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Fit-for-55: New emission trading system in the EU for buildings and road transport

An environmental economic analysis of implementing the new ETS in both the EU and Norwegian sectors

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We take full responsibility for any errors or uncertainties in the resulting work.

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Abstract

This thesis aims to discuss the potential effects of the implementation of a newly proposed emissions trading system (ETS) for the road transport and building sectors in the European Union, laid forward in the recently proposed legislative document “fit for 55”. The EU commission proposes the implementation of this new ETS by 2025, which would operate with the same framework as the existing EU ETS but be separate from it. Implementing a new multinational ETS comes with many questions, where we decided to focus on how this new ETS impacts emissions and carbon pricing in the respective sectors, how EU sectors and non-EU sectors would interact in the new ETS, and finally, based on experience from the existing EU ETS, how overlapping climate policies would impact this new ETS. As such, we created an environmental economical model allowing us to analyse the emissions and carbon pricing of the road transport and building sectors in the EU and in Norway. In order to gain potential answers to our questions we expanded this model across three different scenarios which allowed us to evaluate the outlook for these sectors in the future. The results of our analysis and discussion explains how the new ETS reduces emissions for all sectors as compared to a business-us-usual situation. Furthermore, we deliberate that the EU sectors have a larger influence over the new ETS then the Norwegian sectors, and thus have significant influence on the Norwegian sectors. Finally, we discuss that the overlapping climate policy shifts the balance of emissions between sectors and changes the carbon price in the ETS, and we discuss advantageous and disadvantageous of this.

Sammendrag

Denne oppgaven har som hensikt å diskutere de potensielle effektene av implementeringen av et nylig foreslått kvotehandelssystem (ETS) for veitransport og byggesektoren i EU, fremlagt i det nylig foreslåtte lovdokumentet "fit for 55". EU-kommisjonen foreslår implementering av nytt ETS innen 2025, som vil fungere med det samme rammeverket som det eksisterende EU ETS, men være atskilt fra det. Implementering av en ny multinasjonal ETS kommer med mange spørsmål, der vi bestemte oss for å fokusere på hvordan det nye ETS påvirker utslipp og karbonprising i de respektive sektorene, hvordan EU-sektorer og ikke-EU-sektorer vil samhandle i det nye ETS, og til slutt, basert på erfaring fra det eksisterende EU ETS, hvordan overlappende klimapolitikk vil påvirke det nye ETS. Dermed har vi laget en miljøøkonomisk modell som vil analysere utslipp og karbonprising av veitransport og byggesektoren i EU og i Norge. For å få mulige svar på spørsmålene våre utvidet vi denne modellen på tvers av tre ulike scenarier for å evaluere utsiktene for sektorene i fremtiden. Resultatene av analysen og diskusjonen viser hvordan nye ETS reduserer utslipp for alle sektorer sammenlignet med en "business-us-usual"-situasjon. Videre fremkommer det at EU-sektorene har større innflytelse over det nye ETS enn de norske, og dermed har stor innflytelse på de norske sektorene. Til slutt følger en diskusjon av hvordan den overlappende klimapolitikken forskyver utslippsbalansen mellom sektorer og endrer karbonprisen i ETS, og vi diskuterer fordeler og ulemper ved dette.

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List of acronyms and abbreviations

BaU	Business-as-Usual
EEA	European Economic Area
ESR	Effort Sharing Regulation
EPA	Environmental Protection Agency
EU	European Union
EU ETS	European Union Emission Trading System
GHG	Greenhouse Gas
MAC	Marginal Abatement Costs
MSR	Market Stability Reserve
NEA	Norwegian Environmental Agency
NTP	National Transport Plan
PPP	Polluter pays principle
VECTO	Vehicle Energy Consumption calculation Tool

Introduction

1.1 The Situation

1.1.1 Climate crisis

The impact of climate change upon our society and economy has been drastically increasing over the years, resulting in higher emphasis for climate-oriented policies. Since earth's climate is a global resource, nations have been working towards several multinational agreements, like the Paris agreement or the EU Climate Pact, with the aim to reduce greenhouse gas emissions and mitigate the deterioration of the climate. Future extensions of such agreements reinforce stronger climate targets, and nations aiming towards reaching such targets will therefore often extend their climate regulations to include additional low-regulated industries and sectors. However, such expansions require careful planning and implementation in order to reduce the probability of adverse effects.

1.1.2 Policy – EU

The European Union, EU, has been at the forefront when it comes to climate policies and climate regulations. By utilizing their geographic scope and vast array of resources, the European Union has been able to create a multinational framework where climate policies and regulations can be implemented (Ellerman et al., 2016). Norway is also part of this multinational framework, through their association in the European Economic Area, EEA (Ellerman et al., 2016). As such Norwegian industries and sectors often find themselves operating within EUs climate policies and regulations. Over the years the EU has developed a set of climate legislations, the biggest among them being the 2005 EU-wide cap-and-trade system which aimed to limit Greenhouse Gas (GHG) emissions. This system would eventually become the EU Emission Trading system (ETS), being the world's first international emission trading system. Since 2005, the EU ETS has been further developed and advanced through multiple phases, each focusing on strengthening the system and ensuring that it complemented other policies and measures. On July 2021, the European Commission laid forward new revised proposals aimed towards several parts of the EU climate legislation, known as the ”Fit-for-55” legislative package. The focus of this legislation is to reach a new climate neutrality target of at least 55% net emission reductions in GHG by 2030 compared to 1990 (European Commission, 2021a). One of the more interesting proposals in this package is the introduction of a separate self-standing emission trading system for the road transport and building sectors to be implemented by 2025 (European Commission, 2021a). The implementation of a separated ETS for the road transport and building sectors, which are currently not included in the active EU ETS, will have interesting implications for the EUs, and Norway's, climate policies and regulations in these sectors.

1.1.3 Norway's position

Even though Norway is not a part of European Union, there is still a climate agreement with EU and is therefore affected by regulatory proposals. All member countries, including EEA-countries are expected to do their part to reach the goal of climate neutrality within 2050 (European Commission, 2021b). The Norwegian Government manages the EU ETS within Norway, thru the Norwegian Environment Agency. About half of Norway's emissions is covered in the EU ETS. As such, the implementation of a new ETS for the road transport and building sector, will indeed have an impact on the climate regulations in these Norwegian sectors.

1.2 Research questions

The objective of this paper is to take a closer look on the consequences of implementing a new separate emissions trading system for the road transport and building sectors in the EU. We will investigate the new proposed ETS, evaluate its effects for the relevant sectors, taking especially into account potential issues with overlapping policies. Doing so, 3 scenarios will be presented to evaluate how the outlook for these sectors in both Norway and EU might look in the future, in terms of both emission mitigation and carbon pricing. Focus will also be given to how the Norwegian sectors and EU sectors interact with each other. The problem statement we will focus on answering is therefore as follows:

EU climate policy Fit-for-55: How will the new emission trading system for road transport and building sectors impact the emissions and carbon price in the relevant sectors in Norway and EU. How will then the Norwegian and EU sectors interact among each other, and how will overlapping climate policies impact this ETS?

1.3 Structure of the paper

The remainder of the paper is organized as follows: chapter 2 gives a brief overview on the background of the topic. Here we include current climate goals and policies in Norway and EU today, in addition to the newly proposed ETS. Also coming in more detailed on road transport. In chapter 3, the theoretical analysis is presented. We focus on the most important concepts for our problem statement; carbon pricing and overlapping policies, also basics within climate economics such as cost efficiency. We deliberate on the mechanism behind EU ETS. With that as a backdrop, we continue to the numerical analysis provided in chapter 4. We will present and describe our economic model and how we set this up with 3 following scenarios, in order to answer our research questions. Chapter 5 display the results and the coherent discussion. This paper is finished in Chapter 6 with some concluding remarks, point out limitations and give suggestions to further research.

2.Background

2.1 Current climate goals

2.1.1 EU

Over the years the European Commission has laid forward proposals for new, and revised, climate legislations which the European Union has evaluated and adopted. In turn, these proposals have paved the road towards EUs climate goals. Prior to newer legislative proposals laid forward, the EU had an economy-wide greenhouse gas emission reduction target of at least 40% by 2030 compared to 1990 (European Commission, 2020a). To ensure that the European Union was to reach their climate goal, certain climate legislations were utilized. Among these legislations was implementing a climate goal for the European Union's Emission Trading System, as well as implementing a climate goal for the non-ETS sectors, which are covered under the European Union's Effort Sharing Regulation (ESR). To reach the climate target of 40% by 2030, the EU ETS aimed to reduce its GHG emissions by at least 43% by 2030 compared to 2005 (European Commission, 2020a). Meanwhile the ESR aimed to reduce their GHG emissions by at least 30% by 2030 compared to 2005 (European Commission, 2020a). It is important to note that the ETS and ESR each work in their own specific segments of the European Union. In section 1.1.2 we mentioned that the ETS is an EU wide cap-and-trade system. Meanwhile, the ESR is used to specify binding targets for EU Member States, where nations define their own targets and goals for those sectors which are not included in the EU ETS (European Commission, 2021d).

In 2019 the European Union adopted the European Green Deal, which aims to make the EU the first climate neutral continent by 2050, meaning net zero greenhouse gas (GHG) emissions in the EU by 2050 (European Commission, 2021b). This Green Deal was then written into law through the European Climate Law, resulting in it becoming law for Europe’s economy and society (European Commission, n.d.a). Due to the long-term nature of having a climate goal set for 2050, the Climate Law addressed necessary steps towards achieving the 2050 goal. The following three steps are especially highlighted: 1. A new 2030 climate target plan; 2. Adopting a series of proposals from the Commission, of July 2021, that aim to revise all relevant policy instruments to deliver on the 2030 emission reductions; 3. A process for setting a 2040 climate target (European Commission, n.d.a).

As specified in steps 1 and 2, it was necessary to revise the existing 2030 climate target plan if the European Union was to reach the more ambitious climate goal of 2050. Projections and impact assessment of the European Union's current trends showed that the existing target of the 40% reduction of GHG emission by 2030 was not viable towards achieving the 2050 climate goal (European Commission, 2020a). As such, to ensure that the 2050 target was reached through the most ambitious and cost-efficient path as possible, the European Commission proposed to increase the 2030 climate target plan from a 40% emission reduction to at least a 55% net reduction in GHG emissions compared to 1990 (European Commission, 2020a). There were three key considerations which caused the commission to propose to the EU to set itself the higher target of 55%: 1. While it proved harder to reduce emission from transport and agriculture and in buildings, it is required of the EU to significantly step up its actions in these sectors if they wish to reach the climate neutral target; 2. Risks of carbon lock-in in the coming decade are too high; 3. climate risks are firmly on the downside (European Commission, 2020a). Furthermore, to reach the new climate target of 2030, two additional goals were laid out in the 2030 plan: actions required across all sectors of the economy and the launch of revisions of key legislative instruments, see Figure 1; and prepare to increase EUs contribution to the Paris Agreement and set the stage for the Commission to make detailed legislative proposals by June 2021 (European Commission 2020). The new legislative proposals laid forward by the commission in June 2021, would go on to become the “fit-for-55” legislative package. As of 14 July 2021, these legislatives proposals have been adopted, and the EU is now actively aiming to reach its target of becoming climate neutral by 2050, which includes the target of at least 55% net reduction in GHG emissions by 2030 (European Commission, 2021d).

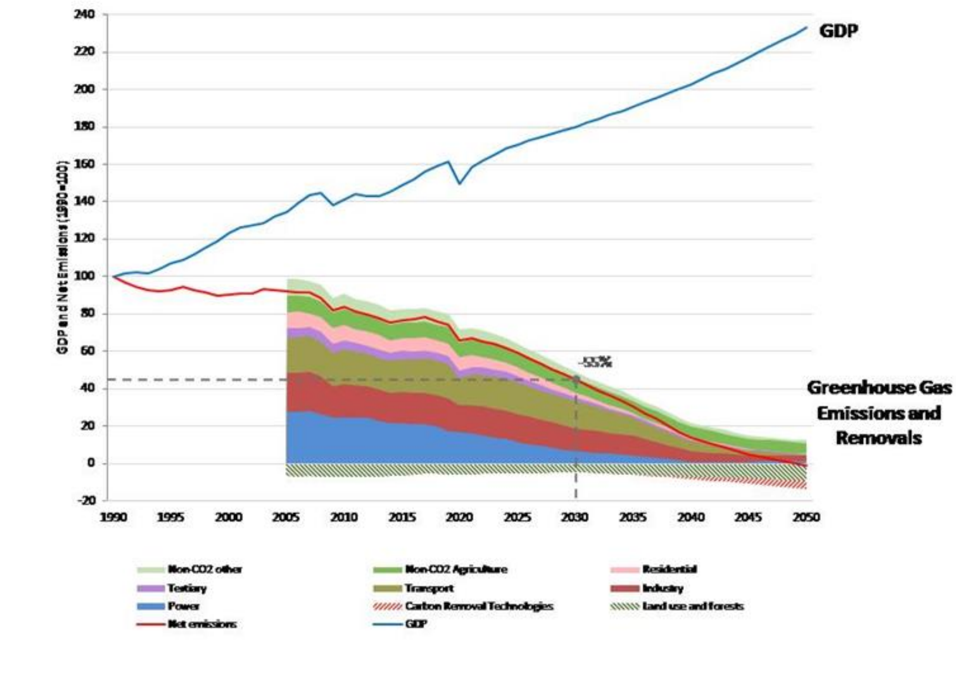

Figure 1: The EU`s pathway to sustained economic prosperity and climate neutrality, 1990-2050. European Commission (2020)

The “fit-for-55” legislative package, as per the name, contains the legislative proposals by the commission aimed towards reaching the reinforced climate target of 2030. This legislative package focuses on several parts of EUs climate legislations, including reinforced targets for both the EU ETS, and the ESR. While the specifics of the new targets for the ETS and ESR are not laid out as of the writing of this paper, they have specified that these legislations climate targets will be adjusted to ensure that the target of at least 55% net reduction in GHG emissions is reached by 2030. It is also possible that the proposals suggested in the “fit-for-55” package might be further adjusted both while this paper is being written and after this paper is written, resulting in further adjustments made to the 2030 climate plan. Furthermore, the European Commission has yet to make any remarks towards their 2040 plan, however, it is highly likely that the 2040 plan will be dependent on how the 2030 climate plan is adjusted and implemented. As for further details on the “fit-for-55” legislative package, we discuss those in section 2.3.

2.1.2 Norway

The Norwegian government has outlined a total of 6 climate goals, each regularly updated in their development and status. As of writing this paper, these 6 goals are roughly defined as followed on Miljøstatus (n.d.a):

1. By 2020 reduce global emission of GHG by 30% compared to Norway's emissions in 1990
2. Following the Paris agreement Norway aims to reduce 50-55% GHG by 2030 compared to the level in 1990.
3. Norway shall be climate neutral by 2030.
4. Norway has legislated the goal of being a low-emission society by 2050.
5. Reduce and reverse the loss of tropical forests.
6. Political goal to improve society now and adjust to climate change.

Norway has developed many of their climate goals around international climate deals, where they have recently focused on the Paris agreement. However, many of these goals do also align themselves with EUs climate goals and climate deals. Following the Paris agreement in 2015, where nations laid forward climate targets aimed at reducing their national GHG emissions, Norway's main climate goal was to reduce a minimum of 40% of their GHG emissions by 2030 compared to 1990 (Regjeringen, 2021a). As part of the Paris Agreement, these targets were to be adjusted and updated every 5th year. Following, in 2020 Norway reinforced their climate target, increasing it to a minimum of 50%-55% reduction of GHG emissions by 2030 compared to 1990 (Regjeringen, 2021a). Furthermore, as specified in goal 3, as a part of the ratification of the Paris Agreement, Norway's parliament, Stortinget, decided that the government should assume that Norway is to be climate neutral as of 2030 (Miljøstatus, 2022a). Stortinget has defined being climate neutral, as ensuring that Norwegian GHG emissions are to match an equal GHG emission reduction in other nations and international markets. As such, Norwegian GHG emissions are to be corresponding to Norwegian climate regulation in other nations, through the EU ETS and international cooperation (Miljøstatus, 2022a). The background for Stortinget to decide on that the nation is to become climate neutral as of 2030, is linked with the process of joint accomplishment with the EU and international cooperation. Also, Norwegian climate law has outlined an additional climate goal, reduce 90-95% of Norwegian GHG emissions by 2050 (Regjeringen, 2021a). This is in relation with goal 4, where Norway aims to become a low-emissions society by 2050, where the focus of the goal is to reduce national GHG emissions instead. The purpose of having such a climate goal aimed at the year 2050 is to allow Norway to orient itself towards becoming more climate friendly in the long-term (Miljøstatus, 2022b).

However, Norway's climate regulation through the EU ETS is included in evaluating how well Norway is on its way towards reaching this goal.

As mentioned earlier, Norway’s climate goals often align themselves with EUs climate goals, making room for potential cooperative partnerships, as seen with climate goals 3 and 4. Therefore, Norway's climate policies are linked to EUs climate policies. Currently Norway’s partnership with the EU, through the European Economic Area, includes two major proponents. The first is Norway’s inclusion and access to the EU ETS, and the second is Norway setting a ESR target for its non-ETS sectors. As mentioned earlier, Norway includes its emission regulations from the EU ETS in its own national targets, while at the same time the EU includes Norway's emissions regulations in the collective climate target of the EU ETS. Furthermore, in 2019, Norway extended their climate deal with the EU, a partnership which focused on reducing Norway’s GHG emissions (Regjeringen 2021a). This extended deal aims to make Norway commit to an ESR target. The deal, focused on the commitments made during the Paris Agreement in 2015, specified that Norway was to reduce their GHG emissions with 40% by 2030 compared to 2005 (St.meld nr. 13 (2020-2021)). However, as mentioned earlier with goal 2, Norway, just like the EU, has now updated their target, from 40% to 50-55%. Therefore, the Norwegian government is working towards updating their climate deal with the EU, especially since the EU recently adjusted their 2030 climate target to a 55% reduction as well, as a result of the “fit-for-55” legislation (Regjeringen, 2021b).

To ensure that these climate goals are reached, Norwegian climate policies adopted the polluter pays principle (PPP), ensuring that the targets are reached through the most effective method as possible. Furthermore, a climate plan for 2021 – 2030 has been developed, describing which policies should be utilized to reach the climate goals (Regjeringen, 2021a). The climate plan outlines which economic incentive instruments to utilize from 2021 to 2030, as well as potential other instruments which the Norwegian government can utilize to reduce GHG emissions in this period. As a final note, the Norwegian government has outlined that the European Union's new legislative package, “fit-for-55”, may have great significance for Norwegian climate policies. Resulting in that the Norwegian climate plan of 2021-2030, including Norwegian climate goals, might be revised sometime in the future (Regjeringen, 2021b).

2.2 Road transport and policies today

As the previous section we divide between the road transport policies from EU and what is specifically for Norway.

The European union has as of today different policies when it comes to road transport. The main goal is *simply* to reduce CO2 emissions from vehicles. The European Commission has divided the regulations into four central measures. The first and foremost is a CO2 emission standard for cars and vans. Secondly, a new standard for heavy-duty vehicles, which will reduce CO2 emission from this group. The third measure is the Vehicle Energy consumption calculation Tool (VECTO). Lastly, car labeling to rate the emission intensity, in order to help drivers, choose new cars with lower fuel consumption (European Commission, n.d.d).

Because road transport is not a part of any ETS today, climate policies for road transport do differ from other industries. In addition to the EU-wide policies, there are a lot of national policies in each country that decide the political measurements for the specific country.

At the Norwegian governments websites, there are highlighted three main measures to reach the overall climate goals when it comes to the transport sector (Regjeringen, 2021c):

1. Switch to cars, boats and planes that emit less or no greenhouse gases and other pollution.
2. To a greater extent use environmentally friendly modes of transport such as bicycles, trams, railways and other public transport.
3. Plan society in a way that the need for transport of goods and people is reduced.

