from the left-wing national politicians, establishing a different translation to the one investigated in this project, where the protagonist was identified to be the local politicians in Copenhagen. It could thus be interesting to compare these translations and investigate the significance of the different protagonists.

10. Literature

Akrich, M., Callon, M. & Latour, B. 2002a, "THE KEY TO SUCCESS IN INNOVATION* PART I: THE ART OF INTERESSEMENT", *International Journal of Innovation Management*, vol. 6, no. 2, pp. 187.

Akrich, M., Callon, M. & Latour, B. 2002b, "THE KEY TO SUCCESS IN INNOVATION* PART II: THE ART OF CHOOSING GOOD SPOKESPERSONS", *International Journal of Innovation Management*, vol. 6, no. 2, pp. 207.

Ankerstjerne, M. 2018, 01-03-2018-last update, *Grønne partier kræver skærpede regler for lastbiler i hovedstaden* [Homepage of TV2LORRY], [Online]. Available: https://www.tv2lorry.dk/artikel/groenne-partier-kraever-skaerpede-regler-lastbiler-i-hovedstaden [2018, 4/4].

Auken, I., Østergaard, M., Gjerding, M.R., Hyllested, H., Matthisen, R.C., Poll, C., Olsen Dyrh, P. & Torp, T. 2017, *Forslag til folketingsbeslutning om opdatering af reglerne for miljøzoner i Danmark*, Beslutningsforslag, Folketinget.

Bredsdorff, M. 2017, 26-09-2017-last update, *Skatteministeriet afviser, at sænket registreringsafgift giver flere biler på vejene* [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/skatteministeriet-afviser-at-saenket-registreringsafgift-giver-flere-biler-paa-vejene-205856 [2018, 15/5].

Bredsdorff, M. 2016, 22-08-2016-last update, *Miljøminister: Nu flytter vi omstridt NOx-målestation* [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/miljoeminister-nu-flytter-vi-omstridt-nox-maalestation-186229 [2018, 4/5].

Byens Udvikling 2015, *Københavns Miljøregnskab 2015*, Municipality of Copenhagen, Copenhagen.

Callon, M. 1999, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis" in *The Social Construction of Technology*, eds. W.E. Bijker, T.P. Hughes & T. Pinch, Massachusetts Institute of Technology Press, Cambridge (Massachusetts), London (England), pp. 83.

Callon, M. 1986a, "The Sociology of an Actor-Network: The Case of the Electric Vehicle" in *Mapping the Dynamics of Science and Technology*, eds. M. Callon, J. Law & A. Rip, 1st edn, Houndsmills, pp. 19.

Callon, M. 1986b, "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay" in *Power, action and belief: a new sociology of knowledge?*, ed. J. Law, Routledge, London, pp. 196.

COWI 2018, *HOVEDRAPPORT - VURDERING AF LUFT OG STØJ*, Region Hovedstaden, Copenhagen.

Det Økologiske Råd 2011, 11-09-2011-last update, *Stort flertal i Stockholm er i dag for betalingsring*. Available: http://www.ecocouncil.dk/udgivelser/artikler/trafik-og-luft/1681-fakta-om-en-betalingsring [2018, 23/5].

Domino, S. & Bloch, C. 2018, 24-04-2018-last update, *Mette F. vil helt forbyde salg af dieselbiler: »Vi har behov for mere ren luft«* [Homepage of Berlingske], [Online]. Available: https://www.b.dk/politiko/mette-f.-vil-helt-forbyde-salg-af-dieselbiler-vi-har-behov-for-mere-ren-luft [2018, 1/5].

Eriksen, L., Davidsen, M., Jensen, H.A.R., Ryd, J.T., Strøbæk, L., White, E.D., Sørensen, J. & Juel, K. 2016, *Sygdomsbyrden i Danmark - risikofaktore*r, Syddansk Universitet for Sundhedsstyrelsen, Copenhagen S.