In our thesis we focus on the road transport sector, therefore the goals will be relevant to a varying degree in our case. The goals and policies today are often included with aviation and shipping, two large distributors to emission within the transport sector. Yet, official public numbers show us that road transport itself has higher emissions than aviation, shipping and power tools combined – as illustrated in the figure below. (Miljøstatus, 2021b).

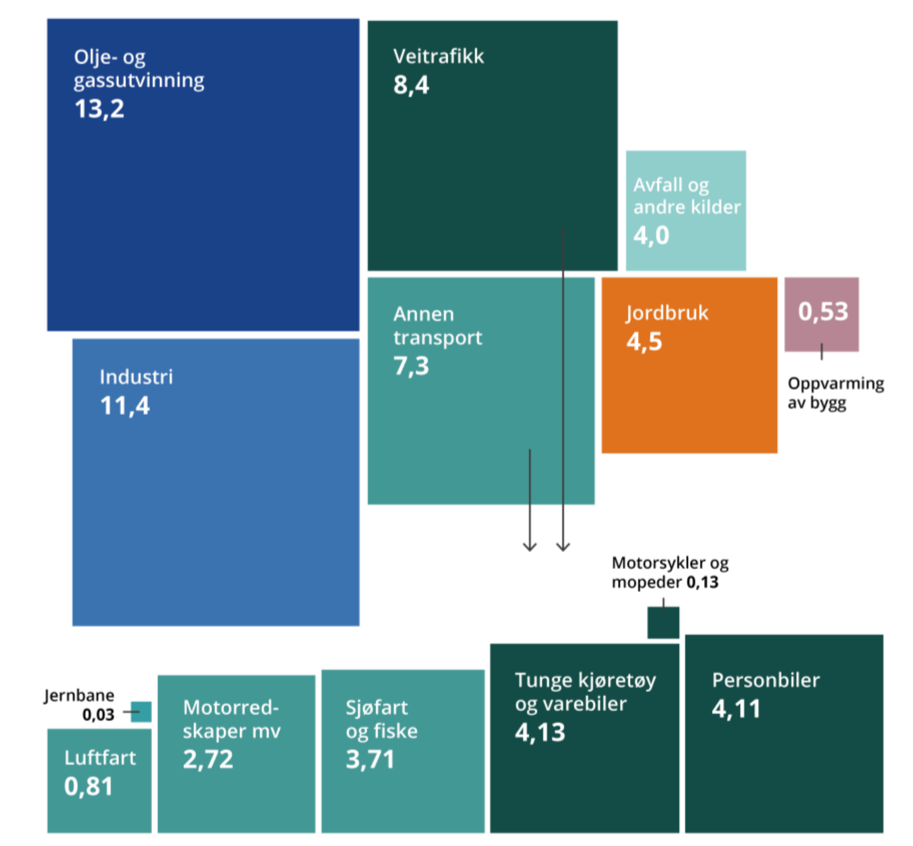

Figure 2: Greenhouse gas emissions from transport, compared with the total greenhouse gas emissions in 2020. (Norwegian Environment Agency and SSB, 2021)

Further on, it is relevant to look at the Norwegian national transport plan (NTP), which is the national plan on how the transport sector will be designed in the years of 2018 to 2029. Every fourth year it is revised, and today the plan involves 2022 to 2033. In addition to a safe and effective transport system, the plan also focuses on a sustainable strategy for the coming years (Regjeringen, 2021c). NTP is a notable example showing how separate national climate policies differ from each other. Not necessarily completely divergent from EU-wide policies, but they have their own framework and scheme. The most central goals in the NTP are as follows:

- All new passenger cars and light vans will have zero emissions by 2025.
- New city buses will have zero emissions or use biogas in 2025.
- By 2030, new heavier vans, 75 per cent of new long-distance buses and 50 per cent of new lorries will have zero emissions.
- By 2030, the distribution of goods in the largest city centers will be almost zero emissions.

The following policies from Norwegian Environmental Agency (NEA), that are relevant with NTP and the transport sector. (Miljødirektoratet, n.d.)

- Carbon tax on petrol, diesel, and other fossil fuels.
- Requirements on mixing ratio for biofuel in fuel used in road transport.
- There are also other fees that are not formally climate taxes, but still have the same effect. For example, with private cars, (some also apply for taxes on company cars): transfer of registration tax, taxes on importing cars, one-off registration tax and the annual motor vehicle tax and weight-based motor vehicle tax (Skatteetaten, n.d.). However, the most essential fee is the tax on petrol and diesel, that consumers pay for when buying fuel.

With today's policies on road transport, there is not enough regulation to reach the climate ambitions that comes with the 55% emission reduction target. Illustrated in the figure below, we see that emission from road transport in Norway have evenly increased from 1990, with a slight decrease in the last half a decade. The total emission is still too high and putting a cap on emissions is therefore the next step.

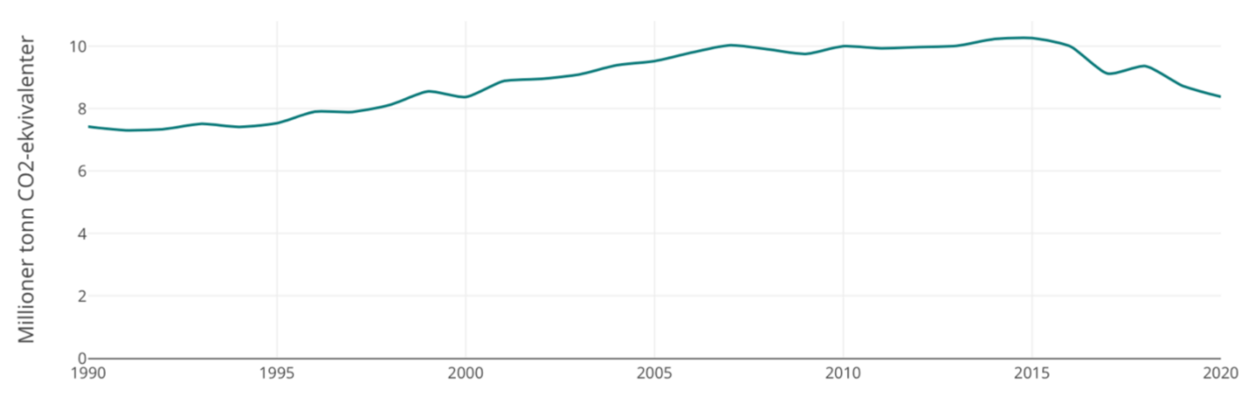

Figure 3: Greenhouse gas emissions from road transport from 1990 to 2020. (Norwegian Environment Agency and SSB, 2021)

2.3 Fit-for-55

2.3.1 A new proposal

Back in section 2.1.1 we explained why the new "fit-for-55" legislative package was proposed. A summary is that the EU adopted the European Green Deal, where the goal is to make the EU climate neutral by 2050. However, to achieve this goal it was necessary to revise the existing 2030 climate target plan, given its goal of 40% net reduction of GHG emission by 2030 was not a viable path towards achieving the 2050 target. Therefore, the European Commission proposed the “fit-for-55” legislative package. The package includes proposals for new and revised legislations, where the goal is to achieve the target of 55% net reduction of GHG emissions by 2030 compared to 1990. According to the commission, the reinforced climate target of 2030 would allow the EU to achieve a better pathway towards their 2050 climate target.

The “Fit for 55” package is the building block for reaching the ambitious 2030 climate target. The legislative package aims to ensure that all sectors of the economy should contribute to the reduction of greenhouse gas emissions. As such the proposals in the package aim for changes to EUs climate laws and regulations, transport sectors and energy sectors. Roughly defined the Fit for 55 package has the following specific objectives as per the European Commission (2021a) proposal:

- Strengthening the EU ETS to provide contribution to the target of at least -55% GHG emissions compared to 1990;
- Ensuring protection for sectors exposed to carbon leakage while incentivizing the uptake of low-carbon technologies;
- Addressing the distributional and social effects of this transition;
- Ensuring that other sectors than those currently included in the EU ETS contribute cost-effectively to the emission reduction needed with EU targets and Paris Agreement commitments notably including emissions from maritime transport and emissions from buildings and road transport under the rules of the EU ETS while ensuring synergies with other policies in those sectors;
- Reviewing the monitoring, reporting and verification system of CO_2 emissions from maritime transport to consider the inclusion of the maritime sector in the EU ETS;
- Reviewing the market stability reserve in line with the corresponding legal obligation and examining possible amendments to its design, fulfil the legal objectives in the MRS decision and addressing issues that may be raised due to the increased ambition.

All the initiatives that are in the package are intricately linked, ensuring consistency within the Fit for 55 legislative package, making it that all sectors of the economy contribute to the reduction of the GHG emissions (European Commission 2021a).

2.3.2 Proposition: New ETS for buildings and transport sectors

The Fit for 55 legislative package includes many interesting proposals to several sectors of the EUs economy, however there is a specific part in the 4th bullet point which is of great interest. Among other things, this proposal looks at including emissions from buildings and road transport under the rules of the existing EU ETS. As such, the commission proposes the introduction of a new emission trading system for the building sector and road transport sector, which will operate with the same rules as the existing EU ETS but separate from the EU ETS. The suggestion of such a proposal comes from the fact that the road transport and the building sectors have significant potential for cost-effective reduction. Road transport has increased its emission by over 25% since 1990, and currently it accounts for 1/5 of EUs GHG emissions (European Commission, 2021a). At the same time, the building sector is currently responsible, both directly and indirectly, for 36% of all energy related GHG emissions in the EU (European Commission, 2021a). While half of the emissions from the building sector are already covered by the existing EU ETS, many homes are still heated with outdated systems which use fossil fuels instead of electricity (European Commission, 2021a).

The European Commission proposal aims to introduce a separate but adjacent emission trading system to the existing EU ETS, for the building and road transport sectors. The purpose is to avoid any disturbance with the existing EU ETS, due to different reduction potentials between the sectors and different factors that influence demand (European Commission, 2021a). Furthermore, this system is to be accompanied by complementary policies and measures which will safeguard against undue price impacts (European Commission, 2021a). Among these complementary policies and measures is the proposal to strengthen the CO_2 standards for cars and vans by 2030, changes to regulations and policies regarding alternative fuels, newer buildings be constructed with more energy efficient technology, and increase the energy-efficiency renovation rate of older buildings.

The European Commission proposes an upstream system which aims to regulate the fuel suppliers of these sectors, given that this approach gives incentives to the suppliers to decarbonize (European Commission, 2021c). As for the new ETS, it should be established as a separate self-standing system in 2025, and during the first year, the regulated entities will hold a GHG emissions permit and report their emissions from the years 2024 and 2025 (European Commission, 2021a). Then in 2026 there will be issuance of allowances and compliance obligations for these entities, making it possible for an upstart of the new ETS (European Commission, 2021a). As for the emission cap in this new ETS, it will be set from 2026 using data collected under the Effort Sharing Regulation. Furthermore, the commission proposes auctioning of allowances as the simplest and most economically efficient allocation method. Both the building and road transport sectors are under small amounts of competitive outside pressure, as such the risk of carbon leakage is low, making auctioning of the allowances more efficient (European Commission, 2021a). The commission also notes that for such an ETS to be effective, it must be possible to monitor emissions with both high certainty and at reasonable cost, something that can be easier achieved through upstream regulation.

The European Commission has outlined an overall goal for the new emissions trading system based on the transport and building sectors. An ambitious level set is to reach an emission reduction of 43% in 2030 compared to 2005 for the sectors of building and road transport (European Commission, 2021a). However, do note that the commission is basing their 2030 climate target on the quota cap that will be set from 2026 using data collected from the ESR, therefore there might be a possibility that the emission target could change. The European Green Deal has outlined a few more specific targets to be reached within each sector. For the transport sector they have set the target of 55% reduction of emissions from cars by 2030 and 50% reduction of emissions from vans by 2030, and a 2035 target which aims for 0% emissions from all newly registered cars (European Commission, 2021b). Meanwhile, for the building sector a climate target of reducing GHG emissions by 60% by 2030 has been set (European Commission, 2020b). Also, the commission proposes that all new public buildings must be zero-emissions as of 2027, and that as of 2030 all new buildings are to be zero-emissions (European Commission, 2021e). Being zero-emission means that the buildings must not be emitting on-site carbon emissions. When it comes to renovations of existing older buildings, a new minimum energy performance standard is proposed, where the worst performing 15% of the building stock of each member state of the EU must be upgraded on their energy performance, from grade G to F (European Commission, 2021e).

As of the 14 of July 2021 the fit-for-55 legislative package has been approved by the European Union. They are now aiming to adopt a series of legislative proposals. It is most likely that the proposal of the new ETS for the road transport and building sector will see further development as the European Union works to implement it. However, currently the EU has not laid forward more detailed plans or information of the implementation of this new ETS. It is highly likely that more details will be laid out after this paper has been written. As such, we base our current knowledge surrounding the new ETS for the road transport and building sectors around what is informed in the European Commission (2021a) legislative proposal package “fit-for-55”.

3. Theoretical analysis

3.1 Market stability

Buyers and sellers across the globe respectively make up the demand side and supply side for specific products and services. The collection of buyers and sellers, who through their actual or potential interaction decide the price, quantity and quality of a specific product or set of products, make up what is known as a market (Synnestvedt et al, 2012 ch.1). Understanding the microeconomics of how a market is created, how it operates, and how it adjusts will help to explain how environmental economics and climate economics operate and how their policies are implemented.

To understand how a market is constructed, one must understand the elements which make up the market, like its supply side, demand side, and market form. The first element which we must determine is which form the market will take, meaning the degree of competition in the market. Majority of economic analyzes and models operate with a market that is perfectly competitive, meaning that no single buyer or seller can influence the market price (Synnestvedt et al, 2012 ch.1). A perfectly competitive market means that there is only one market price for the goods, and that all players in the market have free access to all information. A primary reason to work with a perfectly competitive market has to do with the economic efficiency it achieves. A perfectly competitive market can achieve an equilibrium point where the total economic surplus is maximized. However, we must also take note of whether the market is subject to market failure. Market failure means that the market price might not give the right signals to consumers and producers, resulting in an inefficient economic outcome (Synnestvedt et al, 2012 ch.8). The most common types of market failures are either externalities or lack of information (Synnestvedt et al, 2012 ch.8). In such cases, to ensure that economic surplus is maximized, the market is subjected to regulation. Furthermore, a market may also be subject to weaker competition or higher competition among participants in the market, which may allow certain participants to obtain a position of market power. When there is weaker competition in the market the suppliers can operate with different prices on the same goods (Synnstvedt et al, 2012 ch.1). Meanwhile, suppliers who manage to obtain market power can in some circumstances operate as either a monopoly or oligopoly. In such cases, a supplier's market power increases the lower the elasticity of demand is, allowing them to set the price of the good higher than its marginal cost (Synnstvedt et al, 2012 ch.9). Therefore, to ensure consistency throughout our paper we assume that the markets we work with are perfectly competitive markets where all agents have full access to information.

Having defined the market form, we move onto two core elements which make up the market, the demand curve, and the supply curve. The demand curve represents the sum of all buyers, showing how much of the good consumers want to buy at different price points, that is the demand curve shows the sum of consumers' willingness to pay (Synnestvedt et al, 2012 ch.2). The supply curve represents the sum of all suppliers, showing how large of a quantity of goods each supplier is willing to sell at a given price point, that is the supply curve shows the sum of suppliers' marginal costs (Synnestvedt et al, 2012 ch.2). The demand curve follows a downward facing slope, which is the result of that consumers want to buy more of a good the lower its price is (Synnestvedt et al, 2012 ch.2). Meanwhile, the supply curve follows an upward slope, which is the result of that suppliers want to sell more of their goods when the price is higher (Synnestvedt et al, 2012 ch.2). Both curves are sensitive to economic changes, resulting in the curves either shifting outwards or inwards, which causes the goods price to shift and impacts the quantity sold. On the supply side it is factors related to the production function, primarily the production costs, which determine if the curve shifts inwards or outwards. For example, improved technology can cause the production costs to sink, resulting in the curve shifting outwards, thus allowing the supplier to produce a larger quantity of the goods for the same price or sell the same quantity at a lower price. On the demand side it is factors that are related to the buyers' purchasing power, like the amount of income or price of other products. For example, if consumers receive increased income, the demand curve will shift outwards, allowing the buyer to purchase a larger quantity of the goods at the same price, or purchase a higher quality of the goods for the same price.

The degree of elasticity on the demand side and on the supply side determines the shape and slope of their curves, which has an impact on their influence over the market price. Elasticity is a measure of sensitivity, determining to which degree one variable has an impact over another variable (Synnestvedt et al, 2012 ch.2). That is, how much percentage change do we get in one variable, if another variable increases by 1 percent. When looking at demand and supply elasticities, two areas are of interest, that is their price elasticity over the short-term versus over the long-term. Price elasticity shows the percentage change in demand, or supply, of a good if the price increases by 1%. It is especially interesting to look at the price elasticity on the demand side, since it can be used to determine whether the good has many close substitutes or few substitutes. As mentioned earlier, low demand elasticity, inelastic, gives suppliers more market power, since there are fewer substitutes for the goods. Also, the degree of impact that other goods might have upon the demand depends on whether the products are complementary or substitutes to the good. Should the goods be substitutes, then an increased price of product A will cause increased demand for product B (Synnestvedt et al, 2012 ch.2). Should they be complementary then, an increased price of product A will cause decreased demand for product B (Synnestvedt et al, 2012 ch.2). Furthermore, short-term elasticity and long-term elasticity have different influences on demand and supply. Both the demand and supply of goods will be more price elastic in the long-term. Demand price elasticity might increase because of long-term altercations in people's consumption habits, or long-term changes to the supply of other equal goods. As for supply price elasticity, over the long-term it might increase as producers expand production possibilities. However, the short-term price elasticity is where demand and supply differ. Certain goods can have high demand price elasticity in the short-term due to the characteristics of the goods. Such characteristics can be that the product has a limited stock-life, or it sees frequent value drops in the short-term, like with cars. On the supply side it is quite rare to see a product have high short-term price elasticity, some products are even un-elastic in the shorter-terms. However, there can be cases where the supplier can increase production capabilities in the short term, if it is in the nature of the product that it is highly price sensitive to consumers.

Together, the market form, demand and supply curves make up the basis of a simple market model. In most economic analysis such market models are often built around the structure of a perfectly competitive market. In a perfectly competitive market, one aims to ensure that the market reaches its optimal equilibrium. The equilibrium is where the demand curve meets the supply curve, meaning consumers marginal willingness to pay is equal to suppliers' marginal costs (Synnestvedt et al, 2012 ch.8). At this equilibrium the market would maximize its social economic surplus, that is, it is maximizing the consumer- and producer surplus. Should the market deviate from its equilibrium point, we would end up in a situation where one of the parties in the market would be worse off. For example, should the market price of the product be lower than its equilibrium, we would end up in a situation where a proportion of consumers would have higher willingness to pay than the current price for the product. This means that the current willingness to pay is larger than the product's marginal costs. The result would be that suppliers are missing out on profits, and as such the market is missing a proportion of economic gains. Should instead the market price be higher than the equilibrium, then marginal costs would be above consumers' willingness to pay, meaning the costs of production are higher than consumers' willingness to pay for that product. In this case the suppliers are using more resources than necessary, and there is non-optimal use of resources in the market. In both the situations described, the total social economic surplus in the market is reduced given that there are reductions in either the producer surplus and/or the consumer surplus. To determine the potential shifts in the market, one can analyze the price elasticity of demand and supply, as well as their potential economic changes. The main purpose is to determine the reduction in either producer- or consumer surplus as the market deviates from its equilibrium. Should the market deviate from its optimal point, meaning total social economic surplus is not maximized, then there is some form of market failure arising. Such market failures are quite common when the markets are converted to include environmental values. To correct for such market failures requires regulation, something which is quite common in environmental economics and politics.

It is against this background that we utilize a perfectly competitive market model when looking closer at environmental economics, and politics. Remember that the market system contains the incentive structures which allows us to seek the objective of improving environmental quality (Field, C, B & Field, K, M, 2017 ch. 4). Meaning, that while the market system itself will not give us the environmental quality which is socially efficient, we can alter its incentive systems, so it considers environmental values, yielding a more effective result, then if we were to attempt to adopt a different set of institutions (Field, C, B & Field, K, M, 2017 ch. 4).

3.2 Cost efficiency

Climate goals often have specific targets that they wish to achieve, making it necessary to evaluate the variety of instrument which can be utilized to reach these targets. As such, the regulator, like an environmental protection agency (EPA), often evaluates pollution control instruments on a wide variety of attributes like impact to income and wealth distribution, incentive structures, or costs of abatement (Perman et al, 2011 ch.6). One core attribute which is often evaluated when choosing an instrument, is whether that instrument is the most cost-efficient choice. An instrument is defined as being cost-effective should that instrument attain the climate target at a lower real cost than any other instrument (Perman et al, 2011 ch.6)

With cost efficiency also comes the theorem for least-cost of pollution control, which states that "a necessary condition for abatement at least cost is that the marginal cost of abatement be equalized over all abaters" (Perman et al, 2011 ch.6). Such a theorem means that there will not be equal abatement efforts by all polluters. Furthermore, it also means that when abatement costs differ between sectors or firms, those who are more cost-efficient will undertake most of the abatement, see Figure 4. However, the greater the difference is between firms or sectors abatement cost functions, the greater is the cost penalty of not achieving the least-cost outcome (Perman et al, 2011 ch.6).

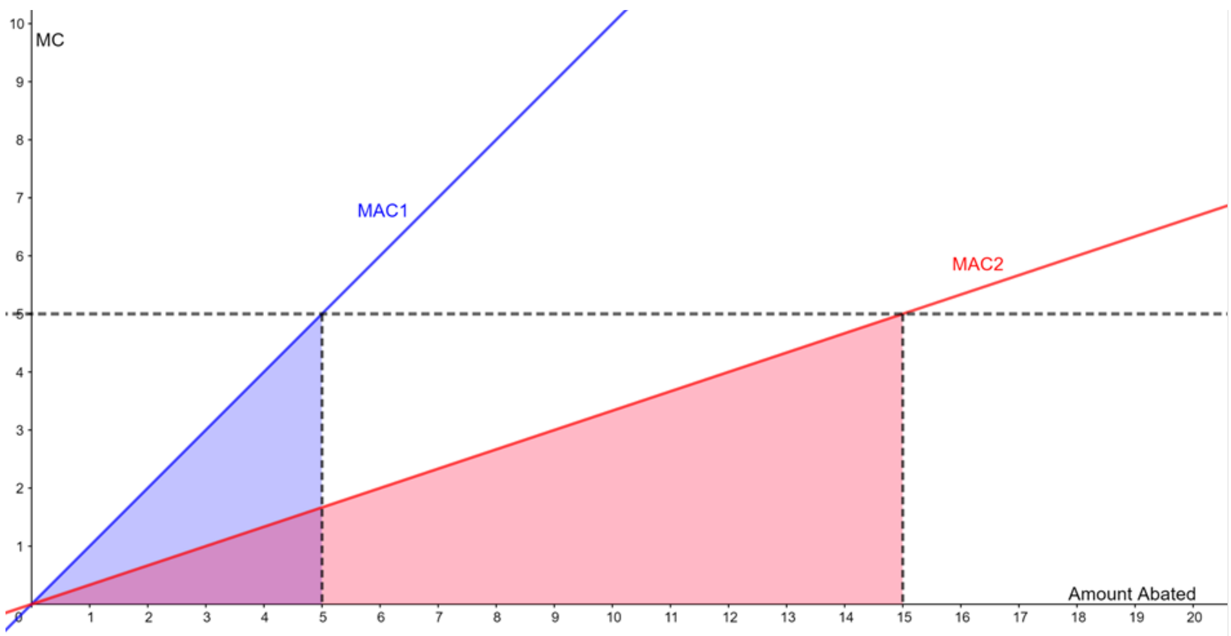

Figure 4: Cost-efficient solution with differing marginal abatement cost functions between two firms.

The figure above highlights how a cost-efficient solution is implemented when there are differing marginal abatement costs, MAC, between firms, (for equal levels of abatement). If the goal is to abate a total of 20 units, then according to the least-cost theorem, firm 1 will abate 5 units meanwhile firm 2 will abate 15 units. The figure shows that firm 2 has lower MAC than firm 1, and as such abates more units than firm 1. At these levels the abatement costs have been minimized, visualized through their shaded areas.

Given an instruments nature, that is whether the instrument meets the requirement of the least-cost theorem, one can determine whether that instrument has the capability to achieve a cost-effective solution. Certain economic incentive instruments, if implemented and monitored properly, like an emission tax or tradable emission permits, can achieve cost-effective solutions. This comes from the fact that the instruments give polluters incentive to reduce their costs in order to maximize profits, something we discuss with more detail in section 3.3.

3.3 Carbon pricing

Agents which are responsible for emitting emissions rarely carry the burden of the damages tied from emitting the pollutant. These damages are not internal to the polluter, meaning they have limited impact upon profits, and therefore it is not in the polluters interest to reduce these damages. Instead, the external nature of the emissions result in society paying for the cost of damage. As such, it is in the interest of regulators to ensure that these external costs are internalized to the polluter, so that they carry the burden of the costs. Regulators make use of a variety of instruments to internalize these costs, and among the most used instrument is the implementation of a carbon price.

Carbon pricing captures the external costs of emitting greenhouse gas emissions and ties them to their source (The World Bank, n.d.). The most common GHG to implement a price on is CO_2, which is where the concept of carbon pricing originates from. By tying a price to emitting CO_2, the polluter has economic incentives, like profit maximization or cost minimization, to reduce their emissions. There are a wide variety of instruments which can be utilized when aiming to implement a carbon pricing. Many of these instruments have in common that they are economic incentive instruments, or so-called quasi-market instruments. Such incentive-based instruments aim towards making polluters voluntarily change their behaviour, by altering the relative prices which the polluter faces (Perman et al, 2011 ch 6). The most utilized carbon pricing instruments are either emissions trading systems or carbon taxes, or in some cases both.

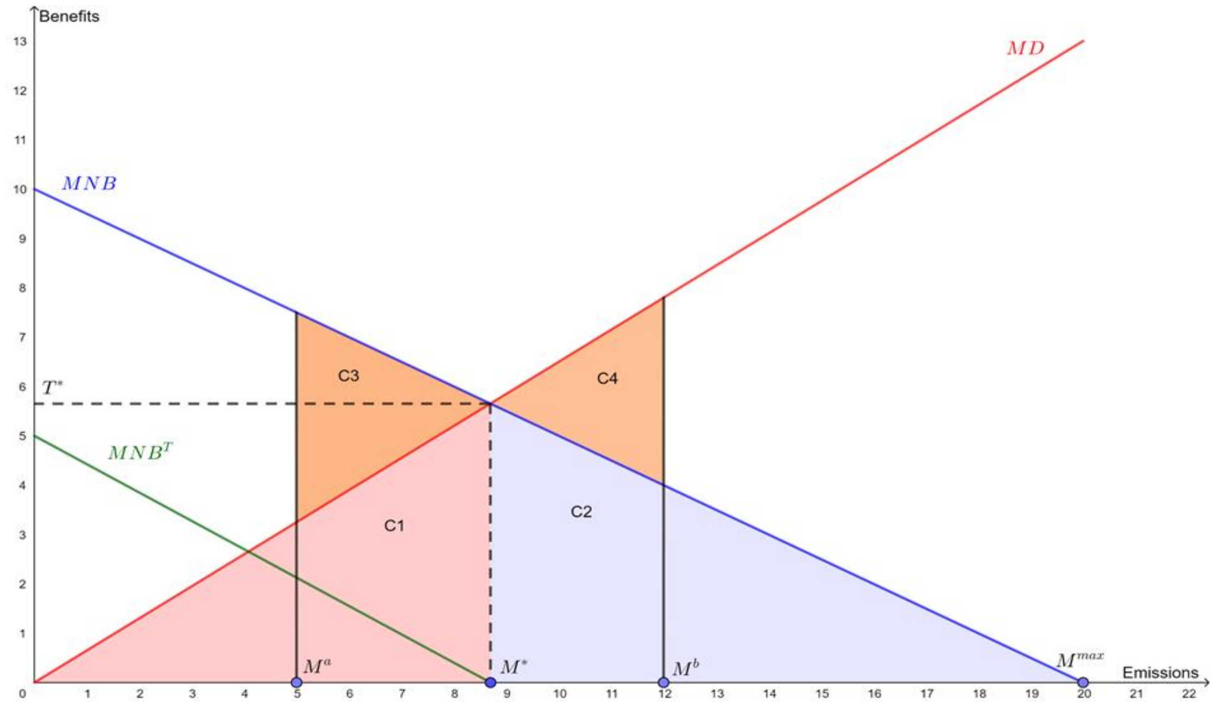

Figure 5: Carbon tax utilized to regulate the emissions of a firm.

Figure 5 describes a simple situation where the regulator implements a carbon tax of T*. In absence of an emission tax, the firm would have a marginal net benefit equal to the dark blue line, MNB. Since the emissions are external to the firm, they will pollute up until the point where their benefits are maximized M^{max}. By implementing a carbon tax of T*, it will result in the firm's marginal net benefit curve shifting to the dark green line MNB^T. This gives the firm a new optimal economical point of M*. Should the firm move away from the optimal emission point M*, then the firm will end up in a non-optimal economic situation. For example, remaining at M* would result in total social costs, that is the sum of damage and abatement costs, of only C1 + C2. However, moving to M^a would result in total social costs being C1 + C2 + C3, resulting in an efficiency loss of C3, and moving towards M^b would result in total social costs being C1 + C2 + C4 resulting in an efficiency loss of C4.

Another simple example of how carbon pricing is utilized, can be viewed by looking back at Figure 4. Imagine that we set a carbon price of 5, which would give the two firms economic incentives to reduce their emissions. Therefore, the firms would reduce their emissions up until the point where their MAC = 5. Furthermore, at that point, both firms MAC would be equal, meaning MAC1 = MAC2, and as mentioned back in section 3.2: “a necessary condition for abatement at least cost is that the marginal cost of abatement be equalized over all abaters" (Perman et al, 2011 ch.6).

We mentioned earlier that there are cases where a carbon price is implemented both through a carbon tax and an ETS. One nation which utilizes both instrument's today is Norway, who have jointly implemented the EU ETS and a national CO2 tax. Earlier in section 2.1.2 we briefly discussed Norway's partnership with the EU, and their inclusion into the EU ETS. Today the EU ETS roughly covers about half of Norway's emissions (SSB, 2021a), and as specified in section 2.1.2, we may see the EU ETS cover more of Norway's emissions in the future. As for Norway's CO2 tax, in 1991 it was implemented upon emissions from mineral products and emissions from the petroleum industry (Regjeringen, 2020a). Furthermore, sectors which are not underlaid the EU ETS are also subject to the CO2 tax. While both these systems are jointly connected, they are also somewhat complicated. The influence they have upon each other's carbon prices has been minimal. The quotas from the EU ETS have had limited impact upon the average carbon price, that is the average price actually paid for emitting, of Norway's CO2 emissions between the period of 2018 – 2020 (SSB, 2021a). Much of this has to do with the fact that majority of Norway's emissions come from sectors not underlaid the EU ETS, and sectors which are underlaid the EU ETS often receive a large amount of freely allocated quotas (SSB, 2021a). Furthermore, the EU ETS has a much lower carbon price compared to the carbon price tied to Norway's CO2 tax, which limits the ETS impact upon the carbon price tied to the Norwegian CO2 tax. However, following 2021, the carbon price of quotas in the EU ETS has rapidly increased, getting closer to the carbon price of the CO2 tax in Norway (SSB, 2021a). It is believed that this price increase might have major significance over how effective the marginal carbon price, the price of the last unit emitted, would be for those sectors which are underlaid the ETS. However, the actual impact upon the average carbon price would still be quite low given that the amount of freely allocated quotas is still high (SSB, 2021a).

As a final remark to this section, we will briefly emphasize upon a main difference between emission taxes and emission trading systems. First and foremost, both are economic incentive instruments, meaning they are utilized to achieve cost efficient solutions. However, they differ in their economic approach to reach their goals. An ETS, like the EU ETS, reaches its goal through limiting the quantity of emissions which can be released within a specified period. That is, the

ETS sets a cap on the number of emissions which can be released, and through its quota market the price of carbon is set. Meanwhile, an emission tax reaches its goal through impacting the price directly. Therefore, a CO2 tax may have no cap on emissions, and instead the quantity of emissions released are regulated through impacting the polluters economy. The result is that Norway has two different systems, where one system, the ETS, will have a carbon price that might vary over time, meanwhile the other system, the emission tax, will have a more predictable carbon price (Regjeringen, 2020b).

3.4 Emission Trading System – ETS

3.4.1 Explaining the Emission Trading System

The emission trading system is a vital part of our research question, given that we are looking into a new emission trading system for the road transport and building sectors in the EU. We have previously discussed some of the core features of a ETS in section 3.2, cost-efficiency, and in section 3.3, carbon pricing. As such, we assume that the reader has a basic understanding of the concept of cost-efficiency in a ETS and how a ETS can be used to set a carbon price. Therefore, in this section we will instead look closer at the details and aspects of the emission trading system.

As previously mentioned, the emission trading system is an economic incentive-based system, where the regulator aims to make an agent freely change their behaviour by altering the price structure that the agent faces. A ETS is preferred given its nature of being a cost-efficient instrument, just like a carbon tax, however, the approach of an emission trading system is different. We briefly discussed this at the end of section 3.3, but an ETS differs given that it works with quantity instead of price. Furthermore, the most distinguishing part of an ETS is the ability of transferable permits between the different sources (Perman et al, 2011 ch.6). It is important to note that we have a variety of such market trading systems, like offset trading or emission rate trading, but the EU ETS is based on a so-called cap-and-trade system. Keep in mind that the new ETS for the road transport sector and building sector will operate with the same rules as the existing EU ETS, meaning it will also operate as a cap-and-trade system. The way a cap-and-trade system works is explained by the name itself, first a cap is put on the quantity of emissions allowed where permits are written in accordance with this quantity (Field

& Field, 2017 ch.13). Then these permits can be traded among different sources through the market. While this may sound simple, there are complex rules and mechanisms in work here, and implementing a cap-and-trade system involves going through several steps. Perman et al (2011 ch.6) has listed the following 6 steps that regulators often go through when implementing a cap-and-trade emission permit scheme:

- Decision on the total quantity of emissions allowed over some time, the cap.
- Creation of a quantity of emissions permits which equal the emission cap, target level of emissions.
- A mechanism to determine how the permits are to be allocated between polluters.
- A rule which states that no firm is allowed to emit pollution beyond the quantity of emission permits it possesses.
- A system to monitor emissions, and where penalties can be applied.
- A guarantee that the permits can be freely traded between firms at whichever price is agreed for that trade.

An important feature of an ETS is the market which it creates. The market gives agents the right to pollute, tying their decision to generate pollution to an opportunity cost (Perman et al, 2011 ch.6). That is, for every extra unit polluted, one unit of permit is used up and therefore the opportunity to sell it disappears. Meaning the agent incurs a cost for each unit polluted the cost being equal to the markets permit price. Therefore, the permit price provides agents with the incentives to reduce their emissions. As such, how the market is created is vital when it comes to the impact which a ETS has upon the polluter. Which mechanism the regulator uses to allocated permits determines how the market is formed. There are normally 2 types of methods used by the regulator to allocate permits: 1. Selling permits by auction; or 2. allocating permits at no charge using a distribution role (Perman et al, 2011 ch.6). Keep in mind that a main difference between these two methods is how the permits equilibrium price emerges, while the equilibrium price itself will be identical (Perman et al, 2011 ch.6). However, there can be situations where the allocation can result in method 2 having a higher equilibrium price, like with the EU ETS where firms get more permits the higher the production, causing the permit price to increase (Rosendahl, E, K. personal mail, 01.04.2022).

The first case is where the permits are sold through auctions. Should there be no strategic behaviour, the regulator can use the firm's bids to determine their aggregate marginal abatement cost curves (Perman et al, 2011 ch.6). The firms reveal their marginal abatement cost curves by submitting bids, where higher bids means that the firm has high abatement costs, meanwhile lower bids mean the firm has low abatement costs. In turn the firm’s marginal abatement cost curves also represent their demand curve for permits, and by summing these together the regulator can determine the markets demand curve for permits. As such, one can determine the markets equilibrium permit price, by looking at where the aggregate marginal abatement cost, being also the markets demand for permits, meets the fixed supply of permits, see Figure 6 (Perman et al, 2011 ch.6). Furthermore, since the permits are being sold in an auction, it means that there is a flow of money towards the regulator. The second case is where the permits are allocated at no charge using some distribution role. For example, the permits can be distributed equally among all polluters, however there is the problem of that firms vary in size. One can also allocate according to either existing emissions, or through grandfathering, which is based on a firm’s history of emissions. However, this does not consider the fact that some firms have taken actions to reduce their emissions, leaving them with fewer permits. Once the allocation has taken place, it is the trade between firms which determine the equilibrium price of the permits. The market will consist of two types of firms, firms whose MAC < permit price, these will be potential sellers, and firms whose MAC > permit price, these will be potential buyers, se Figure 7 (Field & Field, 2017 ch.13). The result is a supply curve and demand curve for permits. If a firm’s MAC is either smaller or larger than the price of the permit, there are gains to be had from trading. A firm will then stop its trading once MAC = permit price (Field & Field, 2017 ch.13). Keep in mind that even while it is the firms in the permit market that determine the equilibrium price, it is still the regulator which allocates the permits and controls the quantity of permits in the market. No matter which type of method is used to allocate permits, it is still the regulator which allocates these permits and therefore can also lower the number of permits in order to reduce emissions.