Europa-Kommissionen 2014, 20-11-2014-last update, *Traktatbrudsprocedure*r. Available: http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/index_da.htm [2018, 8/5].

European Commission n.d., *Infringement procedur*e. Available: https://ec.europa.eu/info/law/law-making-process/applying-eu-law/infringement-procedure_en [2018, 8/5].

European Commission 2017, 22-09-2017-last update, *Air Quality Standard*s. Available: http://ec.europa.eu/environment/air/quality/standards.htm [2018, 21/3].

European Environment Agency 2018, 23-04-2018-last update, *No improvements on average CO2 emissions from new cars in 2017*. Available: https://www.eea.europa.eu/highlights/no-improvements-on-average-co2 [2018, 5/6].

European Environment Agency 2017, 07-12-2017-last update, *Exceedances of air quality objectives due to traffi*c. Available: https://www.eea.europa.eu/data-and-maps/indicators/exceedances-of-air-quality-objectives-7/assessment [2018, 12/5].

FDM 2017a, 01-03-2017-last update, *FDMs mærkesager og mission-visio*n. Available: https://fdm.dk/om-fdm/fdms-maerkesager-mission-vision [2018, 5/6].

FDM 2017b, 24-03-2017-last update, *Hvad bestemmer benzinpriserne*? Available: https://fdm.dk/alt-om-biler/bilen-hverdagen/braendstof-forbrug/hvad-bestemmer-benzinpriserne [2018, 5/6].

Flyvbjerg, B. 2010, "Fem misforståelser om casestudiet", pp. 463.

Flyvbjerg, B. 1992, *Rationalitet og magt Bind 1: Det konkretes videnskab,* 1st edn, Akademisk Forlag, Odense.

Friis, N. 2018, 02-01-2018-last update, *Bilforhandlere forventer fremgang i 2018: - Danskernes lyst er vendt tilbage* [Homepage of Ekstra Bladet], [Online]. Available: https://ekstra-bladet.dk/biler/bilforhandlere-forventer-fremgang-i-2018-danskernes-lyst-er-vendt-tilbage/6980607 [2018, 15/5].

Geels, F.W. 2011, "The multi-level perspective on sustainability transitions: Responses to seven criticisms", *Environmental Innovation and Societal Transitions,* vol. 1, pp. 24.

Google 2018, 25-04-2018-last update, *Search for: region hovedstaden luftforurening* [Homepage of Google], [Online]. Available: https://www.google.dk/search?q=region+hovedstaden+luftforurening&rlz=1C1GGRV_enDK752DK752&oq=region+hovedstaden+luftforurening&aqs=chrome..69i57.9261j0j7&sourceid=chrome&ie=UTF-8 [2018, 25/4].

Grøn, S.V. 2012, 22-02-2012-last update, *Derfor døde betalingsringen: Den fødte tabersag* [Homepage of DR], [Online]. Available: https://www.dr.dk/nyheder/politik/derfor-doede-betalingsringen-den-foedte-tabersag [2018, 12/5].

Hansen, P.R. & Clausen, C. 2017, "Management Concepts and the Navigation of Interessement Devices: The Key Role of Interessement Devices in the Creation of Agency and the Enablement of Organizational Change", *Journal of Change Management,* vol. 17, no. 4, pp. 344.

Jensen, F. n.d., *Ren luft i byen* [Homepage of Frank Jensen kampagnekontor], [Online]. Available: https://frank-jensen.dk/ren-luft-i-byen/ [2018, 25/4].

Jensen, J.S., Cashmore, M. & Elle, M. 2017, "Reinventing the bicycle: how calculative practices shape urban environmental governance", *Environmental Politics,* vol. 26, no. 3, pp. 459.

Jensen, S.S., Brandt, J., Plejdrup, M.S., Nielsen, O. & Andersen, M.S. 2017, *KILDEOPGØRELSE, HELBREDSEFFEKTER OG EKSTERNE OMKOSTNINGER AF LUFTFORURENING I KØBENHAVN*, Aarhus University, DCE - National Center for Environment and Energy.