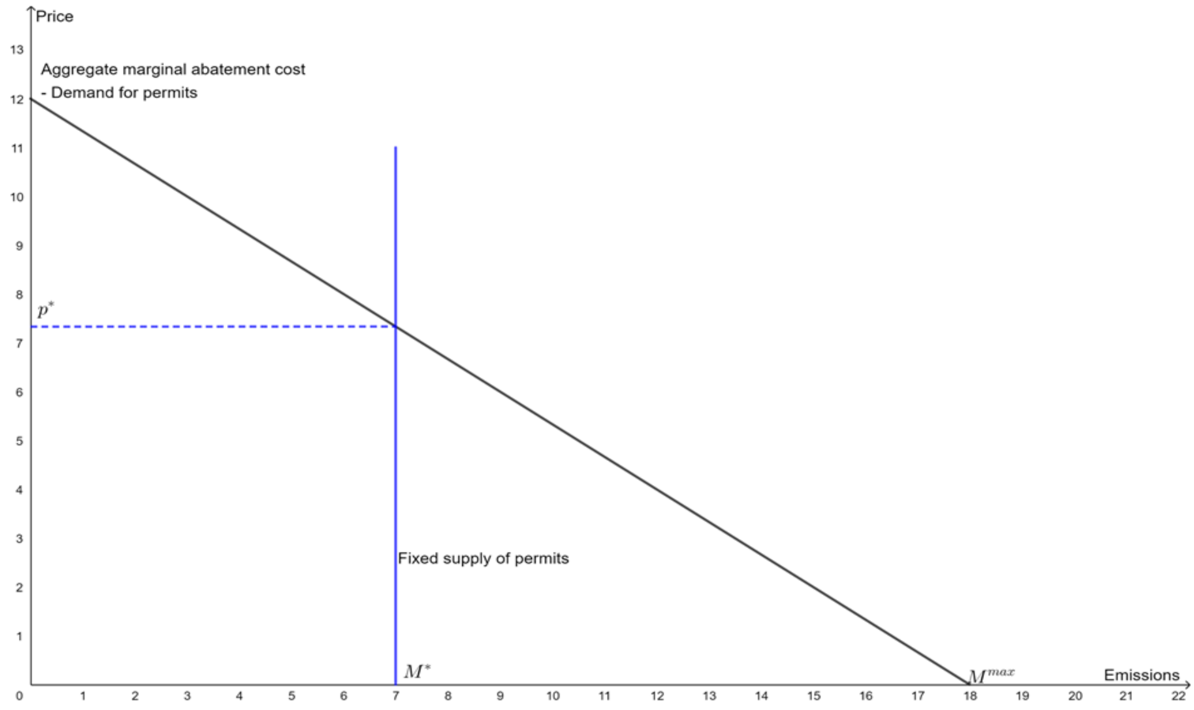

Figure 6: The markets equilibrium quota price p, based on auctions. It is assumed that all permits are sold at one price.*

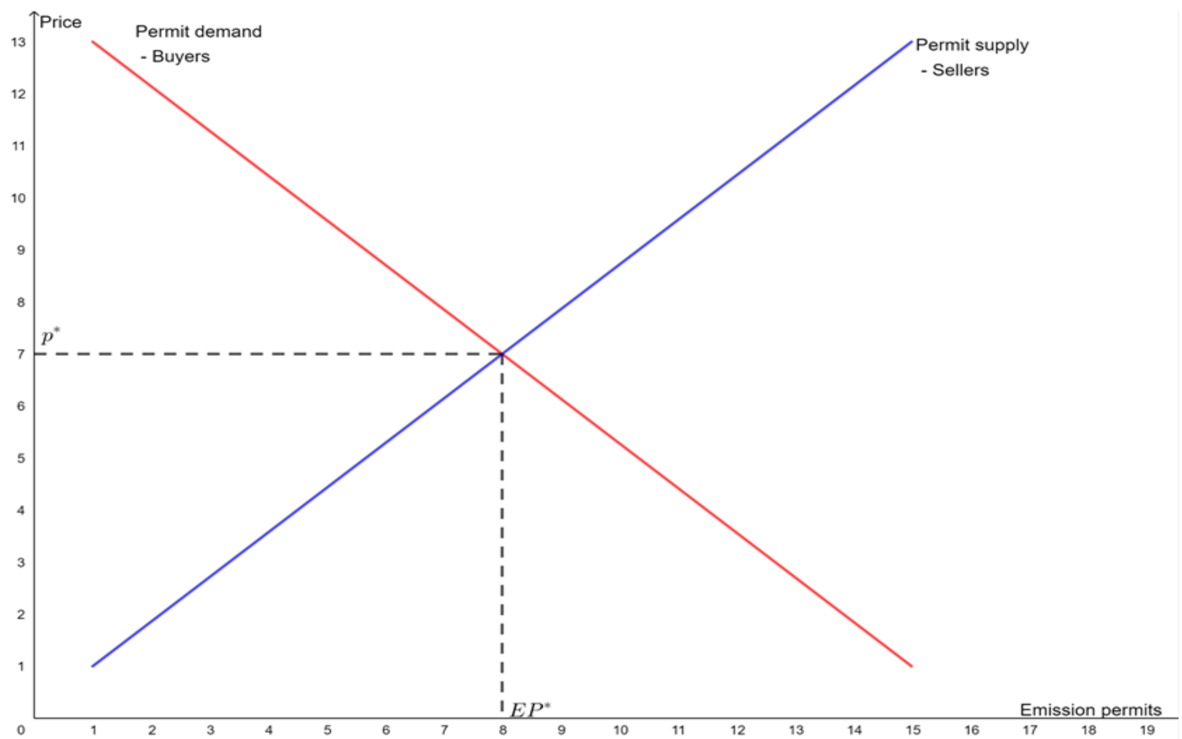

Figure 7: The markets equilibrium quota price p, based on free allocation.*

As described, an emission trading system can be developed by using a variety of different market trading systems. As such, the current EU ETS has been developed through using a variety of different market trading systems. During the 1 phase, the EU ETS gave almost all its allowances out to businesses for free (European Commission, n.d.b). In the 2 phase they allowed businesses to buy international credits, where such credits could be used to cover the businesses obligations, at the same time the amount of free allocated permits was reduced, and auctioning increased. By phase 3 auctioning of allowances had become the preferred method, however a smaller amount of free allocation was still distributed to firms, except for the power industry, meanwhile, certain sectors, like those sectors subject to carbon leakage, received a decent proportion of the freely allocated permits (European Commission, n.d.b).

The new ETS for the road transport and building sectors will utilize the same rules as the EU ETS but will be a separate system to it. As such, the new ETS will operate with much of the same methods as the existing EU ETS. While the European Commission has not outlined specifics about the type of market trading systems which the new ETS will utilize, we did mention earlier that the sectors of road transport and buildings are under small amounts of competitive outside pressure. Therefore, the commission proposes that the new ETS, while still operating with the same rules as the existing EU ETS, will increase the use of auctioned permits, and fewer permits will be freely allocated.

3.4.2 Linked Emission Trading Systems

Previously we specified that the new ETS for the road transport and the building sector would run separately but adjacent to the existing EU ETS. The European Commission proposed such an implementation to avoid potential disturbances between the two emission trading systems. Still, it can be of interest to look closer at what would happen should the new ETS be immediately linked with the existing EU ETS.

In section 2.3.2, we mentioned that the European Commission highlighted some reasons for why the two ETS should be separate. Among these were the different reduction potentials between the sectors covered by the two ETS, and different factors that influence the demand of permits between the two sectors. In section 3.4.1 we explained how a ETS functions, specifying that the permit market exists of potential buyers and sellers of permits, making up the demand and supply of permits. As such, linking two emission trading systems together may result in trade-offs which can cause shifts in the demand and/or supply of permits, causing potential risky changes in the permit prices and abatement activities. It was this risk of change within the existing EU ETS which resulted in the European Commission proposing that the two ETS be separate. The following example might provide a better picture for why the commission proposed the two ETS be separate. For example, say that ETS A is a high-priced system, meanwhile ETS B is low-priced. As such, ETS B gives agents in ETS A access to cheaper allowances. This causes a shift of permits from ETS B to ETS A which can cause the mitigation efforts in ETS A to reduce, se Figure 8. Furthermore, a lowered price in ETS A can cause certain technology or infrastructure lock-in, which in turn might decrease the possibility of setting more ambitious emission targets for the future within ETS A. However, at the same time the increased price in ETS B, may increase the possibility of setting more ambitious emission targets for the future within ETS B.

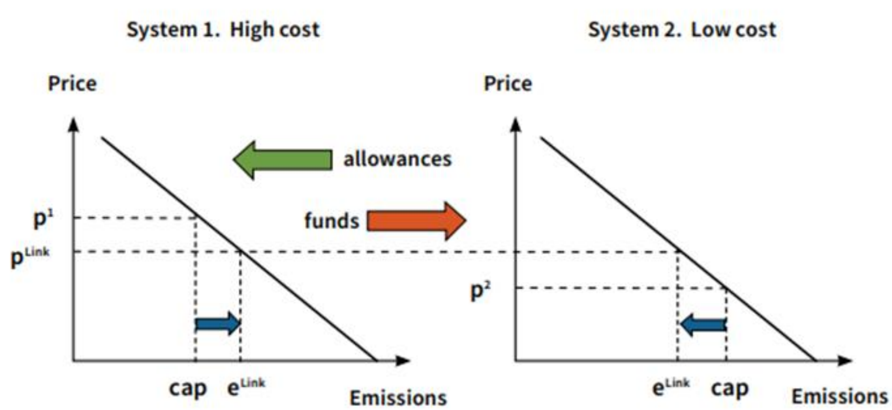

Figure 8: Linking emissions trading systems. (Santikarn, M. et al., 2018)

In *A Guide for Linking Emissions Trading Systems* written by Santikarn et al (2018), further remarks were made about risks to the economic aspects, environmental aspects, and political aspects of linking emission trading systems. Among the risks were: exposure to external shocks in one system to another; linking not equally robust systems, which gave way to weaker emission reduction targets; distributional concerns regarding low- and high-carbon goods and services; loss of control over systems. However, keep in mind that linking emission trading systems is sought after due to the potential benefits they might bring. The benefits can be economic aspects, environmental aspects, and political aspects. Once again, *A Guide for Linking Emissions Trading*

Systems by Santikarn et al (2018) highlights some of these benefits: Increasing cost efficiency; increase marked liquidity and ability to absorb shocks; reduce carbon leakage.

As for deciding on whether to link emission trading systems, or not, depends on the trade-off between the risks and benefits. To make such a decision requires an adequate amount of data and experience. That is why the European Commission proposed in their legislative proposal that it would be better to have the ETS for road transport and building sector be separate from the existing EU ETS. However, future data, and further experience, with the separate emissions trading systems may show that it is more beneficial to link the two ETS together.

3.5 Overlapping policies

So far in our paper little attention has been given to situations where multiple climate policies are implemented together. Given the nature of the new ETS for road transport and building sector in the EU, it will most likely overlap with either existing national climate policies or other system-wide climate policies. The overlap of such climate policies can cause unintended consequences, resulting in either beneficial effects or disruptive effects. As such, we look a bit closer at the consequences the new ETS might have, should it overlap with other climate policies.

First and foremost, as mentioned before, the new ETS will operate with the same rules as the current EU ETS. As such, it may also to some degree be subject to the same consequences occurring from overlapping policies in the EU ETS today. Currently one of the major consequences of the EU ETS overlapping with other climate policies, is the so-called waterbed effect. The waterbed effect is a result of the EU ETS overlapping with national climate policies, such as support for renewable energy or certain carbon taxes. Since the EU-wide emission caps are binding, should a government reduce emissions in a sector which is covered by the ETS, the impact will be neutral since the emission will increase elsewhere, which is why it is named the "waterbed effect" (Perino et al, 2019). However, following 2021 the EU ETS entered its 4th Phase, where refined rules aim to puncture this waterbed effect by replacing the fixed cap of the ETS, with one that is a function of market outcomes (Perino, 2018). Among the refined rules are changes made to the Market Stability Reserve (MSR). The MSR stores oversupply of allowances, to then at a later point release allowances in periods of undersupply, reducing short-term supply of allowances. The goal of the MSR is to provide the EU ETS with a supply side flexibility, with the aim to increase the quota price. The MSR works through a lower- and upper threshold of allowances entering the market, where if the lower threshold is reached allowances are gradually released, meanwhile if the upper threshold is reached then allowances are injected into the MSR (Regjeringen, 2018). Among the refined rules as part of Phase 4, the MSR sees an altercation to the number of allowances which it can store, primarily reducing the number of allowances which the MSR holds in "excess" (Perino et al, 2019). For example, starting in 2023 the MSR will only hold as many allowances as were auctioned in the previous year, being 57% of the annual cap (Perino, 2018). Any number of allowances going above this threshold would then be cancelled, effectively reducing long-term supply of allowances and as such puncturing the waterbed effect (Perino, 2018). However, this puncture is incomplete, as abating one ton of emissions will still result in less than one-ton emissions being reduced. Furthermore, the puncture is temporary since once a certain threshold is reached, the long-term cap will once again become fixed and the puncture will be sealed (Perino, 2018). Given this, it is possible that the new ETS could also overlap with other existing climate policies in either the road transport sector or building sector. Currently, nations in the EU have climate regulations, like carbon taxes, support for renewables or voluntary abatement efforts, implemented in their road transport and building sectors. Should there be no further changes to the rules of the existing EU ETS, then the new ETS for road transport and building sectors will operate with the existing rules, which may result in the waterbed effect occurring in the new ETS as well.

To better explain the impact which the waterbed effect, and other overlapping policies, can have on the new ETS for road transport and building sector, we illustrate a simple example. Below we have altered an existing theoretical analysis of overlapping policies, known as "green promotes the dirtiest" by Böhringer & Rosendahl (2010). Green promotes the dirtiest looks at the consequences of overlapping regulation of black and green quotas in the energy markets. When we have a tradable black (CO2) quota system and green (renewable) quotas are imposed on top, the policies overlap, and the consequence is that power production by the dirtiest technologies is promoted compared to a standalone black quota system. As for the reason, Böhringer & Rosendahl (2010) briefly explain: "The green quota reduces the shadow cost of the emission constraint, mainly benefiting the most emission-intensive technologies". Keep in mind that for our example we are using a highly simplified version of Böhringer & Rosendahl's (2010) green promotes the dirtiest. We utilize their theoretical analysis of overlapping policies to create a simple illustrative example of overlapping policies in the new ETS.

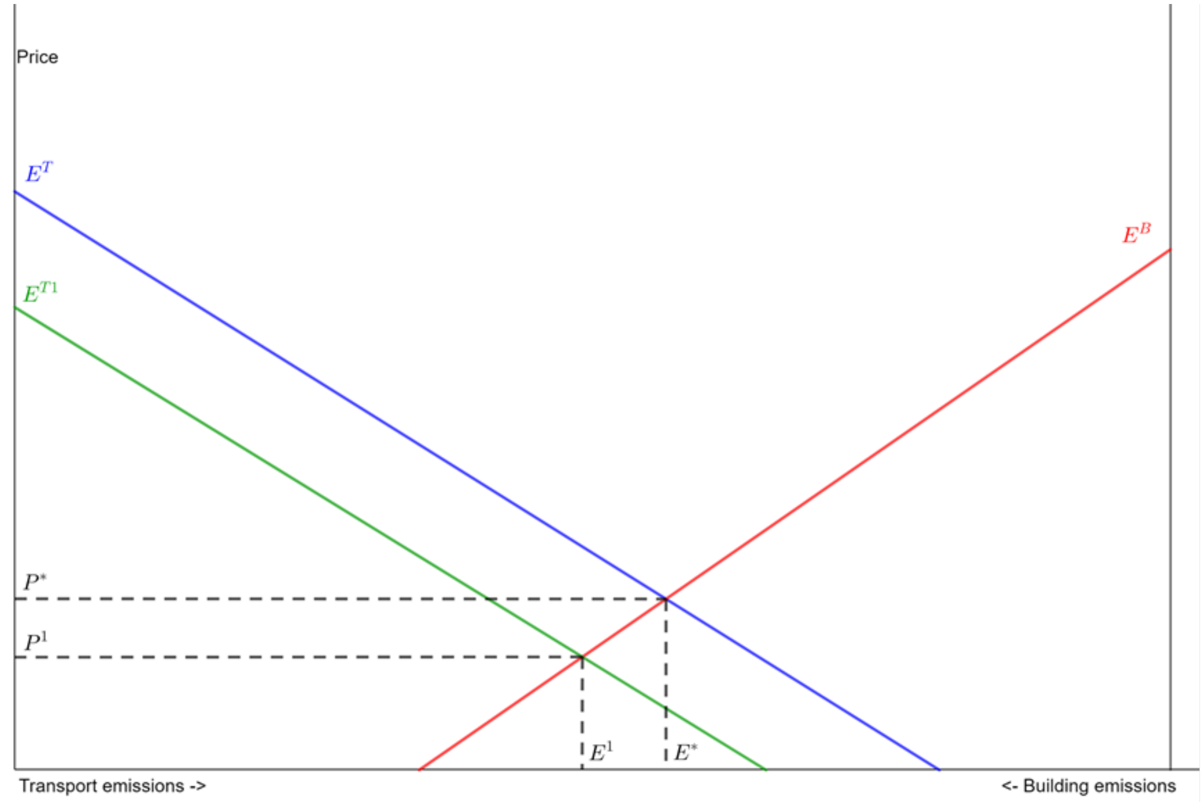

Figure 9: Bathtub diagram of overlapping policies within two sectors.

Figure 9 illustrates a bathtub diagram of the two sectors of building and transport. Going from the left-hand to the right-hand side, we have the emissions for transport, meanwhile, from the right-hand to left-hand side we have the emissions for buildings. Together, both sides make up the market's total emission quota. The curves illustrate the marginal abatement costs for transport, visualized by E^T, and marginal abatement costs for buildings, visualized by E^B. Prior to any type of emission regulation, both sectors would have zero incentives for abatement efforts, meaning we will have the same situation as described in Figure 5 where the current emissions would be at the point where the curves hit the bottom emission axis. Now, imagine a scenario where we implement our first emission regulation, an emissions trading system, and no other climate policies are in effect in either sector. In such a case, the market equilibrium would be where E^T meets E^B, given us the equilibrium price P* and emissions E*. Now imagine a scenario where an additional climate policy, a carbon tax, is implemented into the transport sector. The introduction of an additional policy could cause an overlap with the existing ETS. This would result in further reductions of emissions in the transport sector, as illustrated by the new marginal abatement cost curve E^{T1}. The result would be a lowered price of P^1, and a new emission equilibrium at E^1 for both sectors. While the transport sector sees a decrease of emissions by the distance of E^* to E^1, the lowered price makes it cheaper for other sectors to obtain allowances, promoting the building sector to increase their emissions by the distance of E^* to E^1. As such, total emissions remain neutral, as in the case with the waterbed effect. Keep in mind that this example could also be utilized for the building sector, if we were to implement the carbon tax there instead of in the transport sector. Furthermore, the mechanisms described here have a transfer value, meaning we could utilize them in a situation with for example two different countries, like between Norway and the EU.

Currently it is difficult to determine to what degree the new ETS will overlap with other climate policies, given the lack of information, and that the new ETS is to start operating several years after this paper is written. However, the fact remains that the new ETS for road transport and building sector will most likely be influenced by overlapping policies. Whether the new ETS faces the same overlapping policies as the existing ETS, or other forms of overlapping policies, is unknown, however one should still be aware of the unintended beneficial effects or unintended disruptive effects which can occur from overlapping policies.

4. Numerical analysis

4.1 Model structure

4.1.1 Model description

We now move over to explaining the model used to analyse the impact of the new ETS for road transport and building sector by looking at 3 different scenarios. The focus of the model is to utilize the theoretical framework discussed in section 3, to better visualize how the new ETS might come to impact potential emission reductions in both the road transport sectors and the building sectors for the EU and Norway. Section 4.1 will explain the model description and outline. Section 4.2 will explain the 3 different scenarios used in the model. Meanwhile section 4.3 will explain the data, which includes the numerical version of the model, and explain assumptions made in the model.

A final remark before diving into the details regarding the model. The nature of the new ETS for road transport and building sectors, and the limitations in our access to resources including the time restrictions, had an impact upon how we shaped our model and worked out the scenarios. Primarily, keep in mind that information about the new ETS is vague, given that at the current time of writing this paper the only form of precise and trustworthy information regarding the new ETS was collected through the "Fit for 55" legislative proposal by the European Commission (2021a). Furthermore, the new ETS will not start operations before the year of 2025, giving it plenty of room to be altered after this paper has been handed inn. As such, the limitations of access to resources and information, as well as the time horizon of the new ETS, makes it so that our model is sensitive to potential future changes in the ETS, especially up until it starts operating. Therefore, to reduce potential uncertainty and noise in both our data, model, and scenarios, we have chosen to work with a simple model and construct simple scenarios.

As mentioned, the goal of the model is to look at the impacts which the new ETS would have upon the emissions and carbon pricing in the road transport and building sector of both the EU and Norway. Remember, the overall goal of implementing this ETS, is to lower the emissions of the road transport and building sectors so that the EU can better meet their reinforced target of 55% net emissions reduction of GHG by 2030. As such, our model aims to analyse the amount of emission reductions in both the road transport and building sectors in 2030, that is we assume the new ETS is fully implemented and operational by this year. This will require a basic start point, or reference point, which we have defined as business-as-usual. We will then need data regarding how much the emissions would decrease for each of the respective sectors when the ETS is implemented. Furthermore, while the ETS is primarily implemented EU-wide, it is also of interest to see how it would impact a specific nation, primarily in our case we are interest in its impact upon the Norwegian sectors. Also, as mentioned in section 3.5, the nature of the ETS may cause some degree of overlapping policies, which will have an impact upon emission reduction. Therefore, we will also have to consider scenarios where a strong amount of overlapping policy either exists or could be added.

With the overall goal of our model defined, we move on to explaining its construction. The purpose of the model is to utilise a set of functions to solve unknown variables presented in each scenario, these variables being: the emissions of the building sector after ETS implementation; the emissions of the road transport sector after ETS implementation; and finally, the carbon price in the ETS. As such, the primary function utilised is a linear abatement cost function. This function will need a starting point for the emissions in that specific sector, which has been defined as the emissions under a business-as-usual situation. There will also be need for a segment in the function which can calculate how much the carbon price changes, resulting in emission reduction when the ETS is implemented. As such, this segment is made up by two parts, a variable, and a parameter. The variable is the carbon price, explained in Section 3.3, meanwhile the parameter is the emissions reduction potential, that is how much the emissions decrease for each 1 unit increase in the carbon price. Furthermore, given that we are looking at some scenarios of overlapping policies, we will also need to extend our model to include factors taking account for overlapping policies. This extension is in the form of an additional parameter added to either the carbon price and/or BaU emissions in specific functions, please see Section 4.1.2. Lastly, the model will need one final equation. This equation will illustrate the cap of the ETS, where the total emissions are to be less or equal to the quota cap of the new ETS. Furthermore, keep in mind that should the total BaU emissions be below the cap, then there would be no benefit of implementing the ETS in these sectors.

Depending on the situation and scenario being looked at in the model, the shape and number of functions will differ. The road transport and building sectors have each their own functions. While the functions may look the same, see for example functions 1.1 & 1.2 below, the parameters they use are different. Furthermore, we split these functions based on whether we are looking at the EU sectors or the Norwegian sectors, see functions 1.1-1.3 & 1.4-1.6 below. While the EU version of the model only needs the EU functions, functions 1.1-1.3, the Norwegian version of the model needs both the EU functions and Norwegian functions, functions 1.1-1.2 & 1.4-1.6, since the Norwegian sectors are integrated into the ETS. Also, as previously mentioned, there are some scenarios where we look at overlapping policies, the functions in these scenarios will need to be extended with additional parameters. The result is that we have a different structured model for the EU and for Norway, where, once again, the functions used, and their values, will be different dependent on whether we are looking at the road transport sector or building sector, and which scenario we are analysing.

Below in section 4.1.2, we have outlined our model, where each of the functions are illustrated including an explanation.

4.1.2 Model outline

Explanations for variables and parameters are presented at the end of section 4.1.2. A description of the scenarios is presented in section 4.2. The complete numerical version of the model is presented at the end of section 4.3.

EU functions

EU road transport emission function (1.1)

$$E_{EU}^{T} = E_{EU}^{BaUT} - R_{EU}^{T} \cdot P \quad (1.1)$$

EU building emission function (1.2)

$$E_{EU}^{B} = E_{EU}^{BaUB} - R_{EU}^{B} \cdot P \quad (1.2)$$

Cap restriction for EU (1.3)

$$E_{EU}^{T} + E_{EU}^{B} \leq ETS\ quota\ cap \quad (1.3)$$

Norwegian functions

Norwegian road transport emission function (1.4)

$$E_{N}^{T} = E_{N}^{BaUT} - R_{N}^{T} \cdot P \quad (1.4)$$

Norwegian building emission function (1.5)

$$E_N^B = E_N^{BaUB} - R_N^B \cdot P \quad (1.5)$$

Cap restriction for EU & Norway (1.6)

$$E_{EU}^T + E_{EU}^B + E_N^T + E_N^B \leq ETS\ quota\ cap \quad (1.6)$$

Extended functions including overlapping policies

Overlapping policy impacts carbon price for the Norwegian road transport (1.7)

$$E_N^T = E_N^{BaUT} - R_N^T \cdot (P + O_\alpha) \quad (1.7)$$

Overlapping policy impacts BaU emissions for the EU road transport (1.8)

$$E_{EU}^T = \left(E_{EU}^{BaUT} \cdot O_\beta\right) - R_{EU}^T \cdot P \ (1.8)$$

Model restrictions

Emissions must be above or equal to 0, negative emissions not possible (1.9)

$$E \geq 0 \quad (1.9)$$

Carbon price must be positive, or equal to 0. Cannot have a negative carbon price (1.10)

$$P \geq 0 \quad (1.10)$$

Explanation of variables and parameters

E = Emissions

T = Road transport sector

B = Building sector

BaU = Business-as-Usual

EU = European Union

N = Norway

R = Emission Reduction Potential = $\frac{Emission\ reduction\ in\ 2030}{Carbon\ price\ increase\ in\ 2030}$

P = Carbon price

O_α = *Overlapping policy influence on the Norwegian carbon price*

O_β = *Overlapping policy influence on the EU road transport BaU emissions*

Additional notes

Parameters R & E^{BaU} are acquired through data, please see section 4.3 for details. Parameters O_α& O_β are estimated by using data, please see section 4.3 for details. The variables E_{EU}^T, E_{EU}^B, E_N^T, E_N^B & P are unknown and are estimated by running the model through the 3 scenarios, please see section 4.2 and 4.3 for details.

4.2. Scenario descriptions

4.2.1 Business as usual

We start the model by creating a baseline, or reference situation, described as Business-as-Usual. Which is the setting today before the new ETS is implemented. As there may be other climate policies that form the basis of BaU emissions, the carbon price is in this situation 0. As a reference level, the point is to show the situation as it is and compare our new numbers with it. Our BaU numbers are presented in section 4.3, where we have gathered historical data from the year 2020.

4.2.2 Scenario 1 – implementing the new ETS

In our first scenario, we proposed a stand-alone ETS is implemented. We use the BaU numbers as a baseline where the existing policies which shaped these numbers are included, when implementing the numbers and variables to make it possible to simulate the ETS in our model. The emission cap set in the scenario is based on expected emission from transport and buildings, in both Norway and EU after the ETS has been implemented, please see section 4.3. This scenario is accordingly used to simulate the implementation of the new ETS, where no adjustments to avoid overlapping policies are introduced.

4.2.3 Scenario 2 – overlapping policies 1, Norway and prices

We wish to illustrate how the new ETS will affect the market as close to reality as possible. Looking back at the theoretical analysis, we bring the section about overlapping policies relevant here in scenario 2.

Different industries and activities often have different targets and policy instruments. When combining this with the new ETS, we expect to see some concerns with overlapping policies. As such, in order to cut emissions in the road transport, the Norwegian government have decided on an increase in the CO2 tax to reduce the use of fossil fuels in the sector. This is necessary in order to reach certain 2030 targets, described in Klimakur 2030. One of the 2030 targets is the sale of whole-electric vehicles, where it is expected that in order to reach this target the road transport industry might see reinforced climate policy which would increase in the road transport carbon price with a minimum of 500 NOK/tCO2. So, in our scenario, we decided to add the minimum of around 500NOK/tCO2, on the right side of the Norwegian road transport emission function (please see functions 1.4 and 1.7). The mechanism illustrating overlapping policies in this case is added to the model as O_{α}, see function 1.7. The variable is an added tax on CO2. When adding this increase of tax whilst quota cap stays unchanged, we expect an equal scenario as what we explained in section 3.5. More details regarding the numbers can be found in section 4.3 & Appendix A.

4.2.4 Scenario 3 – overlapping policies 2, EU and emissions

In the third scenario, overlapping policies are still the focus area. Instead of an increase in the CO2 tax in Norway, we simulate how a change in BaU emissions in EU could influence our model and affect our outcome. See function 1.8.

First part of the equation illustrates EUs emission in a BaU situation. As more comprehensive explained in 4.3, we see that there might be a decrease of overall emissions in the EU, because of frequent updated targets. If anything, the signals from the Commission point to a stricter climate policy, and not the other way around. However, we assume that when the new ETS is in place, some other policy might be removed. For example, the target on CO2/km car would be removed or slackened up to some degree. To illustrate this situation, and change the situation, we change the expected BaU emission by adding O_{β} in our model. A parameter to account for a 15% increase in the EU road transport sector as a result of removing the policy. Please see section 4.3 for further details.

4.3 Model data & assumptions

In the following section we present all data utilised to construct the numerical version of our model, including the assumptions made. All the data gathered is either through official or governmental sites, to ensure consistency and validity. The numerical versions of the model in the different scenarios are presented at the end of this section. Furthermore, to keep this section more structured, we have moved some calculations from this section to Appendix A.

First and foremost, as mentioned earlier, the unknown variables, E^T, E^B, & P, are calculated by running the model through the different scenarios, leaving the remaining parameters to be covered through data. Since future climate plans for both the EU and Norway focus on a period between 2021-2030, we have assumed 2020 as the starting year, and therefore have not consider it relevant to adjust for inflation. We also assume 2030 as the end period, that it is the year the new ETS is operating, and therefore have only included data focusing on the years of 2020 and 2030, and not data from 2020 to 2030. As such, data gathered is either historical data from the year of 2020, or official forecasts made regarding the year of 2030. When it comes to emissions, we gathered data regarding CO2 emissions from the different sectors, where the values were converted to Mt or million ton. All prices used, like carbon price, have their currency converted to Euro, where in the case of carbon price we used Euro per ton CO2.

For the business-as-usual emission values, we needed to gather data for the road transport and building sectors from both Norway and the EU in 2020. In the case for data regarding the European Union's sectors, we made use of the European Environment Agency, EEA. Here we found historical records of 431.4 Mt CO2 emissions from buildings in 2020 (EEA, 2021) and 714.8 Mt CO2 emissions from road transport in 2020 (EEA, 2022). In the case for data regarding the Norwegian sectors, we made use of Statistisk sentralbyrå, SSB. Here we found historical records of 8.4 Mt CO2 emissions from road transport in 2020 (SSB, 2021b), and 0.5 Mt CO2 emissions from buildings in 2020 (SSB, 2021b). For model simplicity reasons, we assume that the BaU values of 2020 remain constant with no change over the years. Furthermore, we assume that existing policies which shape these BaU values will still be active in 2030 while the new ETS is operational.

All BaU emission values are presented in Table 1 below.

Parameter	Value (Mt CO2)
$\boldsymbol{E_{EU}^{BaUB}}$	431.4
$\boldsymbol{E_{EU}^{BaUT}}$	714.8
$\boldsymbol{E_{N}^{BaUT}}$	8.4
$\boldsymbol{E_{N}^{BaUB}}$	0.5

Table 1: BaU emission values

The next parameter calculated was the emissions reduction potential known as *R*. As mentioned before, the purpose of this parameter is to calculate how much emissions, that is Mt CO2, decrease for each 1 unit, that is 1 Euro, increase in carbon price. In our case, the purpose of *R* is to show how much emissions decrease in 2030 given the new ETS is implemented. As such, *R* is a value that is calculate by gathering data regarding the amount of emission reduction in 2030, and carbon price increase in 2030, see section 4.1.2.

In the case for data regarding the European Union's sectors, we made use of the European Commission's legislative proposal "fit for 55". Here we found a forecast regarding a MIX scenario, that is a scenario where both the existing EU ETS and an adjacent but separate new ETS for road transport and the building sector are both operational. In this scenario it was expected that the carbon price of the new ETS would be set at 48 Euro per ton CO2 in 2030 (European Commission, 2021a). As such, we used 48 Euro/tCO2 as the carbon price increase in 2030 for the European Union's sectors. Furthermore, in the same legislative proposal we found forecasts regarding the amount of emission reduction for both sectors in 2030. For the road transport sector, MIX scenario, it was assumed that emission reduction would be about 25% more with the new ETS (European Commission, 2021a), giving us an emission reduction of 178.7 Mt CO2, which is 25% of the BaU 714.8 Mt CO2. For the building sector, MIX scenario, it was assumed that emission reduction would be about 27% more with the new ETS (European Commission, 2021a), giving us an emission reduction of 116.5 Mt CO2, which is 27% of the BaU 431.4 Mt CO2.

When it came to gathering data regarding the Norwegian sectors, we made use of the official governmental "klimakur 2030". However, the forecasts made for the year of 2030 were done so without regards to the new ETS for road transport and buildings. Given that there were no other governmental sources which had done forecasts for these sectors, with respect to the new ETS, we decided that the values found in "klimakur 2030" would be our best alternative regarding data concerning the Norwegian sectors. Moving on, Norway expects the carbon price of sectors like road transport and buildings to increase to a minimum of 2000 NOK pr ton CO2 by 2030 (Regjeringen, 2020c). In 2020 the carbon price for these sectors were 544 NOK pr ton CO2 (Regjeringen, n.d), giving us a carbon price increase of 1456 NOK pr ton CO2, or 96.4 Euro pr ton CO2 (see Appendix A for conversion). Furthermore, in the same paper, we found forecasts regarding future emission reductions in both sectors. From 2021-2030, it is expected to see 11.8 Mt CO2 reduction in road transport (Regjeringen 2020c), and 1.8 Mt CO2 reduction in the building sector (Regjeringen, 2020c). Unlike the EU paper, which had specific values for 2030, the Norwegian forecast use the sum of emission reduction from 2021 to 2030. As such, we decided to use the average emission reduction per year, which was 1.2 Mt CO2 for road transport and 0.2 Mt CO2 for buildings. However, given that the CO2 price would normally gradually increase over time, it would mean that the amount of emissions reduction in 2030 would be larger than the amount of emission reduction at the start of the period. As such, we assumed that in 2030 the emission reduction would twice as large, which gave us the final values of 2.4 Mt CO2 for road transport and 0.4 Mt CO2 for buildings

Having gathered all data relevant, we calculated *R* for each sector in Norway and the EU, the results are presented in Table 2 below, as for calculations please see Appendix A.

Parameter	Value (Mt CO2 pr Euro)
$\boldsymbol{R_{EU}^{T}}$	3.7
$\boldsymbol{R_{EU}^{B}}$	2.4
$\boldsymbol{R_{N}^{T}}$	0.02
$\boldsymbol{R_{N}^{B}}$	0.004

Table 2: Emission reduction potential values (See Appendix A for calculations)

We also needed values for the quota cap in the ETS. Looking back at functions 1.3 & 1.6, we can see that two different quota caps would be needed. In the case of function 1.3, which only focuses on the EU sectors, we looked once again at data from the European Commission's legislative proposal “fit for 55”. Here we found a hypothetical cap tied to an option referred to as EXT1, that is extension option 1, which focused on a separate but EU-wide ETS system for buildings and road transport. This hypothetical cap is set at 1105 Mt CO2 (European Commission, 2021a), however it is a hypothetical cap created for the year of 2024. Since there was no further information officially available, we assumed that this cap would also hold for the year 2030, as we already had assumed that the BaU emissions from 2020 would remain constant, giving no reason to change the cap. In the case for function 1.6, it includes the EU sectors and the Norwegian sectors. Unfortunately, there is no official information regarding how the Norwegian sectors could influence the cap in the new ETS. Therefore, based on data gathered previously for function 1.3, we decided to use that information to create a hypothetical cap for function 1.6. The total BaU emissions for the EU sectors are 1146.2 Mt CO2, which is 96.3% of the cap (please see Appendix A for calculation). We assumed the same cap rule would apply for the Norwegian sectors, which is a cap based on 96.3% of total Norwegian BaU emissions. As such, the total Norwegian sectors BaU emissions are 8.9 Mt CO2, giving us a cap increase of 8.6 Mt CO2 (please see Appendix A for calculation). The total cap for function 1.6 becomes therefore 1113.6 Mt CO2.

One final remark regarding functions 1.3 and 1.6. While in section 4.1.2 the ETS cap is ≥ than the sum of emissions, our data show that total BaU emissions are larger than the ETS cap. Therefore, in the numerical version of our model, the cap of functions 1.3 and 1.6 become binding (using =), since BaU is larger than cap, thus allowing us to calculate the unknown variables.

All quota cap values are presented in Table 3 below

Parameter	Values (Mt CO2)
ETS quota cap (1.3)	1105
ETS quota cap (1.6)	1113.6

Table 3: ETS quota cap values

The parameters remaining are O_α and O_β which represent overlapping policies, were O_α influences the Norwegian road transport carbon price, and O_β influences the EU road transport BaU emissions. Unlike the values gathered so far, there exists no exact data regarding these parameters, instead we had to make assumptions by looking through other relevant data. In the case for Norway, we looked once again at "Klimakur 2030" for insight. For the road transport we found that Norway is aiming to implement a variety of policies by 2030 to reach certain goals which can reduce emissions in road transport. One of these goals is to ensure that all sale of new vehicles by 2030 is whole-electric. According to a forecast, such a policy could mean that the carbon price would increase with a minimum of 500 NOK pr ton CO2 (Regjeringen, 2020c), or 33 Euro pr ton CO2 (see Appendix A for conversion), to ensure that the 2030 target is to be reached. We assume that this policy runs independently of the implementation of the new ETS, and that it is ambitious enough to cause it to overlap. In the case for the EU, we looked at their official website which includes targets and goals in the transport sector. Here we found that the EU has set itself stricter EU fleet-wide CO2 emission target, like reducing CO2/km for each new car produced. The purpose of stricter CO2 emissions from each new car produced is to reach specific targets, where one such target is a 15% reduction of emissions in road transport from 2025 and on (European Commission, n.d.c). Earlier we assumed that existing policies that shaped our BaU emission would still be active, meaning that this policy of stricter CO2/km for each new car produced should be active in 2030 when the new ETS is in operation. As such, to create a different scenario for overlapping policy, we have assumed that this policy would be removed before 2030, that is an overlapping policy is removed, which could cause the BaU emissions for the EU road transport sector to increase with 15%.

All overlapping policy values are presented in Table 4 below.

Parameter	Value
$\boldsymbol{O_\alpha}$	33 Euro pr ton CO2
$\boldsymbol{O_\beta}$	15% increase Mt CO2

Table 4: Overlapping policy values

Having presented all data used to gather the values of different parameters in our model, we can now construct the different numerical versions of our model depending on which scenario we are focusing on. These numerical versions are presented below.

Scenario 1 – Implementing the new ETS

$$E_{EU}^{T} = 714.8 - 3.7 \cdot P \ (1.1)$$

$$E_{EU}^{B} = 431.4 - 2.4 \cdot P \ (1.2)$$

$$E_{N}^{T} = 8.4 - 0.02 \cdot P \ (1.4)$$

$$E_{N}^{B} = 0.5 - 0.004 \cdot P \ (1.5)$$

$$E_{EU}^{T} + E_{EU}^{B} + E_{N}^{T} + E_{N}^{B} = 1113.6 \ (1.6)$$

Scenario 2 – Overlapping policies 1, Norway and price

$$E_{EU}^{T} = 714.8 - 3.7 \cdot P \ (1.1)$$

$$E_{EU}^{B} = 431.4 - 2.4 \cdot P \ (1.2)$$

$$E_{N}^{T} = 8.4 - 0.02 \cdot (P + 33) \ (1.7)$$

$$E_{N}^{B} = 0.5 - 0.004 \cdot P \ (1.5)$$

$$E_{EU}^{T} + E_{EU}^{B} + E_{N}^{T} + E_{N}^{B} = 1113.6 \ \ (1.6)$$

Scenario 3 – Overlapping policies 2, EU and emissions

$$E_{EU}^{T} = (714.8 \cdot 1.15) - 3.7 \cdot P \ \ (1.8)$$

$$E_{EU}^{B} = 431.4 - 2.4 \cdot P \ \ (1.2)$$

$$E_{N}^{T} = 8.4 - 0.02 \cdot P \ \ (1.4)$$

$$E_{N}^{B} = 0.5 - 0.004 \cdot P \ \ (1.5)$$

$$E_{EU}^{T} + E_{EU}^{B} + E_{N}^{T} + E_{N}^{B} = 1113.6 \ \ (1.6)$$

5. Results and discussion

5.1 Preface before results

Before diving into the details regarding our result, we have some preface focusing on how the model is run and how the results were analysed. The results for each scenario, including an explanation, can be found from sections 5.2-5.4. Also, given that our model is constructed using data which may contain some degree of uncertainty and noise, which can cause disturbances, we have run a small sensitivity analysis which can be found in section 5.5. Further discussion regarding our results can be found in section 5.6.