Jensen, S.S., Ketzel, M., Nøjgaard, J.K. & Becher, T. 2011, *Hvad er effekten af miljøzoner for luftkvaliteten*?, Danmarks Miljøundersøgelser - Aarhus Universitet.

Jørgensen, J.T., Andersen, Z.J., Møller, P. & Loft, S. 2017, *Luftforurening og hjerte-kar-sygdomme*, Københavns Universitet.

Kayser, A. 2018, *Interview 22-04-2018*, Copenhagen.

Københavns Kommune 2015, *Vedtaget Budget 2016*, København.

Køstler, H. 2003, *Miljøzoner og effekte*r, COWI on behalf of Miljøstyrelsen.

Kvale, S. 2007, *Doing interviews*, SAGE Publications, Ltd, London.

Lykke-Nedergaard, J. 2015, 05-10-2015-last update, *Københavns Kommune: Ministerens parkeringsrabat til elbiler er ubrugeli*g [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/koebenhavns-kommune-ministerens-parkeringsrabat-til-elbiler-er-ubrugelig-179150 [2018, 5/5].

Madsen, C.R. 2018, Phone interview 01-05-2018.

McGhie, S. 2018a, 28-02-2018-last update, *Første tyske by varsler dieselforbud få timer efter do*m [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/foerste-tyske-by-varsler-dieselforbud-faa-timer-efter-dom-210836 2018, 20/4].

McGhie, S. 2018b, 30-04-2018-last update, *Ny rapport om massiv forurening i København: Skærp miljøzone*r [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/ny-rapport-massiv-forurening-koebenhavn-skaerp-miljoezoner-211930 [2018, 4/5].

McGhie, S. 2018c, 27-02-2018-last update, *Tysk domstol siger god for at forbyde dieselbiler i storbye*r [Homepage of Ingeniøren], [Online]. Available: https://ing.dk/artikel/tysk-domstol-siger-god-at-forbyde-dieselbiler-storbyer-210833 [2018, 25/4].

Meyer, D. 2017, 28-11-2017-last update, *Congestion Pricing Was Unpopular in Stockholm — Until People Saw It in Actio*n [Homepage of StreetsBlog NYC], [Online]. Available: https://nyc.streetsblog.org/2017/11/28/congestion-pricing-was-unpopular-in-stockholm-until-people-saw-it-in-action/ [2018, 23/5].

Miljøstyrelsen n.d., *I miljøzonerne* [Homepage of Miljø- og Fødevareministeriet], [Online]. Available: http://mst.dk/luft-stoej/luft/saerligt-for-borgere-om-luftforurening/miljoezoner/ [2018, 4/4].

Miljøstyrelsen 2014, 19-06-2014-last update, *Ren luft til danskerne* [Homepage of Miljø- og Fødevareministeriet], [Online]. Available: http://mst.dk/service/nyheder/nyhedsarkiv/2014/jun/ren-luft-til-danskerne/ [2018, 1/6].

Miljøstyrelsen 1985, *Miljøstyrelsens handlingsplan 1985-1990*, Miljøministeriet, Copenhagen.

Moving Britain Ahead 2016, *Vehicle Emissions Testing Programme*, Department for Transport, UK.

Mygind, K. 2018, *Interview 11-04-2018*, Copenhagen.

Nedergaard, G. 2018a, *Interview 04-04-2018*, Copenhagen.

Nedergaard, G. 2018b, Mødeforberedelse til møde om medlemsforslag om dieselforbud i Københavns Kommune, Meeting preparation, Copenhagen.

Niss, M.K. 2018, *Interview 03-04-2018*, Copenhagen.