The different scenarios are solved by utilizing the mathematical program known as GeoGebra, which functioned well with our model given its simple construction. Here we made use of one of the tools provided in GeoGebra, CAS – Computer Algebra System, which allowed us to solve the unknown variables: carbon price, emissions from road transport and emissions from the building sector. CAS also makes it possible to change any parameter, allowing us to get varying results if one wishes to look at other scenarios. Furthermore, GeoGebra allows us to construct figures to provide visual aid to our scenarios. However, the figures are only there for the visual aspect, given that the purpose of the model is to look at the value changes in the carbon price and emissions.

As for the results and discussion, keep in mind that the purpose of the model and the results we analyse is to find a potential solution to our problem statement:

EU climate policy Fit-for-55: How will the new emission trading system for road transport and building sectors impact the emissions and carbon price in the relevant sectors in Norway and EU. How will then the Norwegian and EU sectors interact among each other, and how will overlapping climate policies impact this ETS?

As such, the results from each sector in each scenario will be compared to their original BaU values for that specific sector. Furthermore, given that scenarios 2 & 3 are looking at the impacts of overlapping policies in the new ETS, their results will also be compared to scenario 1, which looks at the new ETS isolated from influence of external policies. Also keep in mind that some results included many decimals, where we decided that the best option would be to either round up or down when suitable.

5.2 Scenario 1 – Implementing the new ETS for road transport and building sector

For scenario 1, implementing the new ETS for road transport and building sector, we input the corresponding numerical functions, see section 4.3, into CAS to get a solution through our model. Figure 10 shows the results from CAS. Note that x is a replacement for P due to restrictions within CAS.

$TEU(x) = 714.8 - 3.72\,x$

$BEU(x) = 431.4 - 2.43\,x$

$TN(x) = 8.4 - 0.02\,x$

$BN(x) = 0.5 - 0.004\,x$

$CAP:\ TEU + BEU + TN + BN = 1113.57$

STEU = Skjæring(TEU, CAP)
→ (6.727, 689.777)

SBEU = Skjæring(BEU, CAP)
→ (6.727, 415.054)

STN = Skjæring(TN, CAP)
→ (6.727, 8.265)

SBN = Skjæring(BN, CAP)
→ (6.727, 0.473)

Figure 10: Model solutions based on scenario 1, solved through CAS

Here T stands for transport, B for buildings, EU for European Union, N for Norway, and S for solution.

We are interested in the solutions for each sector. The first value, x – value, shows the carbon price, P, in the entire ETS, which is 6.73 Euro pr ton CO2. The second value, y – value, shows the different solutions for emission in road transport, E^T, and solutions for emission in the building sector, E^B. In scenario 1, there is not much to comment on the carbon price of the ETS except for the fact that the price itself is rather low. The low carbon price is a result of the difference between the cap and total BaU emissions being rather small. Keep in mind that given our CAP is binding the total emissions will therefore always be equal to the cap. Our interest is to see how much the emissions change for each sector compared to their BaU values. We are also interest in comparing the results of scenario 1 with scenarios 2 & 3.

Starting with comparing scenario 1 results with the BaU values we get the following: The TEU emissions have decreased from 714.8 Mt CO2, down to 689.8 Mt CO2, which is a 3.5% decrease in emissions for this sector. BEU emissions have decreased from 431.4 Mt CO2, down to 415.05 Mt CO2, which is a 3.8% decrease in emissions for this sector. TN emissions have decreased from 8.4 Mt CO2, down to 8.265 Mt CO2, which is a 1.6% decrease in emissions for this sector. BN emissions have decreased from 0.5 Mt CO2, down to 0.473 Mt CO2, which is a 5.4% decrease in emissions for this sector. The most interesting take-away from this comparison is the fact that the building sectors have a larger % reduction compared to their road transport counterparts. This most likely has to do with the size of the emission reduction potential R, which reflects the costs of reducing emissions, compared to the amount of BaU emissions there are in the sectors, we will however discuss this difference with more detail at the end of this section.

As for comparing scenario 1 to scenarios 2 & 3, you can read the details regarding these comparisons in their respective sections, 5.3 for scenario 2, and 5.4 for scenario 3. The results of scenario 1 are however presented in Table 5 below, which shows how much % change there is from BaU to scenario 1.

Variable	Results in scenario 1	% Change from BaU
TEU	689.8 Mt CO2	-3.5%
BEU	415.05 Mt CO2	-3.8%
TN	8.265 Mt CO2	-1.6%
BN	0.473 Mt CO2	-5.4%
P	6.73 Euro/tCO2	NA

Table 5: Value changes compared Scenario 1

Furthermore, Figures 11 & 12 show the visual solutions provided through GeoGebra for scenario 1. Figure 11 shows the entire picture, meanwhile Figure 12 is a close-up of the Norwegian sectors. Remember that these figures are only for visual aid.

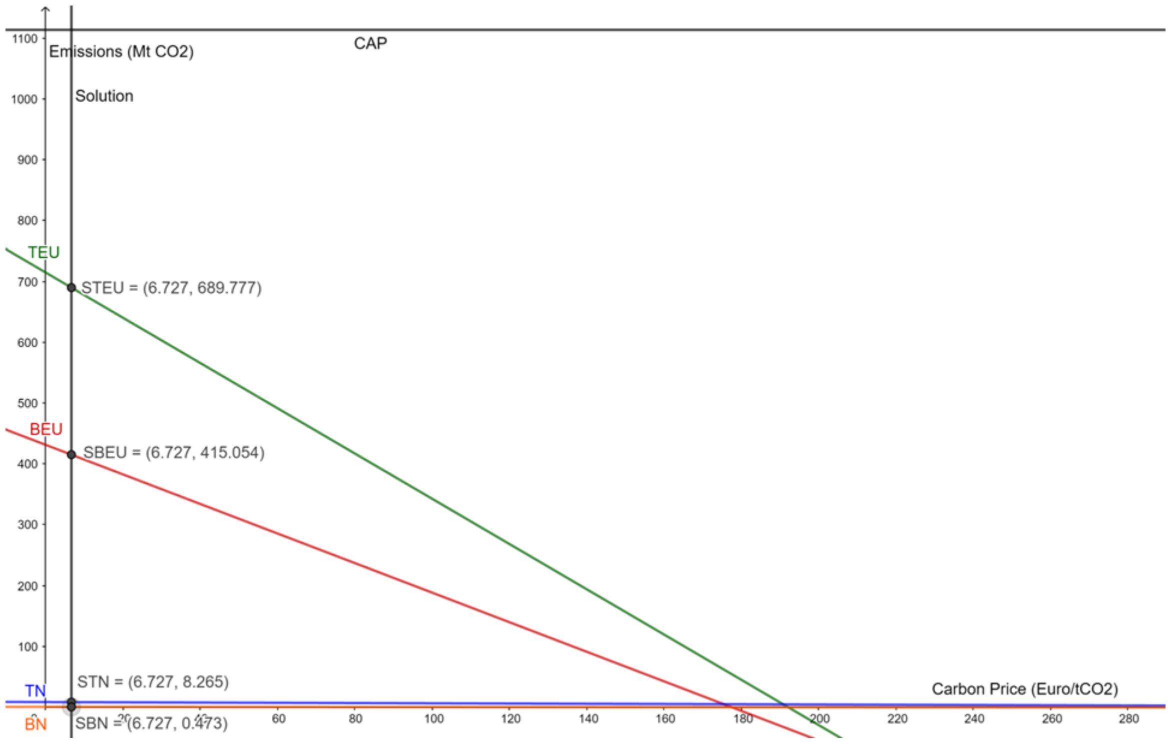

Figure 11: Visual illustration of the solution for scenario 1

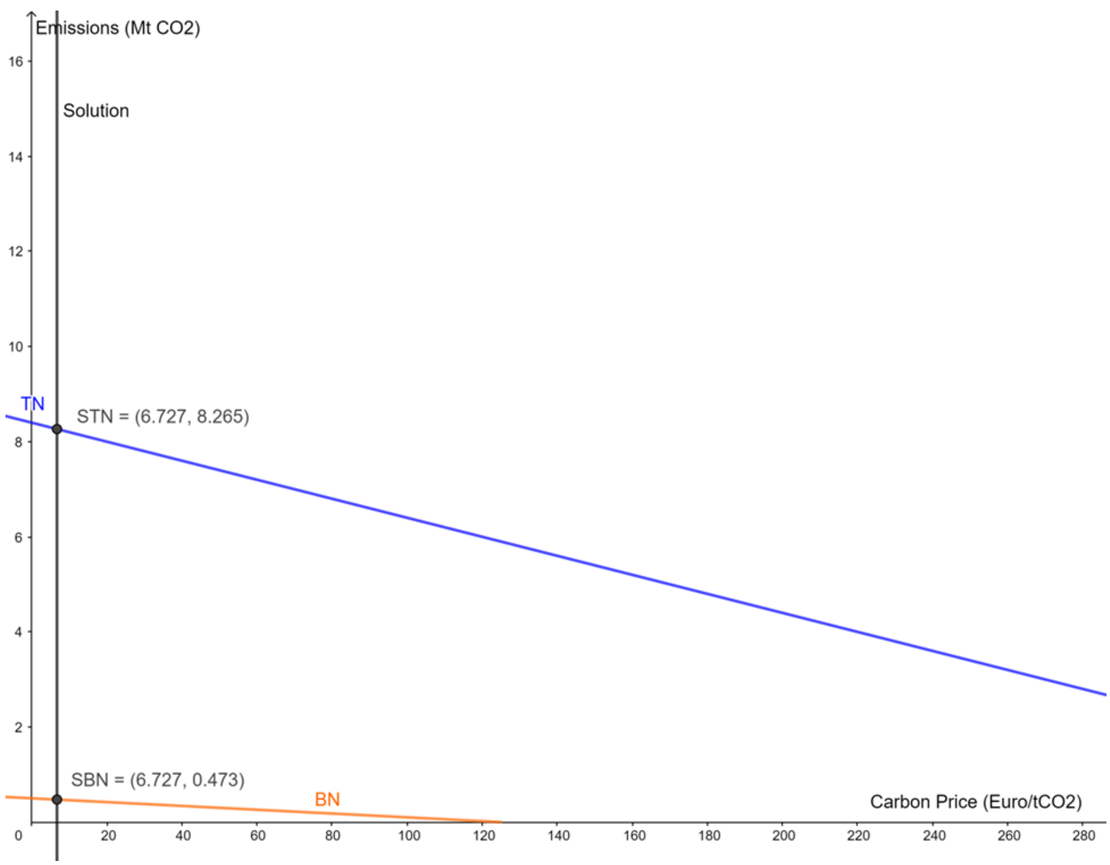

Figure 12: Close-up of Norwegian sectors under Scenario 1

The x-axis shows the carbon price in Euro pr ton CO2, meanwhile the y-axis shows emissions in Mt CO2. The black line "Solution" is here illustrated as a price, where every time this line crosses one of the sectors, a solution is presented for that sector.

The results from Scenario 1 are in line with was expected. The introduction of the new ETS for the road transport and building sectors resulted in decreased emissions for all sectors, as explained back in sections 3.3 & 3.4. The largest % decrease was seen in the Norwegian building sector, followed by the European building sector. This result originates from the relationship between the BaU emission values and R, emissions reduction potential, values. The larger our R/BaU relationship is, the larger is the % reduction in emissions. Therefore, take note of that the R values of both building sectors is considerably larger than their BaU emission, especially when we compare them to the R/BaU relationship of the transport sectors. Another way to explain this is tied to the costs of reducing emissions, focusing on the R value. For both building sectors the R value is lower as compared to the R values in the road transport sectors which are higher, this is highlighted by looking at the model in Figure 10. As such, we got the results that the building sectors see a larger % emissions decrease compared to the transport sectors. However, do keep in mind that the data used to determine BaU and R values may contain some degree of noise and uncertainty, which could have caused disturbances with our results in scenario 1. Overall, the introduction of an ETS into these sectors has resulted in lowered emissions for all sectors, compared to their BaU emissions, up to the ETS cap.

5.3 Scenario 2 – Overlapping policies 1, Norway and price

For Scenario 2, overlapping policies 1 - Norway and price, we illustrate an overlapping policy in the Norwegian transport sector through the additional parameter O_α which adds a carbon tax of 500NOK/tCO2, or 33 Euro/tCO2. As such, we input their corresponding numerical functions, see section 4.3, into CAS to get a solution using our model. Figure 13 shows the results from CAS. Note that x is a replacement for P due to restrictions within CAS.

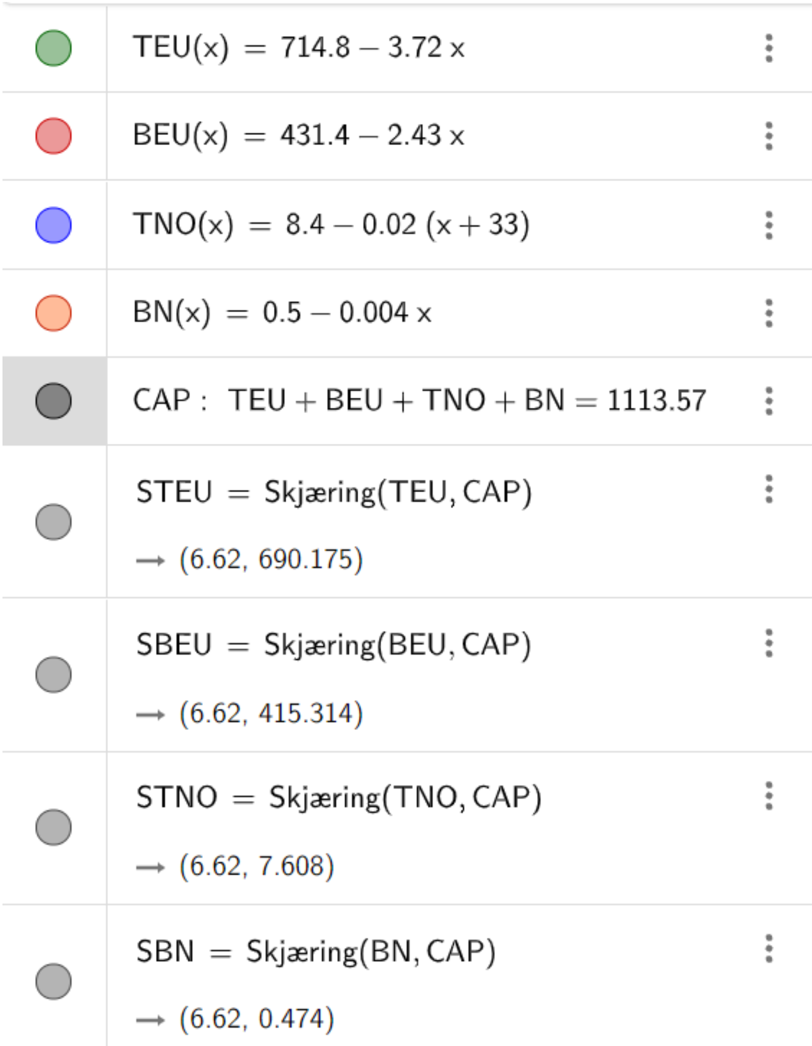

Figure 13: Model based on scenario 2, solved through CAS

Here T stands for transport, B for buildings, EU for European Union, N for Norway, S for solution, and O stands for overlapping policy, reflecting the fact that that specific function has the overlapping policy parameter included.

Through CAS we have ended up with a different carbon price for the overall ETS, landing at 6.62 Euro pr ton CO2, which is a 1.6% decrease in the carbon price compared to the 6.73 Euro/tCO2 from scenario 1. This shift in carbon price has resulted in different emissions for each sector. Once again, keep in mind that our CAP is binding. Our interest is to see how much the emissions and carbon price has changed for each sector in scenario 2, by comparing these results to their BaU values, as well as to scenario 1.

Starting with comparing the scenario 2 results to the BaU values, we got the following: The TEU emissions have decreased from 714.8 Mt CO2, down to 690.18 Mt CO2, which is a 3.5% decrease in emissions for this sector. BEU emissions have decreased from 431.4Mt CO2, down to 415.31 Mt CO2, which is a 3.7% decrease in emissions for this sector. TN emissions have decreased from 8.4 Mt CO2, down to 7.61 Mt CO2, which is a 9.4% decrease in emissions for this sector. BN emissions have decreased from 0.5 Mt CO2, down to 0.474 Mt CO2, which is a 5.2% decrease in emissions for this sector.

Comparing the results of Scenario 2 with Scenario 1, where there exists no occurrence of overlapping policies, we got the following results: TEU emissions have increased by 0.375 Mt CO2, or a 0.05% increase in emissions. BEU emissions have increased by 0.26 Mt CO2, or a 0.06% increase in emissions. TN emissions have decreased by 0.655 Mt CO2, or a 7.9% decrease in emissions. BN emissions have increased by 0.001 Mt CO2, or a 0.2% increase in emissions.

The results of scenario 2 are presented in Table 6 below, including % change from BaU to scenario 2, and scenario 1 to scenario 2.

Variable	Results in scenario 2	% Change from BaU	% Change from scenario 1
TEU	690.18 Mt CO2	-3.5%	0.05%
BEU	415.31 Mt CO2	-3.7%	0.06%
TN	7.61 Mt CO2	-9.4%	-7.9%
BN	0.474 Mt CO2	-5.2%	0.2%
P	6.62 Euro/tCO2	NA	-1.6%

Table 6: Value changes compared to Scenario 2

Furthermore, Figures 14 & 15 below show the visual solution provide through GeoGebra for Scenario 2. Figure 14 shows the entire picture, meanwhile Figure 15 is a close-up of the Norwegian sectors. Once again, keep in mind that the figures are there only for visual aid.

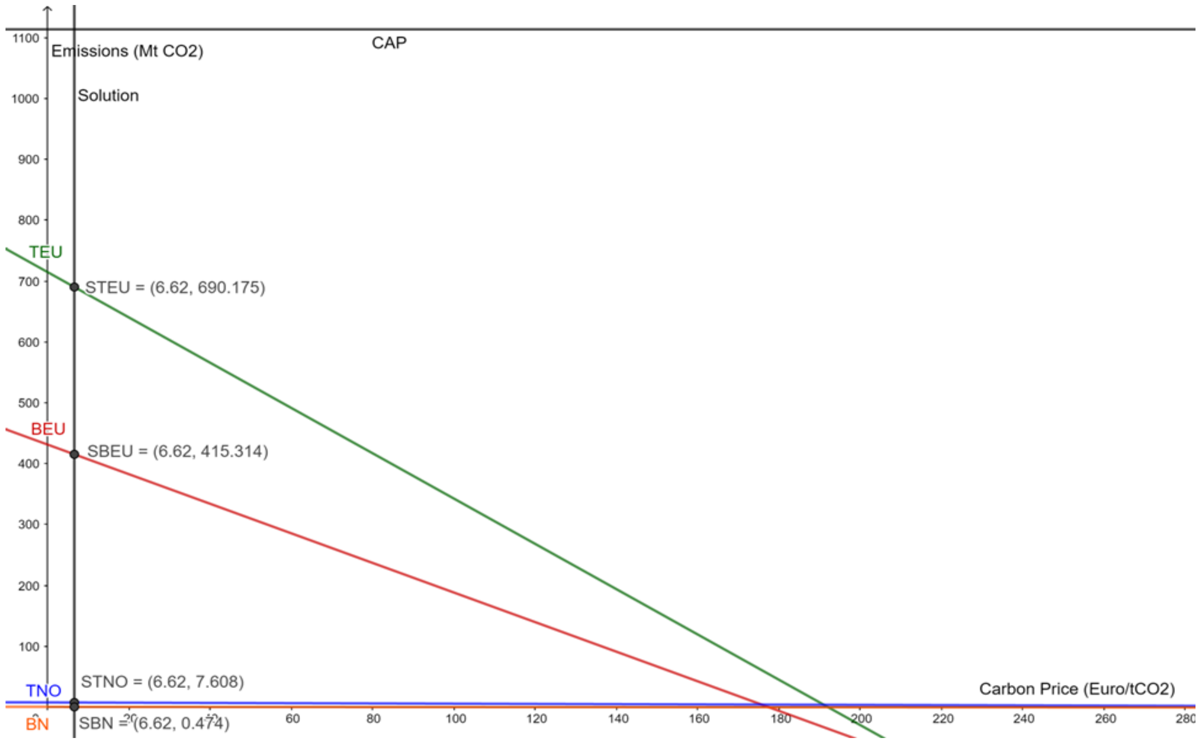

Figure 14: Visual illustration of the solution for scenario 2

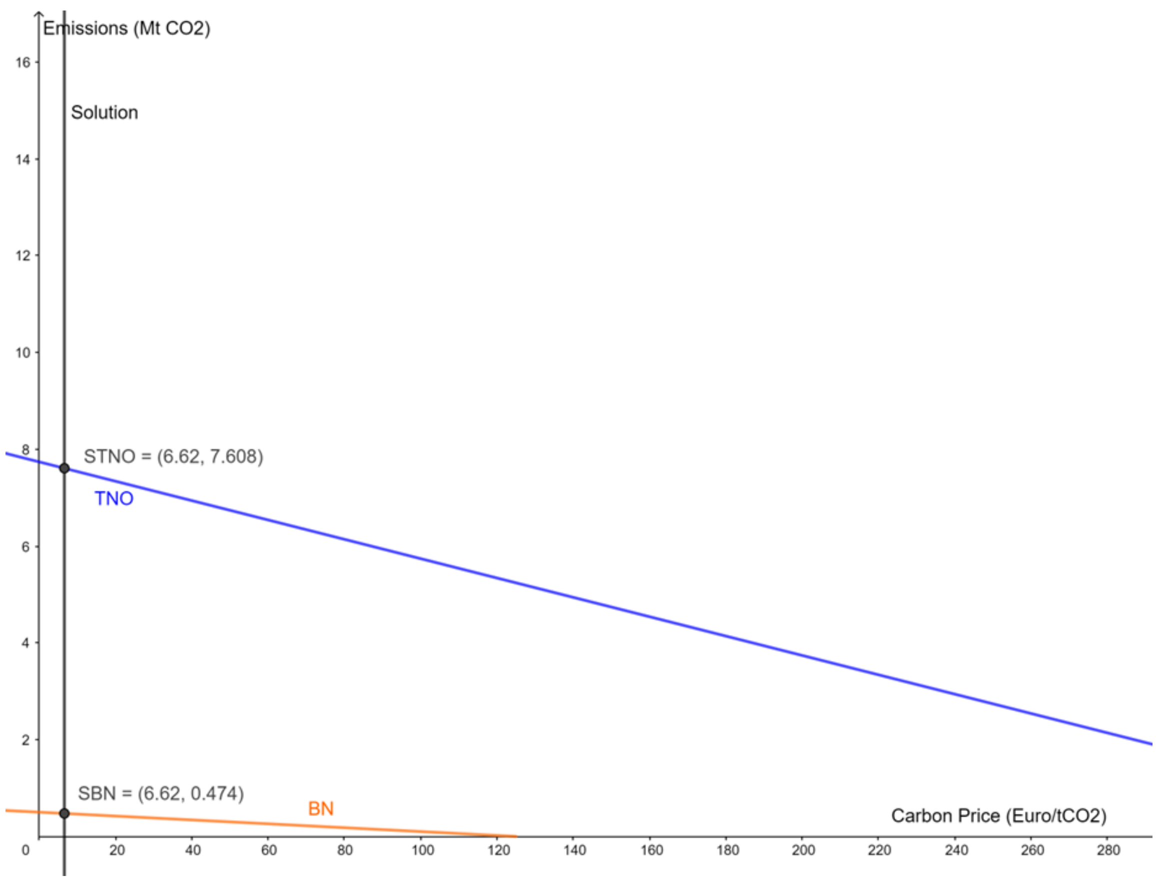

Figure 15: Close-up of Norwegian sectors under scenario 2

The x-axis shows the carbon price in Euro pr ton CO2, meanwhile the y-axis shows emissions in Mt CO2. The black line “Solution” is here illustrated as a price, where every time this line crosses one of the other sectors, a solution is presented for that sector. When comparing the figures of scenario 2 to scenario 1 we can see the following: solution, the system price, has moved slightly to the left. TN, TNO in scenario 2, has shifted upwards moving above 8 Mt CO2 emissions.

The results from Scenario 2 are in line with what was discussed regarding overlapping policies back in section 3.5. Scenario 2 introduced an additional overlapping policy through an additional carbon tax of 33 Euro/tCO2 on top of the carbon price in the Norwegian transport sector. When then comparing the results of scenario 2 towards scenario 1, where no overlapping policy was occurring in the new ETS, we get the same results as those which were explained back in section 3.5. The carbon price in the ETS is lowered, which resulted in decreased emissions for the Norwegian transport sector where the overlapping policy was introduced. This then caused the emissions in the remaining sectors to increase up until they reached the cap of the ETS.

5.4 Scenario 3 – Overlapping policies 2, EU and emissions

For Scenario 3, overlapping policies 2 – EU and emissions, we illustrate the removal of an existing overlapping policy in the EU transport sector by increasing the BaU emissions with 15%. As such, we input their corresponding numerical functions, see section 4.3, into CAS to get a solution using our model. Figure 16 shows the results from CAS. Note that x is a replacement for P due to restrictions within CAS.

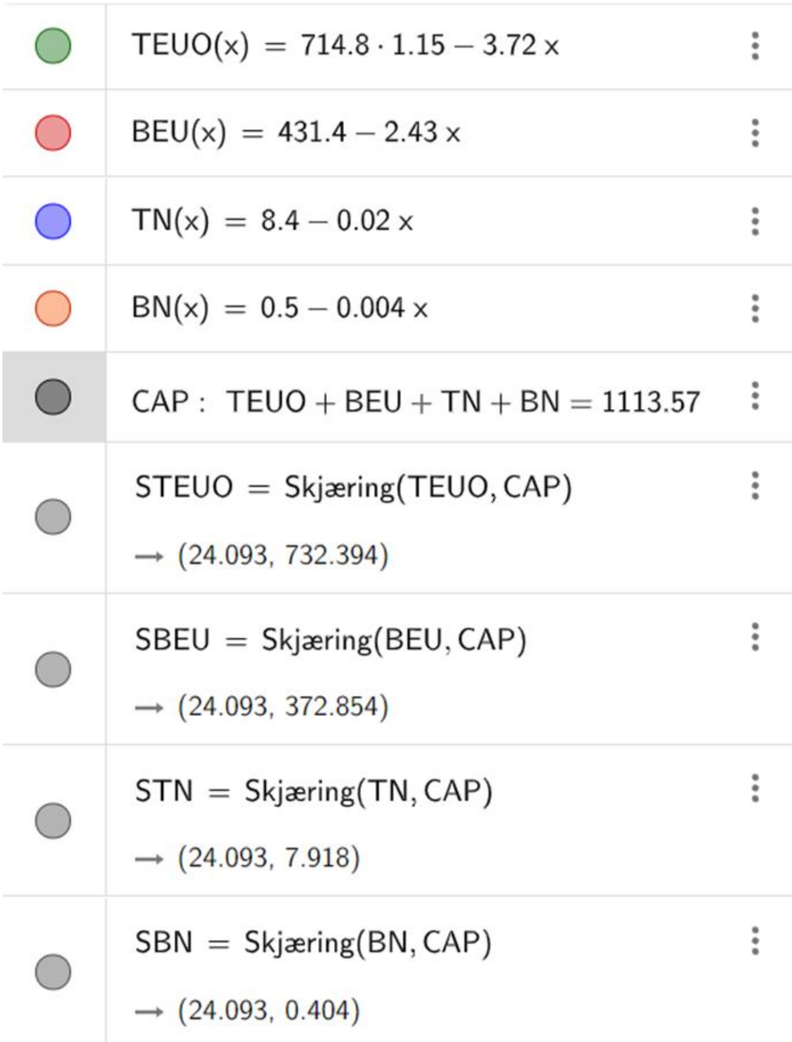

Figure 16: Model based on scenario 3, solved through CAS

T stands for transport, B for buildings, EU for European Union, N for Norway, and S for solution O stands for overlapping policy.

Through CAS we have obtained solutions for each sector, including a carbon price for the whole ETS, landing at 24.1 Euro/tCO2 for scenario 3, which is a 358% increase in the carbon price compared to the 6.73 Euro/tCO2 from scenario 1. Once again, keep in mind that our CAP is binding. As always, our interest is to see how much each the carbon price and emissions change for each sector and compared the results of scenario 3 to the BaU values and to the results from scenario 1.

Moving on to comparing scenario 3 to the BaU values we got the following: While for the TEU emissions we had increased the original BaU value of 714.8 Mt CO2 by 15%, putting the new

BaU value at 822 Mt CO2, we will still be comparing the results of scenario 3 with the original BaU value of 714.8 Mt CO2. As such the TEU emissions increased from 714.8 Mt CO2, up to 732.4 Mt CO2, which is a 2.4% increase in emissions. BEU saw a decrease of emissions from 431.4 Mt CO2, down to 372.85 Mt CO2, which is a 13.6% decrease in emissions. TN saw a decrease from 8.4 Mt CO2, down to 7.92 Mt CO2, which is a 5.7% decrease in emissions. BN saw a decrease from 0.5 Mt CO2, down to 0.404 Mt CO2, which is a 19.2% decrease in emissions. Note the following with scenario 3, due to the massive increase in the ETS carbon price, all sectors except for the TEU sector, see the largest amount of emission decrease out of any other scenario. At the same time scenario 3 is the only scenario where the emissions in one of the sectors, here being TEU, increase from to their BaU values as a result of removing an existing overlapping policy.

Comparing scenario 3 to scenario 1, we got the following results: TEU emission have increased by 42.6 Mt CO2, which is a 6.2% increase in emissions. BEU emissions have decreased by 42.2 Mt CO2, which is a 10.2% decrease in emissions. TN emissions have decreased by 0.345 Mt CO2, which is a 4.2% decrease in emissions. BN emissions have decrease by 0.07 Mt CO2, which is a 14.8% decrease in emissions. Look back to section 5.3 and its results when comparing scenario 2 to scenario 1, notice how the situation in the respective sectors are reversed.

The results of scenario 3 are presented in Table 7 below, including the % change from BaU to scenario 3, and scenario 1 to scenario 3.

Variable	Results in scenario 3	% Change from BaU	% Change from scenario 1
TEU	732.4 Mt CO2	2.4%	6.2%
BEU	372.85 Mt CO2	-13.6%	-10.2%
TN	7.92 Mt CO2	-5.7%	-4.2%
BN	0.404 Mt CO2	-19.2%	-14.8%
P	24.1 Euro/tCO2	NA	358%

Table 7: Value changes compared to Scenario 3

Furthermore, Figures 17 & 18 below show the visual solutions provided by GeoGebra for Scenario 3. Figure 17 shows the entire picture, meanwhile Figure 18 is a close-up of the Norwegian sectors. As always, keep in mind that the figures are only a visual aid.

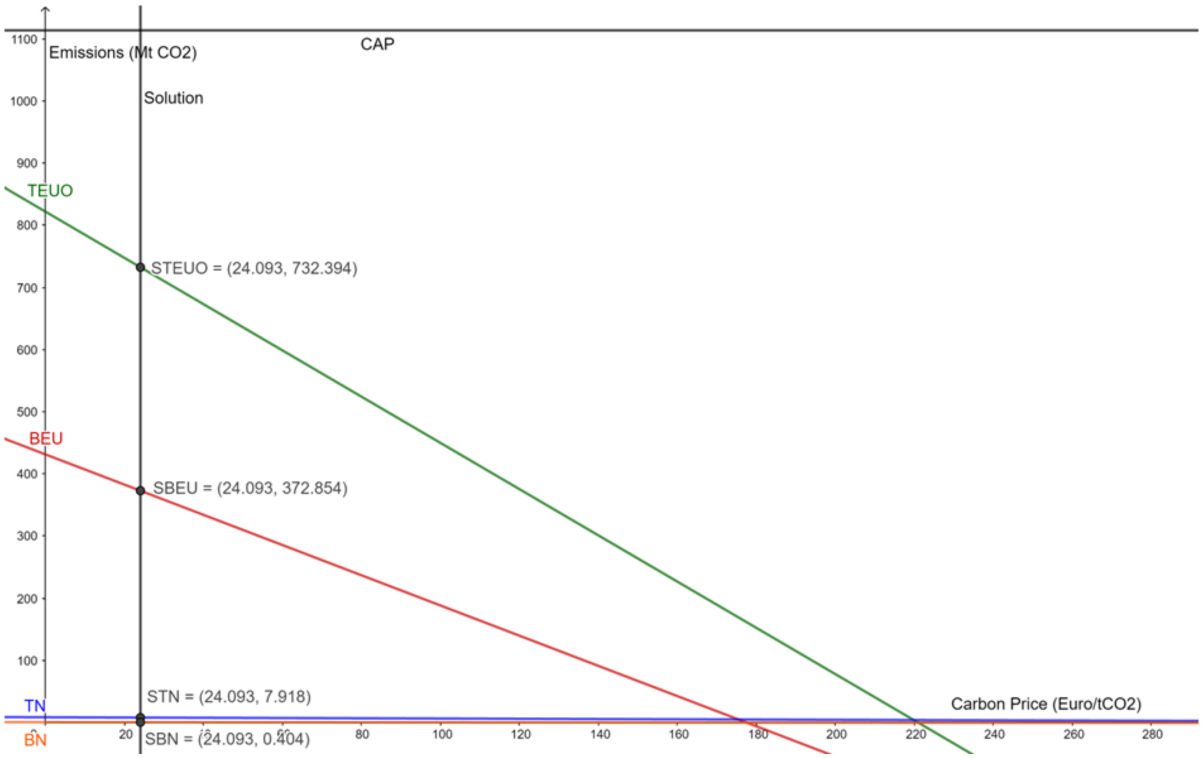

Figure 17: Visual illustration of the solution for scenario 3

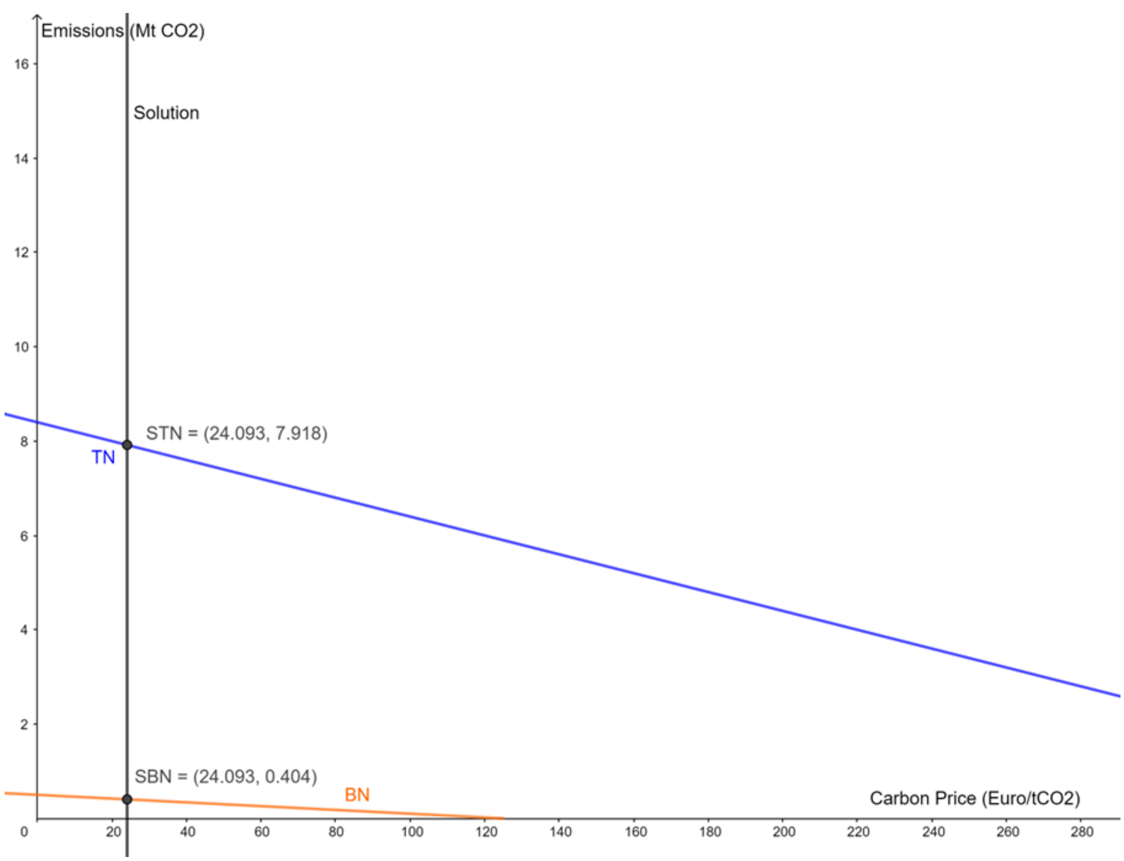

Figure 18: Close-up of Norwegian sectors under scenario 3

The x-axis shows the carbon price in Euro pr ton CO2, meanwhile the y-axis shows emissions in Mt CO2. The black line "Solution" is here illustrated as a price, where every time this line crosses one of the other sectors, a solution is presented for that sector. When comparing the figures of scenario 3 to scenario 1 we can see the following: Solution, the system price, has shifted massively to the right. TEU, TEUO in scenario 3, sees a massive shift upwards as well, going from about 700 Mt CO2 emissions, to about 800 Mt CO2 emissions.

The results of scenario 3 are in line with what was expected based on the results from scenario 2, as well as what was discussed in section 3.5 regarding overlapping policies. In scenario 3 we are doing the opposite of implementing an overlapping policy, we are removing an existing overlapping policy, visualised through a 15% increase in BaU emissions for the European Union's transport sector. As such, the results become that TEU emissions increase, since the overlapping policy was removed from this sector, which caused the carbon price in the ETS to increase, which then resulted in reduced emissions in the remaining sectors. The overall result was a reverse of the situation which happened in scenario 2 where an overlapping policy was implemented into the Norwegian transport sector, however given the massive increase in carbon price the emission reductions is scenario 3 are much larger than the emission increase in scenario 2. Another way to visualize this is to compare the scenario 2 results with scenario 3.

5.5 Sensitivity analysis

Before moving on to our main discussion regarding the results presented from 5.2-5.4, we have dedicated this section to performing a small sensitivity analysis. Both throughout chapter 4 & 5 we explained several times that due to limited access to resources, time, and the time horizon of the new ETS, our data has some degree of uncertainties. As such we have decided to perform a small sensitivity analysis of some parameters in order to make these uncertainties be more visible to the reader.