Persson, S. 2018, 27-04-2018-last update, *1.066 steder i hovedstaden overskrider EUs grænseværdi for luftforurening* [Homepage of Berlingske], [Online]. Available: https://www.b.dk/nationalt/1.066-steder-i-hovedstaden-overskrider-eus-graensevaerdi-for-luftforurening [2018, 4/5].

Press-Kristensen, K. 2018a, Follow-up phone interview 23-05-2018.

Press-Kristensen, K. 2018b, *Phone interview 10-04-2018*.

Press-Kristensen, K. 2013, TRAFIKKENS FORURENING – med fokus på partikler, kvælstofoxider og EU regulering, Det Økologiske Råd, Copenhagen.

Provstgaard, T. 2007, *Miljøzone i København*, Trafikdage på Aalborg Universitet.

Pryn, M.R. & Schousboe, C. 2018, *Phone interview 02-05-2018*.

Rasmussen, M.A. 2018, Phone interview 20-04-2018.

Ritzau 2012, 08-02-2012-last update, *Her er forløbet om betalingsringen* [Homepage of Information], [Online]. Available: https://www.information.dk/telegram/2012/02/forloebet-betalingsringen [2018, 12/5].

Saietz, D. 2016, 16-08-2016-last update, *EU kritiserer Danmark: I gør ikke nok mod luftforurening* [Homepage of Politiken], [Online]. Available: https://politiken.dk/indland/art5632676/EU-kritiserer-Danmark-I-g%C3%B8r-ikke-nok-mod-luftforurening [2018, 8/5].

SF & Enhedslisten 2018, 19-04-2018-last update, *22. Medlemsforslag om øget viden om de sundhedsskadelige virkninger af luftforurening i København (2018-0108064)* [Homepage of Københavns Kommune], [Online]. Available: https://www.kk.dk/indhold/borgerrepraesentationens-modemateriale/19042018/edoc-agenda/6122e9ba-abc0-4580-8e7b-a1b90da2d89b/537787aa-7d91-4423-8466-f5d48b6a6971 [2018, 1/5].

Svalgaard, L. & Arrouas, M. 2017, May 2017-last update, *Mediernes magt* [Homepage of Dagbladet Information], [Online]. Available: https://faktalink.dk/titelliste/mediernes-magt [2018, 15/5].

Technical and Environmental Administration 2016, *CPH 2025 Climate Plan - Roadap 2017-2020*, City of Copenhagen, Copenhagen S.

Teknik- og Miljøforvaltningen 2007, *Miljømetropolen Vores vision CPH 2015*, Københavns Kommune, Copenhagen.

Tetraplan A/S 2014, Regional vækst- og udviklingsstrategi Luft- og støjforurening i Region Hovedstaden, Copenhagen.

Trafikministeriet 1993, *Trafik 2005*, Copenhagen.

Transport for London n.d., *Ultra Low Emission Zone* [Homepage of Mayor of London], [Online]. Available: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone [2018, 25/4].

Transport-, B.o.B. 2015, 10-11-2015-last update, *Bekendtgørelse om parkering på offentlige veje* [Homepage of Retsinformation], [Online]. Available: https://www.retsinformation.dk/Forms/R0710.aspx?id=174799#idcd834a8a-447b-4957-83eb-2f1766239fd8 [2018, 5/5].

Vejdirektoratet 2018, 25-01-2018-last update, *Færre dræbte i trafikken i 2017 - men fortsat for mange* [Homepage of Transport-, Bygnings- og Boligministeriet], [Online]. Available: http://www.vejdirektoratet.dk/DA/om-os/nyheder-og-presse/nyheder/Sider/F%C3%A6rre-dr%C3%A6bte-i-trafikken-i-2017---men-fortsat-for-mange.aspx [2018, 4/5].

World Air Quality 2018, 08-05-2018-last update, *Air Pollution in Europe: Real-time Air Quality Index Visual Map*. Available: http://aqicn.org/map/europe/#@g/58.0512/1.8896/4z [2018, 8/5].