One important parameter that may have uncertainties tied to it, is the cap of the ETS. In our model the cap is binding, and therefore defines an upper emission limit. As mentioned back in section 4.3, we are using a hypothetical cap laid forward by the European Commission based on the year of 2024, not 2030. We assumed that the cap would remain constant until 2030. However, it is possible that this cap could be much lower in 2030 following policy changes, or that the European Commission lays forward an updated cap based on newer analysis, which may result in the hypothetical cap being lower. Do note however, that we look away from situations where the cap increases, since increasing the cap would push it beyond the total BaU values, making the ETS non-relevant. As such, we decided to run a simple sensitivity analysis, where we checked what would happen to our scenario 1 results, should the ETS cap be reduced by 20%. Once again, we made use of CAS, please see Appendix B for CAS calculations. The results are presented in Figure 19.

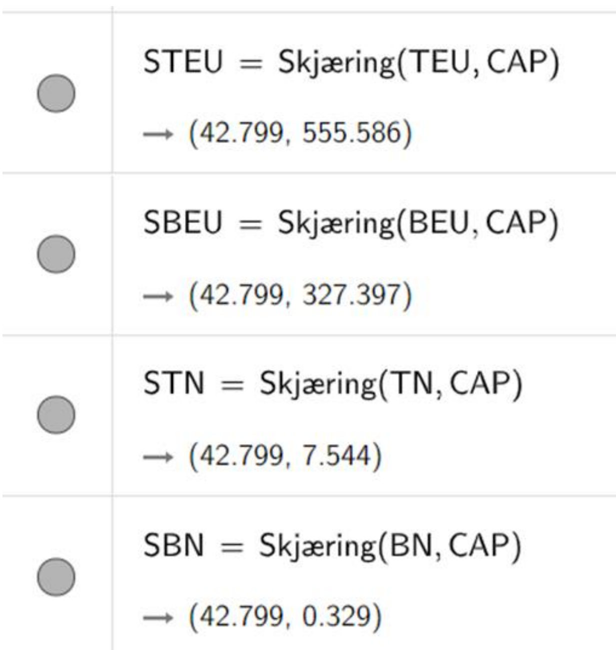

Figure 19: Results from scenario 1 if the cap was reduced by 20%

Comparing these results to those from scenario 1 in section 5.3, we see a massive increase in the ETS carbon price, going from 6.73 Euro/tCO2 to 42.8 Euro/tCO2. Furthermore, the massive increase in price combined with the reduced cap, resulted in large reductions of emissions from all sectors. Overall, the size of the cap is vital for the results obtained from our model, given its influence over the ETS carbon price, and the results from Figure 19, shows us just how much the values could change should the cap be altered. This small sensitivity analysis tells us just how important uncertainties regarding the cap value is.

Another parameter which has uncertainties tied to its data is the emissions reduction potential, R. This parameter was estimated by gathering data regarding emissions reductions in 2030, and carbon price increases in 2030, which is data based on official forecasts, as explained in section

4.3. As such, we considered it relevant to run a small sensitivity analysis of R as well, where we increased the value of this parameter by 100% for the EU sectors in scenario 1, while the Norwegian sectors kept their original R values from scenario 1. Once again, we made use of CAS, please see Appendix B for CAS calculations. The results are presented in Figure 20.

STEU = Skjæring(TEU, CAP)
→ (3.37, 689.728)

SBEU = Skjæring(BEU, CAP)
→ (3.37, 415.023)

STN = Skjæring(TN, CAP)
→ (3.37, 8.333)

SBN = Skjæring(BN, CAP)
→ (3.37, 0.487)

Figure 20: Results from scenario 1 if the EU sectors R was increased by 100%

As can be seen in Figure 20, the carbon price of scenario 1 has almost been reduced by half, going from 6.7 Euro/tCO2 down to 3.4 Euro/tCO2. As for the emissions, there are some few, but smaller changes given that the cap is binding. As a result of the decreased carbon price, the EU sectors, where the R values were increased by 100%, barely see any changes with only a very small decrease in emissions, meanwhile the Norwegian sectors, which kept their original R values from scenario 1, see smaller increases in their emissions. Overall, the higher the reduction factor is for a specific sector, the smaller their emissions and the smaller the carbon price in the ETS, as can be seen with the EU sectors. Since the cap is binding this results in the other sectors having increased emissions, as seen with the Norwegian sectors, due to one, or more, sectors seeing lowered emissions elsewhere in the ETS.

The purpose of section 5.5 was not to perform a large and in-depth sensitivity analysis of each scenario and parameter, but rather to give the reader an insight regarding the uncertainties surrounding our data. The analysis show that the reader should be slightly critical towards the results presented in sections 5.2-5.4. This was also why we decided to utilize a simple model with simple scenarios, as it reduced the amount of data, parameters, and variables our model was dependent on.

5.6 Discussion of results

At the end of the results for each scenario we wrote a small paragraph discussing the results and linking them to what we expected from chapter 3, theory. Section 5.6 will be some repetition of what has already been mentioned in previous sections but will be presented in a much wider picture, including a discussion regarding the interactions between the Norwegian sectors and the EU sectors.

Let us first discuss the results from scenario 1, implementing the new ETS for road transport and building sector. As previously mentioned, this scenario focuses on the sole introduction of the new ETS and assumes no influence from other external policies. The results presented in section 5.2 were in-line with what we had already expected would happen when an ETS is implemented, based on theory from sections 3.3 & 3.4. That is, the purpose of implementing an ETS is to regulate the behaviour of polluting agents to reduce emissions, and as the results show in scenario 1, all sectors see reduced emissions compared to their business-as-usual values. As such, the new ETS performed its purpose as an economic incentive-based system since it regulated polluting agents in the road transport sectors and building sectors of both Norway and the EU.

However, it is quite rare for a climate policy like a multinational ETS, to not overlap with other climate policies, which can result in unintended effects. We tried to illustrate such unintended effects through scenarios 2 & 3, where we at the same time could see the interactions between the Norwegian and EU sectors in the ETS. Scenario 2 looks at the instance of an overlapping policy being implemented in the Norwegian transport sector. We reflected this through the implementation of an additional carbon tax of 500NOK/tCO2, or 33 Euro/tCO2. The purpose behind this increase in the carbon price was due a result of implementing an enforced climate policy in the Norwegian transport sector which aims to ensure that all sale of new vehicles by 2030 is whole-electric. The results presented in section 5.3 were also in-line with overlapping policy theory discussed in section 3.5. The implementation of an overlapping policy resulted in a lower carbon price in the ETS, as compared to scenario 1. The sector which saw the implementation of given policy, the Norwegian transport sector, saw therefore reduced emissions through the overlapping policy, compared to scenario 1. And, as expected, the remaining sectors had an increase in their emissions compared to what they were in scenario 1. This is the same concept which we explained back in section 3.5 using Figure 9 and the concept of "green promotes the dirtiest" by Böhringer & Rosendahl (2010). So, while an overlapping policy means that a specific sector or industry will see lowered emissions, or easier emission reduction, it will also cause the carbon price of specific systems to decrease which will result in higher emissions elsewhere in the system.

As for scenario 3, here we focused on removing an existing overlapping policy in the European Union's transport sector. While there is no theory which covers the removal of an overlapping policy, we could still make use of section 3.5 regarding overlapping policy theory. The removal of an overlapping policy would, simply put, mean a reversal of the impacts discussed in section 3.5, which would mean a reversal of the situation in scenario 2, only for different sectors. As such, for scenario 3 we decided to remove the stricter EU fleet-wide CO2 emission target, which aimed to set specific CO2/km targets for newer cars produced. In the model this was reflected through a 15% increase in BaU emissions for the transport sector of the EU. The results were as expected, a reversal of a situation with overlapping policy. The carbon price of the ETS increased under scenario 3, as compared to scenario 1. This resulted in the sector which saw the implementation of given policy, the EU transport sector, having their emissions increase, compared to what they were in scenario 1. The remaining sectors had instead a reduction in their emissions, compared to what they were in scenario 1. Overall, the results are simply a reversal of scenario 2. Carbon price increased, rather than decreasing; the impacted sector saw emissions increasing, rather than decreasing; and remaining sectors saw emissions decreasing, rather than increasing.

There is one more factor to discuss regarding our results, and that is the interaction between the Norwegian and the EU sectors, which was especially highlighted by scenarios 2 & 3. The Norwegian sectors make up only 0.8% of the total BaU value, and as such have limited impact upon the carbon price of the ETS, as compared to the EU sectors which have a much larger influence. This resulted in that the EU sectors had a more significant impact over the Norwegian sectors. The difference is especially highlighted when comparing scenario 2, which focuses on implementing an overlapping policy in the Norwegian transport sector, to scenario 3, which focuses on removing an overlapping policy in the EU transport sector. We are aware that scenario 2 and scenario 3 change different parameters and use different values, and as such will have different results and be subject to different data disturbances. However, the scenarios still highlight the fact that changes made in the EU sector has a much larger impact on the carbon price of the ETS compared to the Norwegian sectors. To gain a better picture of this difference one can look at the carbon price change between scenarios 2 and 3 compared to scenario 1. Scenario 2 sees a –1.6% change in the carbon price as a result of a change in the Norwegian transport sector. Meanwhile in scenario 3, the carbon price increase with 358% as a result of a change in the EU transport sector. Not surprising, yet information important to consider. This amount of difference in influence over the carbon price between the EU sectors and non-EU sectors can also be applied to different situations, something we will come back to in our conclusion in chapter 6.

6. Concluding remarks and further research

6.1 Conclusion

As we come to the end of our thesis paper, we have dedicated this section to summarize our conclusion surrounding our research question and results. Furthermore, given the nature of our problem statement, we found it relevant to also include section 6.2 which discusses potential future research regarding this area.

Our research question focused on the proposed implementation of a new ETS for the road transport and building sectors in the EU as a result of the “fit for 55” legislative proposal. As such, we decided to develop a model which would not only allow us to analyse the emissions and price impact that the ETS would have upon the EU sectors, but also how it would impact a single nation which is part of the EEA, in this case it was the Norwegian sectors. Scenario 1 aimed to answer the simple question of whether the ETS would reduce emissions in said sectors. The results from scenario 1 were in line with our theory, where implementing such a system resulted in reduced emissions for the road transport and building sectors. However, we have no knowledge of whether these reduced emissions would be enough for the sectors to help reach the “fit for 55” target of 55% net emission reductions of GHG by 2030. Unfortunately, lack of data and limited time resulted in us not being able to do further analyses regarding this target.

We also raised concerns regarding the new ETS potentially overlapping with other climate policies, primarily because the new ETS would be a multinational system which would operate with the same rules as the existing EU ETS. As such, scenarios 2 & 3 were created and compared to scenario 1. Scenario 2 focuses on what would happen should the transport sector of Norway see a higher carbon price as the result of overlapping policy. Meanwhile scenario 3 focuses on what would happen should the EU road transport sector see increased BaU emissions as the result of removing an existing overlapping policy. The results we got were in line with expectations on the background of the theory surrounding overlapping climate policies. In scenario 2 the ETS saw a lowered carbon price, where the Norwegian transport sector saw lowered emissions, while the other sectors saw increased emissions due to the cap binding. In scenario 3, the ETS saw an opposite reaction of scenario 2. The ETS got a higher carbon price, where the EU transport sector saw increased emissions, meanwhile other sectors saw decreased emissions due to the cap binding.

Furthermore, scenarios 2 & 3 helped answer another important question, the influence which the Norwegian sectors and the EU sectors had over the ETS, and therefore in turn over each other. Not surprisingly, scenario 3 showed that the EU sectors had a much larger influence over the carbon price in the ETS compared to the Norwegian sectors. This comes from the fact that the EU sectors, which make up a majority of the total BaU emissions, stand for the majority of the ETS quota cap. This could result in overlapping policies in the EU sectors causing significant unintended disruptive effects in the Norwegian sectors. While there is a probability of this happening, we believe that despite this risk it is beneficial for Norway to enter the ETS. Just like with the existing EU ETS, it would allow Norway to regulate the road transport and building sectors through a multinational emission trading system. Also, since the Norwegian sectors are so small, they can implement overlapping climate policies internally and shift the disruptive effects over to the new ETS where the impacts of these effects would be minimal. Overall, for Norway we believe that the benefits of joining the new ETS for road transport and building sector will outweigh the costs if they remain vigilant regarding disruptive effects of overlapping climate policies.

Interestingly this EU-Norway relationship can also be applicable to other situations. Imagine if the Norwegian sectors in our model were replaced by some other non-EU sectors which had much higher BaU emissions and emission reduction potential, R, values, being somewhat equivalent to the EU sectors values. This could give drastically different results in scenario 2, where the non-EU sector sees the introduction of the additional parameter for overlapping policy. Most likely in such a case, they would have much higher influence over the ETS, compared to the situation with Norway, and as such could cause more significant disruptive effects upon the EU road transport and building sectors. Opening the ETS of road transport and building sector to other non-EU sectors which are not part of the EEA agreement, could therefore result in costly disruptive effects for the EU sectors. For example, a disruptive effect of an overlapping policy from the non-EU sector, could reduce the carbon price in the ETS, resulting in it becoming more costly for the EU to reach certain climate targets, like the "fit for 55" target. So, unless the EU can correct other types of market failures occurring in other non-CO2 GHG, it is most likely that the EU will incur higher costs in such situations. As such, we believe that the ETS should be operational for a certain time period, where more data can be gathered, before deciding whether to link it to other international sectors. Simply said, the unknown risks of linking it to non-EU sectors outside the EEA nations outweighs the benefits that the ETS may receive, at least until more data can be gathered regarding this decision.

So far in our discussion we have mentioned overlapping climate policies multiple times, however we have not discussed in detail their advantages and disadvantages. We have previously highlighted one of the major disadvantages with overlapping policies in the paragraph above. We explained that the implementation of an overlapping policy could result in it becoming more costly for the EU to reach certain climate targets. This concept is briefly discussed in the article "green promotes the dirtiest" by Böhringer & Rosendahl (2010). While an overlapping policy does not increase the total amount of emissions in the ETS, it shifts the balance, resulting in some sectors having higher emissions. Should then these sectors aim to reach certain climate goals, it could entail higher costs of emission reduction. There are however also some advantages when it comes to overlapping climate policies, and we have briefly discussed one such advantage earlier, where we focused on the Norwegian sectors. Overlapping climate policies might help with reaching certain other climate targets, like in scenario 2 it further reduces emissions in the Norwegian road transport sector, allowing them to reach certain climate targets quicker and maybe more cost-efficient. There are also some other aspects with overlapping policies which could be considered an advantage. These are primarily tied to the fact that an overlapping policy reduces the carbon price in the ETS, like it did in scenario 2. For example, the reduction in carbon price in the ETS can be used as a political tool, in order to increase the political acceptability of the ETS. Furthermore, the reduction in the carbon price is followed with reduced emissions in several sectors, however since the cap is binding total emissions do not decrease. As such, overlapping policies can be used to promote the reduction of the cap over time, in order for the total emissions to decrease.

Our concluding remark regarding the new ETS for road transport and building sector is the following. Yes, we believe that the ETS will reduce emissions in the given sectors, and despite the risks we believe that a small nation like Norway would benefit from entering given ETS. Whether the ETS will reach specific climate targets is a question for another analysis. We do also believe that the new ETS may see some issues with overlapping climate policies due to its multinational nature and identical ruleset to the existing EU ETS. It is a system that needs to run for some period, after which newer data and information may provide clearer answers to certain decisions before they are implemented.

6.2 Further research

Throughout our paper we have mentioned several times that there were limitations in our access to resources, limitations to time and potential disturbances with our data. The origin of many these limitations come from our research question itself, and as such we believe that the nature of our question opens our thesis up for further research. Over time there will be good possibilities to extend upon the model we have constructed with larger and more complex data sets.

First, as mentioned before, we decided to use a simple model with few parameters due to the lack of official information regarding the new ETS and that the ETS itself was still several years away from being implemented. As such, in order to reduce disturbance within our data, we decided to limit our research area. As we get closer to 2025, the first year the ETS for road transport and building sector will be implemented, it is most likely that more official information and more accurate data regarding the ETS and its implementation will become available. At that point we believe that the possibility of future research regarding this ETS will be at its prime. Should there be no major significant changes to the plans of implementing the new ETS, according to what we gathered in the "fit for 55" proposal, then our model can serve as a foundation for future research. And as mentioned before, there are many aspects of this new ETS which can be researched further. Example, one can use a more complex data set to illustrate how much the emissions for each sector would decrease for each nation that is part of the European Union. This would allow one to differentiate between which nations sectors would benefit the most from the ETS and can even be extended to include potential consequences of overlapping policies between nations and sectors. Another example for further research, is an extension of the model to do a more indebt analysis of for example the impact upon the Norwegian transport sector because of the ETS. One could focus on how the ETS carbon price would impact certain road taxes and how it would impact the price of petroleum. This can then be extended to evaluate whether joining the ETS would allow Norway to progress certain road transport goals, like the 2030 whole-electric sales of cars, quicker or more cost-efficient.

Since our model is based on the description of the ETS provided in the “fit for 55” legislative proposal, so long as there are no major changes away from the description provided in the proposal, then we believe that our model might be viable to be used in further research. Overall, there are plenty of opportunities of extending our research question and expanding our model to research other areas of the ETS for road transport and buildings. As such, we believe that in the coming years there will be plenty of opportunities for extended research focused on the new ETS, and many more interesting discussions regarding this new ETS.

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Appendix A – Chapter 4

EU road transport emission value conversion: Emissions for road transport in the EU was originally written as 714752 Kt CO_2, or kilo ton. Since we were using Mt CO_2, million ton, as the standard value for emissions, we divided 714752/1000 = 714.752 Mt CO_2. This was rounded up until the first decimal, giving us 714.8 Mt CO_2.

Norwegian carbon price currency conversion: Carbon price for Norway in 2030 sees an increase of 1456 nok pr ton CO_2 compared to the value of 2020: 2000 – 544 = 1456. We made use of the following page https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE4, where values could be converted to US dollars. First the Norwegian value in 2020 was 10.12 NOK pr 1 US dollar, giving us a total of: 1456/10.12 = 143.87 US dollars. Then we converted the value to Euro by looking at the European Union 27 Euro value in 2020, this was 0.668 Euro pr 1 dollar. The result was: 143.87*0.668 = 96.4 Euro pr ton CO_2.

The same method was used to convert 500 nok pr ton CO_2: 500/10.12 = 49.41 US dollars. 49.41*0.668 = 33 Euro pr ton CO_2.

Calculating R – emission reduction potential: We can first look at the EU sectors. For the road transport sector, the calculation was: 178.7/48 = 3.72 Mt CO_2 pr Euro. For the building sector, the calculation was: 116.48/48 = 2.43 Mt CO_2 pr Euro. Moving on to the Norwegian sectors. For the road transport sector, the calculation was: 2.36/96.4 ≈ 0.02 Mt CO_2 pr Euro. For the building sector, the calculation was: 0.36/96.4 ≈ 0.004 Mt CO_2 pr Euro.

Quota cap calculations for the new ETS: Cap set based on BaU emissions for the EU sectors: 1146.2 – 1105 = 1 – (41.2/1105) = 96.27%. Cap increase from Norwegian BaU emissions based on cap set for the EU sectors: 8.9 * 96.27% = 8.57Mt CO_2

Appendix B – Chapter 5

CAS calculations for CAP change:

$TEU(x) = 714.8 - 3.72\,x$

$BEU(x) = 431.4 - 2.43\,x$

$TN(x) = 8.4 - 0.02\,x$

$BN(x) = 0.5 - 0.004\,x$

$CAP: 714.8 - 3.72\,x + 431.4 - 2.43\,x + 8.4 - 0.02\,x + 0.5 - 0.004\,x = 1113.57 \cdot 0.8$

CAS calculations for R change:

$TEU(x) = 714.8 - 3.72 \cdot 2\,x$

$BEU(x) = 431.4 - 2.43 \cdot 2\,x$

$TN(x) = 8.4 - 0.02\,x$

$BN(x) = 0.5 - 0.004\,x$

$CAP: TEU + BEU + TN + BN = 1113.57$

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